

**DIMENSIONS OF MALNUTRITION AMONG
TRIBAL CHILDREN IN ATTAPPADI BLOCK
PANCHAYAT, PALAKKAD DISTRICT, KERALA**

*Thesis Submitted to the University of Calicut
For the award of the Degree of*

Doctor of Philosophy in Economics

By

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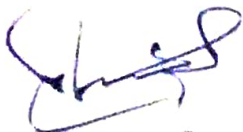
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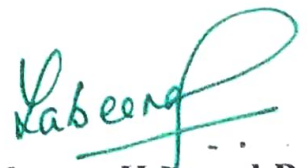
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ACKNOWLEDGEMENT

I express my heartfelt gratitude to my esteemed research supervisor, Prof. Chacko Jose P., Former Principal and Professor of Economics, St. Aloysius College, Elthuruth, Thrissur, Kerala, for his invaluable guidance, unwavering support, and profound insights throughout my research journey. His timely suggestions, thoughtful corrections, and encouraging words have been instrumental in shaping this work. His mentorship enriched the quality of my thesis and inspired me at every step. I remain deeply thankful for his generosity, patience, and continuous encouragement.

I am equally indebted to my co-guide, Dr. Zabeena Hameed P., Associate Professor, Department of Economics, University of Calicut, Dr. John Matthai Centre, for her scholarly advice, consistent support, and constructive feedback that greatly enhanced my research.

I sincerely thank Dr. Rejula Helen (Head of the Department), Dr. Sanoop M.S., Dr. Muneer Babu, and all the Department of Economics faculty members for their kind cooperation and valuable inputs. I am also grateful to the former Heads of the Department, Dr. K.P. Mani, Dr. K.X. Joseph, Dr. Shyjan Davis, and Dr. Zabeena Hameed P., for their continued guidance and support during my research.

I am especially thankful to Dr. K.P. Mani for his dedicated support, timely suggestions, and insightful corrections. His constant encouragement and the generous time he spent reviewing and guiding my work significantly impacted the quality and direction of this study. I am genuinely grateful for his unwavering support and scholarly presence throughout my research.

I also extend my heartfelt thanks to Rev. Fr. Joy Peenikkaparambil, Manager, Christ College (Autonomous), Irinjalakuda, and Rev. Fr. Dr. Jolly Andrews, Principal, along with the Vice Principals and Deans, for their generous support and blessings throughout my study.

Words are insufficient to express my deep appreciation and sincere gratitude to my esteemed colleagues, Dr. Franco T. Francis, Head of the Department, Dr. Sasi C., Dr. Jean Maria George, and Ms. Ann Mary Cherian, for their encouragement,

academic support, and companionship during every stage of this research journey.

My sincere thanks to Dr. Agey Pappachan T., Assistant Professor, Department of Home Science, Vimala College, Thrissur, and the dietitians of Amala Medical College, Thrissur and Jubilee Mission Medical College, Thrissur, for their valuable suggestions and expert guidance on children's dietary habits and for clarifying various nutrition-related queries.

My heartfelt thanks to my congregation, especially Mother General Rev. Sr. Litty FCC and her council, Provincial Superior Rev. Sr. Annie Davis FCC and her council, and Former Provincial Rev. Sr. Lilly Maria FCC and her council, for their constant prayers and support. I sincerely thank the superiors and community members of Mary Rani Convent and Alvernia Convent, Irinjalakuda, especially Rev. Sr. Annie Paul, Sr. Dally Jose, Sr. Anna Emmannuel, and Sr. Mariet, as well as my batchmates, for their encouragement and strength throughout this journey.

Thanks to Rev. Sr. Shanty FCC, Alvernia Province Irinjalakuda, and the Sisters of Assisi Nilayam Convent, Attappadi, for their generous hospitality, kindness, and field-level assistance during the data collection. I am also profoundly grateful to my dear students- Anitha, Ajitha, Jyothi, Santhi, and Sunitha, whose committed help in data collection across remote tribal hamlets significantly contributed to the success of my fieldwork. Their sincere efforts, enthusiasm, and cooperation are deeply appreciated.

I am genuinely grateful to the Sub-Collector and staff of Palakkad District, the Director and staff of ITDP Attappadi, and the promoters of the tribal hamlets for their cooperation and facilitation during my fieldwork. My special thanks go to the doctors, health workers, ASHA workers, Anganwadi teachers, ward members, and caretakers of children, whose honest participation and contributions were vital to the success of this study.

I also owe a debt of gratitude to my fellow research scholars, Ms. Daisy P.K., Dr. Prashobha P., Dr. Vidya A.K., Mr. Manikandan, Ms. Vini Valsan, Ms. Vidhya E.A., Ms. Pavana, Ms. Sneha Johny, and Mr. Sherin for their constant support and camaraderie.

My sincere appreciation goes to the librarians and staff members of the University of Calicut, Dr. John Matthai Centre, Centre for Development Studies, Thiruvananthapuram, and Christ College (Autonomous), Irinjalakuda, for their cooperation and assistance.

I extend my deepest thanks to my beloved parents, siblings, and family members for their unconditional love, support, and prayers, which have been a constant source of strength and motivation throughout this journey.

Finally, I humbly thank the Almighty God for granting me the strength, wisdom, and perseverance to complete this research work. His divine presence has been my guiding light and unwavering support throughout my academic journey.

Rosy V. O.

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LIST OF ABBREVIATIONS

AAY	-	Antyodaya Anna Yojana
AD	-	Abject Deprivation
AMB	-	Anaemia Mukd Bharat
ANC	-	Antenatal Checkups
ANM	-	Auxiliary Nurse Midwives
ARSH	-	Adolescent Reproductive and Sexual Health
ASHA	-	Accredited Social Health Activists
AWC	-	Anganwadi Centers
AWW	-	Anganwadi Workers
BMI	-	Mothers' Body Mass Index
CDDS	-	Child's Dietary Diversity Score
CFCS	-	Child Food Consumption Score
CFIAS	-	Child Food Insecurity Access Scale Score
CINI	-	Child In Need Institute
CMAM	-	Community-Based Management of Acute Malnutrition
CSR	-	Corporate Social Responsibility
DDS	-	Dietary Diversity Score
FANTA	-	Food And Nutrition Technical Assistance
FAO	-	Food And Agriculture Organization
FSSAI	-	Food Safety and Standard Authority Of India
GAIN	-	Global Alliance for Improved Nutrition
GNR	-	Global Nutrition Report
GNT	-	Global Nutrition Target
H ₀	-	Null Hypothesis
H ₁	-	Alternative Hypothesis
HAZ	-	Height-for-Age Z-Score
HDDS	-	Household Dietary Diversity Score
HDS	-	Household Deprivation Score

ICDS	-	Integrated Child Development Services
IFA	-	Iron And Folic Acid
ITDP	-	Integrated Tribal Development Projects
JAD	-	Just Above Deprivation
JSY	-	Janani Suraksha Yojana
JSY	-	Janani Suraksha Yojana
KSY	-	Kishori Shakti Yojana
LSFF	-	Large-Scale Food Fortification
MAM	-	Moderate Acute Malnutrition
MD	-	Moderate Deprivation
MIYCN	-	Maternal, Infant, And Young Child Nutrition Target
MWCD	-	Ministry Of Women and Child Development
NFHS	-	National Family Health Survey
NFHS	-	National Family Health Survey
NFSA	-	National Food Security Act
NGO	-	Non-Governmental Organization
NHM	-	National Health Mission
NHM	-	National Health Mission
NIN	-	National Institute of Nutrition
NPAG	-	Nutrition Program for Adolescent Girls
NRC	-	Nutrition Rehabilitation Centres
NRHM	-	National Rural Health Mission
NUHM	-	National Urban Health Mission
PDS	-	Public Distribution System
PMMVY	-	Pradhan Mantri Matru Vandana Yojana
PPP	-	Public-Private Partnerships
PRI	-	Panchayati Raj Institutions
RGSEAG	-	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls
ROC	-	Receiver Operating Characteristic
SABLA	-	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls
SAM	-	Severe Acute Malnutrition

SD	-	Standard Deviation
SE	-	Standard Error
SeRVe	-	Self-Reliant Village
SNP	-	Supplementary Nutrition Programs
ST	-	Scheduled Tribe
SUN	-	Scaling Up Nutrition
TB	-	Tuberculosis
TFR	-	Total Fertility Rate
THDS	-	Total Household Deprivation Score
TPDS	-	TPDS Beneficiaries
TSFP	-	Supplementary Feeding Programs
UNICEF	-	United Nations Children's Fund
UT	-	Union Territories
VHND	-	Village Health Nutrition Day
VHSNC	-	Village Health, Sanitation and Nutrition Committee
WAD	-	Well Above Deprivation
WAZ	-	Weight-for-Age Z-Score
WB	-	World Bank
WFP	-	World Food Program
WHO	-	World Health Organisation
WHZ	-	Weight-for-Height Z-Score

ABSTRACT

Malnutrition remains a major global health issue, especially among children under five, with tribal populations facing heightened vulnerability. This study examines the prevalence, determinants, and policy responses to malnutrition among tribal children aged 0–59 months in Attappadi, Kerala. Guided by Becker’s Household Production Model and Amartya Sen’s Capability Approach, the research adopts an interdisciplinary framework to explore how socio-economic, maternal, environmental, and institutional factors influence nutritional outcomes. Despite Kerala’s overall progress, tribal children, particularly from the Kurumba, Muduka, and Irula communities, continue to face high rates of stunting, wasting, and underweight due to poverty, low literacy, limited health access, and cultural barriers. A cross-sectional study was conducted across 625 households in 25 tribal hamlets using stratified random sampling. Primary data included anthropometric measurements, caregiver interviews, and validated tools assessing dietary diversity, food insecurity, and household deprivation. Results revealed high malnutrition levels: more than half of the children were stunted, wasted and underweight. Regression and chi-square analyses identified strong links between malnutrition and factors such as maternal education, birth order, breastfeeding practices, deprivation, and tribal identity. Dietary diversity, assessed through CDDS and CFCS, was positively associated with nutritional outcomes, though most diets lacked protein and key micronutrients. Limited access to schemes like ICDS and Poshan Abhiyan, as well as infrastructural gaps and cultural practices, hindered improvements. The findings stress the need for integrated, culturally sensitive, community-specific interventions emphasising health education, maternal empowerment, and local participation. This research supports policy shifts toward nutrition equity and sustainable development in tribal areas, aligning with national and global goals.

Key words: Malnutrition, Nutritional status, Undernutrition, Child Malnutrition, Malnutrition in Attappadi

സംഗ്രഹം

ആഗോളതലത്തിൽ, പോഷകാഹാരക്കുറവ് ഒരു പ്രധാന ആരോഗ്യപ്രശ്നമായി തുടരുന്നു, പ്രത്യേകിച്ചും അഞ്ചു വയസ്സിൽ താഴെയുള്ള കുട്ടികളിൽ. ഗോത്രവർഗ്ഗ വിഭാഗങ്ങൾക്കിടയിൽ ഇതിന്റെ ദുർബലത ഏറെയാണ്. കേരളത്തിലെ, പാലക്കാട് ജില്ലയിലുള്ള അട്ടപ്പാടി ബ്ലോക്ക് പഞ്ചായത്തിലെ അഞ്ചു വയസ്സിൽ താഴെ പ്രായമുള്ള ഗോത്രവർഗ്ഗ കുട്ടികളിലെ പോഷകാഹാരക്കുറവിന്റെ തോത്, കാരണങ്ങൾ, നയപരമായ പ്രതികരണങ്ങൾ എന്നിവയാണ് ഈ പഠനം പരിശോധിക്കുന്നത്. ബേക്കറുടെ ഗാർഹിക ഉൽപ്പാദന മാതൃകയും അമർത്യ സെനിന്റെ ശേഷിസമീപനവും അടിസ്ഥാനമാക്കി, സാമൂഹികം, സാമ്പത്തികം, മാതൃസംബന്ധം, പാരിസ്ഥിതികം, സ്ഥാപനപരം, തുടങ്ങിയ ഘടകങ്ങൾ പോഷകാഹാര ഫലങ്ങളെ എങ്ങനെ സ്വാധീനിക്കുന്നു എന്ന് ഈ ഗവേഷണം ബഹുശാസ്ത്രപരമായ ചട്ടക്കൂടിലൂടെ കണ്ടെത്തുന്നു. കേരള സമൂഹം മെച്ചപ്പെട്ട ആരോഗ്യനിലവാരം പുലർത്തുന്നുവെന്ന് ആവർത്തിച്ച് അവകാശപ്പെടുമ്പോഴും അട്ടപ്പാടിയിലെ കുറുമ്പ, മുതുക, ഇരുള തുടങ്ങിയ ഗോത്രവർഗ്ഗ വിഭാഗങ്ങളിലെ കുട്ടികൾ ദാരിദ്ര്യം, ആരോഗ്യ സേവനങ്ങളുടെ പരിമിതി, സാംസ്കാരിക തടസ്സങ്ങൾ എന്നിവ കാരണം വളർച്ചാ മുരടിപ്പ്, ഭാരക്കുറവ്, മെലിച്ഛിൽ എന്നിവയുടെ ഉയർന്ന നിരക്ക് നേരിടുന്നു. 25 ഗോത്രവർഗ്ഗ ഊരുകളിലെ 625 വീടുകളിൽ നിന്ന് തരംതിരിവ് മാതൃക ഉപയോഗിച്ച് ഒരു ക്രോസ്-സെക്ഷണൽ പഠനം നടത്തി. പ്രാഥമിക വിവരങ്ങളിൽ നരവംശശാസ്ത്രപരമായ അളവുകൾ, കുട്ടികളുടെ അമ്മമാരുമായുള്ള അഭിമുഖങ്ങൾ, ഭക്ഷണ വൈവിധ്യം, ഭക്ഷ്യ അരക്ഷിതാവസ്ഥ, ഗാർഹിക ദാരിദ്ര്യം എന്നിവ വിലയിരുത്തുന്നതിനുള്ള അംഗീകൃത ഉപകരണങ്ങൾ എന്നിവ ഉൾപ്പെടുന്നു. പഠനഫലങ്ങൾ ഉയർന്ന പോഷകാഹാരക്കുറവ് വെളിപ്പെടുത്തുന്നു: പഠനവിധേയമാക്കപ്പെട്ട കുട്ടികളിൽ പകുതിയിലധികം കുട്ടികൾക്ക് വളർച്ചാ മുരടിപ്പും, ഭാരക്കുറവും കണ്ടെത്തി. മാതാപിതാക്കളുടെ വിദ്യാഭ്യാസം, കുട്ടികളുടെ ജനന ക്രമം, മുലയൂട്ടൽ രീതികൾ, ദാരിദ്ര്യം, ഗോത്രവർഗ്ഗ സ്വത്വം എന്നിവയും പോഷകാഹാരക്കുറവും തമ്മിൽ ശക്തമായ ബന്ധമുണ്ടെന്ന് റിഗ്രഷൻ, കൈ-സ്ക്വയർ വിശകലനങ്ങളിലൂടെ തിരിച്ചറിഞ്ഞു. സി.ഡി.ഡി.എസ് സി.എഫ്.സി.എസ് എന്നീ നിലകളിലൂടെ വിലയിരുത്തിയ ഭക്ഷണ വൈവിധ്യം പോഷകാഹാര ഫലങ്ങളുമായി നല്ലരീതിയിൽ ബന്ധപ്പെട്ടിരുന്നുവെങ്കിലും, മിക ഭക്ഷണങ്ങളിലും പ്രോട്ടീനും സൂക്ഷ്മ പോഷകങ്ങളും വളരെ കുറവാണെന്നും കണ്ടെത്തി.

പോഷകാഹാരക്കുറവിനെ നികത്താൻ ഐ.സി.ഡി.എസ്, പോഷൻ അഭിയാൻ തുടങ്ങിയ പദ്ധതികൾ ഇന്ത്യയിൽ നിലനിൽക്കുമ്പോൾ, അവയിലേക്കുള്ള പരിമിതമായ പ്രവേശനം, പോഷകാഹാരങ്ങളെ കുറിച്ചുള്ള അമ്മയുടെ അറിവ് കുറവ്, അടിസ്ഥാന സൗകര്യങ്ങളിലെ വിടവുകൾ, മറ്റു സാംസ്കാരിക ആചാരങ്ങൾ എന്നിവ ആരോഗ്യപുരോഗതിക്ക് തടസ്സമാകുന്നു. ആരോഗ്യവിദ്യാഭ്യാസം, മാതൃശാക്തീകരണം, പ്രാദേശിക പങ്കാളിത്തം എന്നിവയ്ക്ക് ഊന്നൽനൽകിക്കൊണ്ട് സമഗ്രവും, സാംസ്കാരികമായി സംവേദനക്ഷമതയുള്ളതും, ഗോത്രസമൂഹത്തിന് അനുയോജ്യവുമായ ഇടപെടലുകളുടെ ആവശ്യകത ഈ കണ്ടെത്തലുകൾ ഊന്നിപ്പറയുന്നു. ഈ ഗവേഷണം ഗോത്രവർഗ്ഗ പ്രദേശങ്ങളിലെ പോഷകാഹാര സമത്വത്തിനും സുസ്ഥിര വികസനത്തിനും വേണ്ടിയുള്ള നയപരമായ മാറ്റങ്ങളെ പിന്തുണയ്ക്കുന്നു,

പ്രധാന പദങ്ങൾ: പോഷകാഹാരക്കുറവ്, പോഷകാഹാര നില, പോഷകഹീനത, ശിശു പോഷകാഹാരക്കുറവ്, അട്ടപ്പാടിയിലെ പോഷകാഹാരക്കുറവ്

CHAPTER 1

DESIGN OF THE STUDY

1.1 Introduction

Achieving nutritious diets and eradicating malnutrition is a great challenge, especially for children. Malnutrition remains one of the most significant worldwide health issues, affecting millions of children and leading to severe implications for health, development, and societal progress. Malnutrition is keenly felt in marginalised communities, including tribal groups, whose socio-economic inequalities make it worse for nutritional deficiencies. Healthy eating promotion and elimination of malnutrition are imperative worldwide for the health of children. Malnutrition is among the leading causes of death in children around the world (WHO, 2021) and is responsible for close to half of all deaths in children aged less than five years. Malnutrition may come in several forms, such as stunting, wasting, or being underweight or even overweight. Stunting, meaning being short for age, is a sign of long-term undernutrition and can cause long-term developmental problems. Wasting or low weight for height is an indication of acute undernutrition and is a risk factor for death. Underweight or low weight for age is a combination of chronic and acute forms of undernutrition. Overweight, an emerging form of malnutrition, is characterised by excessive weight relative to height and increases the risk of non-communicable diseases (WHO, 2020).

Low and middle income nations are significantly devastated by malnutrition since such nations lack access to high quality foodstuffs, quality healthcare service delivery, as well as safe water (UNICEF, 2020). The issue is common in South Asia and Sub-Saharan Africa, where undernutrition is drastically high. Undernutrition puts one at a higher risk of mortality and impairs cognitive development, school performance, and productivity in adulthood (Bhutta et al., 2013). Conversely, the rising prevalence of childhood obesity presents a new dimension of malnutrition, creating a dual burden of malnutrition in many countries (UNICEF, 2020). The 2000 Millennium Development Goals (MDGs) aimed to cut the rate of undernutrition in half by 2015 (United Nations, 2000). As much as tremendous progress has been made, malnutrition is a significant concern, especially among vulnerable groups. Replacing the MDGs, the Sustainable Development Goals (SDGs), G 2 (Zero Hunger) and G 3 (Good Health and Well-being) have also set

high targets towards the eradication of malnutrition by 2030 (United Nations, 2021). The Global Nutrition Report (2022) highlights that approximately 45% of all child deaths under the age of five are linked to malnutrition, with Sub-Saharan Africa and South Asia bearing the highest burden.

India, despite its rapid economic growth, continues to grapple with a high burden of malnutrition. The National Family Health Survey (NFHS-5, 2020-21) reported that 35.5% of children under five are stunted, 19.3% are wasted, and 32.1% are underweight (IIPS, 2021). The Global Hunger Index (GHI) 2023 ranked India 111th out of 125 countries, with a child wasting rate of 18.7%, the highest in the world (Global Hunger Index, 2023). The prevalence of malnutrition in India highlights the symptoms of the interconnected process of poverty, food insecurity, inadequate healthcare, and socio-cultural factors.

Kerala, with its high human development indicators, presents a contrasting picture. NFHS-5 (2020-21) says that the rates of stunting, wasting, and underweight among children under five in Kerala are lower than the national average. The rates are 21.5%, 15.8%, and 19.5%, respectively (IIPS, 2021). However, tribal groups in Kerala, especially in Attappadi, have much higher rates of malnutrition. The Kerala State Planning Board (2017) said that almost 40% of kids in Attappadi are stunted, and 30% are underweight. It shows how vulnerable tribal groups are because of their location and economic situation.

There are three major tribal groups live in Attappadi, in the Palakkad district of Kerala. These groups are the Irula, Muduga, and Kurumba. These communities are beset by specific challenges in accessing healthy food, healthcare, and education. Poverty, restricted dietary diversity, low maternal education, and poor healthcare facilities, most notably, are responsible for the high rate of malnutrition among children in Attappadi tribals. The convergence of all these factors gives rise to a cycle of undernutrition and poverty, further excluding tribal communities.

The World Food Program (WFP) is central to countering global malnutrition through food and nutritional interventions for vulnerable populations in more than 80 countries (World Food Program, 2021). Targeted interventions like supplementary feeding programs, micronutrient supplementation, and maternal and

child health services effectively reduce nutritional outcomes. In India, the Integrated Child Development Services (ICDS) and the Poshan Abhiyan battle hunger and malnutrition by applying a range of interventions, including food supplements, health provision, and nutrition counselling (Ministry of Women and Child Development, 2021). Prevalence rates of children with a condition of malnutrition in Attappadi are a reason for immediate intervention. Major components of a complete strategy involve dietary diversification improvement, promotion for exclusive breastfeeding, improvement in the levels of education of mothers, and access improvement for healthcare service provisions (Bhutta et al., 2020). Contributions by local communities, self-help groups, and external non-government organisations would increase such initiative effectiveness. Nutritional deficiency needs a holistic intervention, balancing short term nutritional interventions with sustainable socio-economic developments. For sustainable development, there is a need to incorporate nutrition sensitive policies in several sectors, including agriculture, health, education, and social protection. It would inform about the nutritional health status of tribal children in Attappadi and lay a foundation for formulating specific interventions for improving their general health status and quality of life.

1.2 Significance of the Study

The research on malnutrition among tribal children in Attappadi is relevant to academic and policymaking research. Malnutrition is a critical global issue, and it disproportionately impacts vulnerable populations, especially children belonging to marginalised groups in Attappadi. Understanding the nutrition challenges tribal children face is essential to developing effective interventions to break the intergenerational cycle of poverty and malnutrition. Malnutrition of tribal children is strongly linked with several socio-economic, cultural, and environmental determinants. The strength of this study lies in the in-depth examination of the complex aetiology of malnutrition, from its causes to its consequences.

The study has significant policy implications, particularly for formulating targeted nutritional interventions and improving healthcare delivery in tribal regions. Government programs like the ICDS and Poshan Abhiyan aim to address

malnutrition, but several issues hamper their effectiveness in tribal areas. Despite the increasing number of research studies on malnutrition in India, there continues to be a paucity of research studies on the tribal population, specifically children under the age of five. This research contributes to the current pool of knowledge by giving empirical evidence of the nutritional status of Attappadi tribal children. The results can also be used as a good reference for future research studies on the health and well-being of tribal communities, thereby instilling more region-specific studies and studies that address the specific issues of these communities. The study also addresses the importance of dietary diversity in improving child nutrition.

Compromised dietary diversity is one of the most significant indicators of malnutrition among vulnerable groups. The research, through the assessment of the Child Dietary Diversity Score (CDDS) among the tribal children, provides important data on what is being eaten and areas of dietary insufficiency. They can be applied to guide the development of nutrition education programs to promote varied and balanced diets among tribal families. Moreover, the research results can contribute towards meeting the Sustainable Development Goals (SDGs). Specifically, SDG Target 2 is ending hunger and ensuring everyone worldwide has safe, nutritious, and ample food by 2030. Combating malnutrition of children belonging to the native tribes is further aided by such a worldwide movement and, therefore, ultimately fighting inequalities and encouraging health and wellness. Most importantly, it stressed the need for a strong strategy involving nutrition, health, education, and social protection schemes to combat malnutrition. Moreover, research findings might prove broader uses for achieving the Sustainable Development Goals (Montanari et al, 2021). The eradication of malnutrition in children in indigenous settings is in line with the international agenda for reducing inequalities while fostering health and wellness. According to research, there is a need for an integrated multi-sectoral plan in which nutrition, healthcare, education, and social protection are essential in ensuring a battle won in reducing malnutrition. Additionally, the report supports an integrated multisectoral model in which nutrition, healthcare, educational settings, and social protection programs are integrated to fight malnutrition.

The relevance of this research is its addition towards broader knowledge about the multi-dimensional and diversified state of malnutrition among tribal children in Attappadi. The study offers valuable lessons for formulating evidence-based targeted and policy interventions by analysing socio-economic, cultural, and environmental determinants of malnutrition. The findings from this study can be used as stepping stones to build on in subsequent research, inform evidence-based policymaking, and contribute to the broader agenda of nutritional health among vulnerable populations.

1.3 Statement of the Problem

Child malnutrition is also a significant public health concern for India, to which tribal populations are disproportionately vulnerable. Although extensive research exists, much of the research is of broad scope and does not consider the multidimensionality of malnutrition and the socio-cultural heterogeneity of tribal groups. In Attappadi, the three major tribal communities - Irula, Muduga, and Kurumba - have distinct livelihood patterns, dietary habits, healthcare access, etc., yet research on their community-specific malnutrition patterns remains limited. The key drivers like household deprivation, food security, dietary diversity, and traditional food practices strongly impact child nutrition, but their differential impact across these tribal groups is underexplored. The National surveys like NFHS provide broad data but fail to capture localised factors, including traditional food systems, indigenous nutrition practices, and cultural beliefs that shape dietary diversity.

Government programs like ICDS and Poshan Abhiyan often adopt a one-size-fits-all approach, overlooking the distinct nutritional needs of each tribal community. Moreover, land displacement, economic marginalisation, and food insecurity exacerbate malnutrition but have not been adequately examined through a Household Deprivation Score (HDS) framework. This study aims to analyse the multidimensional malnutrition among tribal children in Kerala, focusing on Attappadi.

1.4 Theoretical Framework

A theoretical framework is required to examine the multifaceted nature of

malnutrition among tribal children under five in Attappadi. It offers a systematic lens through which the determinants of nutrition among children - economic, social, personal, environmental, cultural, and institutional - are examined. By combining major theories from each field, this framework allows the research objectives - nutritional status measurement, identification of determinants, and examination of the associations between deprivation and dietary determinants.

1.4.1 Household Production Model of Becker (HPMB)

The HPMB (1965) provides the foundational microeconomic theory for this study. The HPMB (1965) provides the foundational microeconomic theory for this study. It views households as production units that allocate resources like time, income, and commodities to produce items like nutrition, education and health. In this context, nutritional status is viewed as a product of the household and shaped by food intake, care time, the schooling of the mother, and access to healthcare.

This model relates to Objectives 2 and 3 by showing how internal household determinants (e.g., time allocation, income, and education) and maternal characteristics affect malnutrition. The reduced form of the nutritional production function can be explained as follows:

$$N = f(C, W, H, Z, \varepsilon)$$

Where: N = Nutritional status of the child, C = Nutritional inputs (dietary intake, breastfeeding, supplements), W = Child/maternal characteristics (e.g., age, maternal education, BMI), H = Household level socio-economic factors, Z = Environmental /institutional factors (sanitation and health services) and ε = Unobserved factors.

The model given by Becker also reflects the trade-offs of mothers work, increasing earnings but limiting caregiver time, which reflects actual constraints in tribal families, helping to inform intervention strategies.

1.4.2 Capability Approach by Amartya Sen

The Capability Approach of Amartya Sen (1985, 1999) provides a shift in focus from resources to individuals to achieve well-being. It supports objectives 3 and 4 of the study by highlighting that food access alone does not ensure nutritional security; people must also be able to convert food into health via education, health literacy, and the environment.

This perspective is used to develop the Household Deprivation Score (HDS), the core variable in this study, which represents multidimensionally poverty sensitive exposure to fundamental assets, amenities, and services. The framework of Amartya Sen is most applicable in tribal regions such as Attappadi, where structural deprivation restricts the realisation of nutritional potential despite available food schemes.

1.4.3 Genetic Potential Theory and Small but Healthy Hypothesis

To counter arguments over anthropometric measures, two biological hypotheses are taken into account:

- Genetic Potential Theory believes that all children possess a biological potential to achieve normal growth potential if they are nourished and cared for. Deviation from normal is indicative of malnutrition.
- The small but Healthy Hypothesis (Seckler, 1982) posits that smaller body size in low resource settings may be an adaptive outcome rather than a sign of poor health.

These theories help interpret growth patterns in tribal populations, especially relevant to Objective 1, which examines child nutritional status in the broader Kerala context and among marginalised tribal groups. They encourage careful evaluation of stunting and underweight, and thus avoid general conclusions that are non-specific.

1.4.4 Child Food and Nutrition Security (CFNS) Framework

The CFNS Framework combines the four dimensions of food security: availability, accessibility, utilisation, and stability. Malnutrition is subsequently defined as a result of deficits in any of the aforementioned dimensions:

Malnutrition is subsequently defined as a result of deficits in any of the aforementioned dimensions:

- Availability: The presence of food through production, distribution, and stock
- Accessibility: Economic and physical access to food
- Use: Efficient use and biological utilisation of nutrients.
- Stability: Consistent access over time, unaffected by economic or climate shocks

The CFNS framework aligns with Objectives 3 and 5, summarising the role of feeding practices, food diversity, and infrastructure in child nutrition. It also allows for an overall assessment of the Dietary Diversity Score (CDDS) of the child.

1.4.5 Relevance to Research Objectives

The theory used in the current study is closely connected to all five research objectives, thus enabling a comprehensive understanding of malnutrition among children in Attappadi tribal communities. To examine the nutritional status of children under five in Kerala (Objective 1), the study draws upon the Genetic Potential Theory and the Small but Healthy Hypothesis of Beker, contrasting perspectives on child growth standards in diverse populations. The Household Production Model of Becker is central to analysing malnutrition among tribal children (Objective 2), considering how households allocate resources to produce child health outcomes. Identifying factors leading to malnutrition (Objective 3) is supported by a blend of the Becker Model, Capability Approach of Amartya Sen, and the Child Food and Nutrition Security (CFNS) Framework, capturing dynamics in household decisions, individual capabilities, and food system factors. The Capability Approach of Sen operationalised through the Household Deprivation Score (HDS) provides a robust basis for assessing the association between deprivation and child well-being (Objective 4). Finally, the CFNS Framework, combined with Becker insights and child feeding practice indicators, informs the evaluation of nutrition related practices and dietary diversity (Objective 5), capturing the structural and behavioural dimensions influencing child nutrition outcomes.

By integrating economic, social, biological, and food security paradigms, this conceptual framework enables an integrated and context-specific understanding of child malnutrition in tribal populations. It gives scope for evidence-based policy interventions addressed to the specific context of Attappadi.

1.5 Review of Literature

Malnutrition affects children under five worldwide and is a significant public health issue. Despite advances in healthcare and nutrition, undernutrition and overnutrition threaten child health and development worldwide. Millions of

children in low and middle income nations suffer from stunting, wasting, and micronutrient deficiencies, according to the Global Nutrition Report (2022). Socio-economic, demographic, maternal, health related, environmental, and socio-cultural factors cause nutritional inequities in India, which has one of the highest rates of malnutrition. In India, children are malnourished because they are poor, do not have easy access to healthcare, and do not have enough food. To solve this problem, policymakers need to come up with specific solutions.

The level of education of the Mother, the financial situation of the family, limited access to healthcare, and socio-cultural norms that influence food preparation and eating habits cause malnutrition. Policymakers and stakeholders must implement multisectoral solutions to improve child nutrition and promote sustainable development. This research objectively examines global trends, the load of India, and its causes to understand malnutrition. Analysis of these factors can help develop evidence-based nutritional therapies (Black et al., 2013).

Many risk variables were linked to undernutrition in children under five years old. Poor dietary diversity, maternal education, and family socio-economic status were significant drivers of malnutrition because inadequate food intake and nutritional ignorance lead to poor child health outcomes. The nutritional status of preschool tribal children in North Kerala points out their persistent vulnerabilities, including poor access to healthcare and food insecurity (Bina et al., 2017). Similarly, an assessment of children under five in the urban slums of Jagdalpur city, Bastar region, Chhattisgarh, revealed a high prevalence linked to inadequate dietary intake and poor sanitation facilities (Khan et al., 2018).

1.5.1 Malnutrition Among Children at the Global Level

Malnutrition affects children and hinders global poverty eradication, productivity, and economic progress. Addressing malnutrition might reduce 32% of the global illness burden. Despite worldwide efforts, malnutrition remains a significant issue in developing nations (WHO, 2022). The prevalence of malnutrition worldwide is alarming. According to the World Health Organisation, among children under five, 155 million suffer from stunting, 52 million experience wasting, and 41 million are overweight. A comprehensive response to malnutrition requires a multi-pronged

approach, including exclusive breastfeeding for the first six months, access to diverse and nutritious foods, improved sanitation, and maternal nutrition interventions before, during, and after pregnancy (WHO, 2022).

The first two years of life are critical for nutritional interventions, as this period coincides with rapid mental and physical development. Protein energy malnutrition particularly affects children aged six months to two years. Child and maternal malnutrition cause 3.5 million deaths each year and account for 35% of the disease burden among children under five. In 2008, underweight contributed to 8.8 million global deaths in children under five, with 93% of these deaths occurring in Africa and Asia. In sub-Saharan Africa, one in every seven children dies before their fifth birthday due to malnutrition (Akombi et al., 2017; Dani et al., 2017). Modjadji (2019) reports that stunting impacts approximately 27% of South African children under five, while overnutrition rates are rising among both children and adults. Economic inequality, inadequate maternal education, poor newborn feeding practices, and limited access to healthy food and clean water cause malnutrition in South Africa and the Sub-Saharan region.

Studies in Sudan, Ethiopia, Bangladesh, and Haiti suggest the multifactorial causes of malnutrition, including poor diet, food insecurity, and limited access to healthcare. Key determinants include maternal education, antenatal care, and household income (Tette et al., 2016). Findings from Ghana point to the correlation between maternal, social, and demographic factors and malnutrition, emphasising the role of education in breaking the malnutrition cycle (Aboagye et al., 2023). Research from Zambia and Southern Ethiopia also reveals that dietary deficiencies, socio-economic conditions, and healthcare access are critical drivers of malnutrition (Rodamo et al., 2018; Mhango et al., 2017). Global initiatives addressing malnutrition have shown varying degrees of success. Effective techniques encompass exclusive breastfeeding, vitamin A supplementation, deworming, zinc therapy, oral rehydration therapy, food fortification, and iron/folic acid supplementation for pregnant and nursing mothers.

Furthermore, better access to clean water, sanitation, and hygiene has markedly improved child survival and developmental outcomes (Bhutta et al., 2013; Ayoya et

al., 2013). Malnutrition intensifies socio-economic inequalities as the loop of poverty and illness, and it sustains diminished output and escalated healthcare expenses. Education is crucial in alleviating Hunger since children of illiterate mothers have much higher rates of stunting compared to those whose mothers possess secondary education or higher (Kumar & Lakhtakia, 2021).

1.5.2 Malnutrition Among Children in India

Undernutrition and overnutrition are major public health issues in India. Stunting, wasting, and underweight are common in children under five, especially in underprivileged populations with poor healthcare and food options. Overnutrition, especially childhood obesity, is rising due to diet and sedentary lifestyle changes. To make kids healthier overall and fix nutrition problems in different parts of India, we need community-based nutrition programs, policy changes, and campaigns to raise awareness.

Many socio-economic, demographic, and behavioural factors can lead to undernutrition in children under five. Studies have revealed that exclusive breastfeeding rates among infants below six months were 46.4%, while only 56.7% of children aged 6-9 months received adequate complementary feeding. These rates were notably higher among mothers who had attended more antenatal visits and had exposure to mass media, such as television, suggesting that awareness and healthcare accessibility are critical determinants of infant nutrition (Patel et al., 2010). Intervention based research has provided mixed results. A study investigating dietary intake and nutrient access among Dalit mothers for children aged 6-39 months found significant differences in food consumption between intervention and control villages, suggesting that structural barriers may limit the effectiveness of nutritional interventions (Schmid et al., 2007). It also emphasises region-specific policy intervention in consideration of India's variegated socio-economic and cultural realities.

Economic marginalisation, poor health infrastructure, and nutritional deficiencies make Gujarati tribes vulnerable to disease, neglect, and malnutrition, making immediate nutritional interventions necessary (Dave et al., 2019). Community-based treatment for severe malnutrition was studied as an intervention for reducing

undernutrition in Maharashtra's Melghat tribal area, documenting the success of locally conducted nutrition interventions in improving child health and reducing child deaths (Dani et al., 2017). Composite Index of Anthropometric Failure (CIAF) (Obasohan et al., 2024) was used in West Bengal as a proxy measure for undernutrition in children less than five years old, representing vast rural-urban inequalities and the need for region-specific policy interventions for reducing healthcare access inequalities as well as food insecurity (Roy et al., 2018).

There is a need for an established framework for dealing with severe acute malnutrition in children in order for there to be swift identification and treatment of this disorder to prevent malnutrition disorders as well as deaths in children (Mukuku et al., 2019). A higher number of stunting, wasting, and underweight were noted in tribal children under five years in Maldah, West Bengal, which highlights a pressing need for increased dietary intake, better maternal health care, and increased awareness about child nutrition by caregivers to address decades-long nutritional inequalities (Bhattacharyya et al., 2010). A nutritional status survey in children under five in a rural district in Southern Rajasthan found key indicators such as stunting, wasting, underweight, and dietary diversity. Such an assessment recommends immediate enactment of community interventions incorporating nutritional knowledge transmission, food supplementation programs, and enhanced health care service for a drop in child malnutrition prevalence (Bhar et al., 2019). To design effective control measures specific to socio-economic and geographical settings, and to reduce child malnutrition in specific regions, scholars and policy planners need to study risk factors for the nutritional status of children.

Geographic variations in nutritional outcomes of children indicate the crucial role played by socio-economic advancement. Researchers and policymakers ought to define risk factors for those with malnutrition and apply effective control interventions appropriate for various socio-economic and geographic environments to reduce child malnutrition in such places. Underweight children are less common in the Northeastern states with higher female literacy rates. The overall development, enhancements in educational attainment, and decreases in gender disparity are crucial factors influencing improved child nutritional outcomes in

India (Bharati et al., 2008). However, interdisciplinary research is required to explore behavioural risk factors at the family level, as some households continue to report poor nutritional outcomes despite favourable socio-economic conditions (Griffiths et al., 2002). Experts agree that figuring out what causes stunting and coming up with good ways to raise birth weight are both important steps in solving the problem of malnutrition in children under five in India. Mamidi et al. (2011) stress that public health programs must use evidence-based methods to ensure babies get the best nutrition possible and stop children from being undernourished or overnourished.

1.5.3 Overnutrition Among Children

Obesity and overnutrition are becoming public health issues in India. Undernutrition remains a significant issue, but rising childhood overnutrition indicates a transition. Eastern Europe and the Middle East have the most overweight preschoolers, while Asia has the most due to its enormous population (De et al., 2010). According to Indian studies, childhood obesity is gradually increasing and calls for early intervention. Children aged 5 to 16 in Ernakulam District of Kerala became more obese between 2003 and 2005 (Raj et al., 2007). Sedentary lifestyles, diet, and family history influence this trend. A study of children aged 4-12 indicated that while total calorie intake was not high, fat intake exceeded the required 25%, especially in children aged 4-7. It shows that meal composition, not caloric consumption, affects obesity risk (Singh & Sarma, 2005). Low physical activity and excessive screen time also cause childhood obesity. Studies show that children who watch more than an hour of TV or videos every day are more likely to be overweight. A positive family history of obesity enhances susceptibility, emphasising the need for early lifestyle changes (Singh & Sarma, 2005). Despite India and Sri Lanka having a lower prevalence of overweight than other regions, the number of affected youngsters is substantial. With 18 million overweight children in 2010, Asia outnumbered Africa, which had 4.9% but fewer children (De et al., 2010). Growing concern points to the need for rigorous nutritional assessments and region-specific measures to combat early childhood overnutrition.

Obesity in preschoolers suggests the need for more research on regional factors. Preventive efforts should begin in early childhood because obesity may start then. Public health should promote balanced diets, physical activity, and screen time management to reduce child obesity. Education, healthcare, and community involvement are needed to combat childhood overnutrition. Schools can promote diet and exercise. Parents must also know about healthy eating and living. Future studies should identify socio-economic and cultural aspects affecting childhood obesity in India to develop tailored treatments to minimise overnutrition.

1.5.4 Determinants of Malnutrition Among Children

Socio-economic, demographic, maternal, health related, environmental, and socio-cultural factors complicate the malnutrition problem of India. Poverty, illiteracy, poor healthcare, and sanitation worsen undernutrition, especially among children under five. Education and nutrition affect maternal and child health. Environmental issues like water and sanitation also cause nutritional deficits. Cultural norms affect nutrition and healthcare use. These multiple variables require integrated policy actions for vulnerable groups to get equal nutrition and better health.

1.5.4.1 Socio-economic and Demographic Factors of Malnutrition

Children under five had many risk factors for undernutrition. Studies demonstrate regional and population disparities in child malnutrition due to socio-economic and demographic factors. Targeted interventions are needed since Adivasi children in Bangladesh have high rates of underweight, stunting, and wasting (Kabir et al., 2018). The socio-economic and cultural disparities that tribal communities in Thane District, Maharashtra, experience demonstrate how their livelihoods rely on natural resources and the need for targeted tribal development strategies (Chavan, 2016). Development must respect the tribal culture, foster participatory decision making, and address fundamental causes of poverty to improve tribal socio-economic situations in central India (Ballabh & Batra, 2015). Farm and non-farm tribal families in the Gadchiroli area of Maharashtra face infrastructure issues, poverty, and illiteracy, emphasising the need for government initiatives to improve living conditions and promote sustainable agriculture (Meshram et al., 2018). Socio-economic changes in an urban slum in Bastar, Chhattisgarh, worsened child

malnutrition, reflecting tribal concerns about economic instability and food insecurity (Khan et al., 2018). According to the Attappadi Final Report, March 2023, "indigenous people have trouble getting health and nutrition services, worsening socio-economic nutritional disparities". Social support from community nutritional therapy prevents child stunting (Nugraha et al., 2019). The nutritional status of rural tribal children in Tripura reflects socio-economic inequities, underlining the need for resource equity (Debbarma et al., 2018). Research in tribal Maharashtra and Central India shows that malnutrition interventions must be customised to regional differences (Meshram et al., 2012).

Policymakers must prioritise child nutrition for sustainable economic growth, integrating various interventions, including water and sanitation improvements, as suggested by a comprehensive analysis of child health determinants in India (Rajpal et al., 2020). Temporal changes in wealth inequalities in child nutrition across central Indian states indicate reduced disparities. However, poor households need better healthcare, sanitation, and education (Mukhopadhyay & Chakraborty, 2020). Indian tribal children are malnourished due to poverty, illiteracy, unclean water, and poor healthcare (Manhas, 2021). Sociodemographic factors are crucial in addressing nutritional deficiencies because parental education and economic status substantially impact child malnutrition. The link between sociodemographic factors and malnutrition in tribal populations (Puri et al., 2020) shows how economic changes can hurt the health of the public. These results show that indigenous child nutrition programs must be more complex and cover health, education, and economic empowerment. To reduce child malnutrition, researchers must study socio-economic and demographic issues. Studies demonstrate regional and population disparities in child malnutrition due to socio-economic and demographic factors. Targeted interventions are needed since Adivasi children in Bangladesh have high rates of underweight, stunting, and wasting (Kabir et al., 2018). Despite economic progress in India, household socio-economic conditions are critical factors influencing childhood malnutrition (Kanjilal et al., 2010). Tribal communities in Thane District, Maharashtra, face socio-economic and cultural imbalances, showing the dependence of livelihoods on natural resources and the

necessity for focused tribal development strategies (Chavan, 2016). To enhance tribal socio-economic conditions in central India, Ballabh and Batra (2015) suggest promoting tribal culture and democratic decision making and tackling the root causes of poverty. Subramanian et al. (2006) highlight that economic reforms in India have increased inequality between Scheduled Castes and Tribes, emphasising the need for focused interventions to improve the lives of marginalised communities.

Land alienation and economic transformations have also affected child malnutrition in rural and urban tribal populations in Attappadi, Kerala (Edison & Devi, 2019). Indigenous populations struggle to obtain health and nutrition services, adding to socio-economic nutritional inequalities, according to the Attappadi Final Report, March 2023. Socio-economic disparities are reflected in the nutritional status of rural tribal children in Tripura, highlighting the necessity of resource equity (Debbarma et al., 2018). The Integrated Child Development Services (ICDS) program in Palghar, Maharashtra, was successful, which shows that different strategies are needed in different areas to fight child malnutrition (Kumar et al., 2022). According to a comprehensive review of child health determinants in India, governments should prioritise child nutrition for sustainable economic growth, combining various interventions such as water and sanitation improvements (Jose & Hari, 2015). Wealth inequalities in child nutrition have decreased in central Indian states. However, poor households need better healthcare, sanitation, and education (Mukhopadhyay & Chakraborty, 2020). These results show that we must take many steps to improve the nutritional status of children by giving them better healthcare and education.

1.5.4.2 Maternal Factors of Malnutrition

Maternal education, socio-economic position, and healthcare access affect child malnutrition. Child marriage, poverty, rural location, and lower education damage the health of the mother and child and require targeted policy interventions (Rumble et al., 2018). Increasing maternal education has improved maternal health and child nutrition (Weitzman, 2017). A multidimensional approach to malnutrition is necessary, as evidenced by the strong correlation between maternal education and

child health outcomes in India (Vikram & Vanneman, 2020). Due to maternal factors influencing childhood growth, stunting is also a significant problem in India. Pillai and Maleku (2019) propose a strength-based public health strategy for interventions targeting specific stages of stunting. In low and middle-income countries, maternal and paternal education equally reduces childhood undernutrition, advocating the need for gender inclusive education (Vollmer et al., 2017).

A cross-sectional survey among tribals in Maharashtra identified critical rates of underweight, stunting, and wasting among preschoolers, with education and low birth weight as key risk factors (Meshram et al., 2012). Undernutrition causes shorter adult height and lower economic productivity, stressing prenatal and infancy interventions (Victora et al., 2008). Tribal malnutrition is multifaceted. Thus, maternal education, BMI, and place of delivery must be considered (Pravin et al., 2020). It matches research on tribal people of Attappadi, where land dispossession and economic shifts have affected eating patterns and malnutrition (Edison & Devi, 2019). Increased food accessibility and nutritional understanding help mothers eat diversely during nursing (Rajpal et al., 2021). Broader research in tribal dominated regions of Maharashtra has linked poverty, agricultural issues, and educational inequality to food insecurity, emphasising the necessity for specialised interventions (Tagade, 2012).

In Kerala, indigenous moms had lower dietary diversity, feeding frequency, and nutritional intake, which affects child nutrition. Strengthening child health requires culturally appropriate treatments in filling such gaps (Jose et al., 2021). Empirical evidence highlights socio-economic factors in determining malnutrition based on emphasising maternal healthcare service access for enhanced child nutrition (Rathnayake et al., 2021). According to Kumara et al. (2020), increased maternal literacy in Kerala is related to superior complementary child feeding behaviour towards enhanced health status. Child malnutrition persists based on socio-economic disparities, such that all-inclusive interventions in healthcare as well as in education are essential. According to Rathnayake et al. (2020), parents should be adequately informed about child malnutrition to mitigate it. Descriptive studies

found that 58% of Karnataka parents knew enough about malnutrition. The study indicated a favourable association between knowledge and attitude, showing that parental comprehension of malnutrition and their proactive behaviour and child nutrition and healthcare improved. Health education programs markedly enhance parental knowledge, resulting in improved nutritional behaviours for their children (Bagilkar & Savadatti, 2015). It stresses the need for community-based educational programs to help parents learn more about malnutrition prevention and develop positive attitudes toward it.

1.5.4.3 Health Related Factors of Malnutrition

Health considerations affect the nutritional status of children, especially in tribal groups with inadequate healthcare access and understanding. Studies show that poor health, inadequate sanitation, and limited use of healthcare services cause child malnutrition. Ulahannan et al. (2023) report that structural issues, poor sanitation, and inadequate hygiene contribute to undernutrition among Adivasi children in north Kerala. We must deal with these social and economic issues to make kids healthier. Malnutrition has decreased in Palghar, Maharashtra, thanks to focused health and nutrition initiatives, but sustained improvements will require long-term strategies (Surve et al., 2022). Maternal health factors, especially BMI, are key factors in child malnutrition, necessitating socio-economic status (Tigga et al., 2015).

In Kerala, healthcare for indigenous women uses discrepancies that hinder maternal and child health improvements, requiring improved access to healthcare. Ulahannan et al. (2020) state that sociodemographic factors shape the health seeking behaviours of tribal populations and influence maternal healthcare utilisation and nutritional outcomes of children. Mahapatra et al. (2021) in their study explain that lifestyle factors such as alcohol consumption during pregnancy worsen the health vulnerabilities of tribal communities, leading to a negative impact on maternal and child health outcomes and necessitating multisectoral interventions.

Comprehensive healthcare strategies are important since maternal healthcare and social support systems affect the nutritional status of children (Nugraha et al.,

2019). Targeted dietary interventions in rural tribal regions can reduce socio-economic gaps and enhance child health (Debbarma et al., 2018). Anaemia still plagues tribal children and women, compromising health and nutrition. Anganwadi-based nutritional interventions in Attappadi, Kerala, observed high anaemia rates in tribal and non-tribal children, emphasising iron supplements and socio-economic and healthcare access (Raju et al., 2021). High malnutrition and anaemia rates in West Bengal and other tribal communities demand focused health treatments (Mundlod & Thakkarvad, 2023). Micronutrient deficiencies can lead to child malnutrition in tribal societies and must be addressed (Nugraha et al., 2019; C.M., 2017). Apart from child health outcomes, anaemia in mothers, along with an insufficient supply of proper nutrition, can contribute significantly towards child malnutrition. The occurrence of anaemia in indigenous mothers in Kerala also shows an immediate need for improved maternal health for better child nutrition (Rohisha et al., 2019). Integrated policy action encompassing socio-economic support, nutritional care, and healthcare is needed since professionals indicate the multi-interrelated linkages between maternal health, access to healthcare, and child nutrition.

1.5.4.4. Environmental Factors of Malnutrition

Environmental determinants leading to malnutrition are parallel or similar to those affecting child health in the environment. Studies in rural India report improved family environments, reducing stunting incidence in children under five. Studies in rural India show that improvement in aspects concerning the home environment can allow for enhanced stature in children less than five years old. Safe water access, appropriate garbage disposal, and sanitary facilities lower stunting (Chakrabarti et al., 2020). It is indicative of adding dietary interventions along with environmental action. Because of the complicated link between environmental determinants and malnutrition, it is imperative to improve water safety, sanitation, and hygiene to reduce child undernutrition in vulnerable groups (Lee et al., 2021). The study highlights the importance of involving environmental improvement with nutrition-centred interventions instead of food-centred interventions. Because of the complicated link between environmental factors and malnutrition, water safety,

sanitation, and hygiene improvement are essential to avert child undernutrition in vulnerable groups (Lee et al., 2021).

1.5.4.5 Socio-cultural Influences on Malnutrition

Mothers and children display specific dietary behaviours as a result of socio-cultural determinants. Particularly, cultural assumptions, conventional habits, and gender expectations exert considerable effect on the eating frequency of children, medical interventions for children, and the general health of children. Qualitative research within Benin showcases the influence of socio-cultural assumptions on maternal feeding behaviour and child nutrition health outcomes. Culturally appropriate educational programs improve knowledge for mothers and promote proper feeding behaviour to benefit child health (Lokossou et al., 2021). Socio-cultural expectations mould women in Haryana's perceptions about pregnancy, delivery, and child upkeep and thus limit their access to critical healthcare interventions. Community-located maternal educational interventions that challenge such assumptions and promote health-informed behaviours for health-seeking can offset such issues (Akshay & Anand, 2019). Studies in Ghana and Kerala showcase maternal attributes and socio-cultural determinants influencing malnutrition patterns. In Ghana, educational levels and participation in household decision making are key factors in nutritional outcomes. For example, mothers in Ghana with superior educational qualifications are more adept at ensuring proper child nutrition and obtaining medical interventions promptly (Tette et al., 2016). The study in Kerala critically affirms the need to eliminate social and cultural obstacles to the health of mothers and children, especially in food issues, breastfeeding behaviours, and access to medical interventions (Rohisha et al., 2019).

1.5.5 Economic Development and Nutritional Deficiencies

The correlation between economic development and child nutrition is multifaceted, as economic growth does not always result in a superior nutritional result. Based on research, though an increase in per capita income enhances access to foodstuffs and health access, the prevalence level reduction in child undernutrition remains behind economic growth. A look at the history of nutrition in India shows that child

malnutrition decreases at about half the per capita GDP growth rate. It shows the complicated link between economic growth and reducing malnutrition (Deaton & Drèze, 2009). The results show that just growing the economy will not fix malnutrition; policymakers must add health and nutrition programs specific to the problem. A case study of the development history of Kerala shows that economic growth affects poor communities differently. The benefits of the overall economic growth of Kerala have not been shared equally among all communities in Attappadi, home to the Adivasi people. Indigenous groups continue to have nutritional problems because there are no policies that include everyone, and there are inequalities in institutions, even though the state has high socio-economic indicators (George, 2023). Changes in farming and the movement of native people have greatly affected food security and nutrition.

In the past, tribal groups in Attappadi relied on subsistence farming and native food systems to get their food, which gave them diets that were high in nutrients. Changes in society and the environment, like land loss and the commercialisation of farming, have weakened socio-economic and cultural traditions and caused serious nutritional problems. The shift in traditional dietary behaviour towards one shaped by market forces has reduced dietary diversity and reliance on less nutritious food (Edison & Devi, 2019). Economic and environmental shifts have helped erode customary food habits. That is why it is so important for legislation promoting support for indigenous food systems and economic integration to be passed. To combat a high incidence of malnutrition, sustainable forms of agriculture and protection for tribal land rights are essential. In addition, government action promoting access to affordable, nutritious food sources and increased healthcare provision for people in tribal areas is essential for balancing economic progress with health in the population. Other research found a state level link between child nutrition. Its results indicate a connection between a high level of child nutrition and a high level of state level development (Som et al., 2007).

Economic development does lift living standards, but it does not affect malnutrition directly. Instead, it does so through social, cultural, and environmental factors (Haddad et al., 2015). Undernutrition is still common even though the economy is

improving, which shows how important it is to stay focused. These complex strategies bring together policies on health, nutrition, and the economy to make a more inclusive framework for development. To ensure long term health for at risk communities, stopping land expropriation, supporting traditional food systems, and ensuring everyone has equal access to table resources are important.

1.5.6 Dietary Habits and Malnutrition

Dietary habits are essential for determining how healthy children are, and changes in what they eat can lead to undernutrition and diet related chronic diseases worldwide. Children are very likely to be malnourished because of changes in how they eat and live. Poor dietary practices weaken the immune system, making children more prone to infections such as diarrhoea, malaria, and respiratory illnesses, resulting in malnutrition (Blössner et al., 2005). South African children with inappropriate eating habits defined by reduced intake of foodstuffs rich in nutrients and increased intake of foodstuffs rich in energy are significant causes of child malnutrition (Mkhize & Sibanda, 2020). South African children whose families are impoverished experience compromised dietary adequacy in addition to compromised access to medical care centres and are thus most vulnerable to malnutrition (Sharma et al., 2020).

Cultural beliefs and practices are essential in determining food choices in society, mostly in tribal settings. In Sub-Saharan Africa, cultural taboos and dietary restrictions guide children not to take certain nutrient rich foods, thus making such children vulnerable to malnutrition (Janin et al., 2012). Nutrition interventions that are culturally sensitive and recommend consuming locally available nutrient rich foods are in a position to address such a challenge. Moreover, worldwide efforts have increasingly appreciated early life interventions in fighting malnutrition. These kinds of programs can improve the quality of the diets of people and lower the number of malnourished. We must take a whole person approach to malnutrition, including encouraging healthy eating, making it easier to get healthy foods, and considering the social and economic factors affecting health. Community based nutrition programs can help children in poor communities who are malnourished get the nutrients they need to stay healthy.

1.6 Research Gap

Despite extensive research on malnutrition among children under five in India, studies focusing on different tribal communities, particularly in Attappadi, remain limited. While existing literature stresses socio-economic, maternal, health-related, environmental, and cultural determinants of malnutrition, most studies treat tribal populations as homogeneous. Distinct tribal communities inhabit Attappadi - Irula, Muduga, and Kurumba - each possessing unique socio-cultural practices, dietary habits, and livelihood patterns that affect nutritional outcomes. The lack of tribe specific research restricts our comprehension of the distinct manifestations of malnutrition within these communities and stresses the formulation of focused therapies. National surveys like the NFHS offer general insights into malnutrition trends but do not account for particular, community-specific issues influencing tribal communities. There is limited research on the relationship between food security and malnutrition among indigenous children. Limited research addresses how household impoverishment, land relocation, and economic shifts affect Indigenous diets and nutrition. ICDS and other government feeding programs often ignore tribe specific needs. Researchers must assess the efficacy of these interventions in Attappadi by considering the distinct nutritional vulnerabilities of Irula, Muduga, and Kurumba children.

Researchers must learn about the traditional food systems, eating habits, and health of kids in tribal communities. This study fills the gaps by looking at how common malnutrition is, what causes it, and how the eating habits and nutritional status of tribal communities are linked. To make choices about policies and specific actions, we need this information.

1.7 Research Question

The central research question guiding this study is: What are the principal axes of malnutrition in tribal children under five in Attappadi? In order to explore this phenomenon, the study examines different aspects of malnutrition, starting with its prevalence and related patterns. It aims to assess the extent of stunting, wasting, underweight, and overweight among tribal children and understand the variations in nutritional status across the three tribal communities, Irula, Muduga and Kurumba.

In addition, the study analyses how income, education, occupation, and deprivation influence child nutrition. Specific attention will be given to examining the interaction of maternal education and nutritional awareness and their effect on child nutritional outcomes. The study will also assess the role of household food security, child feeding strategies, and diet diversity. The study will examine how maternal health contributes to child nutrition. It will also evaluate the involvement of fathers in child nutrition and care to understand its influence on household dietary and health related decisions. Finally, the research will assess policy and program effectiveness by identifying gaps and challenges in implementing nutrition and health programs for tribal children. It will also promote the perception of tribal families towards government interventions and suggest ways to strengthen existing policies and programs to achieve better nutritional outcomes. Through these broad research questions, the study attempts to provide an in-depth understanding of malnutrition among tribal children in Attappadi and to provide empirically grounded solutions for its mitigation.

1.8 Objectives of the Study

1. To examine the nutritional status of children under five years in Kerala.
2. To analyse the extent of malnutrition among tribal children under five years in Attappadi.
3. To identify the determinants of malnutrition among tribal children under five years in the study area.
4. To analyse the association between household deprivation and the nutritional status of tribal children under five years in Attappadi.
5. To examine the relation between nutritional status and nutritional factors among tribal children in Attappadi.

1.9 Hypothesis

1. There is no significant association between household deprivation status and the nutritional status (wasting, underweight, and stunting) of tribal children (aged 0-59 months) in Attappadi. H₁: There is a significant association between household deprivation status and the nutritional status (wasting, underweight, and stunting) of tribal children (aged 0-59 months) in

Attappadi.

2. There is no significant association between the nutrition status of children (aged 0-59 months) in Attappadi and their Child Food Consumption Score (CFCS). H₁: There is a significant association between the nutrition status of children (0-59 months) in Attappadi and their Child Food Consumption Score (CFCS).
3. There is no significant association between the Child Dietary Diversity Score (CDDS) and the nutrition status (wasting, underweight, and stunting) of tribal children (aged 0-59 months) in Attappadi. Alternative Hypothesis (H₁): There is a significant relation between the Child Dietary Diversity Score (CDDS) and the nutrition status (wasting, underweight, and stunting) of tribal children (aged 0-59 months) in Attappadi.

1.10 Conceptual Framework

The present study develops a conceptual framework to analyse the multidimensional determinants of malnutrition among tribal children under five in Attappadi. It builds on the UNICEF Conceptual Framework for Malnutrition (2021) but adapts it to the socio-cultural heterogeneity of the three tribal communities in Attappadi - Irula, Muduga, and Kurumba. While national surveys such as NFHS provide broad estimates, they fail to capture localised influences like traditional food practices, dietary diversity, cultural norms, and household deprivation that significantly shape child nutrition.

Definition of the Child Population

‘Children’ generally refers to individuals in the early stages of life. According to the United Nations Convention on the Rights of the Child (UNCRC, 1989), a child is any person under 18 years of age unless the laws of a particular country define majority status differently. For health and nutrition research, including in national and international surveys like WHO evaluations and NFHS surveys, children aged 0-59 months are commonly analysed because this age group is essential for growth and development (WHO, 2006; IIPS & ICF, 2021). This study analysed children between 0 and 59 months because this is an essential window of opportunity in child care for reducing or treating malnutrition.

The model holds that malnutrition is caused by immediate and structural causes, which are marked by multiple linkages between internal and external determinants. The framework captures the role of food access, socio-economic status, feeding practices and food security in explaining nutritional outcomes by integrating measures such as the Household Deprivation Score (HDS), Child Food Consumption Score (CFCS), Child Dietary Diversity Score (CDDS) and Child Food Insecurity Access Scale (CFIAS) Score.

Internal Factors:

- **Socio-economic Status:** Household deprivation, income, parental occupation, and land ownership are hypothesised to directly affect food security and healthcare access, influencing nutritional outcomes.
- **Maternal Status:** Maternal age, education, occupation, and nutritional/health awareness mediate child health and nutrition, influencing feeding practices, healthcare utilisation, and dietary diversity.
- **Child Related Factors:** Birth order, birth interval, and family size affect intra household food distribution and caregiving, potentially leading to disparities in child nutrition.

External Factors:

- **Environmental Conditions:** Water quality, sanitation, and cleanliness contribute to disease burden and undernutrition (wasting and stunting).
- **Institutional Support:** Access to healthcare, immunisation, Anganwadi services, ICDS, Poshan Abhiyan, and the Public Distribution System (PDS) play a crucial role in determining the adequacy of child nutrition.
- **Cultural Practices:** Traditional food systems, food taboos, indigenous beliefs, etc., shape feeding practices, influencing dietary diversity and overall child health outcomes.

Dependent Variable:

Malnutrition in this study includes:

- **Undernutrition:** Wasting (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age).
- **Micronutrient related deficiencies,** particularly iron, iodine, and vitamin A,

affect immunity and growth.

- Overweight/Obesity: Although no cases were reported in preliminary fieldwork, it remains part of the broader definition of malnutrition.

Link to Research Problem, Objectives, and Hypotheses:

By recognising the multidimensionality of malnutrition and the heterogeneity of tribal communities, the framework aligns with the research problem. It structures the determinants under measurable variables that correspond to the research objectives:

- Objective 2 & 3 (extent and determinants): Captured through socio-economic, maternal, child, environmental, institutional, and cultural domains.
- Objective 4 (household deprivation): Explicitly modelled through the HDS and linked to malnutrition hypotheses.
- Objective 5 (nutritional factors): Operationalised via CFCS, CDDS, and CFIAS, aligned with the hypotheses that test their association with malnutrition outcomes.
- Accordingly, the hypothesised relationships are:
- Household deprivation (HDS) is significantly associated with malnutrition outcomes.
- Child nutrition status is influenced by food access, and CFCS and CDDS food diversity are measured.
- Maternal education and awareness moderate the adverse effects of deprivation.
- Environmental and institutional factors interact with socio-economic and cultural variables to exacerbate or mitigate malnutrition.

This framework thus provides a systematic and culturally contextualised model to analyse child malnutrition in Attappadi. It integrates quantitative measures (HDS, CFCS, CDDS) with socio-cultural and institutional factors, making it suitable for empirical testing while remaining sensitive to tribal contexts.

1.11 Research Methodology

The present study adopted a mixed-methods approach, combining quantitative and qualitative methodologies to thoroughly investigate malnutrition affecting tribal

children aged 0 to 59 months in the Attappadi block panchayat of Palakkad district, Kerala. While the study primarily emphasised quantitative data, qualitative insights were included to capture the cultural, behavioural, and structural aspects influencing child nutrition.

1.11.1 Research Design

The present study employed a community-based cross-sectional design in estimating different multidimensional factors responsible for malnutrition in tribal children between 0-59 months in Attappadi block panchayat situated in Palakkad district in Kerala. The researcher obtained a list containing 192 tribal villages (Oorus) retrieved from Attappadi Integrated Tribal Development Project (ITDP), the apex agency coordinating tribal development activity. Using a stratified random sampling technique, 25 villages were selected, comprising 18 Irula, 4 Muduga, and 3 Kurumba villages. A house listing was conducted with the support of Anganwadi Workers (AWWs), Accredited Social Health Activists (ASHAs), and Village Promoters to identify 625 eligible households with at least one child aged 0–59 months.

To supplement the quantitative component, qualitative methods, specifically target group discussions, were conducted with mothers, fathers, community elders, Anganwadi teachers, health workers, and tribal promoters. This qualitative phase explored deeper cultural and systemic issues affecting child nutrition.

1.11.2 Sample Size Determination

Due to the unavailability of reliable official data on the number of tribal children under 5 years of age in Attappadi, the sample size was estimated using the 2022 population statistics for Kerala as a reference. Kerala had approximately 35 lakh children below the age of six and around 78 lakh households, yielding an average of 0.5 children per household. In Attappadi, 11,247 tribal households were recorded. Applying the state-level average (0.5 children per household) resulted in an estimated 5,625 children in the study area. Given the relatively higher fertility rates among tribal communities, an additional 20% was added to the estimate, bringing the projected child population to approximately 6,800. Based on this estimated population, a 10% sample was initially proposed, resulting in a target of

680 children. However, the final sample size was adjusted to 625 children to ensure proportional representation across the three major tribal communities in Attappadi. The distribution was as follows: 450 Irula (80%), 100 Muduga (12%), and 75 Kurumba (8%)(Government of Kerala, 2022; NFHS,2022), reflecting their respective population shares. Thus, the sampling frame was proportionally structured to reflect the demographic composition of the tribal communities in the study area.

1.11.3 Tools and Techniques of Data Collection

a. Question Schedule

A pre-tested, structured questionnaire collected information on socio-economic characteristics, demographic details, dietary habits, child health status, and household level variables. The schedule was developed in consultation with experts and fieldtested for clarity and reliability.

b. Anthropometric Measurement Devices

Anthropometric measurements were carried out using standardised tools:

Seca 813 electronic scale for body weight

Seca 213 stadiometer for standing height (children above 2 years)

Seca 417 infantometer for recumbent length (children under 2 years or <85 cm)

1.11.4 Dietary Assessment Tools

To evaluate food and nutrient intake, the following dietary recall methods were used:

- 24-hour dietary recall
- 7-day food group recall
- 30-day recall for food insecurity

Three validated tools were used to analyse food and nutrition intake:

a. Child Dietary Diversity Score (CDDS)

Developed using the ICMR-NIN food group classifications, CDDS assessed the variety of food groups consumed in the past 24 hours. A higher score reflects greater dietary diversity and nutrient adequacy.

b. Child Food Consumption Score (CFCS)

Based on a 7-day recall, CFCS measured the frequency and variety of nutrient-

dense foods consumed. It helped identify gaps in food intake that contribute to malnutrition.

c. Child Food Insecurity Access Score (CFIAS)

Using a 30-day recall, CFIAS assessed household food access and food shortage experiences. It served as a key indicator for understanding economic vulnerabilities affecting child nutrition.

The nutrient composition was computed using the Indian Food Composition Tables (IFCT) and the Nutritive Value of Indian Foods (ICMR-NIN, 2020). The average and median intake values were compared with the Recommended Dietary Intakes (RDI) and the Recommended Dietary Allowances (RDA) for Indians.

1.11.5 Anthropometric Measurements and Nutritional Assessment

The WHO child growth standards were used to assess nutritional status through three indicators:

- The Height-for-age Z-score (HAZ) is used to assess stunting
- The Weight-for-height Z-score (WHZ) is used to assess wasting
- The Weight-for-age Z-score (WAZ) is used to assess underweight

Z-scores were calculated using WHO-Anthro software. Classifications were made as follows:

Table 1.1
Classification of Nutritional Status of Infants and Children by the WHO

Measures	Severe	Moderate	Normal	Overweight/ Obesity
Stunting (HAZ)	<-3SD	<-2SD	-2 SD to +2SD	
Wasting (WHZ)	<-3SD	<-2SD	-2 SD to +2SD	>+2SD
Underweight (WAZ)	<-3SD	<-2SD	-2 SD to +2SD	
MUAC	<11.5 cm	<12.5 cm		

Source: World Health Organisation. (2017). *Guideline updates on the Integrated Management of Childhood Illness (IMCI)*. WHO.

1.11.6 Qualitative Component: Thematic Exploration

To gain context-specific insights into malnutrition, thematic analysis was applied to narratives from diverse community stakeholders. The qualitative component helped reveal underlying social, cultural, and behavioural dimensions - such as gender roles, food taboos, mistrust in public healthcare, and systemic neglect - that quantitative tools could not fully capture. Key themes included the disintegration of

traditional food systems, early marriage, inadequate caregiving, cultural resistance to nutritious foods, and underutilisation of welfare schemes. These insights enriched the interpretation of statistical results and informed actionable recommendations.

1.11.7 Data Collection

Field data were collected between March 1, 2024, and May 30, 2024. Anthropometric measurements and guided interviews were conducted in all the households selected. Standard tools were employed to ensure that anthropometric measurements of child and maternal height and weight were taken accurately. Interviews were facilitated in the local language with assistance from trained field investigators and local health workers.

1.11.8 Data Analysis

Quantitative data were analysed using R Studio (version 4.4.2). The following methods were employed:

- Descriptive statistics to summarise key variables.
- Chi-square tests to assess the prevalence of malnutrition and categorical associations.
- Correlation analysis to examine relationships between nutrition indicators.
- Logistic, multiple and simple linear regressions to identify predictors of malnutrition.
- Regression analysis is used to examine the association of the nutritional status with household deprivation and nutritional factors.
- Z-score generation for HAZ, WHZ, and WAZ using WHO-Anthro software.

Qualitative data were analysed thematically, allowing for the identification of patterns across stakeholder narratives that explain systemic and cultural barriers to nutritional improvement.

1.12 Organisation of the Study

Chapter 1 introduces malnutrition among tribal children in Attappadi, emphasising its relevance and urgency. It formulates the problem statement, emphasising the profound health implications of tribal children. The chapter outlines the key research questions and objectives based on theoretical and conceptual frameworks

that determine the determinants of malnutrition. The literature review provides context, examining global and national trends, contributing factors, and intervention strategies. The research gap is defined to establish the relevance of the study. Methodology describes the study design, sampling, tools, and statistical methods. The chapter concludes with the chapter scheme, summarising the structure of the thesis.

Chapter 2 gives an overview of the nutritional status of children. The chapter examines the nutritional status of children at the global, national, and state levels. It discusses global malnutrition trends, malnutrition patterns in India, and the nutritional landscape in Kerala. Different measures to combat malnutrition are highlighted, covering national and state level interventions, community based approaches in Kerala, and initiatives by ITDP in Attappadi. The chapter concludes with evaluating nutritional programs and strategies for improving child nutrition.

Chapter 3 presents a detailed analysis of malnutrition among tribal children under five in Attappadi. It begins with the socio-economic and demographic profile of the sample population, followed by the prevalence of stunting, wasting, and underweight among children. Regression analysis and correlation examine associations between indicators of malnutrition and covariates, including household deprivation, mother characteristics, and tribal status and determine key health inequities. Additionally, the chapter contains thematic opinions from mothers, fathers, elders, health providers, Anganwadi teachers, and tribal advocates about cultural practices and structural issues affecting child nutrition. Further, it examines neonatal and infant deaths within the region for their causes and consequences.

Chapter 4 explores the basic determinants for malnutrition in tribal children aged between 0 and 59 months in Attappadi. It focuses on identifying key predictors linked with undernutrition, such as wasting, stunting, and underweight, in addition to emerging problems of overweight. The predictors of malnutrition are divided into internal and external factors of malnutrition. Internal factors include household deprivation, income, employment status of parents, maternal attributes, and personal characteristics of children, and external factors include environmental circumstances, accessibility to healthcare, institutional support, and cultural factors.

Regression analysis is used to determine the robustness of such links. As a result, the chapter provides an overview of the complex associations between household, maternal, child, environmental, institutional, and cultural variables which act in concert towards influencing the nutritional wellness of tribal children in Attappadi. Chapter 5 addresses the issue of household deprivation for the nutritional status of children in tribal communities. Here, it intends to initiate a measure called the Household Deprivation Score (HDS) and explore its association with malnutrition of tribal children using a combination of a chi-square test and a series of multiple regression models. Emphasis is placed on an estimated prevalence distribution for indicators of malnutrition, such as wasting, underweight, and stunting, at various deprivation levels. Moreover, its association at a more aggregate level with the nutritional status of children is studied in multiple regression environments for analysing wider socio-economic determinants.

Chapter 6 clarifies the link between nutritional status and dietary factors in tribal children. Chapter 6 depicts dietary practices in tribal children and shows the Child Dietary Diversity Score (CDDS), the Child Food Consumption Score (CFCS), and the Child Food Insecurity Access Scale (CFIAS). The research describes the spread of indicators of malnutrition defined by such scores and their association with nutritional status by use of the chi-square test as well as multiple regression models. Moreover, it thoroughly investigates the effect of breastfeeding behaviour and maternal body mass index on infant feeding behaviour.

The final chapter summarises key findings on malnutrition among tribal children in Attappadi, highlighting socio-economic, maternal, and environmental factors. It notes limitations like geographic constraints and study design. Practical suggestions target policymakers, communities, households, and healthcare providers. The researcher offers locally relevant insights and proposes targeted interventions, concluding with recommendations for future studies to address continuing challenges that similarly vulnerable communities face.

CHAPTER 2

CHILD NUTRITIONAL STATUS - AN OVERVIEW

2.1 Introduction

Malnutrition remains a major global health challenge, affecting millions of children. The Global Nutrition Report (GNR) 2022 highlights persistent undernutrition, including stunting (149.2 million children) and wasting (45.4 million children), particularly in Africa and South Asia. Even though people all over the world are trying to fix the problem, there are still differences, and underweight children are at high-risk for serious health problems. The World Health Organisation (WHO) set six global nutrition goals for 2025, but GNR 2021 shows five are not on track. Also, the rise in obesity and non-communicable diseases shows that people are eating more ultra-processed foods, which is bad for health. Addressing malnutrition requires urgent, multi-sectoral action to improve child nutrition and total well-being. The present chapter examines the prevalence of malnutrition and its causes and consequences at the global, national, and state levels, focusing on Kerala. It looks at the policy framework of India, which includes national nutrition programs, government actions, and the role of international organisations in fighting wasting, being underweight, being stunted, and not getting enough micronutrients. The chapter also looks at specific plans of Kerala to fight malnutrition, especially among tribal children in Attappadi. The chapter also discusses community-based approaches to working with NGOs and how well government led programs like the Integrated Child Development Services (ICDS) and the Janani JanmaRaksha scheme work. Evaluating these interventions gives us information about their effects, problems, and how they can be improved. This chapter lays the groundwork for identifying the gaps and suggesting ways to improve nutrition security among vulnerable groups by looking at current policies and their results.

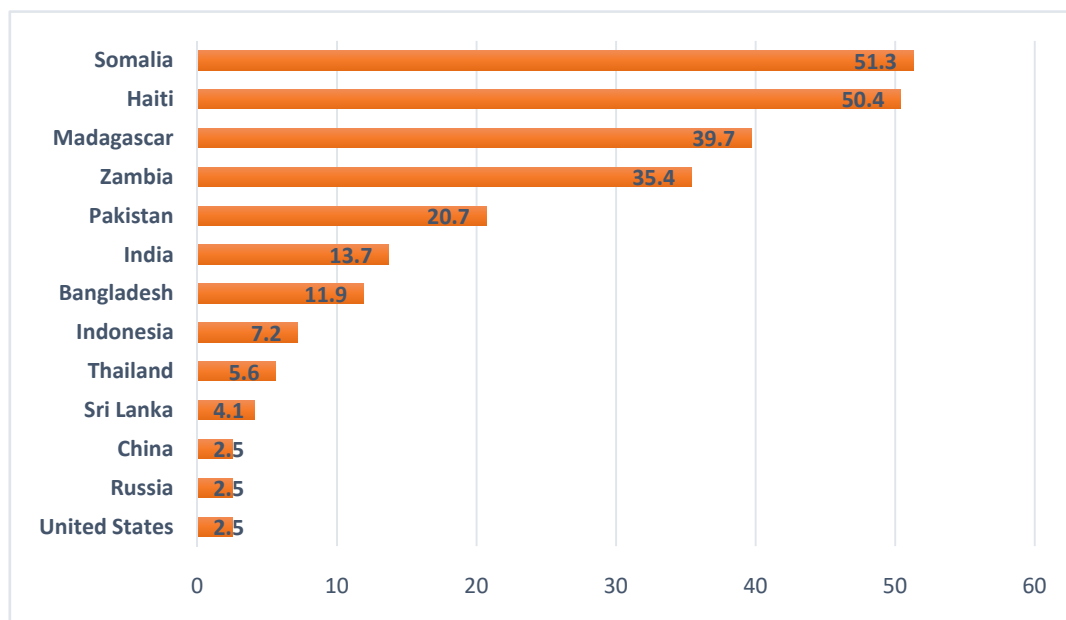
2.2. Global Nutritional Status Among Children

Over the past few decades, the number of people who are malnourished has gone down around the world. In 2000, it was thought that about 15% of people worldwide were malnourished. In 2019, it was thought that about 9% of the world population was malnourished. In a short amount of time, this is a significant drop. Around 690 million people are thought to be undernourished, which is a big

problem that many nonprofit groups are still working to solve. There are still some worries that the global economic problems of the pandemic will make it harder for nonprofits to get the money they need to help people all over the world who are malnourished. Malnutrition persists globally due to limited access to clean water, causing dehydration, food deserts, and restricting fresh food availability. These factors and logistical challenges in developing countries drive high malnutrition rates worldwide.

Malnutrition is still a significant problem all over the world, and some countries have higher rates of malnutrition than others. As per the World Population Review 2024, most of Africa is still developing; it should be no surprise that Africa has a significant malnutrition rate. The country with the highest rate of malnutrition in the world is Somalia. In 2022, it was estimated that 51.3% of people in Somalia suffered from malnutrition. The United Nations has worked hard to give the people of Somalia access to more national resources, but malnutrition is still a big problem in this country.

Figure 2.1
Malnutrition Rate by Country 2021-2023



Source: Malnutrition Rate by Country 2024 - World Population Review

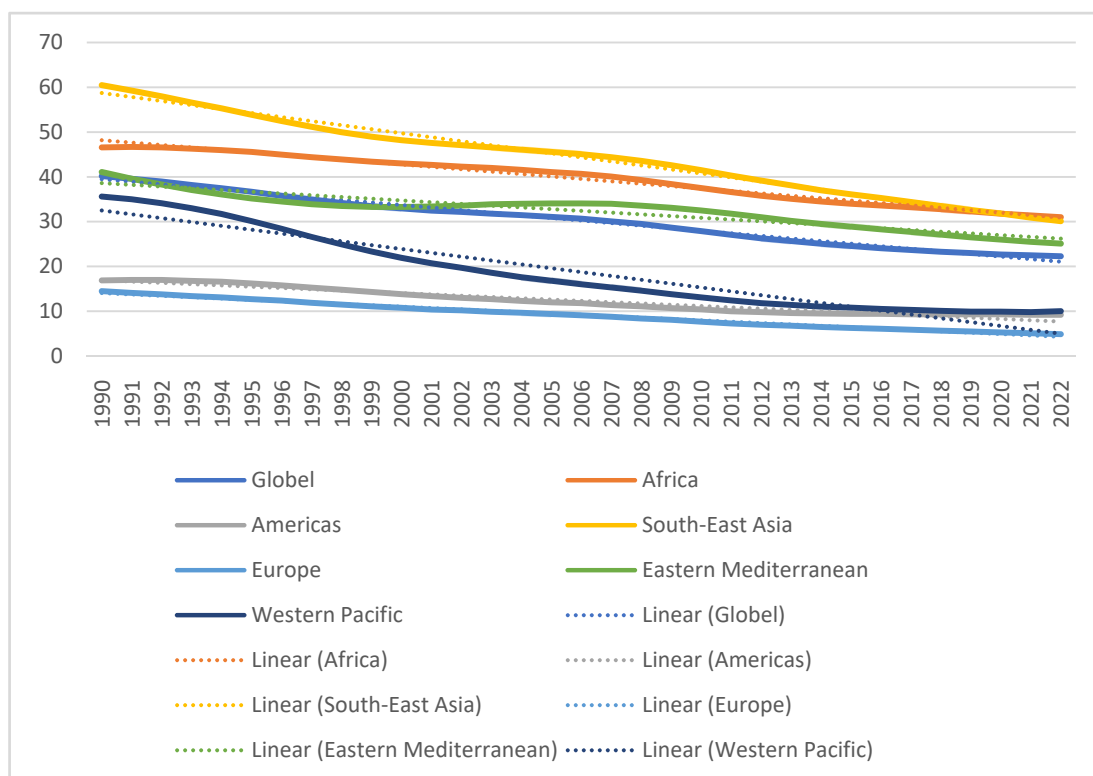
Many other countries also have very high rates of malnutrition. Haiti, for instance, is thought to have a malnutrition rate of about 50.4%. It means that more than half of the people in the country are malnourished. People in Madagascar, an East

African country, are also thought to be very malnourished at a high rate. Experts estimate that about 39.7% of people in Madagascar are malnourished. Lastly, Yemen is also known to have a very high rate of malnutrition. About 39.5% of Yemenis are malnourished, which has caused many problems in this country.

2.2.1 Regional Disparities in Undernutrition

Child malnutrition remains a significant global concern of varying prevalence across different regions. The WHO region-wise data on stunting, underweight, overweight, and wasting among children under five highlight disparities in nutritional status. The global prevalence of stunting among children under five has significantly declined from 40.2% in 1990 to 22.3% in 2022, reflecting a substantial global effort to combat child malnutrition. Southeast Asia exhibited the highest stunting prevalence in 1990 (60.5%) but showed a remarkable decline to 30.1% in 2022. Africa also had a high prevalence (46.6% in 1990), reducing to 31% in 2022, though it remains above the global average. Initially, at 41.1%, the Eastern Mediterranean region saw a consistent decline to 25.1% in 2022. The Americas and Europe have had the lowest stunting rates throughout the years, with Europe showing the most significant reduction, from 14.5% in 1990 to 4.9% in 2022, the lowest among all regions. The Western Pacific region steadily improved, reducing stunting from 35.6% in 1990 to 10% in 2022. Despite these positive trends, Africa and Southeast Asia still have stunting rates above the global average, indicating persistent nutritional challenges. The highest burden continues in Southeast Asia and Africa, where interventions are most needed. In short, while global stunting prevalence has declined, significant regional disparities persist, particularly in low resource settings.

Figure 2.2
WHO Region-wise Prevalence of Stunting Among Children
Under Five Years of Age (% height-for-Age <-2SD)

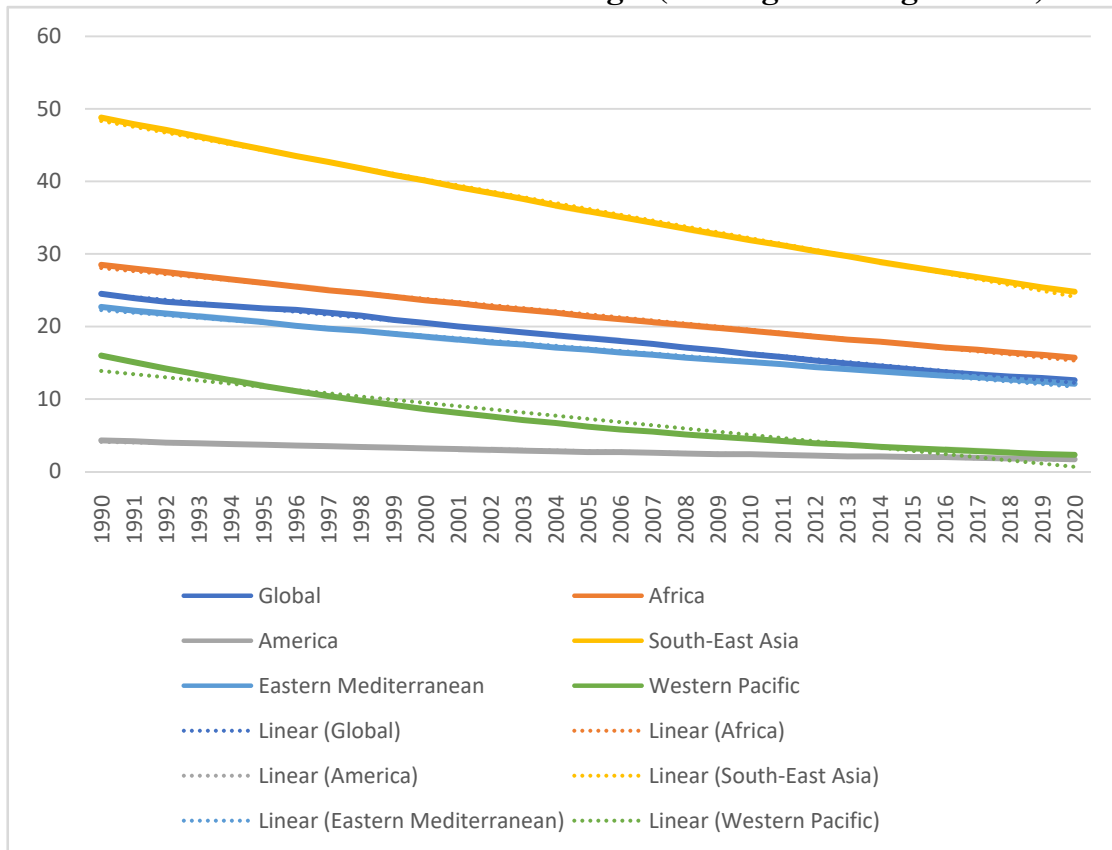


Source: Compiled from Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Stunting: 1990-2020.

The global prevalence of underweight children under five has shown a steady decline from 24.5% in 1990 to 12.6% in 2020, indicating global progress in tackling child malnutrition. South East Asia had the highest prevalence in 1990 (48.8%) and, despite a significant decline, still recorded 24.8% in 2020, remaining the worst affected region. Africa also exhibited a high prevalence of underweight (28.5% in 1990), decreasing to 15.7% in 2020 but still above the global average. The Eastern Mediterranean region started at 22.7% in 1990 and improved to 12.1% by 2020, aligning with the trend. The Western Pacific showed steady progress, reducing its underweight prevalence from 16% in 1990 to 2.3% in 2020. The Americas consistently had the lowest underweight rates, starting at 4.3% in 1990 and dropping to 1.7% in 2020. Despite global improvements, Southeast Asia and Africa continue to bear the highest burden of underweight children, reflecting ongoing nutritional and socio-economic challenges. In short, while global underweight prevalence has declined substantially, disparities remain, with

Southeast Asia and Africa requiring intensified nutrition interventions to reduce child malnutrition further.

Figure 2.3
WHO Region-Wise Underweight Prevalence Among
Children Under Five Years of Age (% weight-for-Age <-2SD)



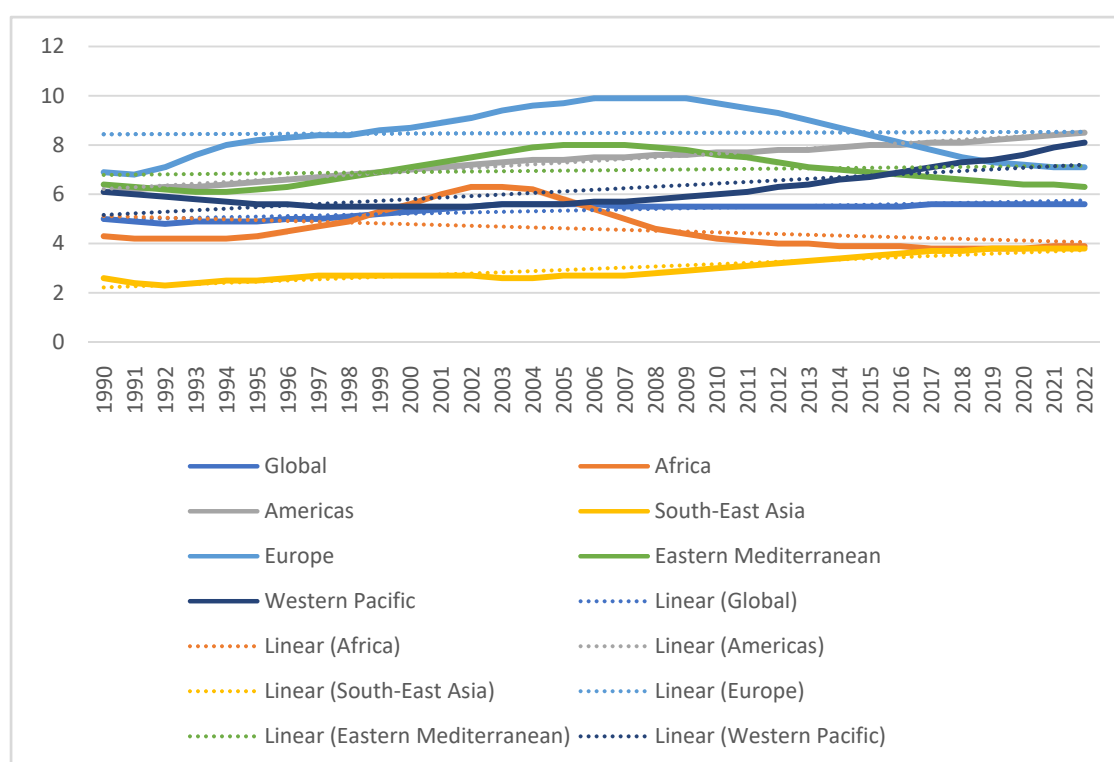
Source: Compiled from Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Underweight: 1990-2020.

The number of overweight kids under five worldwide has stayed stable, between 5% and 5.6% from 1990 to 2022. However, there are significant differences between regions. The Americas have always had the highest rates, from 6.1% in 1990 to 8.5% in 2022. It shows that people are becoming more worried about childhood obesity. Europe has a similar pattern, with a peak of 9.9% in 2007 and a slow drop to 7.1% in 2022. The Eastern Mediterranean region also had a high rate, peaking at 8% in 2005 and dropping slightly to 6.3% in 2022.

Southeast Asia, on the other hand, has many undernourished people. It had the lowest rate of overweight people (2.6% in 1990), up to 3.8% in 2022. The percentage of Africa increased slightly from 4.3% in 1990 to 3.9% in 2022. In contrast, the percentage steadily rose in Western Pacific regions, reaching 8.1% in

2022. These trends show that being overweight and obese is becoming more of a problem in some areas, especially in the Americas and Europe. At the same time, undernutrition is still a big problem in Southeast Asia and Africa. In short, the data shows that there is a double burden of malnutrition, with some areas having problems with both undernutrition and rising rates of overweight people. To solve these problems effectively, targeted interventions are needed.

Figure 2.4
WHO Region-wise Overweight Prevalence Among Children
Under 5 Years of Age (% weight-for-height >+2 SD)

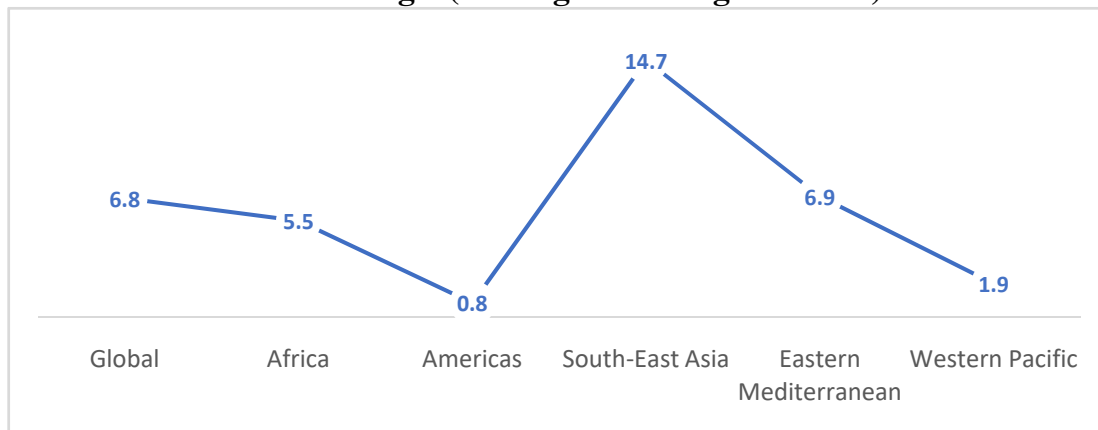


Source: Compiled from Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Overweight: 1990- 2020.

Wasting, or acute malnutrition, is still a big problem worldwide. In 2022, 6.8% of children under five were affected. Southeast Asia had the highest rate at 14.7%, which shows that it is still having trouble with severe child malnutrition. The Eastern Mediterranean area also had a high rate of 6.9%, higher than the world average. Africa had a lower prevalence of 5.5%, even though it was undernourished. The Americas (0.8%) and the Western Pacific (1.9%) had the lowest levels, meaning their nutritional status was relatively better. The big difference between regions shows deeper social and economic problems. Southeast

Asia needs immediate action to stop child malnutrition.

Figure 2.5
WHO Region-wise Wasting Prevalence Among Children
Under 5 Years of Age (% weight-for-height <-2 SD) in 2022



Source: Compiled from Joint Child Malnutrition Estimates (UNICEF-WHO-WB)

Malnutrition is still a big problem for the health of people all over the world, but it hits kids in low and middle income countries the hardest, especially in Africa and South Asia. Even though there has been much progress in lowering the rates of stunting and being underweight, there are still differences, especially among tribal groups, because of socio-economic and geographic barriers. Global efforts, including the nutrition goals of the WHO, have succeeded, but many goals remain unmet. To fix undernutrition, we must work together across sectors, make healthcare more accessible, ensure food security, and improve education. We need long-term policies, targeted interventions, and community involvement to close nutritional gaps and ensure that all children, especially the most vulnerable, have a healthier future.

2.3 Malnutrition in India

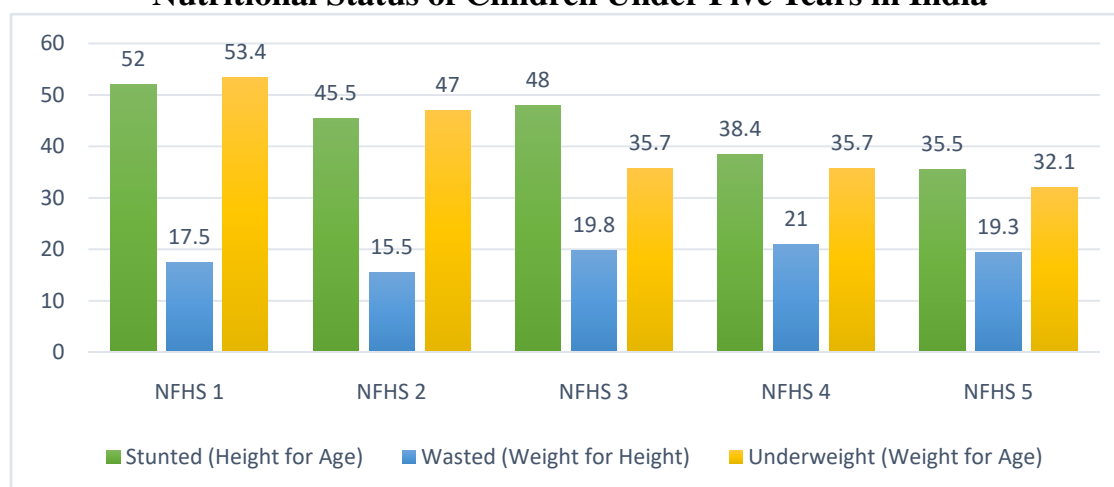
Malnutrition is still a significant public health problem in India, especially for children under five. Even though rates of stunting, wasting, and being underweight have gone down, there are still differences between rural and urban areas, men and women, and people from different socio-economic backgrounds. The National Family Health Survey (NFHS) data from NFHS-1 to NFHS-5 show progress and setbacks in the fight against child malnutrition. Even though the number of stunted and underweight children has gone down, wasting is still a significant problem. The

secondary data analysis on the nutritional status of India shows that targeted interventions are needed to improve child nutrition and overall health.

2.3.1 Nutritional Status of Children Below Five Years in India

The NFHS collects anthropometric data on the height and weight of children to assess nutritional status in India. Measurements identify at risk groups for stunting, wasting, and malnutrition. Three indices height-for-age, weight-for-height, and weight-for-age help to evaluate chronic and acute undernutrition, aiding targeted interventions. The NFHS data on child malnutrition from NFHS-1 to NFHS-5 show a significant decline in stunting, wasting, and underweight prevalence. Stunting (height-for-age) has decreased from 52% in NFHS-1 to 35.5% in NFHS-5. Similarly, underweight children (weight-for-age) declined from 53.4% to 32.1%. Wasting (weight-for-height) increased slightly, but it is still a problem. It went down from 17.5% in NFHS-1 to 19.3% in NFHS-5. From NFHS-3 to NFHS-4, the wasting rate increased by 1.2 percentage points, from 19.8% to 21%. It shows that progress in dealing with severe malnutrition has slowed. However, in NFHS-5, the wasting rate has decreased slightly to 19.3%, which is a slight improvement, but still a big problem. In NFHS-4, 2.1% of kids were overweight, but in NFHS-5, that number rose to 3.4%. India has reduced child malnutrition, but must do more to sustain and accelerate these improvements.

Figure 2.6
Nutritional Status of Children Under Five Years in India

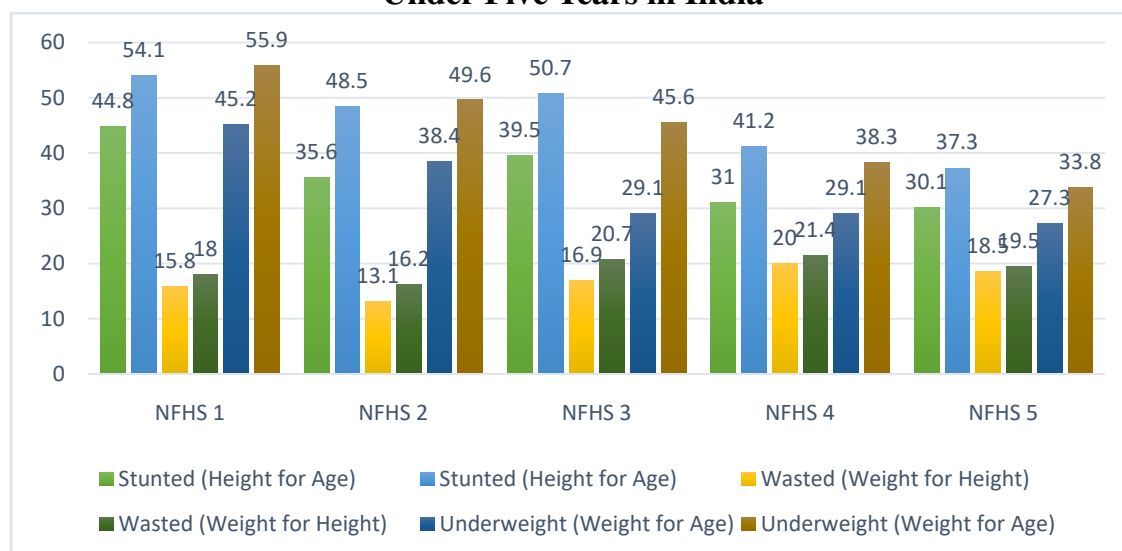


Source: Compiled from NFHS-1 to NFHS-5

The rural and urban divisions in NFHS data show a declining trend in malnutrition

among children under five in both urban and rural areas, though rural children remain more vulnerable. Stunting has significantly decreased from 54.1% (NFHS-1) to 37.3% (NFHS-5) in rural areas and from 44.8% to 30.1% in urban areas. Wasting rates went up and down, reaching their highest point in NFHS-4 at 20% in cities and 21.4% in rural areas before improving. The number of underweight children decreased, but rural kids are still more likely to be underweight (55.9% in NFHS-1 to 33.8% in NFHS-5). Rural children always have higher rates of malnutrition, which shows how important it is to focus on rural India.

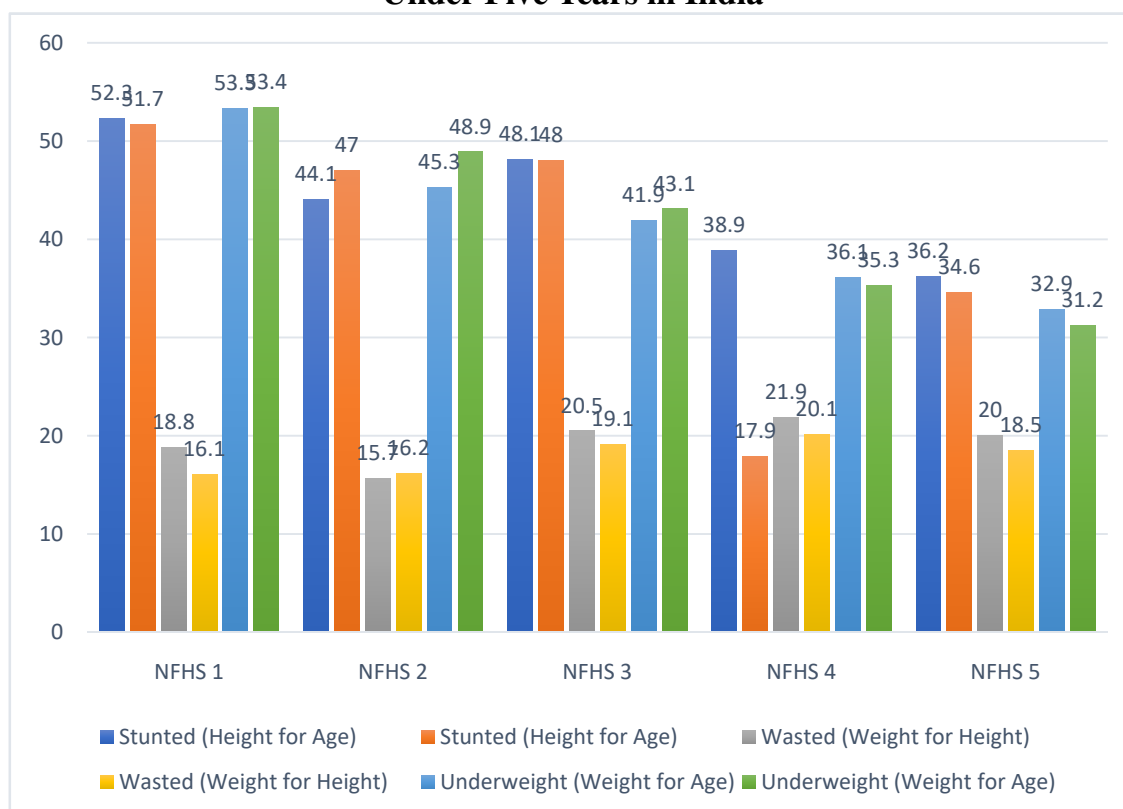
Figure 2.7
Trends in Nutritional Status of Rural and Urban Children
Under Five Years in India



Source: Compiled from NFHS-1 to NFHS-5

There is a steady decline in malnutrition among both male and female children under five years in India. Stunting has decreased for males from 52.3% (NFHS-1) to 36.2% (NFHS-5) and for females from 51.7% to 34.6%, with a sharp decline in NFHS-4. Wasting peaked in NFHS-4 at 21.9% (males) and 20.1% (females) but slightly improved in NFHS-5. Underweight prevalence also dropped, with females improving from 53.4% (NFHS-1) to 31.2% (NFHS-5) and males from 53.3% to 32.9%. Both genders show progress, but persistent wasting requires targeted interventions, particularly for male children.

Figure 2.8
Trends in Nutritional Status of Male and Female Children
Under Five Years in India



Source: Compiled from NFHS-1 to NFHS-5

2.3.1.1 Malnutrition in Indian States

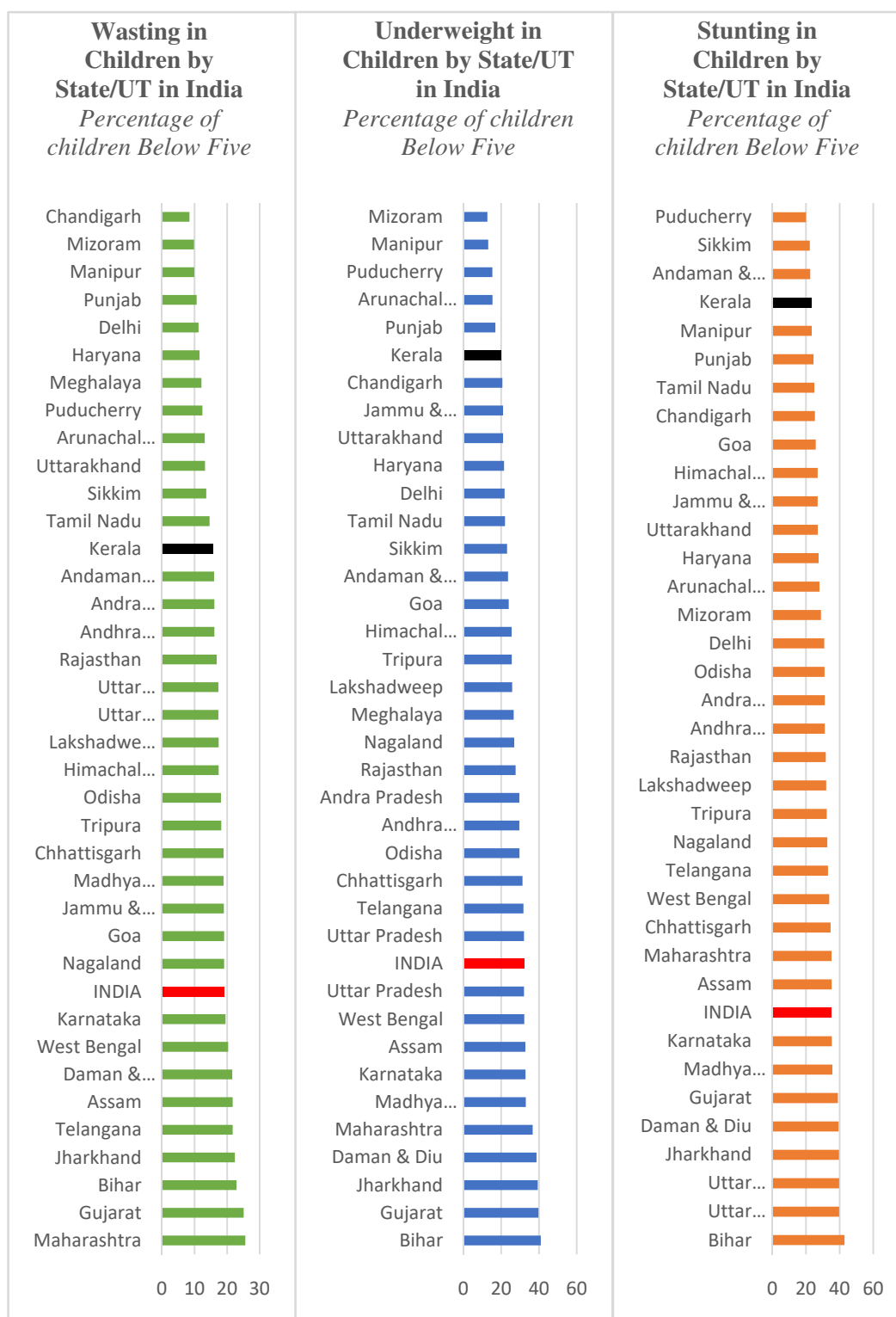
The stunting rate among children below five years varies significantly across Indian states, as per NFHS-5. Meghalaya has the highest stunting rate at 46.5%, followed by Bihar (42.9%) and Uttar Pradesh (39.7%). The national average is 35.3%, with states like Madhya Pradesh (35.7%) and Assam (35.3%) close to it. In contrast, Puducherry has the lowest stunting rate at 20%. The much lower rates in Mizoram, Manipur, and Puducherry point to better child health and nutrition policies. However, in wealthier areas like Kerala and Telangana, the number of underweight kids went up by about 3%. In Kerala, the rates went up from 16.1% to 19.7%, and in Telangana, they went up from 28.5% to 31.8%. It is important to deal with differences by taking specific steps. High burden states need strengthened interventions to improve child growth and development.

The wasting rate (low weight for height) among children under five varies widely across Indian states as per NFHS-5. Maharashtra has the highest wasting rate at

25.6%, followed by Gujarat (25.1%) and Bihar (22.9%). The national average is 19.3%, with states like Karnataka (19.5%) and Nagaland (19.1%) close to it. On the other hand, Chandigarh has the lowest rate at 8.4%, followed by Mizoram (9.8%) and Manipur (9.9%). Wasting is a severe indicator of acute malnutrition, with high levels in Maharashtra and Gujarat requiring urgent intervention. The lower rates in states like Chandigarh and Mizoram highlight better child nutrition and healthcare. The underweight rate (low weight for age) among children under five varies significantly across Indian states as per NFHS-5. Bihar has the highest prevalence at 41%, followed by Gujarat (39.7%) and Jharkhand (39.4%). The national average is 32.1%, with states like Uttar Pradesh (32.1%) and Assam (32.8%) close to it. On the other hand, Mizoram has the lowest underweight rate at 12.7%, followed by Manipur (13.1%) and Puducherry (15.3%). The much lower rates in Mizoram, Manipur, and Puducherry point to better child health and nutrition policies. However, in wealthier areas like Kerala and Telangana, the number of underweight kids went up by about 3%. In Kerala, the rates went up from 16.1% to 19.7%, and in Telangana, they went up from 28.5% to 31.8%. It is important to deal with differences by taking specific steps.

The correlation between stunting, wasting, and underweight rates in Indian states and Union Territories (NFHS-5) shows a significant overlap in child malnutrition patterns. Bihar, Gujarat, and Jharkhand consistently report high prevalence across all three indicators of malnutrition. States like Maharashtra and Madhya Pradesh also show high wasting and underweight levels of malnutrition. Conversely, Mizoram, Manipur, and Puducherry have lower rates in all three categories, suggesting better nutrition and healthcare. The correlation shows that states with high stunting also have high underweight rates, while wasting is more scattered, requiring targeted interventions for both chronic and acute malnutrition. Kerala performs significantly better than the Indian average in all three malnutrition indicators. Stunting in Kerala is 23.4% (India: 35.3%), wasting is 15.8% (India: 19.3%), and underweight is 19.7% (India: 32.1%). However, the condition of Kerala has been worse than that of NFHS-4.

Figure 2.9
Nutrition Status of Children Under Five Years in India by State /UT

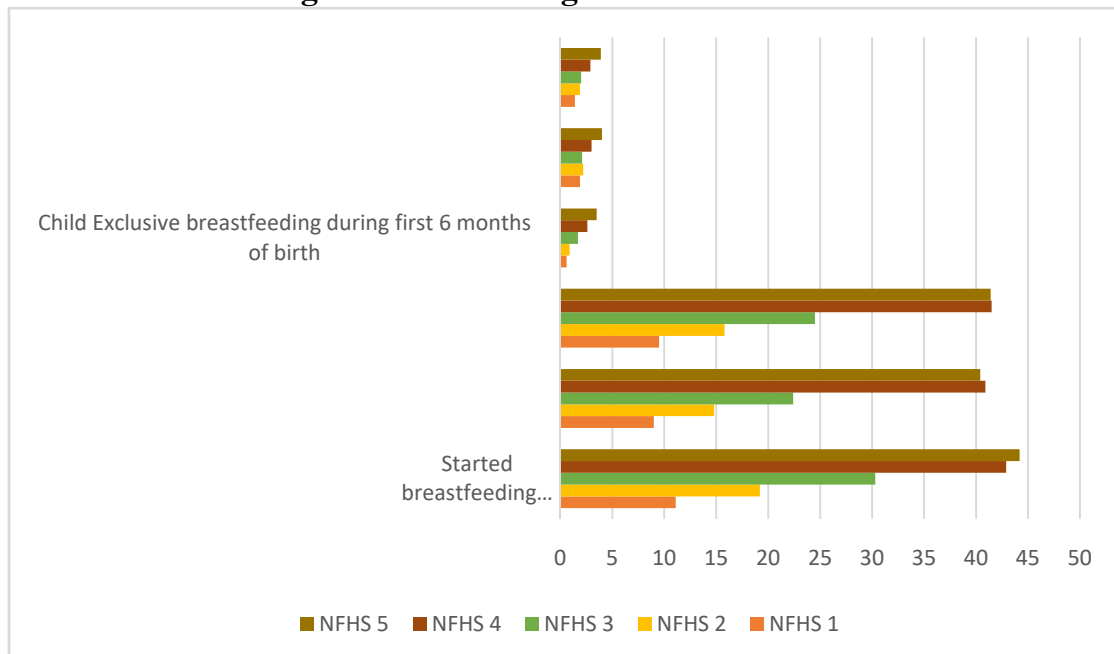


Source: Compiled from NFHS-5

2.3.1.2 Initial Breastfeeding Practices among Children Under Five in India

Early initiation of breastfeeding is important for both the newborn and the mother. The first breast milk is full of colostrum antibodies, which are highly nutritious and give immunity to the newborn from diseases. Early breastfeeding initiation also encourages mother newborn bonding, allowing the mother to provide regular breast milk. Health workers advise parents to initiate breastfeeding by placing the child on the breast immediately or within one hour after birth and to avoid prelacteal feeding, which means giving the newborn anything other than breastmilk before regular breastfeeding begins. The NFHS data reveal a positive trend in early breastfeeding practices in India. The percentage of newborns breastfed within one hour of birth increased from 9.5% in NFHS-1 to 41.4% in NFHS-5, with urban areas showing a slightly higher rate (44.2%) than rural areas (40.4%) in NFHS-5. Similarly, exclusive breastfeeding during the first six months has improved, rising from 1.4% in NFHS-1 to 3.9% in NFHS-5. Rural areas show a higher rate (4%) than urban areas (3.5%) in NFHS-5. Despite this progress, these figures remain low, emphasising the need for more substantial interventions to promote early and exclusive breastfeeding.

Figure 2.10
Initial Breastfeeding Practices Among Children Under Five Years in India

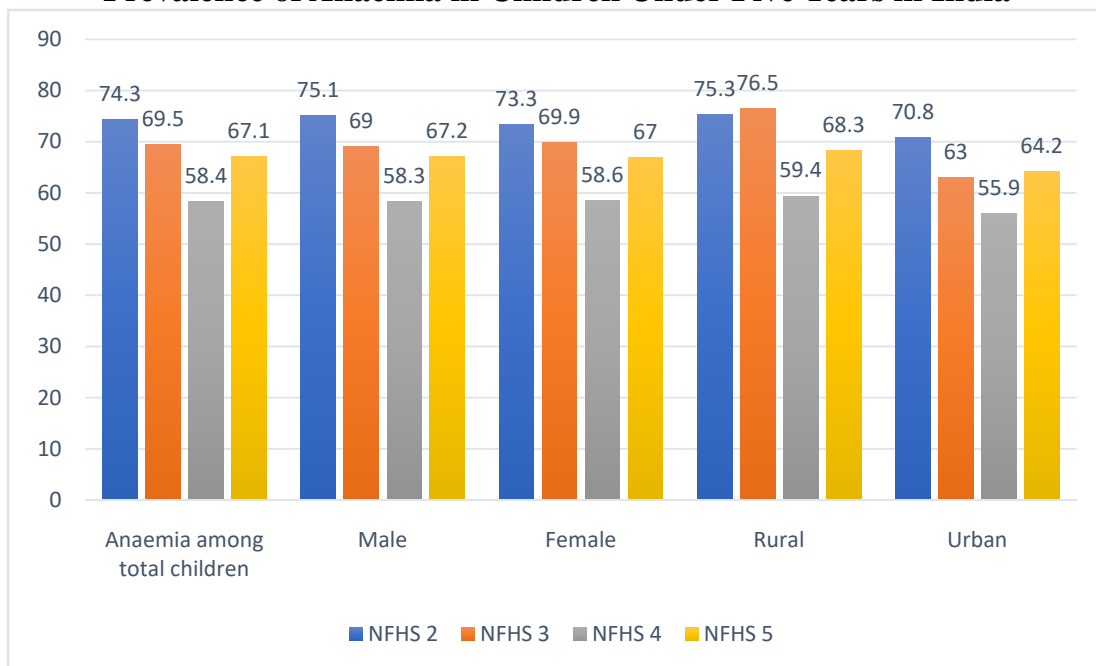


Source: Compiled from NFHS-1 to NFHS-5

2.3.1.3 Anaemia Among Children Under Five Years in India

Iron deficiency, malaria, hookworm, nutritional deficiencies, chronic infections, and genetic diseases primarily cause anaemia, resulting in low haemoglobin levels. Anaemia is highly harmful to children, resulting in poor cognitive function, stunted growth, and increased risk of infection. Anaemia prevention and treatment require good health and nutrition interventions. NFHS data indicate that anaemia trends in children under age five in India are reversing. Between NFHS-2 and NFHS-4, anaemia fell from 74.3% (NFHS-2) to 58.4% (NFHS-4) for all children. NFHS-5, however, reverts to 67.1%, a reversal of gain. The rural-urban gap continues, with anaemia reported to be higher among rural children (68.3% in NFHS-5) compared to urban (64.2%). Gender-wise, it is nearly equal in NFHS-5 (67.2% in males, 67% in females). Notwithstanding the early gain, the increase in anaemia in NFHS-5 confirms that more nutritional interventions and iron supplement programs are required.

Figure 2.11
Prevalence of Anaemia in Children Under Five Years in India



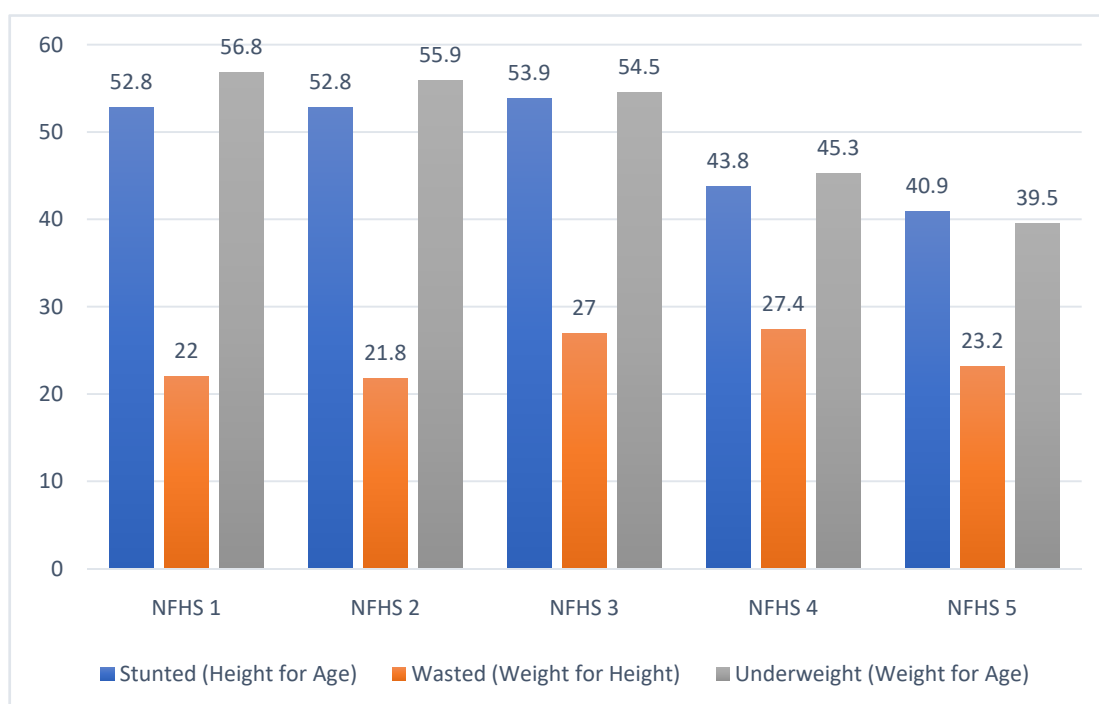
Source: Compiled from NFHS-2 to NFHS-5

2.3.2 Nutritional Status of Scheduled Tribe Children Under Five Years in India

The NFHS data reveal that Scheduled Tribe (ST) children consistently exhibit higher malnutrition rates than the national average. Stunting (low height for age)

remained above 50% until NFHS-3 but declined to 40.9% in NFHS-5, indicating slow improvement. Wasting (low weight for height) peaked at 27% in NFHS-3 and NFHS-4 before reducing to 23.2% in NFHS-5, still higher than the national rate. The prevalence of being underweight went down from 56.8% in NFHS-1 to 39.5% in NFHS-5. Despite the improvement, ST children are still very vulnerable and need special interventions to provide them with adequate nutrition, health, and socio-economic care.

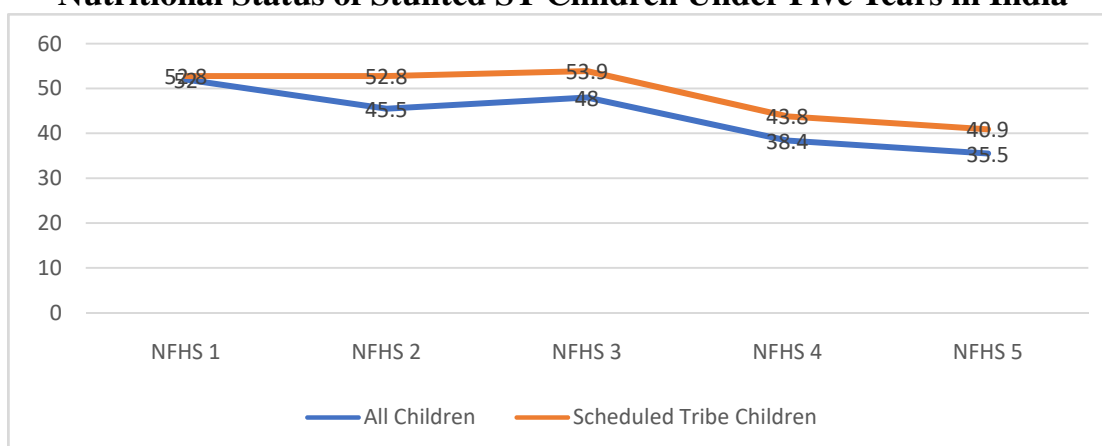
Figure 2.12
Nutritional Status of Scheduled Tribes Children Under Five Years in India



Source: Compiled from NFHS-1 to NFHS-5

NFHS statistics show higher rates of stunting among Scheduled Tribe (ST) children compared to the national average. While overall stunting among Indian children declined from 52% (NFHS-1) to 35.5% (NFHS-5), ST children showed a slower decline, from 52.8% to 40.9% in the same period. The gap was widest in NFHS-3, where ST children had a stunting rate of 53.9% compared to 48% nationally. Although we have made progress, ST children remain more vulnerable. The higher stunting rates among ST children highlight persistent disparities, requiring targeted nutrition and health interventions to bridge the gap.

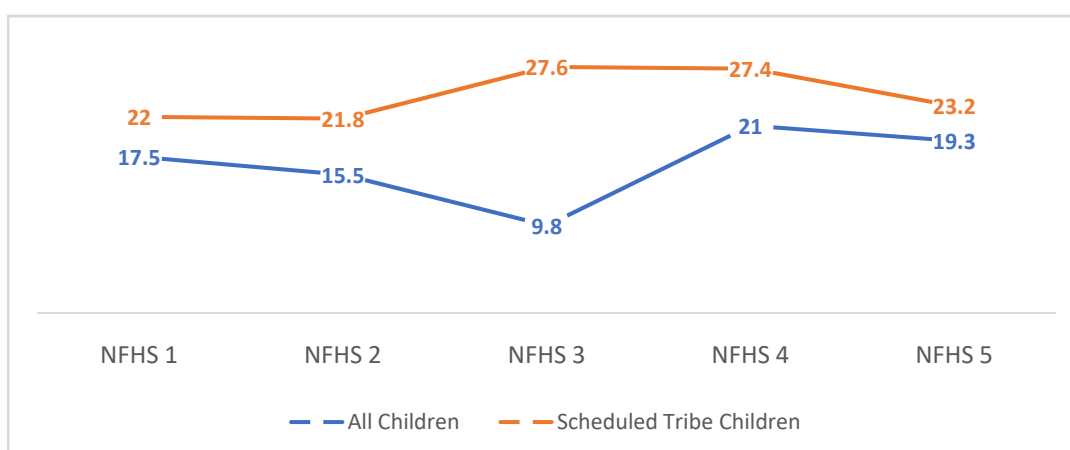
Figure 2.13
Nutritional Status of Stunted ST Children Under Five Years in India



Source: Compiled from NFHS-1 to NFHS-5

The NFHS data indicate that wasting (low weight for height) is consistently higher among Scheduled Tribe (ST) children than the national average. Even though wasting across all Indian children varied from 9.8% (NFHS-3) to 21% (NFHS-4), it was much higher among ST children, reaching 27.6% in NFHS-3. ST children were wasted at 23.2% in NFHS-5 compared to 19.3% for the country overall, reflecting their higher exposure to acute malnutrition. The persistent gap in wasting rates shows the need for targeted nutritional programs, improved healthcare access, and better dietary diversity among Scheduled Tribe children to address acute malnutrition.

Figure 2.14
Nutritional Status of the Wasted ST Children Under Five Years in India

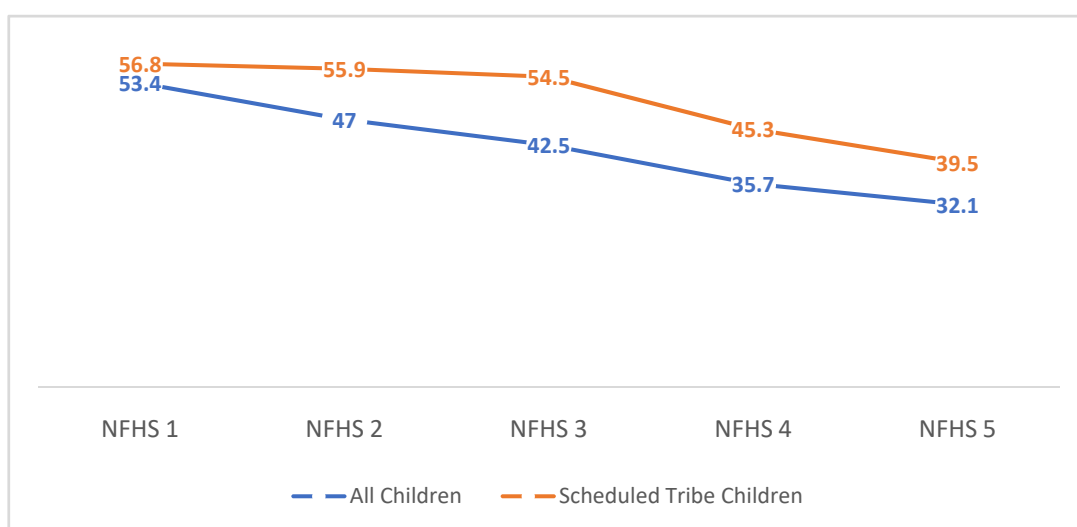


Source: Compiled from NFHS-1 to NFHS-5

The underweight prevalence among Scheduled Tribe (ST) children has consistently

been higher than the national average across all NFHS surveys. In NFHS-1, 56.8% of ST children were underweight, compared to 53.4% for all children. This gap persisted across NFHS rounds, with NFHS-5 showing 39.5% of ST children underweight, whereas the national rate declined to 32.1%. Although underweight prevalence has decreased over time, ST children continue to experience more significant nutritional deprivation. Focused interventions addressing poverty, food security, and healthcare are crucial to reducing this gap and ensuring better nutrition outcomes for tribal children.

Figure 2.15
Nutritional Status of Underweight ST Children Under Five Years in India

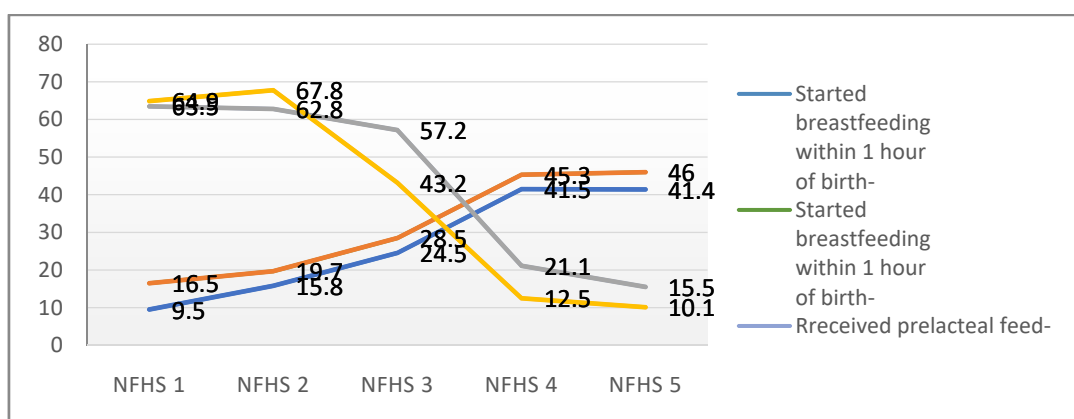


Source: Compiled from NFHS-1 to NFHS-5

3.3.2.1 Child Feeding Practices Among Scheduled Tribes in India

The feeding practices among Scheduled Tribe (ST) children have improved over time, often exceeding the national average. The percentage of ST children who started breastfeeding within one hour of birth increased from 16.5% (NFHS-1) to 46% (NFHS-5), consistently higher than the national figures (9.5% to 41.4%). Similarly, the pre-lacteal feed is an undesirable practice, which declined significantly among ST children, from 64.9% (NFHS-1) to 10.1% (NFHS-5), outperforming the national trend (63.5% to 15.5%). While ST children lag in many nutritional aspects, their breastfeeding practices have improved, indicating better maternal awareness and healthcare interventions.

Figure 2.16
Child Feeding Practices Among Scheduled Tribes in India

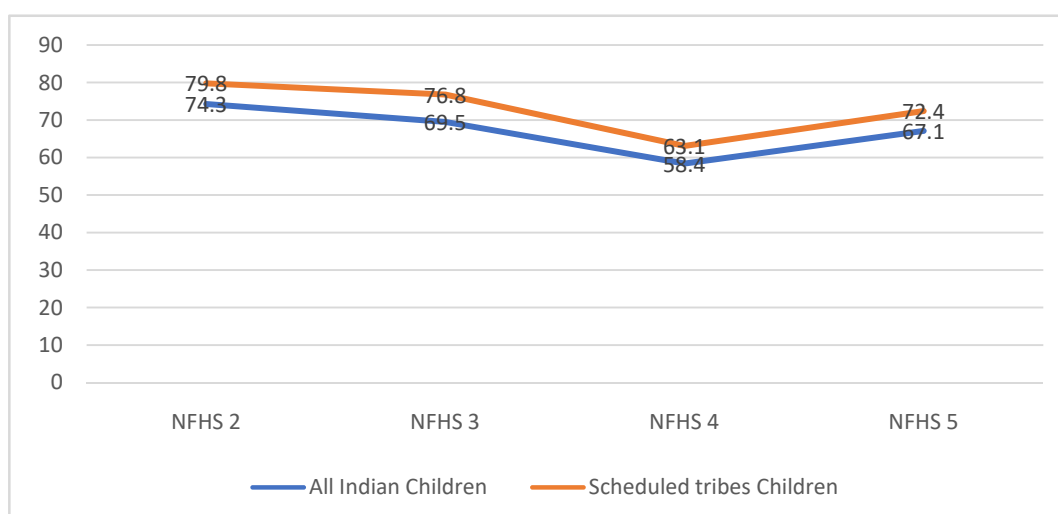


Source: Compiled from NFHS-1 to NFHS-5

2.3.2.2 Prevalence of Anaemia Among ST Children Under Five Years in India

The prevalence of anaemia among Scheduled Tribe (ST) children below five years in India has consistently been higher than the national average across NFHS surveys. In NFHS-2, 79.8% of ST children were anaemic, compared to 74.3% for all Indian children. Even though anaemia prevalence went down in NFHS-4 (63.1% in ST compared to 58.4% in the country), NFHS-5 turned this figure around to 72.4% in ST children and 67.1% in the country. ST children remain more vulnerable to anaemia because of poor diet, nutritional deficiencies, and lack of access to healthcare, and require special interventions.

Figure 2.17
Prevalence of Anaemia Among ST Children Under Five Years in India



Source: Compiled from NFHS-1 to NFHS-5

2.3.2.3 Relationship between Stunting and Background Characteristics

The outcome of nutrition deprivation depends upon various non-economic factors like gender discrimination, poor hygiene, higher morbidity risk, and widespread poverty. The prevalence of undernutrition is almost similar among girls and boys, but girls have slightly lower nutritional status in all three indicators. The prevalence of stunting increases as the child ages from 6-8 months to 6-23 months and then decreases slightly thereafter. Forty four per cent of children born very small become stunted, compared with 35% of children born average size or larger. Children born to mothers with a BMI below 18.5 kg/m² are more likely to experience stunting, wasting, and underweight compared to those whose mothers have a normal BMI or are overweight/obese. Maternal education also plays a significant role: around 46% of children whose mothers have no formal education are stunted, whereas this figure drops to 26% among children of mothers with 12 or more years of schooling. Similarly, 42% of children of uneducated mothers are underweight, compared to 23% of those whose mothers have higher education. Economic status further influences child nutrition, with stunting rates declining consistently as household wealth improves from 46% in the lowest wealth quintile to 23% in the highest. Persistent or recurrent undernutrition during pregnancy, infancy, and adolescence is a major driver of stunting, which restricts children from achieving their full physical and cognitive potential. Wasting, on the other hand, is a life-threatening condition caused by insufficient dietary intake or illness. Undernutrition remains a critical factor behind nearly half of all deaths among children under five. Addressing these gaps requires urgent policy attention, as improvements in child nutrition indicators will remain slow without focused interventions.

2.3.3 Addressing Malnutrition: India's Journey Towards Global Nutrition Targets

The World Health Organisation (WHO, 2014) established six Global Nutrition Targets (GNTs) for 2025 aimed at reducing key forms of malnutrition. The targets aim to reduce anaemia among women of reproductive age by 50%, lower the incidence of low birth weight by 30%, increase the rate of exclusive breastfeeding for infants up to six months to at least 50%, cut stunting among children under five

by 40%, bring wasting levels below 5%, and prevent any further rise in childhood overweight. According to the Global Nutrition Report (GNR, 2021), India is off track in achieving most of these targets, except for moderate progress in exclusive breastfeeding. Currently, 58.0% of infants aged 0-5 months are exclusively breastfed. However, stunting still affects 34.7% of children under five, significantly higher than the Asian average of 21.8%, and the rate of wasting remains unchanged. The Poshan Abhiyaan (2018), a flagship nutrition initiative, has yielded limited success, reducing stunting in children aged 0-3 years by only one percentage point.

Addressing malnutrition in India requires a multidimensional approach that focuses on early childhood nutrition, especially during the first 1,000 days of life. Strengthening maternal care, promoting exclusive breastfeeding, providing timely complementary feeding, and managing inadequate breast milk supply are all essential. The Integrated Child Development Services (ICDS) must focus more intently on children aged 0–3 to support optimal growth and development. Alongside these efforts, reforming the food systems of India is critical. Promoting the consumption of traditional, nutrient-rich foods, such as millet, can address nutritional deficiencies while ensuring ecological sustainability. Reducing dependence on ultra-processed and sugary foods will also help curb the rise of diet related non-communicable diseases (Popkin et al., 2020).

India must also improve nutrition governance, enhance data and monitoring systems, ensure transparency in food distribution, and build human resource capacity. Nutrition education, resource management, and policy accountability are key to accelerating progress. The journey of India towards meeting global nutrition goals requires integrated efforts across sectors. Emphasising early nutrition, promoting sustainable diets, and strengthening implementation systems can significantly reduce malnutrition and build a healthier future for children.

2.4 Malnutrition in Kerala

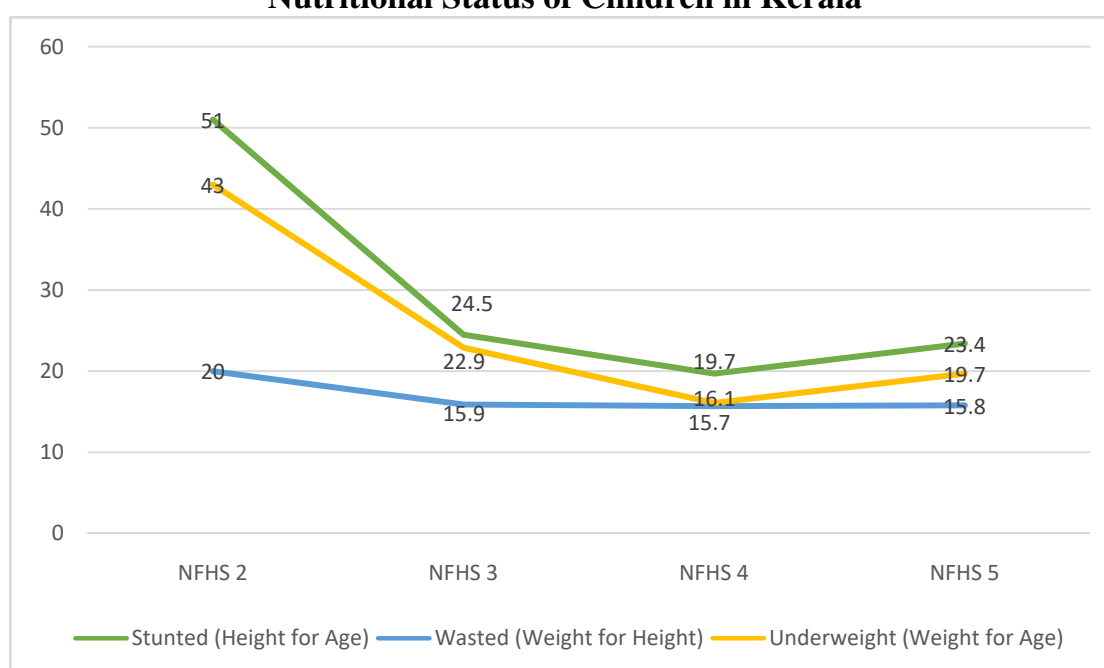
Kerala, often recognised for its robust health infrastructure and high literacy rates, continues to grapple with child malnutrition, especially among vulnerable populations. Despite implementing nutrition programs such as the Integrated Child

Development Services (ICDS), the Midday Meal Scheme, and various maternal and child health initiatives, disparities in nutritional outcomes persist (NFHS-5, 2021). The state has made significant gains in reducing stunting and wasting over the decades. However, recent trends from the National Family Health Survey (NFHS-5) reveal concerning developments, especially the increasing incidence of overweight and the stagnation or reversal in progress related to undernutrition.

2.4.1 Malnutrition Among Children Under Five Years in Kerala

One of the key indicators of chronic malnutrition, stunting among children under five, declined from 51% in NFHS-2 to 23.4% in NFHS-5. Yet, this figure marks a rise from 19.7% in NFHS-4, suggesting a reversal in the earlier positive trend. Similarly, underweight prevalence dropped from 43% in NFHS-2 to 19.7% in NFHS-5, but it too saw a slight increase from 16.1% in the previous survey. Wasting, an indicator of acute malnutrition, declined overall between NFHS-2 and NFHS-5 but showed a marginal increase from 15.7% to 15.8% in the latest data. The prevalence of overweight children rose from 3.4% to 4%, reflecting the impact of changing dietary habits and sedentary lifestyles, particularly in urban areas (MoHFW, 2021).

Figure 2.18
Nutritional Status of Children in Kerala



Source: Compiled from NFHS-2 to NFHS-5

Child nutritional status varies significantly across districts of Kerala, underscoring the need for region specific interventions. Malappuram reports the highest burden of stunting at 21.01%, followed by Palakkad (11.12%), Kozhikode (8.78%), Ernakulam (8.23%), and Thrissur (8.17%). The same districts also show high rates of wasting, with Malappuram (19.26%) and Palakkad (12.02%) being the most affected. When it comes to severe wasting, Malappuram again leads (19%), followed by Palakkad (13.73%), Ernakulam (11.30%), Thiruvananthapuram (9.72%), and Kannur (9.66%).

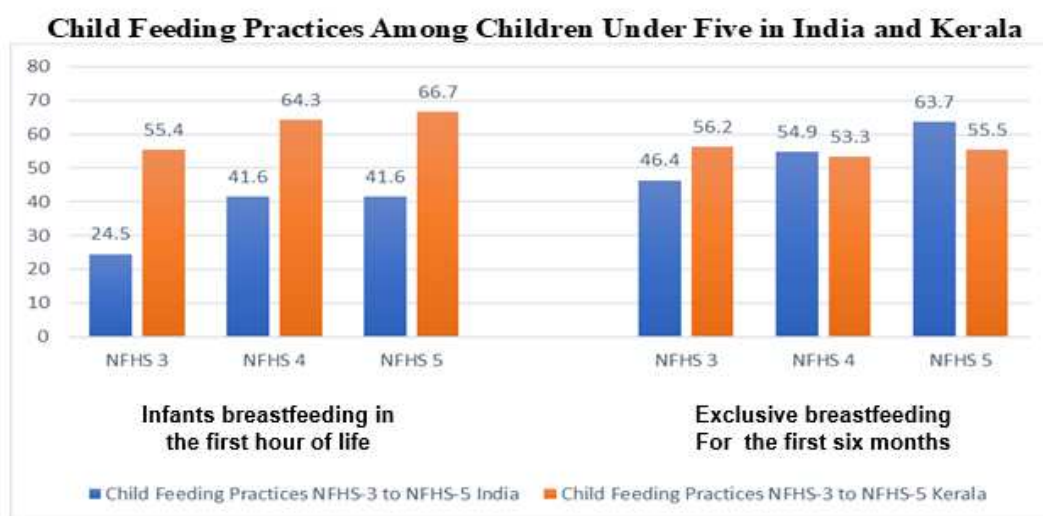
The prevalence of underweight children, indicating both chronic and acute nutritional deficiencies, is also concentrated in specific districts. Malappuram shows a high rate of 18.26%, followed by Palakkad (12.37%), Kozhikode (9.30%), Ernakulam (8.67%), and Thrissur (7.68%). These statistics clearly indicate that district-level nutritional challenges require tailored approaches. Uniform policy interventions are insufficient; targeted strategies focusing on the unique issues of each district are essential.

The NFHS-5 findings highlight the complexity of nutritional outcomes in Kerala. While the state has achieved significant progress, new challenges have emerged in the form of rising overweight rates and the resurgence of stunting and underweight among children. Effective action requires a multi-sectoral approach involving improved access to nutritious food, strengthened primary healthcare systems, and enhanced parental awareness of child feeding practices. Collaborative efforts by policymakers, healthcare providers, and community organisations are crucial to addressing these disparities and ensuring equitable nutrition for all children in the state.

2.4.1.1 Feeding Practices Among Children Under Five Years in Kerala

Although breastfeeding is nearly universal in Kerala, only 66.7% of children were breastfed within one hour of birth, as recommended, compared to 55.4% in NFHS-3. The decrease in exclusive breastfeeding from 56.2% in NFHS-3 to 55.5% in NFHS-5 indicates that many infants still miss out on the highly nutritious first milk.

Figure 2.19
Child Feeding Practices Among Children Under Five in India & Kerala



Source: Compiled from NFHS-3 to NFHS-5

Source: Compiled from NFHS-3 to NFHS-5

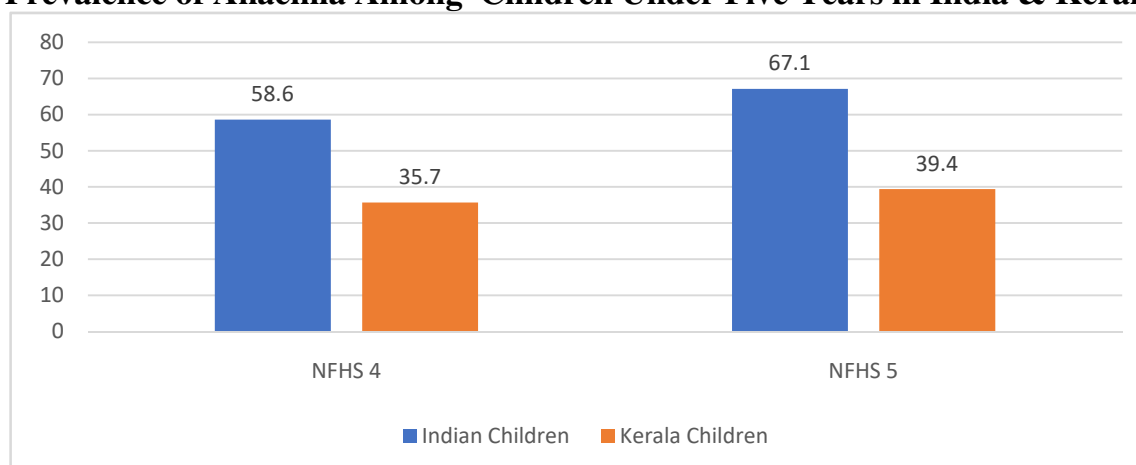
Kerala performs better than India in terms of the early initiation of exclusive breastfeeding. The proportion of infants breastfed in the first hour of life improved in India (24.5% in NFHS-3 to 41.6% in NFHS-5) and in Kerala (55.4% to 66.7%). Exclusive breastfeeding for the first six months improved in India (46.4% to 63.7%), but Kerala showed fluctuations, declining slightly from 56.2% in NFHS-3 to 55.5% in NFHS-5. Kerala consistently maintains higher breastfeeding rates due to better maternal healthcare and awareness, though exclusive breastfeeding needs further improvement compared to the increasing trend in India.

2.4.1.2 Prevalence of Anaemia Among Children Under Five Years in Kerala

Anaemia is a significant health concern in Kerala, particularly among women and children. Nearly 39.4% of children aged 6-59 months are anaemic, with 24% experiencing mild anaemia, 15% moderate anaemia, and 1% severe anaemia. Anaemia can have far-reaching consequences, including maternal mortality, reduced physical and mental capacity, increased susceptibility to infections, and adverse outcomes during pregnancy. The prevalence of childhood anaemia increased from 35.7% in NFHS-4 to 39.4% in NFHS-5. Boys are more likely to be frail than girls (41% vs 38%). Although the prevalence of anaemia in children

varies significantly depending on background factors, it is common in all groups. Nearly two-fifths (39.4%) of children in Kerala are anaemic, even if their mother has 12 or more years of schooling. While Kerala does much better than the national average, the trend requires immediate measures along the lines of improvement in the diet of mothers, diversification of diet, and consolidation of public health programs to check anaemia among children.

Figure 2.20
Prevalence of Anaemia Among Children Under Five Years in India & Kerala

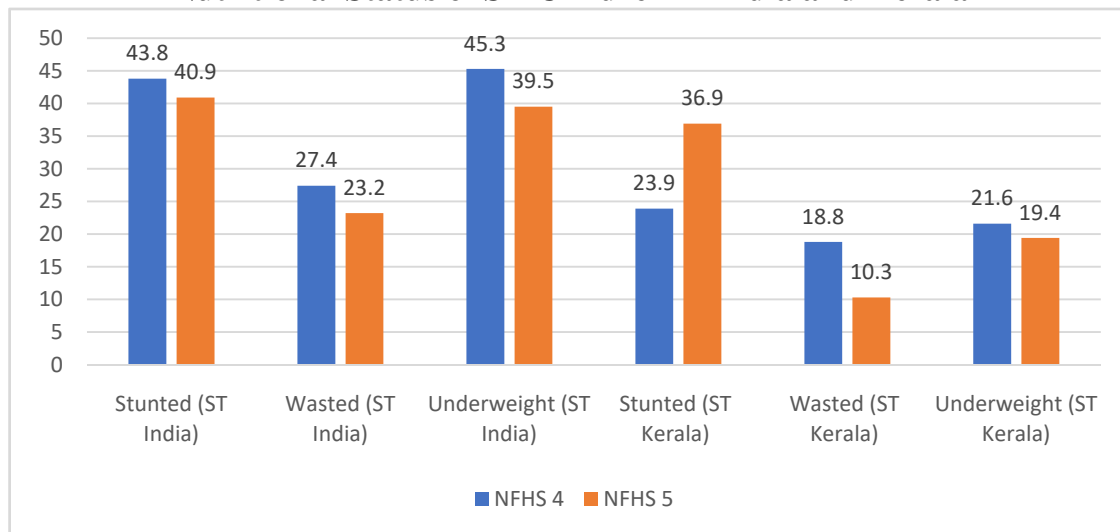


Source: Compiled from NFHS-4 to NFHS-5

2.4.2 Nutritional Status of Scheduled Tribe Children in Kerala

The nutritional status of Scheduled Tribe children in India has slightly improved from NFHS-4 to NFHS-5. Stunting decreased from 43.8% to 40.9%, indicating better long-term nutrition but still a high prevalence. Wasting declined from 27.4% to 23.2%, reflecting improved acute malnutrition management. Underweight prevalence dropped from 45.3% to 39.5%, suggesting overall nutritional progress. However, numbers are still higher than for Kerala ST children, which shows ongoing malnutrition problems at the national level. Stunting rose sharply from 23.9% (NFHS-4) to 36.9% (NFHS-5), showing deteriorating chronic malnutrition. Wasting fell from 18.8% to 10.3%, reflecting better acute malnutrition. Underweight slightly declined from 21.6% to 19.4%, showing mild progress. Despite progress, policymakers need to implement more targeted interventions to effectively address chronic malnutrition and underweight rates among tribal children in India.

Figure 2.21
Nutritional Status of ST Children in India and Kerala

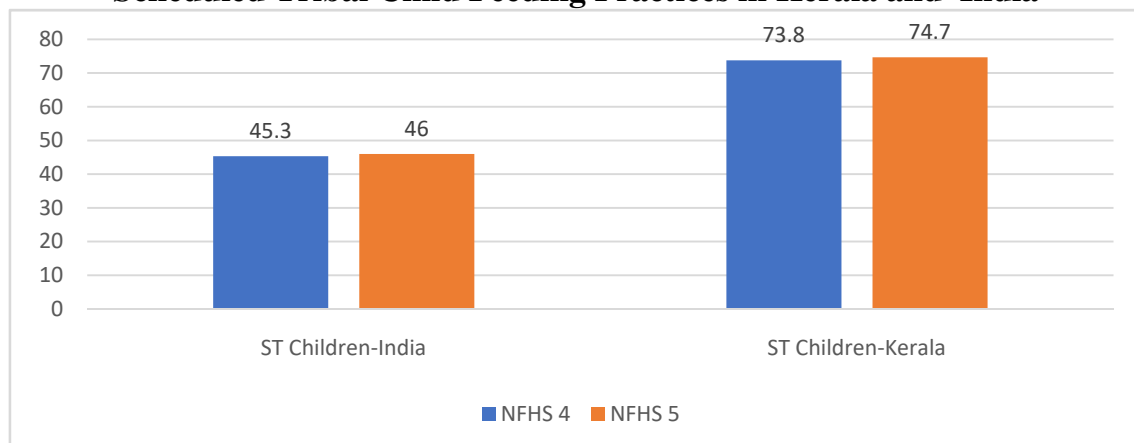


Source: Compiled from NFHS-4 to NFHS-5

2.4.2.1 Child Feeding Practices Among Tribes

Kerala has consistently higher rates of early initiation of breastfeeding compared to India. In NFHS-4, 41.6% of children in India were breastfed within one hour of birth, whereas in Kerala, it was 64.3%. The trend improved in NFHS-5 for Kerala (66.7%), while India remained unchanged at 41.6%. Among Scheduled Tribes (ST), rates of Kerala were significantly higher, improving from 73.8% in NFHS-4 to 74.7% in NFHS-5, whereas the ST population of India had a minor increase (45.3% to 46%). The strong maternal healthcare system of Kerala contributes to better breastfeeding practices than the national average.

Figure 2.22
Scheduled Tribal Child Feeding Practices in Kerala and India

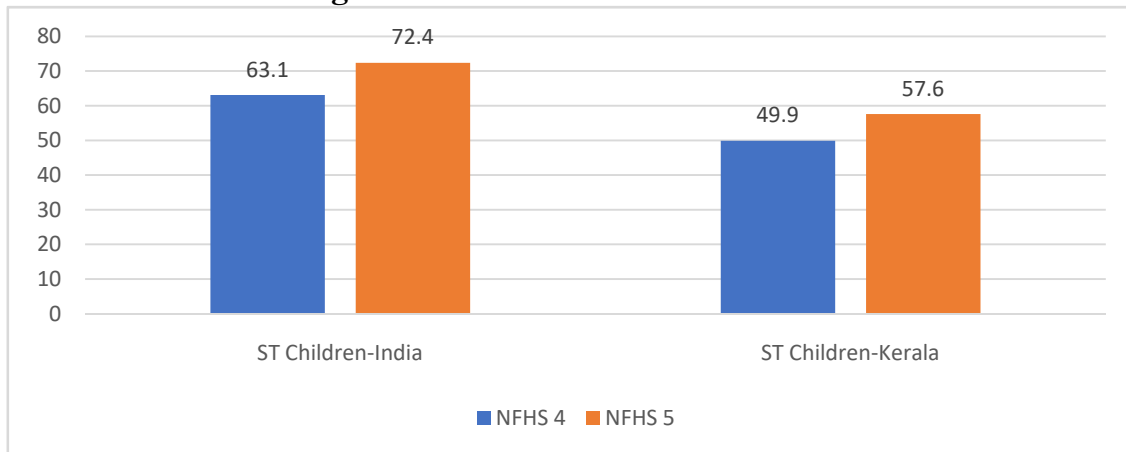


Source: Compiled from NFHS-4 to NFHS-5

2.4.2.2 Anaemia Among Scheduled Tribe Children in Kerala

The prevalence of anaemia among Scheduled Tribe (ST) children has worsened from NFHS-4 to NFHS-5 at both the national and Kerala levels. In India, anaemia of ST children rose from 63.1% to 72.4%, reflecting severe nutritional deficiencies. Similarly, it increased from 49.9% to 57.6%, though it was lower than the national average in Kerala. While Kerala has better health indicators, the rising trend requires urgent policy action, which should assume increased nutritional coverage, iron supplementation, and public health action among vulnerable tribal groups. Eradication of malnutrition and anaemia among Scheduled Tribe children is the key to better health of children in general.

Figure 2.23
Anaemia Among Scheduled Tribe Children in India and Kerala



Source: Compiled from NFHS-4 to NFHS-5

2.4.3 Factors Contributing to Child Undernutrition

Variations in malnutrition rates are apparent across a range of factors. In particular, stunting is most likely to decrease as the schooling level of the mother, the nutritional level of the mother, and the birth size of the child increase. Stunting is relatively high for children of higher birth orders. Lack of access to various nourishing foods can result in inadequate nutrient intake. Missed early detection and intervention possibilities can stem from poor access to high quality healthcare services and routine checkups. Low socio-economic position, lack of education, and poverty can make it difficult for families to give their kids healthy food. Undernutrition can be made worse by using poor sanitation and hygiene techniques, raising the risk of illnesses. Child nutrition heavily depends on maternal health.

Children born to malnourished moms are more likely to be undernourished themselves.

2.4.4 Comparison Between India and Kerala

NFHS-5 Kerala also finds that the prevalence of stunting went up from 19.7% during 2015-16 to 23.4 per cent. Underweight children in Kerala also rose from 16.1% to 19.7 per cent. Whereas wasting among children has risen by a minimal 0.1 per cent, the prevalence of overweight children has increased by 0.6 per cent. Although breastfeeding is nearly universal in Kerala, only 66.7% of children were breastfed within 1 hour of birth, as recommended. While exclusive breastfeeding improved over NFHS-4, many infants still miss the highly nutritious first milk. Exclusive breastfeeding, as per NFHS 5, 55.5% of children under the age of six months are exclusively breastfed in Kerala.

Nearly two fifths (39%) of children aged 6-59 months in Kerala are anaemic (NFHS-5), and one fifth (31%) of pregnant women in Kerala are anaemic (NFHS-5). Boys are slightly more likely to be anaemic than girls (41% vs 38%). Children of anaemic mothers are much more likely to be anaemic. Anaemia varies by maternity status, and 34% of women who are breastfeeding are anaemic, compared with 31% of women who are pregnant. Approximately one in four young women in India was married before their 18th birthday, in NFHS-5, 23% compared to NFHS-4, 27%. NFHS-5 data show that 40.8% of girls in Bihar, 40.1% in Tripura, and 41.6% in West Bengal married below age 18. In Kerala, NFHS-5 (2019-20) reports that 6.3% of women aged 20-24 married before turning 18, down from 7.6% in NFHS-4 (2015-16) and 15% in NFHS-3 (2005-06).

The total fertility rate (TFR), the average number of children born per woman, increased from 1.6 to 1.8 between 2015-16 and 2019-20 in Kerala, while at the national level, the TFR has declined from 2.2 to 2.0. Bihar (3.0) and Uttar Pradesh (2.4) have the highest rate compared to Sikkim (1.1) and West Bengal (1.4), which have the lowest rate. Kerala (1.8) and Tamil Nadu are the only states where fertility increased marginally in 2019-20. Teenage pregnancy declined only marginally by 1% between NFHS 4 and NFHS 5, and 6.8% of women in the age group of 15-19 in India were already mothers or pregnant. It is lowest in states like Kerala (2.4%),

Sikkim (3.1%), and Himachal Pradesh (3.4%), and highest in Tripura (21.9%), West Bengal (16.4%), and Andhra Pradesh (12.4%) in NFHS 5.

Kerala showed a decline in mothers going for checkups in the first trimester (93.6%) in 2019-20 compared to NFHS-4 (95.1%). The percentage of mothers who received antenatal checkups (ANC) in the first trimester has decreased considerably in Kottayam (98% to 82%), Alappuzha (93% to 85%), Trivandrum (93% to 88%), Idukki (98% to 93%), Malappuram (97% to 95%), Kollam (94% to 92%) and Ernakulam (94% to 93%) and Kannur (96% to 95%) shows 1% reduction in between NFHS 4 and NFHS 5. Whereas the percentage of mothers who received ANC in the first trimester has increased considerably in Pathanamthitta (86% to 93%), Palakkad (93 to 98%), Kozhikode (95% to 98%), Wayanad (95% to 98%), and Kasargod (96% to 97%) and Thrissur (97%), it is constant.

There has been a substantial drop in the proportion of women who had four or more ANC visits (90.1% to 78.6%) in Kerala. It may be the impact of natural calamities and the Nipah outbreak during the survey period. Kottayam, Alappuzha, and Thiruvananthapuram districts lag far behind in First trimester registration and four or more ANC. Health facility births have been universal in Kerala since NFHS-3 (99.5%), and it ranked top in NFHS-5 (99.8%). Overall, institutional deliveries in India have increased from 26% in 1992-93 to 79% in 2015-16 and further to 89% in 2019-20. The immunisation coverage of the children aged between 12 and 23 months in Kerala, according to NFHS 5, shows that 78% of the children are fully immunised, 20% are partially immunised, and 2% are not immunised. The immunisation Status of children between 12-23 months in Kerala (NFHS 5) reports that 78% of children are completely immunised, 20% are partially immunised, and 2% are not immunised.

2.5 Measures to Combat Malnutrition

Malnutrition among Indigenous children poses serious risks to their physical and cognitive development due to limited access to healthcare, nutrition, and education in remote areas. Targeted interventions are crucial for addressing health disparities, reducing intergenerational poverty, and promoting sustainable development. Prioritising nutrition focused programs for indigenous communities in national and

state policies can significantly enhance the health of children, development, and future opportunities.

2.5.1 Measures to Combat Malnutrition at the Global Level

Malnutrition is a critical worldwide health issue that affects people of all ages across diverse geographic regions. It adversely affects millions of individuals, particularly children and women, and contributes to long-term health complications, decreased productivity, and hindered economic development. Recognising its multidimensional impact, global organisations such as the WHO, UNICEF, FAO, and GAIN have implemented coordinated interventions to address immediate and structural causes of malnutrition.

2.5.1.1 WHO's Global Nutrition Targets 2025

In 2012, the WHO launched six Global Nutrition Targets to be achieved by 2025. These targets aim to reduce stunting in children under five by 40%, cut anaemia among women of reproductive age by 50%, decrease low birth weight by 30%, and keep childhood overweight from rising. They also suggest exclusive breastfeeding for less than six months to at least 50% and a decline in childhood wasting to less than 5% (WHO, 2014). These are part of the Sustainable Development Goals (SDGs) of the United Nations. WHO helps countries with technical assistance, policy guidance, and monitoring tools to create optimum nutrition programs adapted to the national context of each country.

2.5.1.2 Comprehensive Nutrition Programs of UNICEF

United Nations International Children's Emergency Fund (UNICEF) takes a life course approach to nutrition, emphasising prevention, early treatment, and rehabilitation. For instance, the Community-Based Management of Acute Malnutrition program treats severely malnourished children with therapeutic foods, while the Scaling Up Nutrition movement strengthens national policies on nutrition. UNICEF advocates enhanced breastfeeding, complementary feeding, and micronutrient supplementation. UNICEF also promotes optimal breastfeeding practices, complementary feeding, and micronutrient supplementation. Its interventions are designed to reach the marginalised people, especially in regions affected by poverty or conflict, and are delivered through partnerships with

governments and NGOs (UNICEF, 2021).

2.5.1.3 School-Based and Emergency Nutrition Strategies of WFP

The World Food Programme (WFP), which was founded in 1961, provides targeted food assistance in emergencies and regular nutrition in the form of supplementary feeding and school feeding. The Targeted Supplementary Feeding Program (TSFP) aims to prevent children and pregnant or lactating women from entering acute malnutrition. The Food for Education program provides nutritious meals to schoolchildren, leading to better health and school performance. WFP works with national governments to build resilient food systems, particularly in crisis affected areas (WFP, 2020).

2.5.1.4 Food Security and Agricultural Initiatives of FAO

Since 1945, the FAO has worked towards promoting nutrition through sustainable agriculture and improving food security. Initiatives such as the Food-Based Dietary Guidelines allow nations to develop policies that incorporate nutrition sensitive agriculture. The organisation also promotes biofortification to improve the nutrient content of staple foods, making healthy diets accessible to the population. FAO promotes efforts towards improving food diversity, access to markets, and sustainable agriculture through smallholder farmer programs (FAO, 2021).

2.5.1.5 Innovative Food Fortification and Workforce Programs of GAIN

Global Alliance for Improved Nutrition (GAIN), established in 2002 with funding from the United Nations, seeks to make healthy food even healthier through multi-sector alliances. Its Large Scale Food Fortification (LSFF) initiative raises the micronutrient content of staple foods such as salt, flour, and oil. GAIN also runs the Workforce Nutrition Program, which seeks to motivate employers to invest in nutrition training and meal programs among employees. The programs have been set up to boost nutrient intake and public health in general, especially in low-resource settings (GAIN, 2020).

Global reduction of malnutrition needs a concerted, multi-sector effort. World Health Organisation (WHO), UNICEF, WFP, FAO, and GAIN led efforts have contributed immensely to curbing malnutrition and improving maternal and child health outcomes. More must be done, especially in fragile states and vulnerable

groups. Global nutrition goals will be contingent on marginalised funding, strong political will, and innovative and scalable solutions. Global collective action must be taken to achieve a healthier and better nourished future.

2.5.2 Interventions for Reversing Malnutrition in India

Malnutrition is a priority problem in India that mainly affects children belonging to marginalised and tribal communities. Manifesting as stunting, wasting, underweight, and micronutrient deficiencies, it severely restricts the physical growth and development, as well as the cognitive and productivity potential of children at an early stage. With an appreciation of the multi-dimensional nature of malnutrition, the Indian government has launched a range of national programs to tackle health, nutritional, and socio-economic causes of malnutrition. This section describes major national-level interventions to improve child and maternal nutrition with specific reference to their impact on tribal areas.

2.5.2.1 Integrated Child Development Services (ICDS)

ICDS is launched in 1975, one of the most extensive programs of India targeting the health and nutrition of children below 6 years, pregnant and lactating women, and adolescent girls. Through an Anganwadi Centres (AWCs) network, ICDS delivers supplementary nutrition, immunisation, health check-ups, referral services, and preschool education. In tribal and remote areas, where poverty and limited health access prevail, ICDS is especially vital. Although the program has improved nutritional indicators, issues like inadequate infrastructure, insufficient staffing, cultural disconnects, etc., persist. Technological innovations, such as digital record keeping and community-based management of malnutrition, have recently enhanced their efficiency (MoWCD, 2020).

2.5.2.2 Mid-Day Meal Scheme (MDMS)

Introduced in 1995, the MDMS provides free, nutritious meals to government and government assisted school going children to reduce malnutrition and dropout rates. In addition to providing children, particularly poor and tribal children, with adequate calorie and nutrient intake, the meals also promote school attendance. Meals are often procured locally, supporting agricultural livelihoods and culinary culture. Despite its successes, operational challenges persist, such as inconsistent

meal quality and inadequate kitchen infrastructure. Reforms such as community monitoring and centralised kitchens have been introduced to improve service delivery (Drèze & Goyal, 2003).

2.5.2.3 Village Health Sanitation and Nutrition Committees (VHSNCs)

Established under the NRHM in 2005, VHSNCs are grassroots level health and nutrition governing bodies. The local stakeholders of these committees control the public health programs, sanitation behaviour, and nutrition intervention, particularly among children under six years of age. Their participatory nature facilitates their role as a bridge between the health system and the community. Capacities, lack of proper training, and irregular utilisation of funds restrict their potential. Capacities can be developed, and digital monitoring of VHSNCs can significantly enhance the outcomes in tribal and rural districts (MoHFW, 2018).

2.5.2.4 Janani Suraksha Yojana (JSY)

JSY, launched in 2005, encourages institutional deliveries among economically disadvantaged women, especially in tribal areas, to reduce maternal and neonatal mortality. Women receive cash incentives to deliver in health facilities, ensuring access to skilled birth attendants and essential newborn care. This intervention indirectly benefits child nutrition by enhancing maternal health and birth outcomes. In tribal belts, the scheme has increased institutional births but continues to face barriers like transportation issues and cultural preferences for home births (Lim et al., 2010).

2.5.2.5 Pradhan Mantri Matru Vandana Yojana (PMMVY)

Introduced in 2017, PMMVY offers financial support to pregnant and lactating women during their first pregnancy to address their increased nutritional needs. The scheme promotes healthier pregnancies and birth outcomes by encouraging rest, improved nutrition, and antenatal check-ups. Particularly in tribal areas, PMMVY complements JSY in strengthening maternal and infant health. Integrating mobile health services and local health worker engagement has helped increase program reach, though infrastructural and logistical limitations remain (MoWCD, 2020).

2.5.2.6 Poshan Abhiyaan (National Nutrition Mission)

Launched in 2018, Poshan Abhiyaan is a convergence approach to address

malnutrition by coordinating the efforts of various ministries and stakeholders. It targets stunting, wasting, anaemia, and low birth weight and employs real time monitoring mechanisms, behaviour change communication, and community mobilisation (Jan Andolan). The program is localised in interventions in tribal areas by being responsive to food culture and encouraging family participation. Despite language and geography challenges, the program has increased awareness and service use and has made progress in reducing child malnutrition (NITI Aayog, 2021).

2.5.2.7 Anaemia Mukht Bharat (AMB)

Initiated in 2018, AMB targets the reduction of anaemia among children, adolescents, and pregnant and lactating women through six key strategies: prophylactic iron supplementation, deworming, intensified behaviour change communication, testing and treatment, dietary diversification, and addressing non-nutritional causes, such as infections. In the tribal population, the program focuses on modifying food habits and iron supplementation with foods acceptable at local levels. Healthcare professionals play a vital role in carrying out and supporting the implementation of these strategies. Outcomes expected are improved awareness and haemoglobin levels, although there is resistance to food change and service gaps (MoHFW, 2021).

2.5.2.8 National Health Mission (NHM) and Tribal Health Strategies

The National Health Mission NHM, combining NRHM and NUHM, was launched in 2013 to expand accessible, equitable, and quality healthcare services. It focuses on child and maternal health, nutrition, and disease prevention; NHM operates through a decentralised approach involving ASHAs, ANMs, and AWWs. In tribal regions, the NHM has introduced mobile medical units, health camps, and community-based nutrition interventions. Immunisation and antenatal care have been enhanced, but health infrastructure, workforce shortage, and social determinants limit service reach (MoHFW, 2022).

2.5.2.9 National Food Security Act (NFSA), 2013

NFSA legally provides subsidised food grains to nearly 67% of the Indian population. Every individual is subsidised monthly with 5 kg of rice, wheat, or

coarse grains. Under the Antyodaya Anna Yojana (AAY), the poorest families are subsidised with 35 kg per family. It has significantly reduced hunger and food access among tribal and rural communities. Inefficiencies in the Public Distribution System (PDS), identification errors, and infrastructural shortages have reduced its impact. Digitisation and better grievance redressal are being promoted to minimise these issues (Khera, 2011).

2.5.2.10 Food Safety and Standards Authority of India (FSSAI)

FSSAI, founded in 2008, maintains food safety and nutrition quality by regulating and fortifying food. FSSAI, state governments and school meal programs encourage fortified staples like iron fortified rice to counter anaemia and vitamin deficiency. For instance, pilot programs in Odisha included training school employees to cook mid-day meals from fortified food items. Despite such advancements, weak law enforcement and a lack of outreach in rural areas are problems. Improved coordination with state level agencies and increased consumer awareness are ways to maximise the performance of FSSAI (FSSAI, 2020).

2.5.2.11 Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (SABLA)

The SABLA, implemented by the Ministry of Women and Child Development, addresses the nutritional and developmental needs of adolescent girls. It integrates two components: nutritional supplementation for out of school girls aged 11-14 and non-nutritional services, including life skills, hygiene education, and reproductive health awareness. Anganwadi Centres serve as delivery points. While SABLA has improved health awareness and IFA intake of girls, it faces operational bottlenecks, including overburdened workers and poor infrastructure. Enhancing worker training and cross sector collaboration with education and health departments can enhance its effectiveness (MWCD, 2020).

2.5.2.12 Village Health Nutrition Day (VHND)

The VHND, a monthly outreach initiative under NRHM, provides immunisation, antenatal care, nutrition education, and growth monitoring at the village level. It involves ASHAs, ANMs, and AWWs working together to ensure that health services reach rural and tribal populations. VHND promotes awareness of sanitation, breastfeeding, hygiene, and disease prevention. Community

participation is key to its success, although better supply chain management and stronger panchayat involvement are needed to maximise its reach and efficiency. Customised strategies based on local needs and settings can further enhance suitability (MoHFW, 2019). The approach of India to dealing with malnutrition includes a range of holistic programs throughout the life course, from fetal to adolescence, through integrated health, nutrition, food security, and community action strategies. Direct nutrition demands are met through the Integrated Child Development Services (ICDS)

ICDS, Poshan Abhiyan, and the Midday Meal Scheme. At the same time, support for the underlying broader socio-economic determinants of health arises through programs such as JSY, PMMVY, and NFSA. NHM and VHSNCs augment service delivery and local governance, while VHNDs and AMB campaigns reach the unreached. Schemes such as SABLA empower adolescent girls, and FSSAI ensures quality nutrition through food safety standards and fortification. While significant progress has been made, the majority of the causes at the systemic level remain, ranging from insufficient infrastructure and vacancies in personnel to cultural issues, logistical challenges, and coordination challenges. These are most evident in tribal and hard to reach environments. Bridging these gaps requires continued investment, cross sectoral action, increased participation by communities, and culturally responsive strategies adapted to local contexts. In the next few years, a rights based and equity oriented approach that synergises nutrition with education, livelihood, sanitation, and empowerment of women is required to arrest malnutrition. Strong monitoring, digital tracking, and real time feedback mechanisms must also be top priorities to ensure responsiveness and accountability. The strengthening of frontline workers and community institutions remains the cornerstone for making these national level measures truly transformative, especially for tribal and marginalised children in India.

2.5.3 State Level Measures to Combat Malnutrition in Kerala

Kerala, known for its strong social indicators, has consistently prioritised public health and nutrition. Despite these achievements, tribal communities in the state continue to face nutritional challenges due to geographic isolation, economic

vulnerability, and limited access to essential services. The Kerala government has implemented several specialised programs to combat undernutrition and improve the overall health and nutritional status of tribal people, with particular emphasis on women and children. Coordinated multi-sectoral collaborations, dedicated financial resources, robust institutional frameworks, etc., drive these efforts.

2.5.3.1 Nutrition Programs by the Scheduled Tribes Development Department

The Scheduled Tribes Development Department has introduced specific nutrition programs for tribal people, especially mothers and children. It includes distributing nutrient rich food packages, micronutrient supplementation, running community kitchens in areas with high malnutrition prevalence, etc. Regular health check-ups, growth monitoring, nutrition counselling, etc., help ensure early undernutrition detection and management. Despite the success in reducing illnesses related to malnutrition, issues like cultural barriers continue to challenge implementation.

2.5.3.2 Janani JanmaRaksha Scheme

This scheme supports pregnant and lactating tribal women through cash transfers from the third month of pregnancy until the child turns one. The financial support enables mothers to access nutritious food and essential healthcare services. The scheme also organises health camps that offer antenatal care, immunisation, infant care, and breastfeeding training. These interventions have improved maternal and child health and reduced infant mortality rates among tribal groups.

2.5.3.3 Supplementary Nutrition Programs (SNP)

SNP under the ICDS is operational through Anganwadi centres. These centres serve cooked meals and distribute take home rations to children, pregnant women, and lactating mothers. Meals are fortified with essential nutrients to address common deficiencies. Community health workers are crucial in meal preparation, distribution, and health education. Although the program has helped reduce child undernutrition, challenges persist due to rugged terrain and infrastructure gaps.

2.5.3.4 Health and Medical Camps in Tribal Areas

Kerala has introduced mobile health units and regular health camps to provide preventive and curative healthcare in tribal settlements. Services include growth monitoring, immunisation, nutrition counselling, and basic medical care. The

camps also train tribal families on sanitation, hygiene, and nutrition. These have offered solutions to access gaps and community level awareness of nutrition problems by bringing health services to the doorsteps.

2.5.4 Community-based Approaches to Combat Malnutrition in Kerala

Despite the overall health achievements of Kerala, tribal communities in remote areas continue to experience undernutrition and poor dietary diversity. Community-based initiatives have emerged as an effective solution to this problem, with the participation of local people, support of NGO, and engagement of the private sector.

2.5.4.1 Community-based Management of Malnutrition (CMAM)

CMAM is a decentralised approach to managing acute malnutrition during the early stages at the local level. In Kerala, Accredited Social Health Activists (ASHAs) and Anganwadi Workers (AWWs) are trained to screen out children with SAM and MAM. They provide therapeutic feeding and refer critical cases to hospitals. The integration of CMAM into the primary healthcare system of Kerala has significantly improved recovery rates. Support from the NHM and state resources has ensured the sustainability and reach of these programs in tribal regions.

2.5.4.2 Role of Non-Governmental Organisation (NGO)

NGOs have played a key role in bridging gaps in government schemes, especially in inaccessible tribal tracts. Save the Children, Child in Need Institute (CINI), and Muthoot Snehasraya NGOs have conducted nutritional interventions, held health camps, and carried out community level awareness drives. These NGOs also address the causal determinants of malnutrition, such as poor sanitation, contaminated drinking water, and poor livelihood options. Community level livelihood schemes conducted by NGOs have economically empowered tribal households to make the right food decisions and choices for their children.

2.5.4.3 Public Private Partnerships (PPP)

Kerala has managed to implement PPP models successfully in the battle against malnutrition. These include partnerships between the government, private business firms, and civil society to improve service delivery. Examples include collaborative ventures between the Kerala Social Security Mission and Corporate Social

Responsibility (CSR) initiatives to provide fortified food. Programs like Amrita SeRve focus on overall rural development, including nutrition. PPPs have been employed to provide micronutrient enriched food products, which have contributed to reducing anaemia and other deficiencies among tribal children and mothers. They also provide a sustainable option by combining financial and logistical resources from different sectors.

2.5.5 ITDP Interventions in Attappadi to Avert Malnutrition

Attappadi tribal block of Kerala, Palakkad district, is home to the Irular, Mudugar, and Kurumbar tribes. Malnutrition has been a long standing problem in the region because of socio-economic marginalisation and poor healthcare. Extensive interventions have been undertaken by the Integrated Tribal Development Project (ITDP) to battle the problem with the assistance of government departments, NGOs, and local bodies.

2.5.5.1 Integrated Child Development Services (ICDS)

ICDS centres in Attappadi provide children and mothers with supplementary nutrition, growth monitoring, immunisation, and preschool education. Meals use locally available nutritious foods like ragi, which are culturally acceptable and nutrient rich. These efforts have significantly improved service utilisation by tribal households and reduced child undernutrition and stunting.

2.5.5.2 Tribal Health and Nutrition Project

The program aims to regularly check growth and perform health examinations by mobile health teams. Specific nutritional treatment is given to Severe and Moderate Acute Malnutrition (SAM/MAM) diagnosed children. Anaemia screening and treatment are also part of the program so that nutritional disorders can be detected early and health outcomes in tribal children are improved.

2.5.5.3 Food Security and Community Kitchens

Community kitchens in tribal village communities prepare nutritious meals using traditional recipes and locally grown foods. Food insecurity is reduced, and community engagement is increased. The working of community kitchens has enhanced caloric intake, reduced hunger, and maintained interest in traditional food systems.

2.5.5.4 Adolescent Nutrition Programs

The program seeks to address anaemia and dietary deficiencies among adolescent tribal girls. It offers iron folic acid supplements, menstrual hygiene kits, and counselling from school and community centres. There has been an increase in haemoglobin levels and awareness regarding adolescent health, and that has led to healthier future pregnancies.

2.5.5.5 Traditional Agricultural Revival

ITDP has promoted indigenous millet, vegetable, and pulse farming, recognising the link between food diversity and malnutrition. Seed distribution and organic farming practices have enabled tribal families to become self-sufficient in producing and eating healthy food. It has reduced dependence on market purchased food and enhanced local food security.

2.5.5.6 Mother and Child Nutrition Program

With a focus on the first 1,000 critical days, the project provides supplementary nutrition and complementary feeding and breastfeeding training. The health workers make regular home visits so that the intervention arrives at the right time. The program has seen a decline in infant and maternal mortality and low birth weight.

2.5.5.7 Nutrition Rehabilitation Centres (NRCs)

NRCs provide medical treatment and therapeutic feeding to severely malnourished children. Home based nutrition and hygiene education is also provided to parents in these centres. Sustained recovery is ensured through follow up care. High weight gain and improved health status among children in these centres are reported in a study.

2.5.5.8 Capacity Building and Awareness

ITDP conducts training for Anganwadi workers, health volunteers, and community leaders. Behaviour change communication in local languages improves awareness about balanced diets, sanitation, and safe cooking practices. These programs have increased local participation in nutritional activities.

2.5.5.9 Water Supply and Sanitation Program

ITDP has conducted clean sanitation and drinking water projects to fight

waterborne diseases, aggravating malnutrition. Toilet construction and promotion of personal hygiene reduced diarrhoea and related infections, which improved nutritional status in general.

2.5.5.10 Collaboration with Kudumbashree and NGOs

ITDP partners with Kudumbashree units and NGOs to form self-help groups that promote nutrition sensitive livelihoods. Tribal women receive training in food processing and preparation of healthy snacks, enabling income generation and increased access to nutritious food within their communities. Kerala has adopted a comprehensive and integrated approach to addressing malnutrition among tribal communities, centred on policy support, local engagement, and cross sector coordination. Key interventions include mobile health camps, state sponsored nutrition schemes, ITDP run community kitchens, and agricultural development in Attappadi. These efforts have significantly reduced Severe and Moderate Acute Malnutrition (SAM/MAM cases), primarily through programs like the CMAM and Village Health and Nutrition Days (VHNDs).

Despite a strong health infrastructure and high development indicators, tribal populations in remote, disadvantaged regions still suffer from undernutrition, anaemia, and stunting. Cultural food practices, limited accessibility, and poor infrastructure pose implementation challenges. Initiatives such as Amrita SeRve, in partnership with local governments, have promoted holistic village development, improving maternal nutrition knowledge and child health outcomes. NGOs like Save the Children have supported these efforts by reducing infant mortality through targeted interventions. Evaluations highlight that inter agency collaboration, culturally sensitive strategies, community participation, etc., are key to success. To maintain progress, Kerala must invest in infrastructure, ensure continuous funding, and scale up evidence-based models like VHND and Amrita SeRve, ensuring equity and long-term nutrition security for its tribal populations.

2.6 Conclusion

Chapter 2 discusses the prevalence, determinants, and intervention measures towards malnutrition among tribal children globally, explicitly focusing on India and Kerala. It outlines how malnutrition results in socio-economic inequalities,

poor nutrition, limited access to healthcare, and cultural determinants. Despite introducing schemes like ICDS, Poshan Abhiyan, and Kerala tribal specific nutrition schemes, NFHS-5 data reflect increasing stunting, underweight, and wasting, reflecting ongoing concerns. Janani JanmaRaksha, SNP, and CMAM evaluations reflect improvement and deficiencies in the battle against malnutrition. The Attappadi Integrated Tribal Development Program (ITDP) at Attappadi is exemplary with its culturally sensitive and localised program. Successful community-based interventions like Amrita SeRve and Village Health and Nutrition Days (VHNDs) have significantly improved child nutrition and maternal health practices. Nonetheless, geographical remoteness, cultural diversity, and resource limitations hinder smooth progress. It suggests that coordination must be maintained between government agencies, NGOs, and the private sector to address malnutrition. Healthcare infrastructure must be improved, maternal education promoted, diet diversification promoted, and traditional food systems mainstreamed. Moreover, establishing monitoring and evaluation systems will ensure effective implementation and accountability. Such precise and culturally sensitive interventions are required to reduce malnutrition and enhance the health condition of children belonging to the tribal communities in Kerala.

CHAPTER 3

MALNUTRITION AMONG TRIBAL CHILDREN IN ATTAPPADI

3.1 Introduction

Malnutrition remains a significant public health challenge among tribal children in Attappadi, where persistent socio-economic and cultural disadvantages continue to hinder child development. Nutritional status, persistent in children below five years of age, is a critical measure of community health and well-being. The present chapter provides a comprehensive analysis of the demographic profile and the prevalence of stunting, wasting, and underweight among tribal children in Attappadi. It further examines the correlation between these indicators, highlighting the interrelated nature of undernutrition. Beyond quantitative measures, the chapter incorporates qualitative insights from community stakeholders, addressing issues such as gender roles, cultural beliefs, healthcare access, and structural neglect. By integrating quantitative and qualitative perspectives, the chapter seeks to uncover the multidimensional causes of malnutrition and infant deaths in Attappadi.

3.2 Demographic Profile of Tribal Children in Attappadi

Understanding the demographic composition of tribal communities in the study area is essential, as it forms the basis for analysing the prevalence of malnutrition among children under five within the three tribal groups in the Attappadi Block Panchayath: Irula, Kurumba, and Muduga.

3.2.1 Tribe wise Distribution of the Sample

Table 3.1 depicts the sample distribution of children across Attappadi tribes, specifically under the Irula, Kurumba, and Muduga categories. To study nutritional differences and design specific measures to combat malnutrition among these native populations, researchers must know tribal composition.

Table 3.1
Tribe wise distribution of the sample

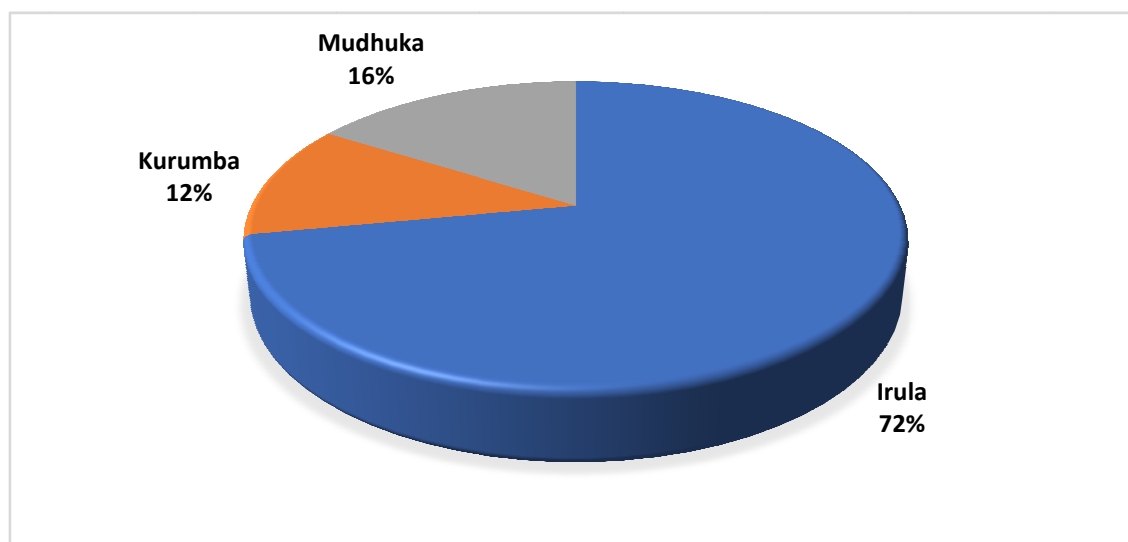
Type of Tribe	Frequency	Percentage
Irula	450	72
Kurumba	75	12
Mudhuka	100	16
Total	625	100

Source: Primary Data

Table 3.1 above shows the percentage distribution of the sample in the three tribal

groups in the Attappadi Block Panchayath. The Irula tribe constitutes the majority, comprising 72% of the sample population, followed by the Muduga tribe, which accounts for 16%.

Figure 3.1
Demographic Composition of Sample



Source: Primary data

The Kurumba tribe represents 12% of the total sample population. This demographic distribution resembles the significant demographic presence of the Irula tribe, comprising nearly three quarters of the sample, and the Kurumba and Muduga tribes, forming just one third of the respondents. The distribution in question is needed to comprehend the general trends in malnutrition and health status in the region, along with assessing the degree to which the distribution of interventions and resources is consistent with the specific needs and population size of each tribe.

3.2.2 Age wise Distribution of Sample Children in Attappadi

Table 3.2 shows the age structure of sample children by the age groups of Irula, Kurumba, and Muduga tribes of Attappadi. Age grouping is necessary while assessing child health since younger children are more vulnerable to malnutrition. The analysis facilitates the identification of age related inequalities and the development of targeted interventions.

Table 3.2
Age wise Distribution of Sample Children in Attappadi

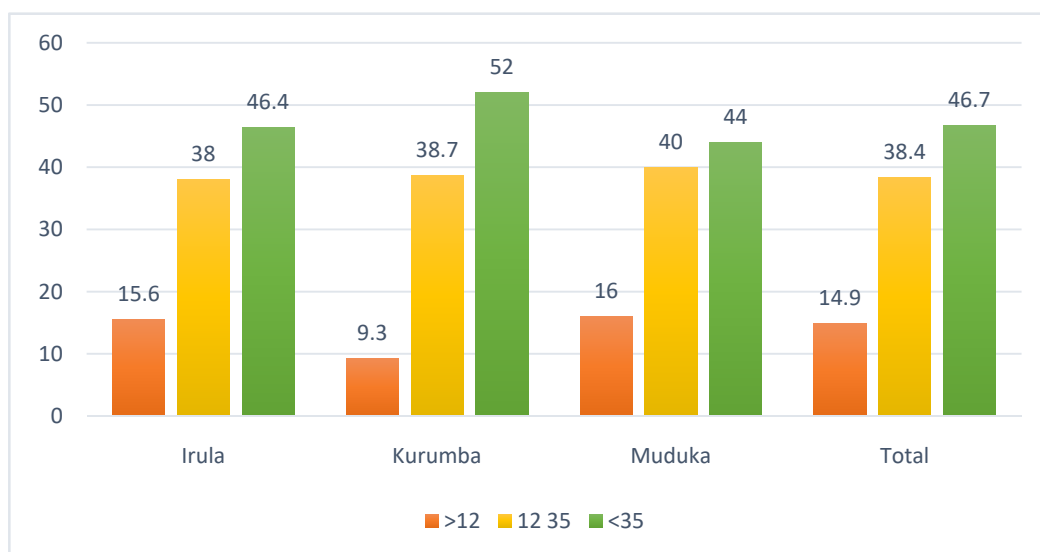
Age in Months	Irula	Kurumba	Muduga	Total
<12	70 (15.6)	7 (9.3)	16 (16.0)	93 (14.9)
12-35	171 (38.0)	29 (38.7)	40 (40.0)	240 (38.4)
>35	209 (46.4)	39 (52.0)	44 (44.0)	292 (46.7)
	450 (100)	75 (100)	100 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 3.2 shows that among the 625 children, the majority (46.7%) are above 35 months, 38.4% are in the 12–35 months category, and 14.9% are below 12 months. Among Irula children, 46.4% are above 35 months, 38% are between 12 and 35 months, and 15.6% are below 12 months. In the Kurumba community, 52% are above 35 months, 38.7% are between 12 and 35 months, and 9.3% are below 12 months. Among the Muduga children, 44% are above 35 months, 40% are between 12 and 35 months, and 16% are below 12 months. Most children above 35 months are in the Kurumba Community (52%).

Figure 3. 2
Age wise Distribution of Children in Attappadi



Source: Primary data

The distribution indicates that more than half of the sample consists of children

above 35 months of age.

3.2.3 Gender wise Distribution of the Sample Tribal Children in Attappadi

Table 3.3 shows the gender distribution of sample children among the Irula, Kurumba, and Muduga tribes in Attappadi. Gender is a significant variable when considering child health, as nutritional status and access to healthcare may differ. This analysis is significant in shedding light on gender representation and its possible effects on malnutrition.

Table 3.3
Gender wise Distribution of the Tribal Children in Attappadi

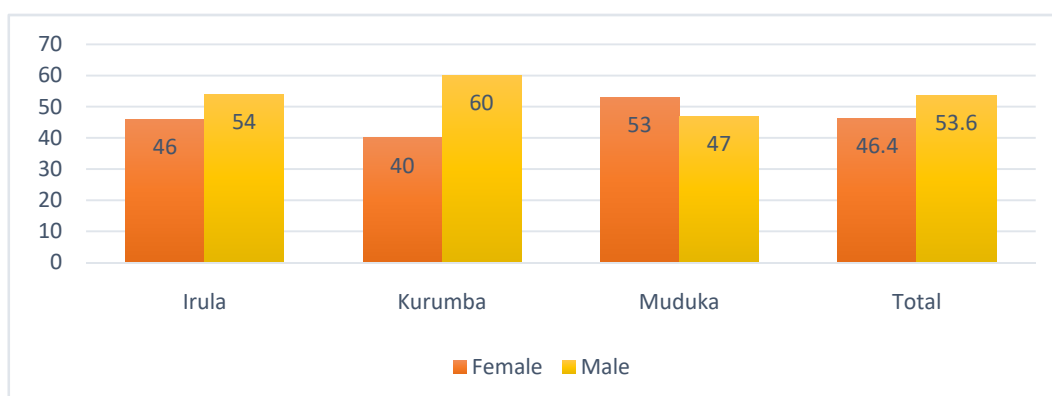
	Irula	Kurumba	Muduga	Total
Female	207 (46.0)	30 (40.0)	53 (53.0)	290 (46.4)
Male	243 (54.0)	45 (60.0)	47 (47.0)	335 (53.6)
Total	450 (100)	75 (100)	100 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 3.3 shows that among the 625 children, 53.6% are male, and 46.4% are female. Among the Irula community, 54% of males are male, while 46% are female. In the Kurumba community, males account for 60% and females for 40%. Among the Muduga children, females (53%) outnumber males (47%).

Figure 3.3
Gender wise Distribution of Sample Tribal Children in Attappadi



Source: Primary data

The Kurumba tribe has the most significant number of male children, at 60%, while the Muduga tribe has a greater number of female children, at the ratio of 53%. The overall gender distribution has a slightly greater percentage of male children in the sample, and there are differences between tribal affiliations.

3.2.4 Type of House of Tribal Children (0-59 Months) in Attappadi

Adequate housing provides better health outcomes, especially for children under five. Therefore, the present study analyses housing types among the three major tribal groups in Attappadi. It categorises the types of houses into Kutcha, Pucca, and Semi-pucca.

Table 3.4
Type of House of Tribal Children in Attappadi

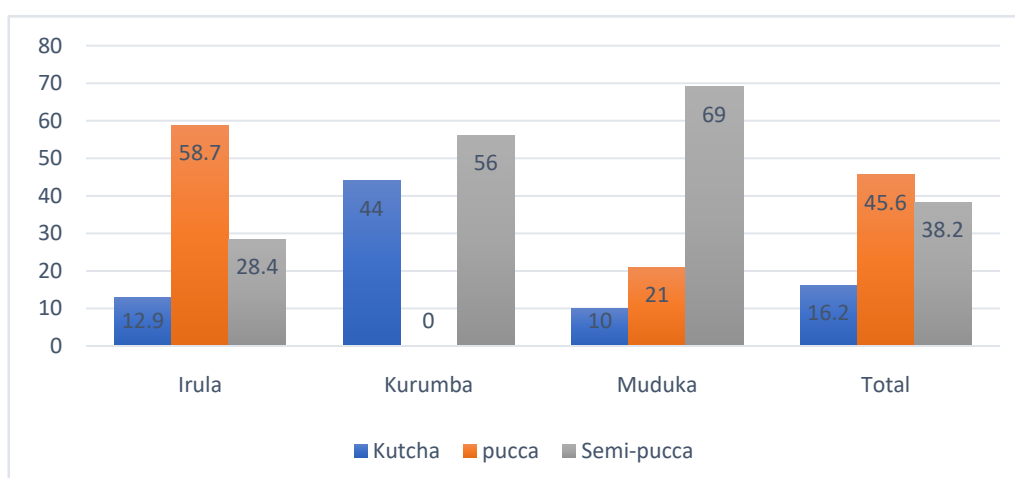
Type of house	Tribe			Total
	Irula	Kurumba	Muduga	
Kutcha	58 (12.9)	33 (44.0)	10 (10.0)	101 (16.2)
pucca	264 (58.7)	0 (0)	21 (21.0)	285 (45.6)
Semi-pucca	128 (28.4)	42 (56.0)	69 (69.0)	239 (38.2)
Total	450 (100)	75 (100)	100 100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 3.4 shows that among the Irula families, 12.9% live in kutcha houses, 58.7% in pucca houses, and 28.4% in semi-pucca houses. In contrast, the Kurumba community shows a higher prevalence of kutcha houses, with 44% living in such conditions, while no families live in pucca houses. A majority, 56%, reside in semi-pucca houses. The Muduga tribe presents a different pattern, with only 10% living in kutcha houses, 21% in pucca houses, and 69% in semi-pucca houses. Across all three tribes, 16.2% of families live in kutcha houses, 45.6% in pucca houses, and 38.2% in semi-pucca houses.

Figure 3.4
Type of House of Tribal Children in Attappadi



Source: Primary data

The housing conditions in Attappadi tribal communities are apparent from the table. Kurumba and Muduga families live in semi-pucca dwellings, suggesting a lower socio-economic position and environmental vulnerability. Irula families have better living conditions. These discrepancies influence the health and nutrition of children, requiring focused interventions to address malnutrition and raise living standards.

3.3 The Prevalence of Stunting, Wasting, and Underweight Among Tribal Children in Attappadi

The tribal territory of Attappadi faces serious health and nutritional issues due to stunting, wasting, and underweight in children aged 0-59 months. Height-for-age, weight-for-height, and weight-for-age markers can explain chronic and acute malnutrition and growth deficiencies. The researcher examined these factors to determine differences in gender, age, and tribe (Irula, Kurumba, and Muduga). These factors are essential for identifying vulnerable people, assessing malnutrition, and leading targeted interventions to enhance child health and break the intergenerational starvation cycle in Attappadi.

3.3.1 The Prevalence of Wasting (Weight for Height) Among Tribal Children in Attappadi

Wasting is a critical form of acute malnutrition characterised by low weight-for-height, often resulting from inadequate food intake, prolonged illness, or infections.

It denotes recent and severe weight loss, which, if untreated, significantly increases the risk of mortality, especially among children. Researchers assess the condition using the Weight-for-Height Z-score (WHZ), where $WHZ < -3$ standard deviations (SD) from the median (as per WHO standards) indicates severe malnutrition, WHZ between $-3SD$ and $-2SD$ represents moderate malnutrition, $WHZ \geq -2SD$ to $<+2SD$ is considered normal, and $WHZ >+2SD$ suggests overweight. Wasting is a sign of insufficient calorie intake or poor health, and it increases the risk of mortality, particularly in children. Wasting indicates more immediate issues like famine or disease outbreaks (WHO, 2021).

3.3.1.1 The Prevalence of Wasting by Type of Tribe among Children in Attappadi

Table 3.5 examines the prevalence of wasting among tribal children under five in Attappadi by tribal group using the Weight-for-Height Z-score (WHZ). It shows nutritional disparities among the Irula, Kurumba, and Muduga tribes. Wasting, an indicator of acute malnutrition, is categorised into severe ($WHZ < -3$ SD), moderate ($WHZ -3$ SD to -2 SD), and normal ($WHZ \geq -2SD$).

Table 3.5
The Prevalence of Wasting by Type of Tribe among Children in Attappadi

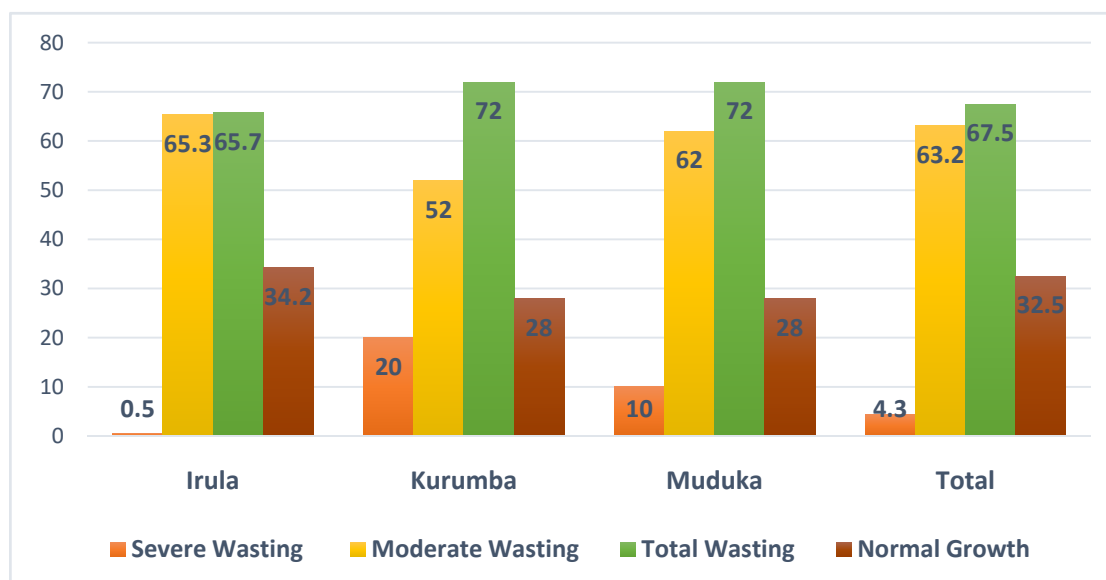
Nutritious Status	Irula (N=450)	Kurumba (N=75)	Muduga (N=100)	Total (N=625)
Severe Wasting ($WHZ < -3SD$)	2 (0.5)	15 (20.0)	10 (10.0)	27 (4.3)
Moderate Wasting ($WHZ -3SD$ to -2 SD)	294 (65.3)	39 (52.0)	62 (62.0)	395 (63.2)
Total Wasting	296 (65.7)	54 (72.0)	72 (72.0)	422 (67.5)
Normal Growth ($WHZ \geq -2SD$)	154 (34.2)	21 (28.0)	28 (28.0)	203 (32.5)
Total	450 (100)	75 (100)	100 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.5 shows the prevalence of wasting among different tribal groups in Attappadi. The overall wasting rate is 67.5%, with Kurumba and Muduga children showing the highest prevalence (72%) compared to Irula children (65.7%).

Figure 3.5
The Prevalence of Wasting by Type of Tribe



Source: Primary data

Severe wasting is most prevalent among Kurumba children (20%), followed by Muduga (10%) and Irula (0.5%). Moderate wasting is highest among Irula (65.3%), followed by Muduga (62%) and Kurumba (52%). The study found normal growth in 32.5% of children, with Irula children (34.2%) having a slightly better status than Kurumba and Muduga (28%). The prevalence of wasting among the Kurumba and Muduga tribes suggests the urgency of specific nutritional interventions. Fortification of health and nutrition interventions specific to the tribes can reduce inequities and improve child health status.

3.3.1.2 The Prevalence of Wasting by Gender among Tribal Children in Attappadi

Table 3.6 examines the prevalence of wasting among tribal children under five in Attappadi by gender using the Weight-for-Height Z-score (WHZ). It shows gender disparities in malnutrition among the Irula, Kurumba, and Muduga tribes. Wasting, an indicator of acute malnutrition, is classified into severe ($WHZ < -3 SD$), moderate ($WHZ -3 SD$ to $-2 SD$), and normal ($WHZ \geq -2SD$).

Table 3.6
The Prevalence of Wasting by Gender among Tribal Children in Attappadi

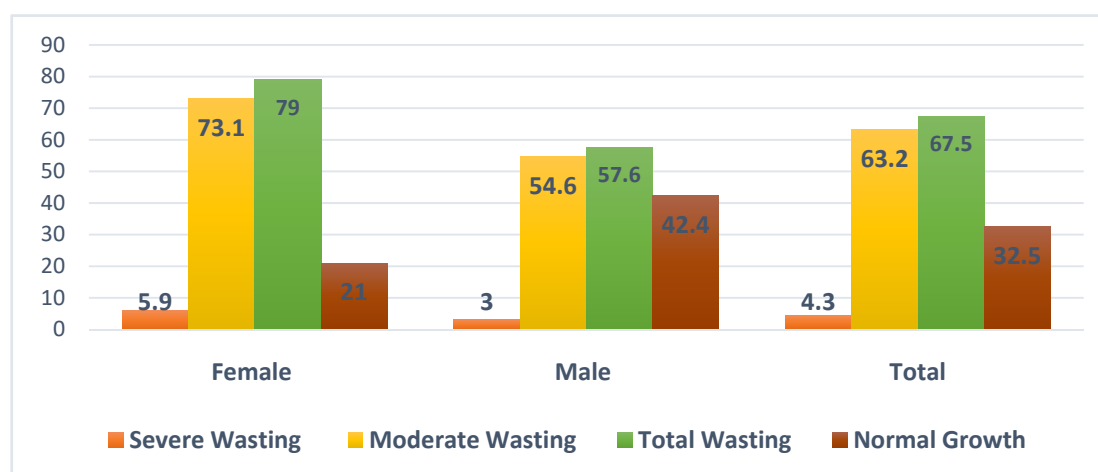
Nutritious Status	Female (N=290)	Male (N=335)	Total (N=625)
Severe Wasting (WHZ <-3SD)	17 (5.9)	10 (3.0)	27 (4.3)
Moderate Wasting (WHZ -3SD to -2 SD)	212 (73.1)	183 (54.6)	395 (63.2)
Total Wasting	229 (79.0)	193 (57.6)	422 (67.5)
Normal Growth (WHZ ≥ -2SD)	61 (21.0)	142 (42.4)	203 (32.5)
Total	290 (100)	335 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.6 illustrates the prevalence of wasting (weight-for-height) by gender among children below five years. The findings echo that the overall prevalence of wasting is alarmingly high, affecting 36.8% of the sampled children. Of these, 12.48% are female and 24.32% are male.

Figure 3.6
The Prevalence of Wasting by Gender



Source: Primary data

Severe wasting occurs more frequently in females (2.73%) than in males (1.6%), but moderate wasting is considerably more common in males (22.72%) than in females (9.76%). The data presented reflect significant gender differences in malnutrition trends. In addition, 63.2% of the children are of normal growth, with a comparatively higher proportion of females (33.92%) than males (29.28%). Acute malnutrition is of concern in Attappadi, where more than one third of the children

are wasted. Male children tend to have moderate wasting, and female children tend to have severe wasting. It requires gender sensitive nutrition interventions to cover the differences and improve the nutritional status of tribal children in the Attappadi area.

3.3.1.3 The Prevalence of Wasting by Age among Tribal Children in Attappadi

Table 3.7 examines the prevalence of wasting among tribal children under five in Attappadi by age group using the Weight-for-Height Z-score (WHZ). It reveals age related disparities in malnutrition. Wasting, an indicator of acute malnutrition, is categorised into severe (WHZ <-3 SD), moderate (WHZ -3 SD to -2 SD), and normal (WHZ $\geq$ -2SD).

Table 3.7
The Prevalence of Wasting by Age among Tribal Children in Attappadi

Nutritious Status	<12 Months (N=93)	12-35 Months (N=240)	> 35 Months (N=292)	Total (N=625)
Severe Wasting (WHZ <-3SD)	1 (1.1)	13 (5.4)	13 (4.4)	27 (4.3)
Moderate Wasting (WHZ -3SD to -2 SD)	59 (63.4)	176 (73.3)	160 (54.7)	395 (63.2)
Total Wasting	60 (64.5)	189 (78.7)	173 (59.2)	422 (67.5)
Normal Growth (WHZ $\geq$ -2SD)	33 (35.5)	51 (21.3)	119 (40.8)	203 (32.5)
Total	93 (100)	240 (100)	292 (100)	625 (100)

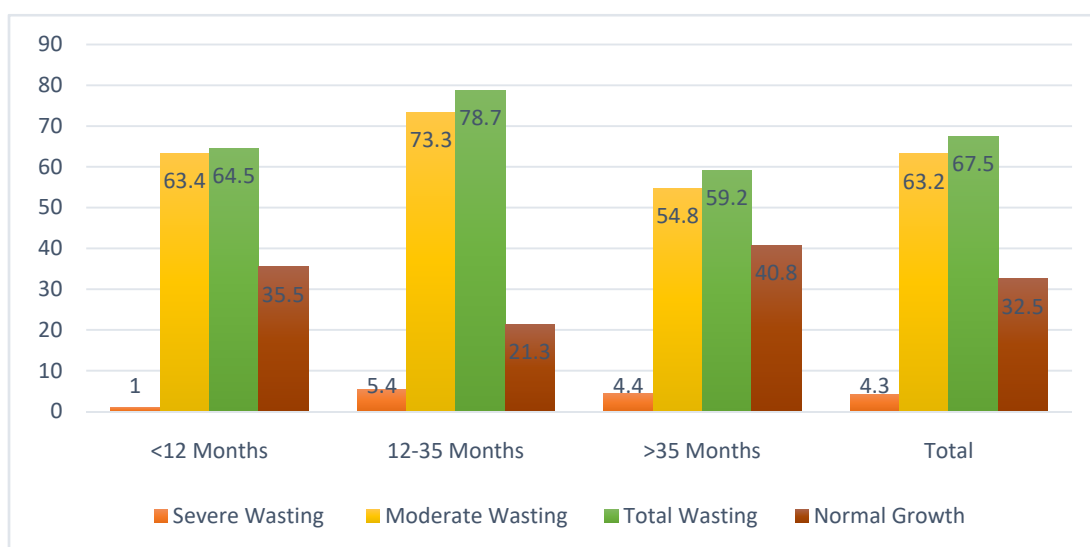
Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.7 shows the prevalence of wasting among different age groups of tribal children in Attappadi. The researcher observed the highest prevalence among children aged 12-35 months, with 78.7% classified as wasted, including 5.4% severely wasted and 73.3% moderately wasted. Among children under 12 months, 64.5% are wasted, with 1.1% suffering from severe wasting. The lowest prevalence is among children older than 35 months, with 59.2% classified as wasted, including 4.4% severely wasted. Normal growth is observed in 32.5% of children, with the highest proportion among those older than 35 months (40.8%), followed by infants under 12 months (35.5%), and the lowest among those aged 12-35 months (21.3%). Strengthening early childhood nutrition programs and increasing dietary diversity

can minimise malnutrition in this vulnerable group.

Figure 3.7
Prevalence of Wasting by Age among Tribal Children in Attappadi



Source: Primary data

3.3.2 The Prevalence of Underweight (Weight for Age) Among Tribal Children in Attappadi

WHO defines underweight as low weight-for-age, measured using the Weight-for-Age Z-score (WAZ). A WAZ below -3 SD indicates severe malnutrition, while -3 SD to -2 SD represents moderate malnutrition. Children with $WAZ \geq -2$ SD to $<+2$ SD are considered normal, and those above +2 SD are overweight. Insufficient caloric consumption, long-term or acute malnourishment, and frequent illness cause underweight. It is evident through short-term (wasting) and long-term (stunting) nutritional deficits. Underweight children are susceptible to impaired intellectual growth, impaired immunity, and heightened disease susceptibility, and hence, early nutrition interventions are critical.

3.3.2.1 The Prevalence of Underweight by Type of Tribe among Children in Attappadi

Evaluating the underweight condition (weight-for-age) of tribal children between 0 and 59 months in Attappadi is critical for analysing the nutritional imbalance among the Irula, Kurumba, and Muduga. Table 3.8 presents the prevalence of underweight among tribal children in Attappadi by type of tribe using the Weight-for-Age Z-score (WAZ). It categorises underweight status into severe ($WAZ < -3$

SD), moderate (WAZ -3 SD to -2 SD), and normal (WAZ $\geq$ -2SD).

Table 3.8
The Prevalence of Underweight by Type of Tribe

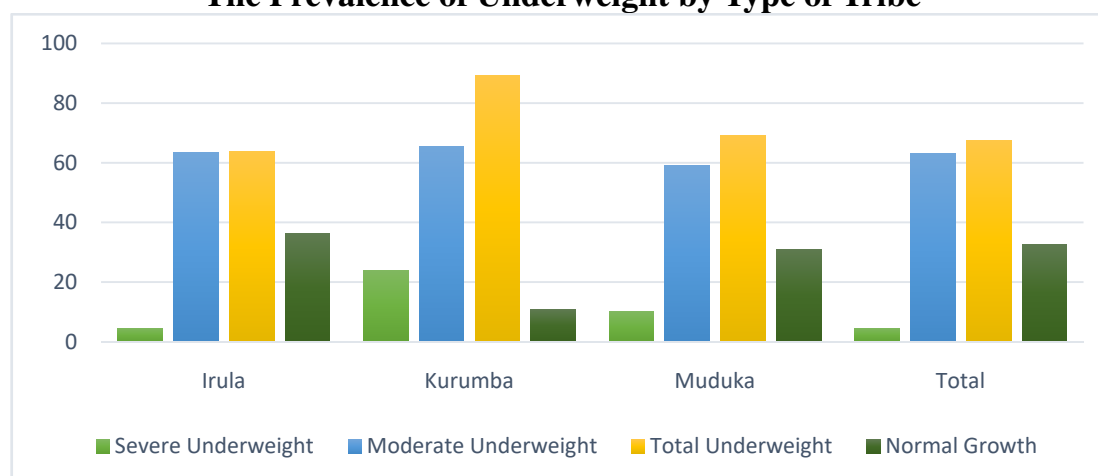
Nutritious Status	Irula (N=450)	Kurumba (N=75)	Muduga (N=100)	Total (625)
Severe Underweight (WAZ <-3SD)	2 (4.5)	18 (24.0)	10 (10.0)	30 (4.5)
Moderate Underweight (WAZ -3SD to -2 SD)	285 (63.3)	49 (65.3)	59 (59.0)	393 (63.0)
Total Underweight	287 (63.8)	67 (89.3)	69 (69.0)	421 (67.4)
Normal Growth (WAZ $\geq$ -2SD)	163 (36.2)	8 (10.7)	31 (31.0)	202 (32.5)
Total	450 (100)	75 (100)	100 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.8 shows that the overall underweight prevalence among tribal children in Attappadi is 67.4%. The Kurumba tribe exhibits the highest underweight prevalence (89.3%), followed by the Muduga (69%) and Irula (63.8%) tribes. Severe underweight is most prevalent among Kurumba children (24.0%), compared to Muduga (10%) and Irula (4.5%). Moderate underweight is similarly high across all groups, affecting 65.3% of Kurumba, 59% of Muduga, and 63.3% of Irula children. Normal growth is lowest among Kurumba (10.7%), while 31% of Muduga and 36.2% of Irula children have normal weight-for-age.

Figure 3.8
The Prevalence of Underweight by Type of Tribe



Source: Primary data

The high underweight prevalence among Kurumba children necessitates targeted

special nutritional interventions. Strengthening food security and child healthcare programs can help mitigate malnutrition disparities among tribal communities.

3.3.2.2 The Prevalence of Underweight by Gender among Tribal Children in Attappadi

Table 3.9 examines the prevalence of underweight among tribal children under five in Attappadi by gender using the Weight-for-Age Z-score (WAZ). It reveals gender-based disparities in malnutrition. Underweight, a key indicator of nutritional status, is categorised into severe (WAZ <-3 SD), moderate (WAZ -3 SD to -2 SD), and normal (WAZ ≥ -2SD).

Table 3.9
The Prevalence of Underweight by Gender

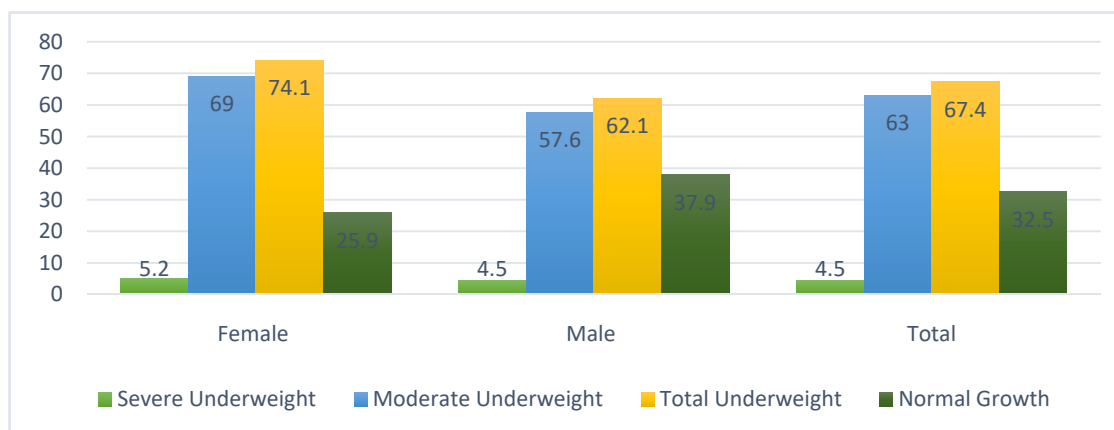
Nutritious Status	Female (N=290)	Male (335)	Total (625)
Severe Underweight (WAZ <-3SD)	15 (5.2)	15 (4.5)	30 (4.5)
Moderate Underweight (WAZ -3SD to -2 SD)	200 (69.0)	193 (57.6)	393 (63.0)
Total Underweight	215 (74.1)	208 (62.1)	421 (67.4)
Normal Growth (WAZ ≥ -2SD)	75 (25.9)	127 (37.9)	202 (32.5)
Total	290 (100)	335 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.9 shows the prevalence of underweight among tribal children in Attappadi by gender. The overall underweight prevalence is 67.4%, with females showing a higher prevalence (74.1%) than males (62.1%).

Figure 3.9
The Prevalence of Underweight by Gender



Source: Primary data

Severe underweight is nearly equal among both genders, with 5.2% of females and 4.5% of males affected. Moderate underweight is significantly higher among females (69.0%) than males (57.6%). Normal growth is observed in 32.5% of children, with a higher proportion among males (37.9%) than females (25.9%). The fact that girls have a greater prevalence of underweight indicates that gender-sensitive nutrition interventions are necessary. Strengthening maternal and child health programs is necessary to improve child nutrition in general and decrease underweight prevalence.

3.3.2.3 The Prevalence of Underweight by Age among Tribal Children in Attappadi

Underweight (weight-for-age) prevalence for children aged 0-59 months in Attappadi is a valuable analysis of malnutrition trends by age in this tribal community. Table 3.10 presents the prevalence of underweight among tribal children in Attappadi by age group using the WAZ. It aims to examine age based nutritional disparities among children under five, categorising underweight status into severe (WAZ < -3 SD), moderate (WAZ -3 SD to -2 SD), and normal (WAZ $\geq$ -2SD).

Table 3.10
The Prevalence of Underweight by Age

Nutritious Status	<12 Months (N=93)	12-35 Months (N=240)	> 35 Months (N=292)	Total (625)
Severe Underweight (WAZ <-3SD)	4 (4.3)	15 (6.2)	11 (3.8)	30 (4.5)
Moderate Underweight (WAZ -3SD to -2 SD)	55 (59.1)	178 (74.2)	160 (54.8)	393 (63.0)
Total Underweight	59 (63.4)	193 (80.4)	171 (58.6)	421 (67.5)
Normal Growth (WAZ $\geq$ -2SD)	34 (36.6)	47 (19.6)	121 (41.4)	202 (32.5)
Total	93 (100)	240 (100)	292 (100)	625 (100)

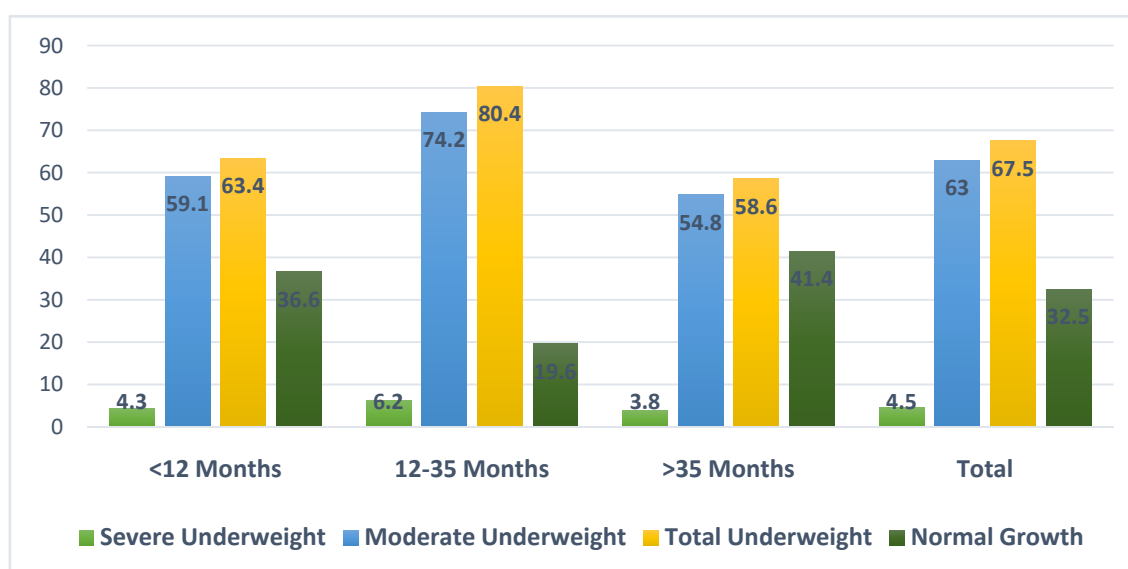
Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.10 shows that the overall underweight prevalence among tribal children in Attappadi is 67.5%. The highest prevalence is observed among children aged 12-35 months (80.4%), followed by those under 12 months (63.4%) and those above 35

months (58.6%). Severe underweight is most prominent in the 12-35 months age group (6.2%), compared to 4.3% in those under 12 months and 3.8% in children over 35 months. Moderate underweight is also highest in the 12-35 months group (74.2%), followed by 59.1% in those under 12 months and 54.8% in children above 35 months. Normal growth is most prevalent among children over 35 months (41.4%) and least among those aged 12-35 months (19.6%). The high underweight prevalence among children aged 12-35 months emphasises the need for targeted interventions during this critical growth period.

Figure 3.10
The Prevalence of Underweight by Age



Source: Primary data

Improvements in complementary feeding practices and access to healthcare can mitigate malnutrition in young children.

3.3.3 The Prevalence of Stunting (Height for Age) Among Tribal Children in Attappadi

Chronic malnutrition (WHO, 2021), recurring infections, and poor psychosocial development characterise stunting by impeding the growth and development of children. It is measured using the Height-for-Age Z-score (HAZ). A HAZ below -3 SD indicates severe malnutrition, while -3 SD to -2 SD represents moderate malnutrition. Children with $HAZ \geq -2$ SD to $<+2$ SD are considered normal. Stunting indicates chronic undernutrition and poor health status and is in contrast to wasting, a measure of acute undernutrition. Stunting leads to decreased educational

achievement, lost adult productivity, and vulnerability to chronic disease. Healthcare providers must address stunting to improve child health, development, and economic potential.

3.3.3.1 The Prevalence of Stunting by Type of Tribe among Tribal Children in Attappadi

Stunting, a severe manifestation of chronic malnutrition, is an expression of chronic growth failure in children and an indicator of their health and well-being. Table 3.11 presents the prevalence of stunting among tribal children under five in Attappadi, categorised by tribe (Irula, Kurumba, and Muduga), using the Height-for-Age Z-score (HAZ). This analysis aims to assess chronic malnutrition and inter-tribal disparities in growth impairment, which are critical for understanding long-term health and development challenges.

Table 3.11
The Prevalence of Stunting by Type of Tribe

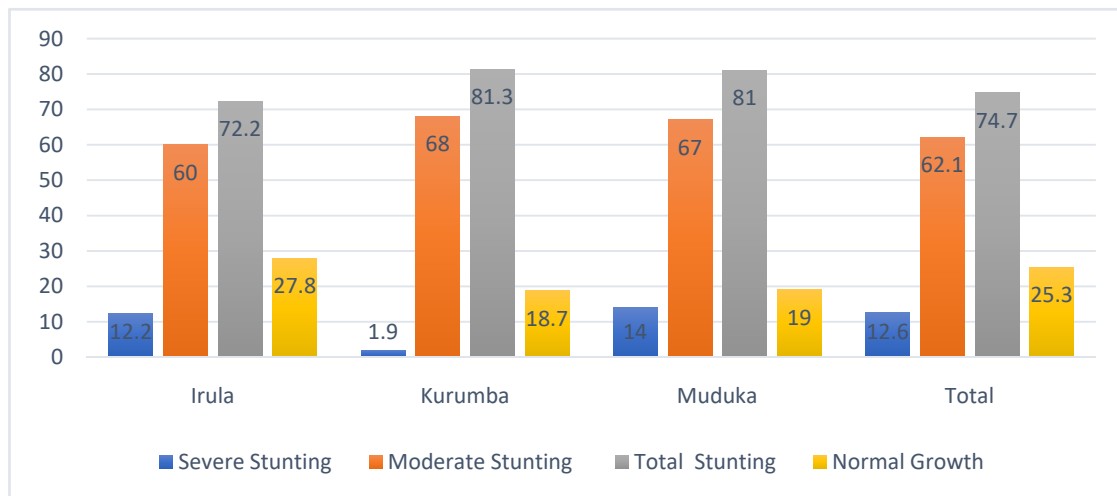
Nutritious Status	Irula (N=450)	Kurumba (N=75)	Muduga (N=100)	Total (625)
Severe Stunting (HAZ <-3SD)	55 (12.2)	10 (1.9)	14 (14.0)	79 (12.6)
Moderate Stunting (HAZ -3SD to -2 SD)	270 (60.0)	51 (68)	67 (67.0)	388 (62.1)
Total Stunting	325 (72.2)	61 (81.3)	81 (81.0)	467 (74.7)
Normal Growth (HAZ $\geq$ -2SD)	125 (27.8)	14 (18.7)	19 (19.0)	158 (25.3)
Total	450 (100)	75 (100)	100 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.11 illustrates the prevalence of stunting among Irula, Kurumba, and Muduga children. The overall prevalence of stunting is 74.7%, with the highest rates among Kurumba (81.3%) and Muduga (81%), followed by Irula (72.2%).

Figure 3.11
The Prevalence of Stunting by Type of Tribe



Source: Primary data

Severe stunting is most prominent among Muduga (14%) and Irula (12.2%), while Kurumba exhibits the lowest severe stunting rate (1.9%). Moderate stunting affects 60% of Irula children, 68% of Kurumba, and 67% of Muduga. In contrast, only 25.3% of children have normal growth, with Irula the highest proportion (27.8%) and Kurumba the lowest (18.7%). The prevalence of stunting is very high in all three tribal groups, reflecting severe chronic malnutrition. Stunting is much too high in all three tribal populations, reflecting extreme chronic malnutrition. Focused interventions in nutrition and health programs with attention to long-term diet change and maternal health are needed to treat stunting and enhance child growth outcomes in Attappadi.

3.3.3.2 The Prevalence of Stunting by Gender among Tribal Children in Attappadi

Gender wise analysis of stunting among children of 0 to 59 months in Attappadi provides us with critical information regarding chronic malnutrition among the tribal population. Table 3.12 shows the prevalence of stunting among tribal children under five in Attappadi, categorised by gender, using the Height-for-Age Z-score (HAZ). Stunting indicates chronic malnutrition, reflecting prolonged nutritional deprivation and health issues.

Table 3.12
The Prevalence of Stunting by Gender

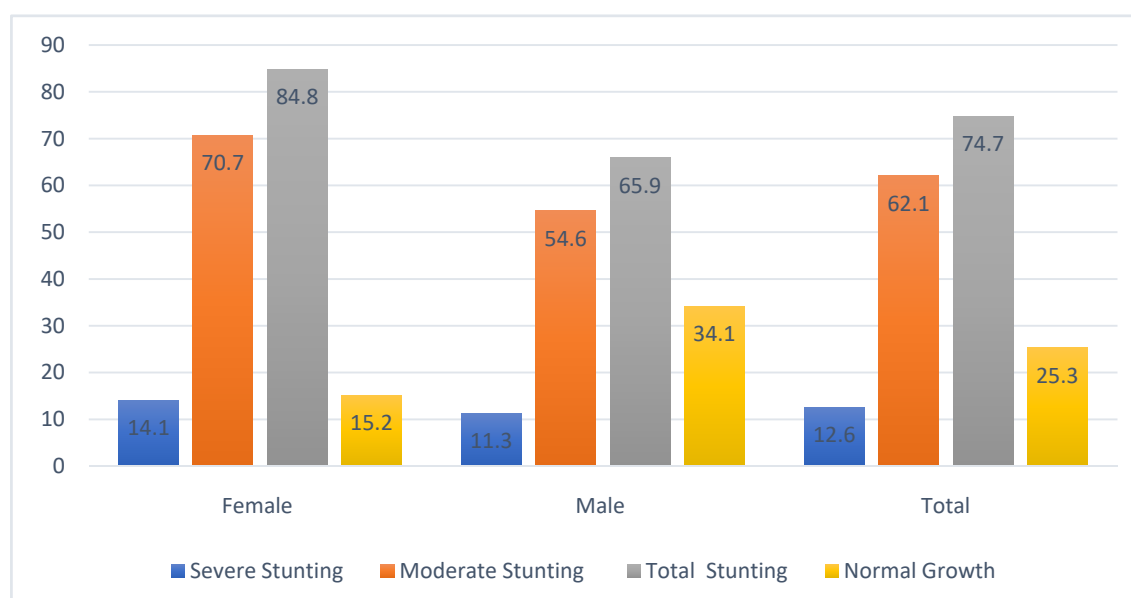
Nutritious Status	Female (N=290)	Male (335)	Total (625)
Severe Stunting (HAZ < -3SD)	41 (14.1)	38 (11.3)	79 (12.6)
Moderate Stunting (HAZ -3SD to -2 SD)	205 (70.7)	183 (54.6)	388 (62.1)
Total Stunting	246 (84.8)	221 (65.9)	467 (74.7)
Normal Growth (HAZ $\geq$ -2SD)	44 (15.2)	114 (34.1)	158 (25.3)
Total	290 (100)	335 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.12 shows the prevalence of stunting among male and female tribal children in Attappadi. The overall stunting prevalence is 74.7%, with a higher rate among females (84.8%) than males (65.9%). Severe stunting (HAZ < -3SD) affects 12.6% of children, with females (14.1%) exhibiting a slightly higher prevalence than males (11.3%).

Figure 3.12
The Prevalence of Stunting by Gender



Source: Primary data

Moderate stunting (HAZ -3SD to -2SD) is higher, affecting 62.1% of children, with females (70.7%) more affected than males (54.6%). Only 25.3% of children exhibit

normal growth, with males (34.1%) faring better than females (15.2%). Stunting is more common in girls than in boys. Improved maternal nutrition, early childhood feeding programs, and healthcare treatments are needed to reduce stunting and enhance growth outcomes for tribal children in Attappadi.

3.3.3.3 The Prevalence of Stunting by Age among Tribal Children in Attappadi

Stunting based on the Height-for-Age Z-score (HAZ) is a measure for assessing chronic malnutrition in children. Table 3.13 analyses the stunting rate among Attappadi tribal children and reflects differences in nutritional deficiencies in various age groups. This research identifies susceptible age demographics requiring focused nutritional interventions.

Table 3.13
The Prevalence of Stunting by Age

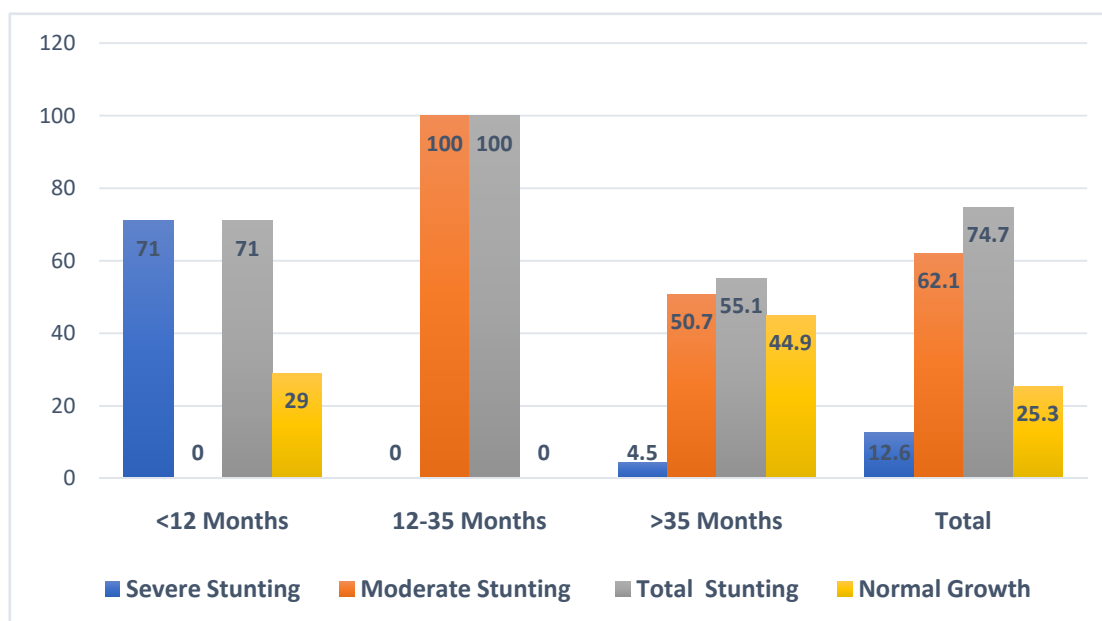
Nutritious Status	<12 Months (N=93)	12-35 Months (N=240)	> 35 Months (N=292)	Total (625)
Severe Stunting (HAZ <-3SD)	66 (71.0)	0 (0)	13 (4.5)	79 (12.6)
Moderate Stunting (HAZ -3SD to -2 SD)	0 (0)	240 (100)	148 (50.7)	388 (62.1)
Total Stunting	66 (71.0)	240 (100)	161 (55.1)	467 (74.7)
Normal Growth (HAZ $\geq$ -2SD)	27 (29.0)	0 (0)	131 (44.9)	158 (25.3)
Total	93 (100)	240 (100)	292 (100)	625 (100)

Note: Figures in brackets indicate percentages.

Source: Primary data

Table 3.13 indicates a high prevalence of stunting among tribal children, with significant variations across age groups. Among children below 12 months, 71.0% experienced severe stunting, whereas no cases of moderate stunting were recorded. In the 12-35 month group, all children (100%) were moderately stunted, reflecting chronic nutritional deprivation during early childhood.

Figure 3.13
The Prevalence of Stunting by Age



Source: Primary data

Among children older than 35 months, 55.1% were stunted, with 4.5% severely affected. The overall stunting prevalence among tribal children was 74.7%, indicating a serious public health concern. The decreasing trend of severe stunting with age suggests possible catch up growth for some children, but also reflects prolonged exposure to risk factors during infancy. The high prevalence of stunting, especially in children in early life, highlights the importance of specific nutritional interventions aimed at the first 1,000 days of life. Healthcare systems must further strengthen maternal and child healthcare, communities must enhance diet diversity, and policymakers must address socio-economic disparities to reduce stunting and promote healthy growth trajectories in Attappadi tribal children.

3.4 Correlation Between Wasting, Underweight, and Stunting Among Tribal Children in Attappadi

The correlation between wasting and being underweight is robust and positive ($r = 0.957$), indicating that children with low weight-for-height are also highly likely to have low weight-for-age. It reflects the close relationship between acute malnutrition (wasting) and chronic undernutrition (underweight).

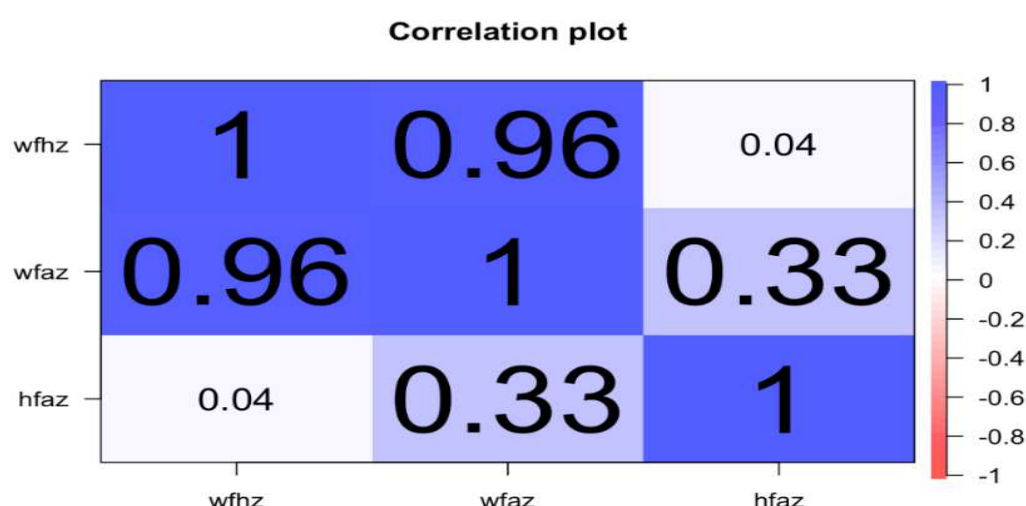
Table 3.14
Correlation Between Wasting, Underweight and Stunting

Nutritional Status	Wasting (Weight for Height)	Underweight (Weight-for- Age)	Stunting (Height-for- Age)
Wasting (weight for Height)	1	0.9566617	0.042241
Underweight (weight- for-age)	0.95666169	1	0.326877
Stunting (height-for- age)	0.04224058	0.326877	1

Source: Primary Data

The correlation between underweight and stunting is moderate and positive ($r = 0.327$), suggesting that lower weight-for-age is somewhat associated with shorter height-for-age. However, wasting and stunting are poorly correlated ($r = 0.042$) and indicate that the two indicators measure dissimilar dimensions of malnutrition with hardly any overlap. The study indicates a good correlation between wasting and underweight, a moderate correlation between underweight and stunting, and a poor correlation between wasting and stunting. These findings reinforce the need to address malnutrition comprehensively.

Figure 3. 14
Correlation Between Wasting, Underweight and Stunting



Source: Primary data

The correlation between wasting and underweight ($r = 0.957$) is strong, reflecting

that children with low weight-for-height also have low weight-for-age. A moderate correlation between stunting and underweight ($r = 0.327$) indicates that chronic undernutrition contributes to overall insufficiency in weight. The poor correlation between wasting and stunting ($r = 0.042$) indicates that acute and chronic malnutrition must be due to different causes and require different intervention measures.

3.5 Health Inequality Among Tribal Children in Attappadi by Nutritional Status

Health inequality affects tribal children critically in Attappadi, where malnutrition manifests through high rates of stunting, wasting, and underweight. These indicators emphasise disparities across age, gender, and tribal groups (Irula, Kurumba, and Muduga), signifying chronic and acute undernutrition. The present study investigates inequities to comprehend the intensity and distribution of malnutrition and its wider consequences for health and social equity.

3.5.1 Wasting (Weight-for-Height) Disparities

Wasting, a severe form of acute malnutrition, affects 36.8% of children in Attappadi. Gender wise, males experience a higher prevalence of moderate wasting (22.72%) than females (9.76%), while severe wasting is more frequent in females (2.73%) than in males (1.6%). Among tribal groups, Kurumba (72%) and Muduga (72%) have the highest wasting rates compared to Irula (65.7%), with severe wasting being significantly more pronounced among Kurumba children (20%). Age-wise, children aged 12-35 months suffer the highest wasting prevalence (78.7%), followed by those below 12 months (64.5%) and above 35 months (59.2%). The information above captures age related nutritional vulnerability, which requires early intervention.

3.5.2 Underweight (Weight-for-Age) Disparities

Underweight prevalence is alarmingly high at 67.4%, with female children (74.1%) affected more than males (62.1%). Severe underweight is nearly equal in both genders, but moderate underweight is significantly higher among females (69%) than males (57.6%). Tribe wise, Kurumba children show the highest underweight prevalence (89.3%), followed by Muduga (69%) and Irula (63.8%). Being severely underweight is particularly concerning among the Kurumba (24%). Age-based

disparities indicate that children aged 12-35 months have the highest underweight prevalence (80.4%), followed by those under 12 months (63.4%) and those older than 36 months (58.6%). Children between 12 and 35 months of age are highly malnourished, possibly due to inadequate breast milk and insufficient complementary feeding after the discontinuation of breastfeeding. As they are admitted to Anganwadi only from 36 months onwards, doubling the quantity of supplementary nutrition during this critical period is essential to prevent further deterioration of their nutritional status. The findings suggest that young children, particularly girls and those from the Kurumba tribe, are at a heightened risk of malnutrition and need special attention.

3.5.3 Stunting (Height-for-Age) Disparities

Stunting, as a manifestation of chronic malnutrition, is present in 74.72% of children. Differentials by gender indicate that females (84.8%) are much more prevalent than males (65.97%). The prevalence of severe stunting is also marginally higher in females (14.1%) than in males (11.3%). Among tribal groups, Kurumba (81.3%) and Muduga (81%) children have the highest stunting rates, while Irula children (72.2%) fare slightly better. Age-wise, children below 12 months exhibit the highest rate of severe stunting (71%), whereas all children in the 12-35 month group (100%) experience moderate stunting. The record low stunting rate (55.1%) among children older than 36 months indicates potential for recovery from growth. The high rate of malnutrition among the children of the tribal population is a common finding from Attappadi, and this calls for specific interventions. The highest priority must be targeted nutritional interventions, enhanced maternal and child care, and nutrition interventions at the community level. Healthcare providers must focus on the Kurumba tribe and children between 12 and 35 months, who constitute the highest risk group. Increasing food availability, diversity, and access to healthcare are key interventions for eradicating health inequities in Attappadi.

3.6 Qualitative Analysis of Malnutrition Among Tribal Children in Attappadi: Insights from Community Stakeholders

Target group discussions were conducted with tribal mothers, fathers, community senior citizens, Anganwadi teachers, health workers, and tribal promoters from

Attappadi. Qualitative studies attempted to unearth the root causes and situational factors of child malnutrition in the Attappadi region. The narratives reveal a complex interplay between cultural beliefs, economic insecurity, social neglect, and systemic barriers, all of which contribute to persistent undernutrition among tribal children.

3.6.1 Thematic Analysis

Thematic analysis is a qualitative approach employed to identify, analyse, and interpret key themes or recurring patterns within textual or narrative data. This method allows researchers to explore participants lived experiences, understanding, and social contexts in depth. Through detailed narratives, the method helped illuminate structural, cultural, and behavioural factors that shape nutritional practices, thereby offering context-specific insights for targeted interventions and policy improvements.

3.6.1.1 Disintegration of Traditional Food Systems and Livelihoods

Elders like Nanchiyamma and Edavanni recalled the self-sufficient food systems that once flourished in Attappadi. Millet cultivation, wild roots, and leafy vegetables formed the core diet. However, multiple respondents emphasised that these practices have declined due to wild animal conflicts, water scarcity, and high agricultural input costs. Vanitha noted, "Even if we want to grow something, where is the water or land protection?"

There is a gradual erosion of traditional age ecological knowledge, replaced by dependence on market purchases and the Public Distribution System (PDS), which often lacks diversity. Many families now purchase even basic food staples, further pushing them toward economic insecurity.

3.6.1.2 Gender Roles, Early Marriage, and Care Deficit

Community members such as Geethamma and Valli raised the issue of early marriage and early motherhood among women in the tribal population. Women are becoming primary caregivers and economic contributors at the age of 23, with 3-4 children. Fathers, as described by women such as Lakshmi, have become disconnected and utilise most of their income on alcohol. Women like Lakshmi demonstrated that they remained employed under MGNREGA during the advanced

stages of their pregnancy to ensure economic survival. Vasanthi added that, consequently, children are taken to the workplace and abandoned in temporary cradles. This practice completely reduces appropriate feeding, hygiene, and intimate care.

3.6.1.3 Cultural Beliefs and Nutritional Practices

A significant cultural factor emerged in food consumption behaviour. Elders expressed beliefs that animal protein, such as eggs and meat, could harm children, with statements like "eating such foods may cause tumours in the head of the child." Consequently, even though many households rear chickens and goats, consumption of animal protein remains limited.

Likewise, IFA syrup (Iron Folic Acid) was primarily perceived as "medicine" rather than a preventive nutritional supplement. Many mothers administer it only when children appear sick, not as a regular measure against anaemia.

3.6.1.4 Health Seeking Behaviours and Mistrust in Public Health System

Health officials and tribal promoters shared that despite high Severe Acute Malnutrition rates, admissions to Nutrition Rehabilitation Centres (NRCs) remain low. Tribal families hesitate due to potential wage loss, fear of unfamiliar settings, and lack of understanding about the benefits of NRC. Further, women like Vanitha chose to use private health facilities to receive antenatal care, driven by fears of referrals at the last moment to public facilities. It signifies distrust and intrinsic inefficiencies in the public health system.

3.6.1.5 Inaccessibility and Disuse of Welfare Schemes

While schemes like ICDS, MGNREGA, community kitchens, and the PDS are active in the region, many respondents, including Vignesh and Vinu, observed that their implementation often lacks community participation. For example, though well intentioned, community kitchens are reportedly non-functional in many hamlets due to irregular funding. Stakeholders noted that welfare programs are top-down, with insufficient community consultation. Thulasi, a youth in the community, said, "They plan everything from offices. Nobody asks us what we need."

3.6.1.6 Structural Neglect and Challenges to Education

The individuals identified poor transportation, infrastructure, and school dropouts as the greatest hindrances to sustainable transformation. For example, PSC coaching classes run under ITDP were poorly attended due to distance and transport issues, as reported by Manikandan.

Moreover, respondents shared that Anganwadi teachers and workers, being tribals themselves, sometimes underestimate the severity of malnutrition. The community urgently needed trained professionals from outside or better sensitised tribal staff to ensure accountability and effectiveness.

3.6.2 Theme Implications for Child Nutrition

The collapse of traditional food practices results in decreased dietary diversity and nutrition security. Early marriage and the female work burden reflect the neglect of infant care and feeding. Cultural beliefs are revealed in food resistance to nutritious foods like eggs, meat, and IFA tablets. Mistrust in healthcare and NRCs shows poor management of severe malnutrition; the top-down scheme implementation results in low community ownership and poor sustainability. Structural issues result in poor health and educational outcomes.

3.6.3 Recommendations Based on Community Voices

The recommendations based on community voices are given below.

1. Revive traditional farming practices through sustainable inputs, water support, and protection from wild animals.
2. Strengthen community kitchens and ICDS services with regular funding and quality monitoring.
3. Enhance father and male involvement in child care through awareness programs and behavioural interventions.
4. Design culturally sensitive nutrition programs, including myth busting campaigns on eggs, meat, and IFA.
5. Promote participatory planning by engaging tribal leaders (Moopans), mothers, adolescents, and local stakeholders in policy formulation and implementation.
6. Improve health communication and follow up to increase uptake of NRC

services and health seeking behaviour.

7. Strengthen education and vocational training of tribal women to delay early marriages and enhance autonomy.
8. Appoint sensitised and accountable frontline workers with appropriate training and supervision.

The qualitative results in Attappadi record an entrenched environment of malnutrition driven by socio-cultural forces, gender dynamics, livelihood related challenges, and systemic gaps in implementation. While interventions by the government provide the underlying backdrop, gaps in participation by the community, erosion of traditional knowledge, and a general mistrust of formal health systems continue to create impediments. A solution oriented, participatory, and culturally respectful model is urgently needed to combat malnutrition in tribal communities in Attappadi.

3.7 Neonatal/Infant Deaths Among Tribal Children in Attappadi

Understanding the death status of tribal children is essential for addressing deep rooted health disparities in marginalised communities like Attappadi. The research team visited 625 tribal households and documented 54 cases of neonatal and infant deaths. The current age of the mothers of deceased children ranged from 18 to 42 years. Analysing the gender distribution, 29 male and 25 female deceased children, and the timing and causes of death provides valuable insights to design effective, culturally appropriate maternal and child health interventions in tribal areas.

3.7.1 Neonatal/Infant Deaths Among Tribal Children in Attappadi

Table 3.15 presents the distribution of deaths among tribal children aged 0–36 months in Attappadi between 2012 and 2022, categorised by age at death and tribal affiliation (Irula, Kurumba, and Muduga). The age groups are divided into <1 month (neonatal), 1–12 months (infant), 13–24 months (toddler), and 25–36 months (early childhood). These distinctions help identify the most vulnerable stages of early life among tribal populations. The neonatal period (first 28 days) is universally acknowledged as the most critical for child survival due to its association with perinatal and delivery related complications.

Table 3.15
Neonatal/Infant Deaths Among Tribal Children in Attappadi

Age at death	Tribe			Total
	Irula	Kurumba	Muduga	
>One month	11 (78.6)	20 (74.1)	10 (76.9)	41 (75.9)
1-12 Months	2 (14.3)	4 (14.8)	2 (15.4)	8 (14.8)
13-24 Months	1 (7.1)	2 (7.4)	0 (0)	3 (5.6)
25-36 Months	0 (0)	1 (3.7)	1 (7.7)	2 (3.7)
Total	14 (100)	27 (100)	13 (100)	54 (100)

Note: Figures in brackets indicate percentages.

Source: Primary Data

The majority of child deaths occurred during the neonatal period. Among Irula children, 78.6% of deaths happened within the first month, while 74.1% of Kurumba and 76.9% of Muduga children died in the same early stage. Overall, 41 out of 54 deaths (75.9%) occurred during the neonatal phase, emphasising the pressing need for improved maternal and neonatal care in tribal regions. Infant deaths (between 1 and 12 months) contributed 14.8% of total cases, with consistent patterns across tribes: 14.3% (Irula), 14.8% (Kurumba), and 15.4% (Muduga). It suggests that while risk persists through the first year of life, it diminishes after the neonatal stage.

Deaths between 13 and 24 months were minimal, with just three cases reported, one among Irula and two among Kurumba children. The 25-36 months category recorded only two deaths (one each from the Kurumba and Muduga tribes), reflecting a further decline in mortality risk as children grow older. Importantly, no child deaths were reported in the 37-59 month age group across any of the tribal communities. It indicates that once children survive the initial three years, especially the critical neonatal and infant stages, their likelihood of survival significantly increases. Among the total deaths reported, the Kurumba tribe accounted for the highest share (50%), followed by Irula (25.9%) and Muduga (24.1%). It could reflect greater structural vulnerabilities, limited healthcare access,

or more profound socio-economic deprivation within the Kurumba population.

Table 3.15 shows that a staggering 75.9% of child deaths among the Irula, Kurumba, and Muduga tribes in Attappadi occurred during the neonatal period, emphasising the urgent need for improved perinatal and immediate postnatal care services. The absence of deaths in the 37-59 month age group indicates that child survival prospects improve substantially after the early years of life. However, the relatively higher death burden among Kurumba children suggests a need for targeted, tribe sensitive health and nutrition interventions. These findings call for enhanced antenatal monitoring, skilled delivery services, and community-based neonatal care to prevent early childhood mortality in tribal regions.

Table 3.15 outlines the medically attributed causes of neonatal and infant deaths among the three major tribal communities - Irula, Kurumba, and Muduga - over ten years (2012-2022). The data reflect the underlying clinical and health system related factors contributing to early childhood mortality among tribal children. Causes of death are categorised into both biological conditions (e.g., preterm birth, extremely low birth weight, congenital heart disease) and preventable or treatable illnesses (e.g., acute respiratory distress syndrome, meningitis, anaemia). This analysis helps identify the health conditions most associated with mortality during the neonatal and infant stages within tribal areas.

3.7.2 Causes of Neonatal/Infant Deaths Among Tribal Children in Attappadi (2012–2022)

Table 3.16 outlines the medically attributed causes of neonatal and infant deaths among the three major tribal communities - Irula, Kurumba, and Muduga - in Attappadi over ten years (2012-2022). The data reflect the underlying clinical and health system related factors contributing to early childhood mortality among tribal children. Causes of death are categorised into both biological conditions (e.g., preterm birth, extreme low birth weight, congenital heart disease) and preventable illnesses (e.g., acute respiratory distress syndrome, meningitis, anaemia). This analysis helps identify the health conditions most associated with mortality during the neonatal and infant stages within tribal areas.

Table 3.16
Causes of Neonatal/Infant Deaths Among Tribal Children in Attappadi

Cause of death	Tribe			Total
	Irula	Kurumba	Muduga	
Acute respiratory distress syndrome	4 (28.6)	8 (29.6)	3 (23.1)	15 (27.8)
Preterm Birth	4 (28.6)	4 (14.8)	3 (23.1)	11 (20.4)
Congenital Heart Disease	2 (14.3)	0 (0)	0 (0)	2 (3.7)
Extreme Low Birth Weight	2 (14.3)	9 (33.3)	2 (15.4)	13 (24.1)
Sudden Infant Deaths	0 (0)	5 (18.5)	1 (7.7)	6 (11.1)
Sickle Cell Anaemia	0 (0)	0 (0)	2 (15.4)	2 (3.7)
Meningitis	1 (7.1)	0 (0)	0 (0)	1 (1.9)
Severe Anaemia	1 (7.1)	1 (3.7)	2 (15.4)	4 (7.4)
Total	14 (100)	27 (100)	13 (100)	54 (100)

Note: Figures in brackets indicate percentages.

Source: Primary Data

Among all reported causes, acute respiratory distress syndrome (ARDS) was the most common, accounting for 27.8% of total deaths. Incidence was proportionally uniform between tribes (28.6%) in Irula, 29.6% in Kurumba, and 23.1% in Muduga children. It indicates overall susceptibility to respiratory complications, perhaps due to poor neonatal care, environmental exposure, or poor early access to treatment. Extreme low birth weight was the second most common cause, at 24.1%. The most significant incidence among Kurumba children was in this group (33.3%), followed by Irula (14.3%) and Muduga (15.4%). It may reflect issues related to maternal nutrition, antenatal care, or high-risk pregnancies, particularly in the Kurumba community. Preterm birth accounted for 20.4% of total deaths and was evenly distributed among Irula (28.6%) and Muduga (23.1%), but was notably lower in Kurumba (14.8%). Preterm complications are a major contributor to global

neonatal mortality and highlight gaps in obstetric services in tribal areas.

Other causes were less frequent but remain critical. Sudden infant deaths contributed to 11.1% of total mortality, with Kurumba children disproportionately affected (18.5%) compared to Muduga (7.7%), and none were reported among Irula. This pattern may suggest undiagnosed conditions or socio-cultural caregiving practices that need further investigation. Rare but notable causes include severe anaemia (7.4%), which was more prevalent among Muduga (15.4%) and Irula (7.1%) than Kurumba (3.7%), and sickle cell anaemia, which affected two Muduga children (15.4%) and none from the other two tribes. These findings indicate the need for genetic screening and better child nutrition practices. Congenital heart disease was recorded as the cause of death in two Irula children (14.3%) and not in other groups, while meningitis was found in just one Irula child (7.1%). Though lower in frequency, these conditions reflect gaps in early detection and pediatric healthcare access.

Table 3.16 identifies acute respiratory distress syndrome (27.8%), extreme low birth weight (24.1%), and preterm birth (20.4%) as the primary causes of neonatal and infant mortality among tribal children in Attappadi, with the Kurumba tribe facing the highest burden from low birth weight and sudden infant deaths. The data highlight the need for enhanced maternal and newborn care, strongly focusing on prenatal screening, nutritional interventions, and community-level newborn health services. Tribe non-specific risks, such as the increased prevalence of sickle cell anaemia among Muduga children and congenital heart disease among Irula children, need tribe specific responses in health, such as genetic counselling, neonatal screening, and improved access to neonatal intensive care, in order to decrease avoidable mortality. These insights emphasise the urgent need for focused tribal health strategies to prevent early childhood deaths and ensure equitable child survival.

3.8 Conclusion

This chapter has examined the complex dimensions of malnutrition among tribal children in Attappadi through both statistical analysis and community-based perspectives. The demographic analysis revealed inequalities across tribal groups,

gender, and age, with children between 12 and 35 months being the most vulnerable due to inadequate feeding practices. High prevalence rates of stunting, wasting, and underweight emphasised the severity of malnutrition, while correlations among these indicators demonstrated their overlapping and cumulative nature. The health inequality assessment highlighted stark disparities, with Kurumba children disproportionately affected due to greater socio-economic marginalisation. Qualitative findings reinforced these results, revealing how gender roles, cultural beliefs, inadequate healthcare use, and poor access to welfare schemes exacerbate malnutrition. The testimonies of community stakeholders emphasised the urgency of addressing structural neglect, poverty, and educational barriers. Infant and neonatal deaths further illustrated the tragic consequences of sustained undernutrition and poor maternal care. Overall, the findings stress the need for holistic and integrated interventions, combining nutritional support, maternal education, healthcare accessibility, and livelihood enhancement. Policy strategies must prioritise community participation and intersectoral collaboration to break the cycle of deprivation and ensure the long-term nutritional well-being of tribal children in Attappadi.

CHAPTER 4

DETERMINANTS OF MALNUTRITION

4.1 Introduction

This chapter examines the critical factors influencing malnutrition among tribal children under five years in Attappadi. The analysis is organised into two major categories: internal and external determinants. Internal factors encompass socio-economic, parental, and personal characteristics that directly shape the nutritional status of children. The determinants are education and occupation of parents, alcohol use, family income, age of mother, health and nutrition awareness, body mass index (BMI), family size, birth order, birth interval of children, and tribal status. The determinants mirror the socio-economic and demographic context in which malnutrition occurs. External determinants are structural determinants that include environmental circumstances, support institutions, and cultural practices. Variables were assessed by applying a structured Likert scale method to quantify norms and beliefs at the community level affecting child nutrition. Regression and Chi-square tests were utilised to explore the relationships with malnutrition outcomes. The findings are designed to yield statistically significant predictors and insights for developing evidence-based, targeted interventions to address the multifaceted and complex malnutrition issues among Attappadi's tribal children.

4.2 Internal Factors of Malnutrition

This section examines the internal factors contributing to malnutrition among tribal children under five years in Attappadi. Internal factors refer to the socio-economic and demographic characteristics of households and parental factors that directly shape the nutritional status of children. Internal factors encompass socio-economic, parental, and personal characteristics that directly shape the nutritional status of children. The indicators analysed include household income, size of land holdings, parental education, occupation, alcohol consumption, maternal age, body mass index (BMI), health and nutrition awareness, family size, birth order, and birth interval of children. The tribal identity is also considered, given its relevance to access to resources and community-specific vulnerabilities. This analysis aims to cover the household-level determinants that elevate the risk of malnutrition. To achieve this, both Chi-square tests and regression analyses (logistic and multiple linear) were applied to assess the significance of associations between these

variables and malnutrition outcomes. Understanding of these internal influences is crucial for designing targeted, evidence-based interventions that address malnutrition among tribal children and help to reduce disparities across tribal groups in Attappadi.

4.2.1 Socio-Economic Factors Influencing Malnutrition

Socio-economic determinants play an important role in child nutrition outcomes. Income, level of education, and occupation status of parents affect access to proper food, healthcare, and general standard of living, particularly among the tribal communities of Attappadi. This chapter explores the degree to which socio-economic determinants are associated with malnutrition among children under the age of five years, learning about the economic risk and social disadvantage in determining poor nutritional status. Knowledge of such associations is critical in identifying risk groups and developing interventions for poverty related nutritional inequalities in tribal families.

4.2.1.1 Distribution of Households of Tribal Children Based on Income Status

Table 4.1 shows the average monthly income distribution of sample households across the Irula, Kurumba, and Muduga tribes in Attappadi. The income is categorised into five groups: below Rs. 2,000, Rs. 2,000 - Rs. 4,000, Rs. 4,000 - Rs. 6,000, Rs. 6,000 - Rs. 8,000, and above Rs. 8,000. Understanding income distribution helps to assess economic vulnerability and its impact on household well-being.

Table 4.1
Income Status of Sample Households

Monthly Income	Irula	Kurumba	Muduga	Total
Below 2000	112 (24.9)	31 (41.3)	25 (25.0)	168 (26.8)
2000-4000	89 (19.8)	7 (9.3)	6 (6.0)	102 (16.3)
4000-6000	133 (29.6)	34 (45.3)	61 (61.0)	228 (36.5)
6000-8000	89 (19.8)	3 (0.7)	6 (6.0)	98 (15.7)
Above 8000	27 (6.0)	0 (0)	2 (2.0)	29 (4.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=78.32 \cdot df=8 \cdot \text{Cramer's } V=0.25$				

Note: Figures in brackets indicate percentages.

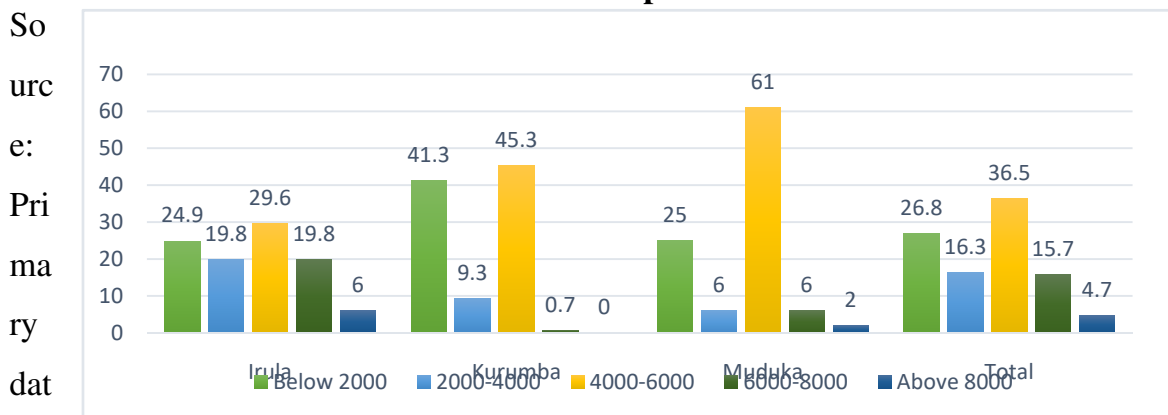
Source: Primary Data

Most of the Irula households fall within the Rs. 4000-6000 range (29.6%), with a proportion (24.9%) earning below Rs. 2000. Similarly, Kurumba households also

show a concentration in the Rs. 4000-6000 income bracket (45.3%). However, 41.3% earn less than Rs. 2000, indicating higher vulnerability. In contrast, Muduga households appear to have a relatively better income distribution, with 61.0% reporting incomes in the Rs. 4000-6000 range and only 25.0% earning below Rs. 2000. Only a small proportion of households in all three tribes reported incomes above Rs. 8000, with the Kurumba tribe having no representation in this category. The income band of Rs. 6000-8000 also shows significant disparities; while 19.8% of Irula households fall into this group, only 0.7% of Kurumba and 6.0% of Muduga households report similar income levels.

The Chi-square test was utilised to determine whether an association existed between tribal affiliation and household income levels. The result shows a statistically significant result, $\chi^2(8) = 78.32$, $p < .001$, showing that income distribution varies significantly across the three tribal communities. The strength of this association, as reflected by Cramer's V value of 0.25, points to a moderate linkage between tribal affiliation and income category. The findings emphasise inter-tribal disparities in household income among the tribal communities in Attappadi. All tribal groups in Attappadi experience income constraints. Kurumba households exhibit the most significant economic vulnerability, with a higher concentration in the lowest income bracket and no households earning above Rs. 8000. These differences in income distribution may have critical implications for targeted interventions to improve child nutrition and overall tribal welfare.

Figure 4.1
Income Status of Sample Households



4.2.1.2 Distribution of Breadwinners of the Family of Tribal Children in Attappadi

Table 4.2 shows the role of the primary breadwinner within families across the three major tribal groups in Attappadi: Irula, Kurumba, and Muduga. It is necessary to understand the primary sources of family income in assessing the economic status of families since the factor above directly impacts the nutritional status of children and overall health, particularly those under five years. Classification here brings in the father, grandfather, grandmother, and mother as the primary source of income for the family.

Table 4.2
Breadwinner of the Family of Tribal Children in Attappadi

Breadwinner	Tribe			Total
	Irula	Kurumba	Muduga	
Father	152 (33.8)	1 (1.3)	21 (21.0)	174 (27.8)
Grandfather	25 (5.6)	13 (17.3)	15 (15.0)	53 (8.5)
Grandmother	20 (4.4)	17 (22.7)	13 (13.0)	50 (8.0)
Mother	253 (56.2)	44 (58.7)	51 (51.0)	348 (55.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=73.731 \cdot df=6 \cdot \text{Cramer's } V=0.243 \cdot p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 4.2 shows the distribution of primary breadwinners of tribal households in Attappadi, disaggregated by tribe. Among Irula households, 33.8% reported that the father is the primary breadwinner, but this proportion drops in Kurumba (1.3%) and Muduga (21.0%) households. The role of grandparents as breadwinners is more prevalent among the Kurumba and Muduga tribes. Specifically, 17.3% of Kurumba and 15.0% of Muduga families identified the grandfather as the primary provider, while 22.7% of Kurumba and 13.0% of Muduga families indicated the grandmother in this role. Only 5.6% and 4.4% of Irula families reported grandfathers and grandmothers as breadwinners. Most notably, mothers are the predominant breadwinners across all three tribal groups, Kurumba (58.7%) and Irula (56.2%) families, followed by Muduga (51.0%) families. Overall, mothers account for 55.7% of breadwinners among the total sample. These figures emphasise the central economic role of women, particularly mothers, in the tribal households of Attappadi.

The chi-square test result reveals a statistically significant association between tribal identity and status of household primary breadwinner, $\chi^2(6) = 73.731$, $p < .001$. The association measured by Cramer's V is 0.243, indicating a moderate effect size. It shows the role of tribal affiliation in shaping patterns of economic responsibility within households. It reveals a marked shift from traditional male breadwinner roles, especially among the Kurumba tribe, showing elevated male unemployment among tribes. It has increased the economic burden on women, particularly mothers and grandmothers, which may affect household food security and child nutritional well-being in these communities.

The following logistic regression analysis explores the impact of household income on the nutritional status of tribal children.

4.2.1.3 Binary Logistic Regression Model on Economic Factors Influencing Malnutrition Among Tribal Children in Attappadi

Logistic Regression Analysis examines the critical economic factors determining malnutrition among tribal children under five years old in Attappadi. The objective is to assess the relationship between household economic factors and the likelihood of malnutrition. The dependent variable is the malnutrition status of children, classified into two categories: Malnourished (severely and moderately malnourished) and Standard Growth or normal. The independent variables used in this model are household average monthly income and breadwinner status (father, mother, grandfather, grandmother vs. baseline category). Based on these predictors, Binary logistic regression estimates the probability (Brophy S,2025) of a child being malnourished. The equation below gives the logistic regression.

$$\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right) = \beta_0 + \beta_{1hami} + \beta_{2bwf} + \beta_{3bwm} + \beta_{4bwgf} + \beta_{5bwgm}$$

Where, $\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right)$ - $\text{Log} \left(\frac{P_{malnutrition}}{P_{standard\ growth}} \right)$, β_0 - Constant term, β_{1hami} - Household average monthly income, β_{2bwf} - The breadwinner is the father, β_{3bwm} - The breadwinner is the mother, β_{4bwgf} - The breadwinner is the grandfather, and β_{5bwgm} - Breadwinner being the grandmother. Logistic regression analysis was employed to analyse the results, and Table 4.3 depicts the results.

Table 4.3
Economic Factors Influencing Malnutrition

Predictor	B	SE	z	p-value	OR
Intercept	4.6152	1.2547	3.678	0.0002	101.003
Household Average Monthly Income	-0.0017	0.00015	-11.084	< .001***	0.998
Breadwinner - Father	-0.00024	0.00038	-0.631	0.528	0.999
Breadwinner - Mother	0.2051	1.2667	0.162	0.871	1.228
Breadwinner-Grandfather	-8.2400	1.8187	-1.003	0.316	0.161
Breadwinner-Grandmother	0.3998	1.3329	0.300	0.764	1.492
<i>McFadden R² = 0.65, Cox & Snell R² = 0.54, and Nagelkerke R² = 0.77</i>					

Note. B = logistic regression coefficient; SE = standard error; z = Wald statistic; p = probability value; OR = Odds Ratio. The Odds Ratio represents the change in odds of child malnutrition associated with a one-unit increase in the predictor variable. An OR > 1 indicates a positive association, OR < 1 indicates a negative association, and OR = 1 indicates no association. Statistical significance is determined at ***p < .001 (highly significant), **p < .01 (very significant), *p < .05 (significant), +p < .10 (marginally significant), and p > .10 (not significant). McFadden R² = 0.65, Cox & Snell R² = 0.54, and Nagelkerke R² = 0.77 indicate the explanatory power of the model.

Source: Primary Data.

The binary logistic regression results presented in Table 4.3 examine the influence of economic factors on child malnutrition. In logistic regression, the Odds Ratio (OR) indicates how the odds of malnutrition change with a one-unit increase in the predictor variable, holding other variables constant. The results reveal that household average monthly income significantly predicts child malnutrition status. The regression coefficient for income is negative (B = -0.0017) and highly statistically significant (p < .001). The corresponding Odds Ratio (OR = 0.998) is less than 1, indicating a protective effect. Specifically, for every one unit increase in household income, the odds of child malnutrition decrease by a factor of 0.998. Although the unit change effect appears small, the consistent negative association suggests that as income increases, the likelihood of malnutrition declines. Since OR < 1, this confirms that higher income reduces the risk of child malnutrition among tribal households.

Regarding the role of the breadwinner, none of the categories shows a statistically significant association with malnutrition ($p > .05$). The Odds Ratios for breadwinner categories - father (OR = 0.999), mother (OR = 1.228), grandfather (OR = 0.161), and grandmother (OR = 1.492) - indicate varying directions of association; however, these effects are not statistically significant. An OR slightly above 1 (e.g., mother or grandmother) suggests increased odds of malnutrition relative to the reference category, whereas an OR below 1 (e.g., father or grandfather) suggests reduced odds. Nevertheless, because the p -values exceed the conventional significance level ($p > .05$), these variations may be due to sampling fluctuation rather than true effects. Therefore, breadwinner identity alone does not significantly influence child malnutrition.

The model fit statistics demonstrate strong explanatory power. The McFadden R^2 (0.65), Cox & Snell R^2 (0.54), and Nagelkerke R^2 (0.77) indicate that the independent variables collectively explain a substantial proportion of the variation in child malnutrition. Particularly, the Nagelkerke R^2 value of 0.77 suggests that approximately 77% of the variance in malnutrition status is accounted for by the economic factors included in the model. Overall, the findings indicate that household income is a significant protective economic determinant of child malnutrition in Attappadi, whereas the breadwinner's identity does not exert a statistically significant impact. These results emphasise the importance of improving household economic conditions and strengthening income-based interventions to effectively reduce malnutrition among tribal children.

4.2.1.4 Size of Land Owned by Households of Tribal Children in Attappadi

Table 4.4 presents the distribution of households of tribal children in Attappadi according to their land size, classified by tribal group - Irula, Kurumba, and Muduga. Land ownership is categorised into four groups: no land (zero acres), 1 acre, 2 acres, and more than 3 acres. Ownership of land is crucial for economic security, agricultural productivity, and food availability of households, affecting child nutrition and well-being.

Table 4.4
Size of Land Owned by Households of Tribal Children in Attappadi

Size of Land in Acres	Tribe			Total
	Irula	Kurumba	Muduga	
0	202 (44.9)	59 (78.7)	40 (40.0)	301 (48.2)
1	247 (54.9)	6 (8.0)	53 (53.0)	306 (48.9)
2	1 (0.2)	0 (0)	7 (7.0)	8 (1.3)
More than 3	0 (0)	10 (13.3)	0 (0)	10 (1.6)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=149.93 \cdot df=6 \cdot \text{Cramer's } V=0.346 \cdot \text{Fisher's } p= <.001$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table reveals significant inter-tribal disparities in land ownership. Most of the Kurumba households (78.7%) reported owning no land, compared to 44.9% among Irula and 40.0% among Muduga households. Conversely, ownership of 1 acre of land was highest among Muduga households (53.0%), followed closely by Irula (54.9%), but extremely low among Kurumba (8.0%). Very few households owned 2 acres only 0.2% of Irula and 7.0% of Muduga households. Notably, the 'More than 3 acres' category was represented exclusively by Kurumba households (13.3%), with no Irula or Muduga households in this category.

The chi-square test shows a statistically significant association between tribe and land size ($\chi^2 = 149.93$, $df = 6$, $p < .001$), with a moderate to strong strength of association (Cramer's $V = 0.346$). It suggests that the distribution of land size is not random but strongly linked to tribal identity. It shows disparity in land ownership patterns among tribal households in Attappadi, with Kurumba households disproportionately represented in the landless category. In contrast, Muduga and Irula households are more likely to own 1 acre of land. The results emphasise the role of land ownership inequality as a potential structural determinant of socio-economic and nutritional outcomes among tribal children, warranting targeted policy measures to improve equitable access to land resources.

4.2.1.5 Education Status of the Parents of Tribal Children in Attappadi

Table 4.5 presents a cross-tabulation of the educational attainment of the parents of tribal children in Attappadi, disaggregated by tribe (Irula, Kurumba, and Muduga) and parental gender (mother and father). It covers five educational attainment

categories: absence of formal education (illiterate), 1-4 years, 5-8 years, 9-12 years, and more than 12 years of schooling. Understanding inter-tribal and gender based disparities in the educational attainment of parents of tribal children is critical, as it influences the health, nutrition, and overall well-being of the tribal children.

Table 4.5
Education Status of the Parents of Tribal Children in Attappadi

Years of Education	Tribe						Total
	Irula		Kurumba		Muduga		
	Mother	Father	Mother	Father	Mother	Father	
0	114 (12.7)	79 (8.8)	74 (49.3)	74 (49.3)	32 (16.0)	22 (11.0)	395 (31.6)
1-4	104 (11.6)	134 (14.9)	1 (0.7)	1 (0.7)	47 (23.5)	53 (26.5)	340 (27.2)
5-8	83 (9.2)	27 (3.0)	0 (0)	0 (0)	17 (8.5)	12 (6.0)	139 (11.1)
9-12	144 (16.0)	198 (22.0)	0 (0)	0 (0)	4 (2.0)	13 (6.5)	359 (28.7)
>12	5 (0.6)	12 (1.3)	0 (0)	0 (0)	0 (0)	0 (0)	17 (1.4)
Total	900 (100)		150 (100)		200 (100)		1250 (100)
$\chi^2 = 503.782 \cdot \text{df} = 20 \cdot \text{Cramer's V} = 0.317 \cdot \text{p} < .001$							

Note: Figures in brackets indicate percentages.

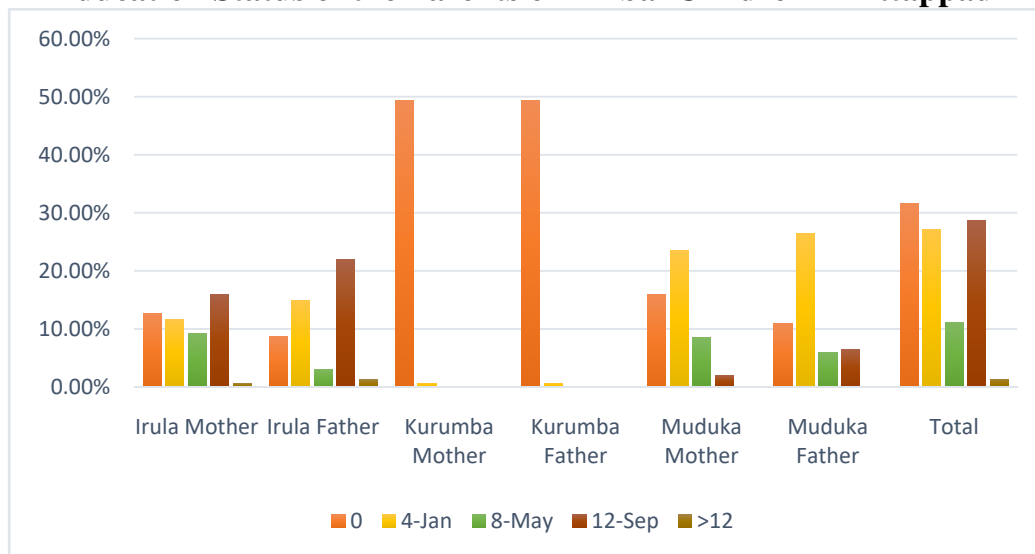
Source: Primary Data

The findings reveal substantial differences across tribal groups. Kurumba parents exhibit the highest proportion without formal education (49.3% for both mothers and fathers), and none reported schooling beyond the primary level. In contrast, Irula parents demonstrate comparatively better educational attainment, particularly at the secondary level (9-12 years), where 16.0% of mothers and 22.0% of fathers fall within this category. Muduga parents occupy an intermediate position, with moderate representation in the 1-8 years categories but limited participation beyond that level. Across tribes, fathers generally report slightly higher educational attainment than mothers, particularly among the Irula community. The proportion of parents with more than 12 years of education remains minimal (1.4%) across all groups.

The chi-square test confirms a statistically significant association between tribal affiliation, parental gender, and years of schooling ($\chi^2 = 503.782$, $df = 20$, $p < .001$).

Cramer's V (0.317) indicates a moderate strength of association, suggesting meaningful intergroup differences in educational attainment. Overall, Kurumba parents appear most educationally disadvantaged, especially beyond the primary stage, whereas Irula parents show relatively better schooling profiles. These disparities underscore the need for targeted educational initiatives, particularly for mothers, to enhance long-term child development outcomes.

Figure 4.2
Education Status of the Parents of Tribal Children in Attappadi



Source: Primary data

Figure 4.2 visually reinforces these patterns, highlighting the pronounced educational disadvantage among Kurumba parents and the comparatively stronger representation of Irula fathers in secondary education. The subsequent sections examine whether these educational differences translate into variations in child nutritional outcomes.

4.2.1.6 Multiple Linear Regression Model on the Influence of Parental Education on Underweight (Weight-for-age) Tribal Children

The multiple linear regression model examines the influence of parental education on the underweight status (measured by weight-for-age) of tribal children in Attappadi. The dependent variable is the underweight status of the child, and the independent variables are the number of years of schooling completed by the father and the mother. The objective is to determine whether parental education levels significantly predict the underweight status of the children.

$$UW_i = \beta_0 + \beta_1 FYS + \beta_2 MYS + \varepsilon_i$$

Where, UW_i - Nutritional status of the child (Underweight), β_0 - Constant term $\beta_1 FYS$ - Years of Schooling of the Father, $\beta_2 MYS$ - Years of Schooling and ε_i - Error term.

The results of the multiple linear regression analysis are presented in Table 4.6

Table 4.6
Influence of Parental Education on Underweight (Weight-for-age)
Tribal Children

Predictor	B	SE	t	P
(Intercept)	8.501	0.631	13.463	< .001***
Years of Schooling of Father	-0.234	0.254	-0.920	0.357
Years of Schooling of the Mother	0.506	0.255	1.985	0.047*
<i>Multiple R² = .02187, Adjusted R² = .01872</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression analysis explains that the model explains only approximately 2.2% of the variance in underweight status among tribal children ($R^2 = .02187$, Adjusted $R^2 = .01872$), suggesting a low explanatory power. Among the predictors, only the years of schooling of the mothers showed a statistically significant effect on the underweight status ($B = 0.506$, $p = .047$), indicating that increased maternal education is associated with improved weight-for-age outcomes for children. In contrast, the education of the father was not significantly related to the nutritional status of the child ($B = -0.234$, $p = .357$). These results imply that maternal education is more influential than paternal education in determining child nutrition outcomes in this tribal setting. Although the overall model explains only a small portion of the variance in nutritional status, promoting maternal education may be an important strategy in addressing undernutrition, specifically underweight, among tribal children in Attappadi.

4.2.1.7 Multiple Linear Regression Model on Influence of Parental Education on Stunting (Height-for-Age) Among Tribal Children

The multiple linear regression model examines the effect of parental schooling on the underweight status (as measured in terms of weight-for-age indicators) of the children in Attappadi. The underweight status of the child is the dependent variable, and the total number of schooling years of the father and the mother are the independent variables. The prime objective is to examine whether the schooling status of the parents is a reliable predictor of the underweight status of the children.

$$ST_i = \beta_0 + \beta_1 FYS + \beta_2 MYS + \varepsilon_i$$

Where, ST_i - Nutritional status of the child (Stunting), β_0 - Constant term $\beta_1 FYS$ – Years of Schooling of Fathers, $\beta_2 MYS$ - Years of Schooling of Mothers and ε_i - Error term.

The results of the multiple linear regression analysis are presented in Table 4.7.

Table 4.7
Influence of Education of Parents on Stunting (Height for Age)
Among Tribal Children

Predictor	B	SE	t	p
(Intercept)	12.4835	0.367392	33.97867	< .001 ***
Years of Schooling of Father	-0.32232	0.148083	-2.17662	0.029884.
Years of Schooling of the Mother	0.408729	0.148584	2.750831	0.006117**
<i>Multiple R² = .01951, Adjusted R² = .01636</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression model reveals that the education levels of both parents have statistically significant but contrasting effects on child stunting. The regression coefficient for years of schooling of the fathers is negative and statistically significant (B = -0.322, $p = .030$), suggesting that increased paternal education is linked to lower levels of stunting among children. It implies that for every additional year of schooling of the father, the height-for-age z-score of the child improves by approximately 0.32 units. Conversely, the coefficient for years of schooling of the mother is positive and statistically significant (B = 0.409, $p =$

.006), which is unexpected and suggests that as maternal education increases, stunting also increases. This counterintuitive result may reflect unmeasured confounders, such as the work status or time availability for child care of the mother, that might offset the potential benefits of education in this context. The intercept is statistically significant ($B = 12.484$, $p < .001$), indicating the average stunting score when both parents have zero years of education. While the predictors are statistically significant, the overall explanatory power of the model remains low, indicating that other factors beyond parental education may play a more substantial role in determining child stunting outcomes.

4.2.1.8 Occupation Status of Fathers of Tribal Children in Attappadi

Table 4.8 presents the distribution of occupation status of fathers of tribal children in Attappadi, categorised by tribal affiliation - Irula, Kurumba, and Muduga. Understanding paternal occupation is essential, as it directly correlates with household income and impacts the nutritional and overall well-being of children. The occupation of fathers of tribal children is classified into three categories: daily labour, salaried employment, and unemployment, showing the economic conditions of the tribal people.

Table 4.8
Occupation Status of Fathers of Tribal Children in Attappadi

Occupation level	Tribe			Total
	Irula	Kurumba	Muduga	
Daily Labour	155 (34.4)	1 (1.3)	20 (20.0)	176 (28.2)
Salaried Employees	66 (14.7)	0 (0)	1 (1.0)	67 (10.7)
Unemployed	229 (50.9)	74 (98.7)	79 (79.0)	382 (61.1)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=81.471 \cdot df=4 \cdot \text{Cramer's } V=0.255 \cdot p=0.000$				

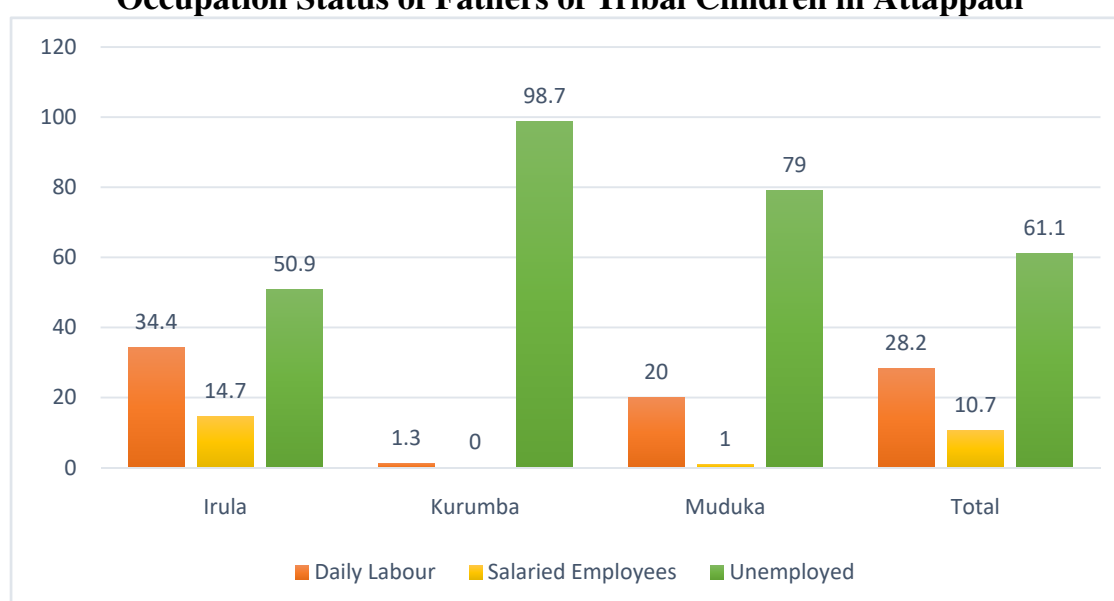
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among Irula fathers, 34.4% are engaged in daily wage labour, the most common form of employment within this group. In comparison, only 1.3% of Kurumba and 20.0% of Muduga fathers are daily labourers. Overall,

28.2% of fathers across all three tribal groups work as daily wage earners. Salaried employment is low across all communities. Only 14.7% of Irula fathers and 1.0% of Muduga fathers hold salaried positions, while none of the Kurumba fathers are in salaried jobs. The total percentage of fathers with salaried employment across the sample is 10.7%. Unemployment is the most dominant category, especially among Kurumba fathers, where 98.7% are unemployed. It is followed by 79.0% among Muduga and 50.9% among Irula fathers, resulting in an overall unemployment rate of 61.1%. It highlights the acute employment crisis in tribal communities, particularly among Kurumbas and Mudugas.

Figure 4.3
Occupation Status of Fathers of Tribal Children in Attappadi



Source: Primary Data

A chi-square association test confirms a statistically significant relationship between tribal identity and paternal occupation, $\chi^2(4) = 81.471$, $p < .001$. The Cramer's V value of 0.255 indicates a moderate strength of association, showing that paternal employment status varies meaningfully across tribal groups. The findings of the study point to high levels of paternal unemployment among the Kurumba and Muduga tribes in Attappadi, coupled with limited opportunities for salaried work and low representation in daily labour. These occupational disparities contribute to the economic marginalisation of tribal households and are likely to affect the nutritional and developmental outcomes of children adversely. The

findings emphasise the need for targeted employment and livelihood interventions in these tribal communities.

4.2.1.9 Alcohol Consumption of the Parents of Tribal Children in Attappadi

Table 4.9 presents the distribution of alcohol consumption among the parents of tribal children in Attappadi, disaggregated by tribal group (Irula, Kurumba, and Muduga) and parent (father or mother). The table shows both the frequency and percentage of alcohol use across different tribal affiliations, reflecting potential behavioural risk factors contributing to child health outcomes.

Table 4.9
Alcohol Consumption of the Parents of Tribal Children in Attappadi

Alcohol Consumption	Tribe						Total
	Irula		Kurumba		Muduga		
	Father	Mother	Father	Mother	Father	Mother	
Yes	220 (24.4)	108 (12)	56 (37.3)	33 (22.0)	62 (31.0)	29 (14.5)	508 (40.6)
No	230 (25.6)	342 (38.0)	19 (12.7)	42 (28.0)	38 (19.0)	71 (35.5)	742 (59.4)
Total	900 (100)		150 (100)		200 (100)		1250 (100)
$\chi^2=125.22$. $df=5$. $Cramer's\ V = 0.317$. $p < .001$							

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among Irula families, 24.4% of fathers and 12.0% of mothers consumed alcohol. In contrast, 37.3% of Kurumba fathers and 22.0% of Kurumba mothers reported alcohol consumption. Among the Muduga tribes, 31.0% of fathers and 14.5% of mothers consumed alcohol. Overall, 40.6% of parents consumed alcohol, while 59.4% did not.

The result of the Chi-square test reveals a significant relationship between parental alcohol consumption and tribal identity and gender, $\chi^2(5) = 125.22$, $p < .001$. It indicates that alcohol consumption among parents of tribal children differs notably across tribes and between mothers and fathers. The strength of this association, reflected in a Cramer's V of 0.317, points to a moderate association between the variables. The analysis indicates a significant and moderately strong association between tribal affiliation, parental gender, and alcohol consumption behaviour among the tribal population in Attappadi. These findings suggest that alcohol

consumption is more prevalent among Kurumba and Muduga fathers compared to their Irula counterparts and that maternal alcohol consumption, while lower than paternal, still varies notably between tribes. This behaviour may affect child health and nutrition outcomes in the region.

4.2.2 Maternal Factors Influencing Malnutrition

Maternal factors play an important role in determining the nutritional outcomes of children, especially among vulnerable tribal populations. The present study examines how maternal characteristics such as age, occupation, income, health awareness, and nutritional knowledge affect malnutrition of children among tribes in Attappadi. These factors influence economic stability, caregiving capacity, and health seeking behaviours.

4.2.2.1 Age of Mothers of Tribal Children in Attappadi

Table 4.10 illustrates the distribution of mothers of tribal children in Attappadi according to their age groups and tribal affiliation (Irula, Kurumba, and Muduga). Age is an important demographic factor influencing maternal health, caregiving capacity, and nutritional outcomes of children. The age groups are 18-22, 22-26, and 26-30.

Table 4.10
Age of Mothers of Tribal Children in Attappadi

Age of Mothers	Tribe			Total
	Irula	Kurumba	Muduga	
18-22	75 (16.7)	11 (14.7)	1 (1.0)	87 (13.9)
22-26	251 (55.8)	49 (65.3)	46 (46.0)	346 (55.4)
26-30	124 (27.5)	15 (20.0)	53 (53.0)	192 (30.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=37.84 \cdot df=4 \cdot \text{Cramer's } V=0.174 \cdot \text{Fisher's } p=<.001$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows a significant variation in maternal age distribution across tribal mothers. Most of the Irula mothers (55.8%) fall within the 22-26 age group, followed by 27.5% in the 26-30 age group and 16.7% in the 18-22 age group. The same trend is observed among Kurumba mothers, with 65.3% in the 22-26 group, 20.0% in the 26-30 group, and 14.7% in the youngest category.

The Muduga tribes, on the other hand, show a clear-cut pattern of distribution such

that over half (53.0%) of the mothers are in the 26-30 age group, 46.0% in the 22-26 age group, and only 1.0% in the 18-22 age group. This finding shows delayed motherhood among the Muduga women compared to Irula and Kurumba women.

The chi-square test of independence reveals a statistically significant association between tribal affiliation and maternal age group ($\chi^2 = 37.84$, $df = 4$, $p < .001$). The strength of this association, measured by Cramer's V, is 0.174, indicating a small to moderate association between the two variables.

There is a statistically significant association between tribe and maternal age among tribal women in Attappadi. Irula and Kurumba mothers are strongly age concentrated in the 22-26 group, while Muduga mothers are older, with the majority in the 26-30 group. Such age structures might have implications for maternal and child health planning, indicating the necessity for tribe specific maternal welfare and health education interventions that are responsive to the age structure of each tribe.

4.2.2.2 Occupation Status of Mothers of Tribal Children in Attappadi

Understanding the occupations of mothers is essential as it directly influences the socio-economic status of the household, affecting the nutritional status of children. Therefore, the present study attempts to analyse the occupational distribution of mothers among the three primary tribal groups across the Irula, Kurumba, and Muduga tribes in Attappadi. It categorises the occupations of mothers into daily labour, salaried employees, and the unemployed. This variable is a key socioeconomic indicator, influencing household income, caregiving capacity, and child nutrition and well-being.

Table 4.11
Occupation Status of Mothers of Tribal Children in Attappadi

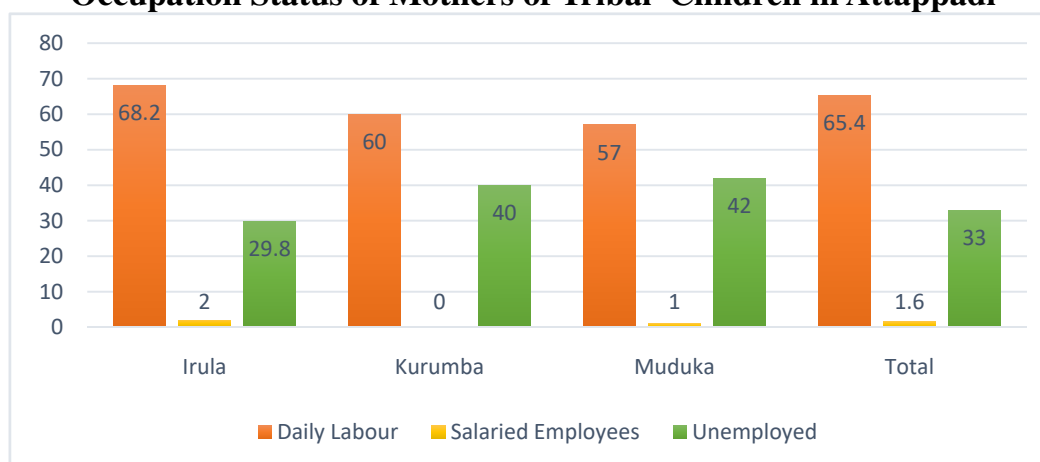
Occupation level	Tribe			Total
	Irula	Kurumba	Muduga	
Daily Labour	307 (68.2)	45 (60.0)	57 (57.0)	409 (65.4)
Salaried Employees	9 (2.0)	0 (0)	1 (1.0)	10 (1.6)
Unemployed	134 (29.8)	30 (40.0)	42 (42.0)	206 (33.0)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=8.825 \cdot df=4 \cdot \text{Cramer's } V=0.084 \cdot \text{Fisher's } p=0.073$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 4.11 presents the distribution of maternal occupation across the three tribal groups. Daily wage labour constitutes the primary occupation among mothers, accounting for 65.4% of the total sample (409 out of 625). Among the tribes, 68.2% of Irula mothers, 60.0% of Kurumba mothers, and 57.0% of Muduga mothers are engaged in daily labour. Salaried employment is extremely limited, representing only 1.6% overall, with no salaried employees reported among Kurumba mothers. Unemployment accounts for 33.0% of the total, with relatively higher proportions observed among Muduga (42.0%) and Kurumba (40.0%) mothers compared to Irula mothers (29.8%). The chi-square test examining the association between tribal identity and maternal occupation status yielded $\chi^2(4) = 8.825$. Fisher's Exact Test produced a p-value of .073, which exceeds the conventional 5% level of significance ($p < .05$). Therefore, there is no statistically significant association between tribe and occupation status. Cramer's V of 0.084 indicates a weak relationship between the variables.

Figure 4.4
Occupation Status of Mothers of Tribal Children in Attappadi



Source: Primary data

Figure 4.4 visually compares occupational categories across the three tribes. The graphical representation clearly highlights the dominance of daily wage work and the limited presence of salaried employment across all communities. It also makes visible the comparatively larger share of mothers outside the workforce in the Kurumba and Muduga groups.

4.2.2.3 Monthly income of mothers of Tribal Children in Attappadi

Table 4.12 presents the distribution of the monthly income of mothers of tribal

children in Attappadi, disaggregated by tribe - Irula, Kurumba, and Muduga. Maternal income is a critical indicator of the economic stability of households and directly influences access to food, healthcare, and education for children. This table categorises maternal income into five groups: no income, Rs. 1-2,000, Rs. 2,000-4,000, Rs. 4,000-6,000, and Rs. 6,000 and above.

Table 4.12
Monthly income of mothers of Tribal Children in Attappadi

Monthly income of mothers	Tribe			Total
	Irula	Kurumba	Muduga	
0	141 (31.3)	31 (41.3)	42 (42.0)	214 (34.2)
1-2000	146 (32.4)	17 (22.7)	27 (27.0)	190 (30.4)
2000-4000	105 (23.3)	5 (6.7)	6 (6.0)	116 (18.6)
4000-6000	49 (10.9)	22 (29.3)	24 (24.0)	95 (15.2)
6000 and above	9 (2.0)	0 (0)	1 (1.0)	10 (1.6)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=145.183 \cdot df=36 \cdot \text{Cramer's } V=0.341 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that a substantial proportion of mothers across all tribal groups have no personal income. It includes 31.3% of Irula mothers, 41.3% of Kurumba mothers, and 42.0% of Muduga mothers, contributing to 34.2% of mothers without earnings.

Among those with income, Irula mothers are more concentrated in the Rs. 1-2,000 (32.4%) and Rs. 2,000-4,000 (23.3%) categories. A smaller proportion earn between Rs. 4,000-6,000 (10.9%), and only 2.0% earn Rs. 6,000 or more. Kurumba mothers have relatively fewer earners in the Rs. 1-2,000 (22.7%) and Rs. 2,000-4,000 (6.7%) ranges, but a slightly higher percentage (29.3%) fall into the Rs. 4,000-6,000 category. Muduga mothers follow a similar pattern, with 27.0% earning Rs. 1-2,000, 6.0% earning Rs. 2,000-4,000, and 24.0% in the Rs. 4,000-6,000 range. Salaried earnings above Rs. 6,000 are rare across all three tribal

groups.

The chi-square test of association reveals a statistically significant relationship between tribal identity and maternal income level, $\chi^2(36) = 145.183$, $p < .001$ (Fisher's Test). The Cramer's V value of 0.341 suggests a moderate strength of association, indicating that maternal income patterns differ substantially across the three tribal groups.

The subsequent logistic regression analysis explores the impact of maternal socio-economic status on the nutritional status of tribal children.

4.2.2.4 Binary Logistic Regression Model on Maternal Socio-economic Factors Influencing Malnutrition Among Tribal Children in Attappadi

Binary Logistic Regression analysis was conducted to examine the influence of maternal socio-economic factors on malnutrition among tribal children under five years old in Attappadi. The objective of this analysis is to assess how maternal age, occupation, and monthly income impact the likelihood of malnutrition. The dependent variable in this model is the malnutrition status of children, classified into two categories: malnourished (severely and moderately malnourished) and standard growth (normal). The independent variables included in this model are the age of the mother, the occupation of the mother (salaried employee, unemployed, vs. baseline category), and the monthly income of the mother. The logistic regression equation used in the analysis is as follows:

$$\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right) = \beta_0 + \beta_1 ma + \beta_2 mose + \beta_3 moue + \beta_4 mmi$$

Where, $\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right) = \text{Log} \left(\frac{P_{\text{malnutrition}}}{P_{\text{standard growth}}} \right)$, β_0 - Constant term, $\beta_1 ma$ – represents the coefficient for age of the mother, $\beta_2 mose$ – represents the coefficient for the occupation of the mother (salaried employee), $\beta_3 moue$ – represents the coefficient for the occupation of the mother (unemployed), and $\beta_4 mmi$ – represents the coefficient for the monthly income of the mother.

The results of the logistic regression analysis are presented in Table 4.13

Table 4.13
Influence of Maternal Socio-economic Factors on Malnutrition

Predictor	B	SE	z	p	OR
Intercept	-32.99	4.33	-7.62	< .001 ***	4.71e-15
Age of the mothers	10.81	1.35	8.03	< .001 ***	4.96e+04
Occupation (Salaried Employee) of the mother	0.48	75.87	0.001	.999	1.62e+00
Occupation (Unemployed) of the mother	-4.14	0.39	-10.73	< .001 ***	1.59e-02
Monthly Income of the mother	-0.001	0.0001	-8.60	< .001 ***	9.99e-01
<i>McFadden R² = 0.35, Cox & Snell R² = 0.34, Nagelkerke R² = 0.49</i>					

Note. B = logistic regression coefficient; SE = standard error; z = Wald statistic; p = probability value; OR = Odds Ratio. The Odds Ratio indicates the change in the odds of child malnutrition associated with a one-unit increase in the predictor variable, holding other variables constant. An OR > 1 indicates a positive association, OR < 1 indicates a negative association, and OR = 1 indicates no association. Statistical significance levels are denoted as ***p < .001 (highly significant), **p < .01 (very significant), *p < .05 (significant), +p < .10 (marginally significant), and p > .10 (not significant). McFadden R² = 0.35, Cox & Snell R² = 0.34, and Nagelkerke R² = 0.49 represent the explanatory power of the model.

Source: Primary Data.

The binary logistic regression results presented in Table 4.13 examine the influence of maternal socio-economic factors on child malnutrition in Attappadi. In logistic regression, the Odds Ratio (OR) explains how the odds of malnutrition change with a one-unit increase in a predictor variable, controlling for other factors in the model. The findings reveal that the age of the mother is a highly significant predictor of child malnutrition (B = 10.81, p < .001). The positive regression coefficient indicates a direct relationship between maternal age and malnutrition. The Odds Ratio (OR = 4.96e+04) is substantially greater than 1, suggesting that an increase in maternal age dramatically increases the odds of child malnutrition. This indicates that older mothers are significantly more likely to have malnourished children compared to younger mothers.

Regarding maternal occupation, the category salaried employee is not statistically significant (B = 0.48, p = .999). Although the Odds Ratio (OR = 1.62) is greater than 1, indicating higher odds of malnutrition than the reference group, this effect is not statistically significant due to the extremely high p-value. Therefore, salaried

employment does not significantly influence child malnutrition.

In contrast, maternal unemployment is highly significant ($B = -4.14$, $p < .001$). The negative coefficient indicates an inverse relationship with malnutrition. The Odds Ratio ($OR = 1.59e-02$), which is far below 1, suggests a strong protective effect. Specifically, unemployed mothers have substantially lower odds of having malnourished children compared to the reference occupational group. This may reflect increased time spent on caregiving and greater involvement in child nutrition and feeding practices.

Similarly, the monthly income of the mother is highly significant ($B = -0.001$, $p < .001$). The negative coefficient indicates that increasing income reduces the likelihood of malnutrition. The Odds Ratio ($OR = 0.999$) is slightly below 1, suggesting that each unit increase in income reduces the odds of child malnutrition. Although the effect per unit appears small, cumulative increases in income may have a meaningful protective impact on child nutritional status.

The model fit statistics indicate moderate explanatory strength. The McFadden R^2 (0.35), Cox & Snell R^2 (0.34), and Nagelkerke R^2 (0.49) suggest that maternal socio-economic variables explain a considerable proportion of the variation in child malnutrition, though the explanatory power is lower than that observed in the economic factors model. Overall, the results demonstrate that maternal age, unemployment status, and maternal income significantly influence child malnutrition in Attappadi. Older mothers show substantially higher odds of having malnourished children, while higher maternal income and unemployment status appear to reduce the risk. These findings highlight the importance of targeted maternal health interventions, income enhancement strategies, and supportive childcare policies to effectively address malnutrition among tribal children.

4.2.2.5 Rate of Health Awareness among Mothers of Tribal Children in Attappadi

Table 4.14 presents the distribution of health awareness levels among mothers of tribal children in Attappadi, disaggregated by tribal identity - Irula, Kurumba, and Muduga. Health awareness is crucial to maternal and child well-being, as it influences nutrition, disease prevention, healthcare utilisation, and hygiene

practices. This table categorises health awareness as very low, low, and moderate, based on composite indicators from the survey.

Table 4.14
Rate of Health Awareness among Mothers of Tribal Children in Attappadi

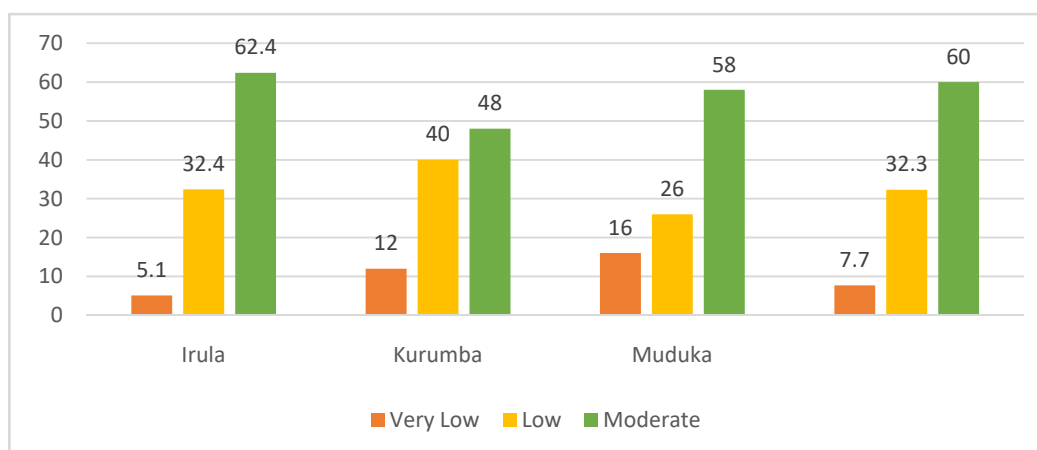
Rate of health awareness	Tribe			Total
	Irula	Kurumba	Muduga	
Very Low	23 (5.1)	9 (12.0)	16 (16.0)	48 (7.7)
Low	146 (32.4)	30 (40.0)	26 (26.0)	202 (32.3)
Moderate	281 (62.4)	36 (48.0)	58 (58.0)	375 (60.0)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=19.624 \cdot df=4 \cdot \text{Cramer's } V=0.125 \cdot p=0.001$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that Irula mothers (62.4%) demonstrate moderate health awareness, while 32.4% have low awareness and 5.1% fall in the very low category. Among Kurumba mothers, 48.0% show moderate awareness, but 40.0% exhibit low awareness and 12.0% have very low awareness, which is higher than in the Irula group. In the Muduga community, 58.0% of mothers have moderate awareness, 26.0% have low, and 16.0% show very low awareness. Over three tribes, 60.0% of mothers have moderate health awareness, 32.3% have low awareness, and 7.7% have very low awareness. It suggests that although moderate awareness is prevalent, many mothers, particularly in the Kurumba and Muduga tribes, lack adequate health knowledge.

Figure 4.5
Rate of Health Awareness among Mothers of Tribal Children in Attappadi



Source: Primary Data

Chi-square association test reveals a statistically significant relationship between tribal identity and health awareness level, $\chi^2(4) = 19.624$, $p = .001$. The Cramer's V value of 0.125 shows a small to moderate association, showing that health awareness levels vary meaningfully, though not drastically, across tribal groups. Moderate health awareness is predominant among tribal mothers in Attappadi, but disparities remain, especially among Kurumba and Muduga mothers, where low or very low awareness is more pronounced. These disparities may hinder optimal health seeking behaviour, maternal care, and child nutrition practices. The following multiple regression analysis further investigates the influence of maternal health awareness on the nutritional status of tribal children.

4.2.2.6 Multiple Linear Regression Model on Influence of Maternal Health Awareness on Malnutrition

Table 4.15 presents the results of the Multiple Linear Regression Model analysing the influence of Maternal Health Awareness on the nutritional status of tribal children in Attappadi. The dependent variable is child malnutrition (underweight), with independent variables including maternal health awareness levels.

$$UWBM I_i = \beta_0 + \beta_5 rmham + \beta_6 rhavl + \varepsilon_i$$

Where, $UWBM I_i$ - Nutritional status of the child (underweight), β_0 - Constant term, $\beta_5 rmham$ - Rate of Maternal health awareness level - Moderate, $\beta_6 rhavl$ - Rate of Maternal health awareness level - Very low and ε_i - Error term.

The results of the multiple linear regression analysis are presented in Table 4.15

Table 4.15
Influence of Maternal Health Awareness Level on Malnutrition

Predictor	B	SE	t	p
(Intercept)	12.88973	6.96526	1.851	0.0647.
Rate of health awareness -Moderate	1.06455	0.50709	2.099	0.0362.
Rate of health awareness -Very Low	-1.11528	0.88355	-1.262	0.2073
<i>Multiple $R^2 = .04663$, Adjusted $R^2 = .03581$</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression analysis examined the influence of maternal health awareness on malnutrition among tribal children in Attappadi. The intercept ($\beta = 12.89$, $p = .065$) was not statistically significant, indicating that the baseline level of child malnutrition (when maternal health awareness is high) does not differ significantly from zero.

Mothers with moderate health awareness were much more likely to have malnourished children than mothers with high health awareness ($\beta = 1.06$, $p = .036$), which implies that higher maternal health awareness is associated with better nutritional status of children. On the other hand, very low health awareness did not show any significant relationship with child malnutrition ($\beta = -1.12$, $p = .207$), which means that very low levels are not significantly different from high awareness in predicting child malnutrition in this context.

The relatively low explained variance is expected, as maternal health awareness was measured using a Likert scale. When variables are based on Likert scales, smaller R^2 values are typical because the ordinal measures have limited variability. Although limited in explanatory ability, the estimates emphasise the significant role of maternal health awareness in determining variations in the nutritional status of children. Further, there exist some unmeasured factors that are most probably responsible for other variations in malnutrition outcomes. Nonetheless, the results stress the importance of enhancing maternal health awareness through culturally appropriate, community-based education interventions to improve child nutrition among tribal populations in Attappadi.

4.2.2.7 Nutritional Awareness Among Mothers of Tribal Children in Attappadi

Awareness about dietary practices and nutritional status among children is crucial to identifying knowledge gaps in addressing malnutrition among tribal children under five. Therefore, the present exercise is intended to analyse nutritional awareness among the Irula, Kurumba, and Muduga tribes in Attappadi. It categorises nutritional awareness into Low, Moderate, and Very Low.

Table 4.16
Nutritional Awareness Among Mothers of Tribal Children in Attappadi

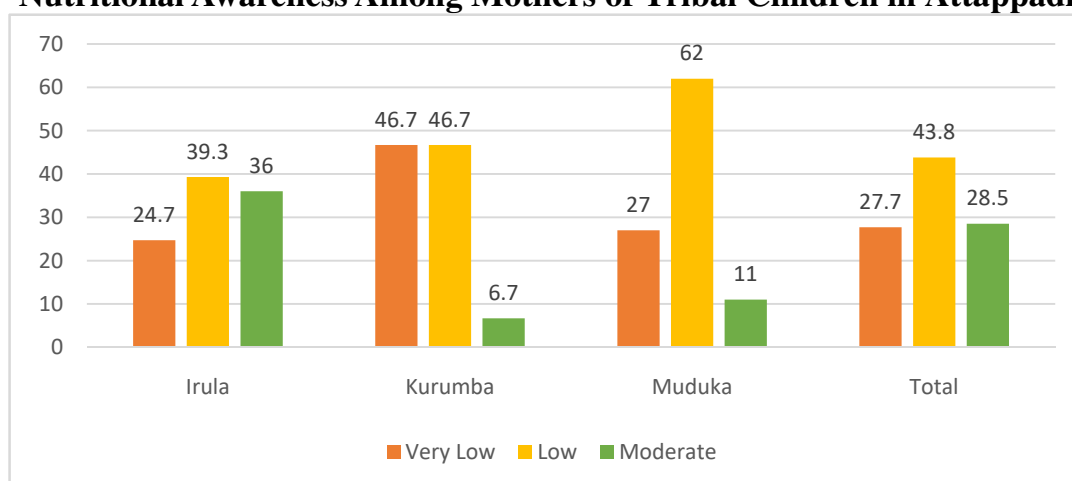
Nutritional Awareness Score	Tribe			Total
	Irula	Kurumba	Muduga	
Very Low	111 (24.7)	35 (46.7)	27 (27.0)	173 (27.7)
Low	177 (39.3)	35 (46.7)	62 (62.0)	274 (43.8)
Moderate	162 (36.0)	5 (6.7)	11 (11.0)	178 (28.5)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=53.199 \cdot df=4 \cdot \text{Cramer's } V=0.206 \cdot p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 4.16 presents the nutritional awareness scores among mothers of tribal children in Attappadi, disaggregated by tribe. Among Irula mothers, 39.3% fall into the low awareness category, 36.0% have moderate awareness, and 24.7% have very low awareness. In the Kurumba tribe, the low and very low awareness categories are equally high at 46.7%, while only 6.7% demonstrate moderate nutritional awareness. The Muduga tribe shows the highest percentage of low nutritional awareness (62.0%), followed by 27.0% in the very low category and 11.0% with moderate awareness. When combining the data across all three tribes, 43.8% of mothers have low nutritional awareness, 28.5% have moderate awareness, and 27.7% have very low awareness. These findings point to a general deficiency in nutritional knowledge among tribal mothers in Attappadi, with particularly low awareness among the Kurumba and Muduga communities.

Figure 4.6
Nutritional Awareness Among Mothers of Tribal Children in Attappadi



Source: Primary Data

The chi-square test indicates a statistically significant association between tribal identity and nutritional awareness level ($\chi^2(4) = 53.199, p < .001$), with a Cramer's V value of 0.206, showing a moderate strength of association. The variation across tribal groups emphasises the need for culturally tailored nutritional education interventions, especially targeting the Kurumba and Muduga mothers.

The subsequent multiple regression analysis explores the impact of maternal nutritional awareness on the nutritional status of tribal children.

4.2.2.8 Multiple Linear Regression Model on Maternal Nutritional Awareness Level on Wasting (Weight-for-Height) Among Tribal Children in Attappadi

The table displays a multiple linear regression analysis that explores how maternal nutritional awareness and tribal affiliation affect the wasting status (weight-for-height) of tribal children in Attappadi. In this model, wasting serves as the dependent variable. In contrast, the independent variables include the tribal group (with Irula as the baseline category) and the level of maternal nutritional awareness (with high awareness used as the reference category).

$$WS_i = \beta_0 + \beta_1 tk + \beta_2 tm + \beta_3 mnalm + \beta_4 mnalvl + \varepsilon_i$$

Where, WS_i - Nutritional status of the child (Wasting), β_0 - Constant term, $\beta_1 tk$ - Tribe Kurumba, $\beta_2 tm$ - Tribe Muduga, $\beta_3 mnalm$ - Maternal nutritional awareness level -Moderate, $\beta_4 mnalvl$ - Maternal nutritional awareness level -Very low, ε_i - Error term.

The results of the analysis are presented in Table 4.17

Table 4.17
Influence of Maternal Nutritional Awareness Level on Wasting (Weight-for-Height) Among Tribal Children

Predictor	B	SE	t	p
(Intercept)	2.3753	0.3737	6.357	< .001***
Tribe Kurumba	-0.7069	0.6955	-1.016	0.30984
Tribe Muduga	-0.8382	0.6145	-1.364	0.17307
Nutritional Awareness Level - Moderate	-0.493	0.5395	-0.914	0.3612
Nutritional Awareness Level - Very Low	-1.9453	0.5309	-3.664	0.00027
<i>Multiple R² = .02654, Adjusted R² = .02026</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The multiple regression analysis assessed the influence of maternal nutritional awareness and tribal affiliation on wasting (weight-for-height) among tribal children in Attappadi. The intercept ($\beta = 2.38, p < .001$) was statistically significant, indicating that, for children from the reference categories (Irula tribe and mothers with high nutritional awareness), the average predicted wasting score was significantly different from zero.

The analysis showed that there was a strong association between very low awareness of mothers and increased measures of child wasting ($\beta = -1.95, p < .001$), which implies that children whose mothers have very low awareness are at greater risk for the development of acute malnutrition than children of mothers with high awareness. There was no association between moderate levels of awareness and child wasting ($\beta = -0.49, p = .361$), which implies the adverse impact of only very low levels of awareness on the nutritional status of children. About the tribal group, Kurumba ($\beta = -0.71, p = .310$) and Muduga ($\beta = -0.84, p = .173$) children were not statistically different in wasting outcomes from their Irula tribe counterparts. These results indicate that tribal groups are not predictors of wasting and are statistically controlled for maternal nutrition awareness.

4.2.2.9 Multiple Linear Regression Model on Maternal Nutritional Awareness Level on Underweight (Weight-for-age) Among Tribal Children

Table 4.18 presents the results of the Multiple Linear Regression Model examining the influence of Maternal Nutritional Awareness Level and Tribal Affiliation on the malnutrition status of tribal children in Attappadi. The nutritional status of children (Underweight) is the dependent variable, with the predictor variables being the Tribal Group (Irula as the reference category) and Nutritional Awareness Level (High as the reference category).

$$UW_i = \beta_0 + \beta_1 tk + \beta_2 tm + \beta_3 mnalm + \beta_4 nalvl + \varepsilon_i$$

Where, UW_i - Nutritional status of the child (Underweight), β_0 - Constant term, $\beta_1 tk$ – Tribe Kurumba, $\beta_2 tm$ - Tribe Muduga, $\beta_3 mnalm$ – Maternal nutritional awareness level -Moderate, $\beta_4 mnalvl$ - Maternal nutritional awareness level -Very low, ε_i - Error term.

The results of the analysis are presented in Table 4.18

Table 4.18

**Influence of Maternal Nutritional Awareness Level on
Underweight Among Tribal Children**

Predictor	B	SE	t	p
(Intercept)	2.3753	0.3737	6.357	< .001***
Tribe Kurumba	-0.7069	0.6955	-1.016	0.30984
Tribe Muduga	-0.8382	0.6145	-1.364	0.17307
Nutritional Awareness Level - Moderate	-0.493	0.5395	-0.914	0.3612
Nutritional Awareness Level - Very Low	-1.9453	0.5309	-3.664	0.00027***
<i>Multiple R² = .02654, Adjusted R² = .02026</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The multiple regression analysis evaluated the impact of maternal nutritional awareness and tribal affiliation on underweight prevalence among tribal children in Attappadi. The intercept ($\beta = 2.38$, $p < .001$) was statistically significant, indicating that children from the reference categories (Irula tribe and mothers with high nutritional awareness) had a predicted average underweight score significantly different from zero. Neither children from the Kurumba tribe ($\beta = -0.71$, $p = .310$) nor the Muduga tribe ($\beta = -0.84$, $p = .173$) showed significant differences in underweight status when compared to those from the Irula tribe, regarding tribal affiliation. These results suggest that, after controlling for maternal nutritional awareness, tribal identity does not significantly influence the likelihood of underweight malnutrition.

In terms of maternal nutritional awareness, children of mothers with very low awareness were significantly more likely to be underweight than those whose mothers had high nutritional awareness ($\beta = -1.95$, $p < .001$). The negative regression coefficient shows lower nutritional awareness is associated with higher underweight prevalence among children. However, moderate awareness levels did not have a statistically significant association with underweight status ($\beta = -0.49$, $p = .361$), indicating that only extremely low levels of maternal awareness significantly impact child nutritional outcomes.

4.2.2.10 Multiple Linear Regression Model on Maternal Nutritional Awareness Level on Stunting (Height for Age) Among Tribal Children

The multiple linear regression model investigates the relationship between maternal nutritional awareness and tribal affiliation on the stunting status (height-for-age) of tribal children in Attappadi. The dependent variable is stunting, while the independent variables include tribal identity (with Irula as the reference category) and maternal nutritional awareness (high as the reference category).

$$ST_i = \beta_0 + \beta_1 tk + \beta_2 tm + \beta_3 mnalm + \beta_4 mnalvl + \varepsilon_i$$

Where, ST_{mnal_i} - Nutritional status of the child (Stunting), β_0 - Constant term, $\beta_1 tk$ – Tribe Kurumba, $\beta_2 tm$ - Tribe Muduga, $\beta_3 mnalm$ – Maternal nutritional awareness level -Moderate, $\beta_4 mnalvl$ - Maternal nutritional awareness level -Very low, ε_i - Error term.

The results of the multiple linear regression analysis are presented in Table 4.19

Table 4.19
Influence of Maternal Nutritional Awareness Level on Stunting (Height for Age) Among Tribal Children

Predictor	B	SE	t	p
(Intercept)	12.7598	0.358	35.638	< .001***
Tribe Kurumba	1.5916	0.6664	2.388	0.01722
Tribe Muduga	0.6191	0.5889	1.051	0.29349
Nutritional Awareness Level - Moderate	1.3437	0.517	2.599	0.00957
Nutritional Awareness Level - Very Low	-1.5817	0.5087	-3.109	0.00196
<i>Multiple R² = .04322, Adjusted R² = .03705</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The multiple regression analysis evaluated the influence of maternal nutritional awareness and tribal affiliation on stunting (height-for-age) among tribal children in Attappadi. The intercept ($\beta = 12.76$, $p < .001$) was statistically significant, representing the average stunting score for children from the Irula tribe whose mothers had high nutritional awareness. Children from the Kurumba tribe exhibited significantly higher scores of stunting than the Irula tribe ($\beta = 1.59$, $p = .017$), indicating greater vulnerability to chronic malnutrition and concerning tribal

affiliation. In contrast, children from the Muduga tribe showed no significant difference in outcomes of stunting ($\beta = 0.62, p = .293$) compared to the Irula group. Children of mothers with a moderate level of awareness had significantly higher stunting scores than children with high awareness ($\beta = 1.34, p = .010$), regarding maternal nutritional awareness. Conversely, low maternal nutritional awareness was significantly associated with lower stunting scores ($\beta = -1.58, p = .002$). This unexpected negative association may indicate factors not accounted for in the current model, suggesting the need for further qualitative research to explore contextual explanations.

Despite the low explanatory power, the model shows the significance of tribal identity and maternal nutritional awareness in shaping stunting outcomes among tribal children in Attappadi. These findings emphasise the need for targeted, culturally sensitive interventions to improve maternal nutritional awareness across tribal subgroups to address chronic malnutrition. However, given the low explanatory strength of the model, further research incorporating broader socio-economic, environmental, and cultural variables is necessary to better understand the determinants of stunting in this population.

4.2.3 Personal Factors of Children

Malnutrition among tribal children in Attappadi is a multifaceted issue influenced by personal factors such as birth order, birth interval and family size. These demographic characteristics affect household resource distribution, caregiving dynamics, and child nutritional outcomes. Understanding how such factors vary across tribal groups - Irula, Kurumba, and Muduga - offers insight into culturally specific patterns impacting child health. This study examines the extent to which these personal factors contribute to malnutrition using logistic regression analyses. The findings inform targeted, child centred interventions within tribal populations.

4.2.3.1 Distribution of the Tribal Children based on the Size of the Family

Table 4.20 presents the distribution of total household members among tribal children in Attappadi, categorised by tribal group - Irula, Kurumba, and Muduga. The primary variable in this table is household size, explained in terms of the total number of individuals living in a child's household, including parents, siblings, and

other family members. The table examines household size as an important socioeconomic variable influencing child well-being, resource allocation, and care dynamics.

Table 4.20
Distribution of Tribal Children Based on the Size of the Family

Total Members in the Household	Tribe			Total
	Irula	Kurumba	Muduga	
3	80 (17.8)	15 (20)	2 (2.0)	97 (15.5)
4	161 (35.8)	8 (10.7)	29 (29.0)	198 (31.7)
5	92 (20.4)	20 (26.7)	46 (46.0)	158 (25.3)
6	90 (4.9)	20 (26.7)	13 (13.0)	123 (19.7)
7	22 (4.9)	10 (13.3)	10 (10.0)	42 (6.7)
8	(1.1)	2 (2.7)	0 (0)	7 (1.1)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=64.094 \cdot df=10 \cdot \text{Cramer's } V=0.226 \cdot \text{Fisher's } p=< .001$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 4.20 presents the distribution of total household members among tribal children in Attappadi. Notably, all children in the study reside with their families, and there are no orphaned or parentless children. Among Irula households, the most common family size is four members (35.8%), followed by households with five (20.4%) and three (17.8%) members. Larger households with six or more members are comparatively less frequent. In contrast, Muduga households most commonly consist of five members (46.0%), followed by four (29.0%) and six members (13.0%). Smaller households (three members) are rare in this group (2.0%). Kurumba families are relatively evenly distributed among five member (26.7%) and six member (26.7%) households. Interestingly, the proportion of three-member households is relatively high at 20.0%, while households with four members are the least common (10.7%). The overall distribution reveals that 31.7% of tribal children live in households with four members, followed by 25.3% in five member families and 19.7% in six member families. There are 1.1% of households with eight members in the family, showing that large families are not ordinary in the Attappadi region.

A chi-square test shows the association between tribal identity and household size. The results indicate a statistically significant association, $\chi^2(10) = 64.094$, $p < .001$

(Fisher's Test), with a Cramer's V value of 0.226, signifying a moderate effect size. The study shows that there are differences in household composition among the Irula, Kurumba, and Muduga tribes; smaller households (three to four members) are more prevalent among Irulas and Kurumbas, and larger households (five to six members) dominate the Mudugas. These variations may reflect cultural, economic, and demographic differences that affect child care, resource distribution, and household nutrition dynamics.

4.2.3.2 Distribution of Tribal Children Based on Birth Order

Table 4.21 presents the birth order distribution of tribal children under five years of age in Attappadi, classified by tribe - Irula, Kurumba, and Muduga. Birth order refers to the chronological position of the child within the family, such as first born, second born, and so on. This variable is a significant demographic indicator associated with child nutrition, care, attention, resource allocation, and health outcomes in households with limited means. Tribal identity is a grouping variable to explore intertribal variations in reproductive patterns.

Table 4.21
Distribution of Tribal Children Based on Birth Order

Birth Order of the Child	Tribe			Total
	Irula	Kurumba	Muduga	
1	162 (36)	31 (41.3)	0 (0)	193 (30.9)
2	119 (26.4)	17 (22.7)	72 (72.0)	208 (33.3)
3	105 (23.3)	19 (25.3)	27 (27.0)	151 (24.2)
4	57 (12.7)	6 (8.0)	1 (1.0)	64 (10.2)
5	7 (1.6.0)	2 (2.7)	0 (0)	9 (1.4)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=105.322 \cdot df=8 \cdot \text{Cramer's } V=0.290 \cdot \text{Fisher's } p=0.000$				

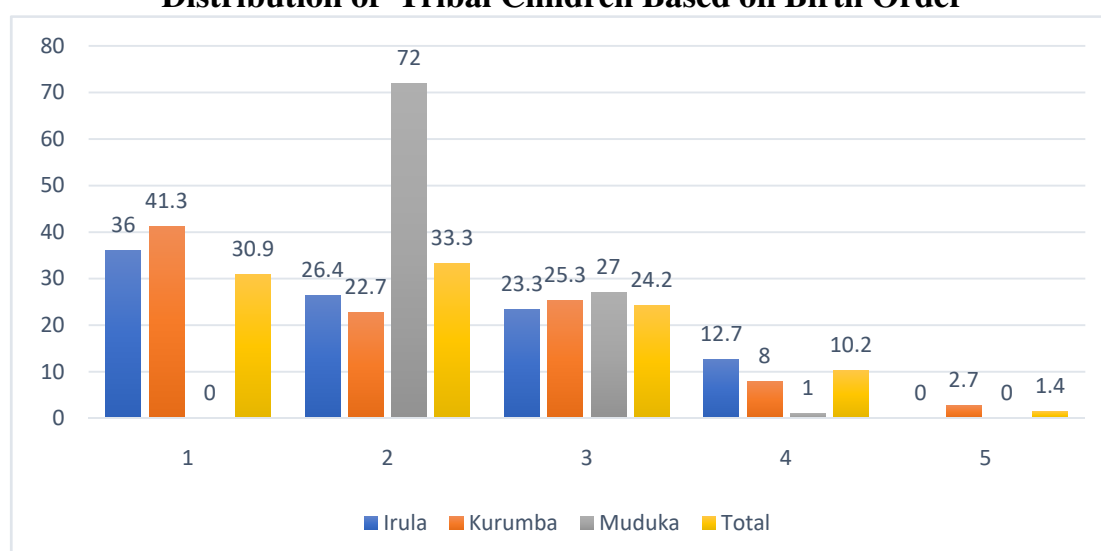
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that the most significant proportion of first borns (36.0%) is among Irula children, followed by second born (26.4%) and third born (23.3%) children. A notable 12.7% fall under the fourth birth order, and a small proportion (1.6%) are fifth borns. In contrast, Kurumba children show a similar pattern, with

41.3% being first borns, 22.7% second borns, and 25.3% third borns. Only 8.0% of Kurumba children are of the fourth birth order, and 2.7% are fifth borns. The Muduga tribe displays a significantly different trend: an overwhelming 72.0% of the children are second born, while none are first born. It implies that in most cases, the first born child may be older than the five year cut off of the study, and the sample captured predominantly second or later born children. Additionally, 27.0% are third born, and only 1.0% are fourth born. No fifth order births are reported among Muduga children. Overall, 33.3% of the total tribal children in the sample are second born, 30.9% are first born, and 24.2% are third born. A smaller proportion is of fourth (10.2%) and fifth (1.4%) birth order.

Figure 4.7
Distribution of Tribal Children Based on Birth Order



Source: Primary Data

A chi-square test of association reveals a statistically significant relationship between tribal identity and birth order, $\chi^2(8) = 105.322$, $p < .001$ (Fisher's Test). The Cramer's V value of 0.290 indicates a moderate association between variables, showing that birth order patterns vary meaningfully across the three tribal groups. The study reveals that the Irula and Kurumba families tend to have a balanced distribution of first to third born children, the Muduga families show a heavy concentration in second and third born children, with no first born children captured in the sample. These patterns reflect underlying demographic and reproductive behaviours that may influence child nutrition outcomes, caregiving

responsibilities, and intra household dynamics in tribal communities of Attappadi.

4.2.3.3 Distribution of Tribal Children Based on Birth Interval

Table 4.22 presents the distribution of birth intervals among tribal children in Attappadi, categorised by tribal group - Irula, Kurumba, and Muduga. Birth interval refers to the number of years between the birth of a child and the immediately preceding sibling, classified into three categories: 0 years (no gap/twins/closely spaced births), 1 year, and 2 years or more. This demographic variable is important to child nutrition, maternal recovery, and overall child health. Tribal identity is a grouping variable to assess how spacing patterns differ across tribal communities.

Table 4.22
Distribution of Tribal Children Based on Birth Interval

Birth Interval of the Children	Tribe			Total
	Irula	Kurumba	Muduga	
0	160 (35.6)	31 (41.3)	0 (0)	191 (30.6)
1	136 (30.2)	29 (38.7)	27 (27.0)	192 (30.7)
2	154 (34.2)	15 (20.0)	73 (73.0)	242 (38.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=78.600 \cdot df=4 \cdot \text{Cramer's } V=0.251 \cdot p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among Irula children, birth intervals are relatively evenly distributed: 35.6% have no birth interval (i.e., born within the same year as a sibling or closely spaced), 30.2% have a one year gap, and 34.2% have a two year or more gap. Kurumba children show a similar trend, with the majority having a 0-year interval (41.3%), followed by a one year interval (38.7%), and only 20.0% having a two year or more birth spacing. The Muduga tribe presents a strikingly different pattern. 73.0% of the children have a two year or more birth interval, while 27.0% have a one year gap. Notably, no Muduga children were born without a birth interval (0 years), highlighting a strong preference or perhaps a structural pattern for wider spacing between births in this community. Overall, among all

tribal children in the sample, 38.7% have a birth interval of two years or more, 30.7% have a one year gap, and 30.6% were born with no spacing between them and the previous sibling.

A chi-square test indicates a statistically significant association between tribal identity and birth interval, $\chi^2(4) = 78.600, p < .001$. The Cramer's V value of 0.251 reflects a moderate association, suggesting that birth interval patterns differ meaningfully across the tribal groups. The result of the study highlights important intertribal differences in birth spacing among children in Attappadi. The Muduga tribe follows a predominantly longer birth interval than the Irula and Kurumba tribes. These variations may have implications for maternal health, child nutrition, and the ability of families to allocate adequate resources and care to each child.

The subsequent logistic regression analysis explores the impact of personal factors such as the size of the family, birth order, and birth interval of the child on the nutritional status.

4.2.3.4 Binary Logistic Regression Model on Personal Factors Influencing Malnutrition Among Tribal Children in Attappadi

Binary logistic regression analysis examined how personal factors influence malnutrition among tribal children under five in Attappadi. The objective of this analysis is to assess the relationship between tribal identity, family size, birth order, and birth interval and the likelihood of child malnutrition. The dependent variable is the malnutrition status of children, categorised as malnourished (severely and moderately malnourished) versus standard growth. The independent variables used in this model are tribes (Kurumba and Muduga, with Irula as the baseline category), total family members, birth order, and birth interval of the child. The model used is logistic regression, which is given below.

$$\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right) = \beta_0 + \beta_1 tk + \beta_2 tm + \beta_3 tfm + \beta_4 boc + \beta_5 bic$$

Where, $\text{Log} \left(\frac{P_{mn}}{P_{sg}} \right) = \text{Log} \left(\frac{P_{malnutrition}}{P_{standard growth}} \right)$, β_0 - Constant term, $\beta_1 tk$ - Tribe Kurumba, $\beta_2 tm$ - Tribe Muduga, $\beta_3 tfm$ - Total members of the family, $\beta_4 boc$ - Birth order of the child and $\beta_5 bic$ - Birth interval of the child.

The results of the model are presented in Table 4.23.

Table 4.23
Personal Factors Influencing Malnutrition Among
Tribal Children in Attappadi

Predictor	B	SE	z	p	OR
Intercept	-9.46	0.90	-10.54	<.001	0.00008
Tribe - Kurumba	0.75	0.41	1.83	.067	2.11
Tribe - Muduga	2.12	0.45	4.74	<.001	8.30
Size of the Family	1.34	0.20	6.72	<.001	3.80
Birth Order of the Child	1.25	0.23	5.49	<.001	3.50
Birth Interval of Child	-1.67	0.30	-5.49	<.001	0.19
<i>McFadden $R^2=0.51$, Cox & Snell $R^2=0.45$, Nagelkerke $R^2=0.65$</i>					

Note. B = regression coefficient; SE = standard error; z = Wald statistic; p = probability value; p < 0.10 indicates statistical significance. OR = Odds Ratio. An OR > 1 indicates a positive association, OR < 1 indicates a negative association, and OR = 1 indicates no association.

The logistic regression results in Table 4.23 indicate that tribal identity is a significant determinant of malnutrition. Children from the Mudukha tribe are significantly more likely to be malnourished than those from the Irula tribe ($B = 2.12$, $p < .001$). The odds ratio (OR = 8.30) suggests that children from the Muduga tribe have 8.3 times higher odds of being malnourished than Irula children. However, belonging to the Kurumba tribe is not a statistically significant predictor ($p = .067$), though the odds ratio (OR = 2.11) suggests a possible increased risk of malnutrition. Family size plays a crucial role in malnutrition. A larger number of total family members is associated with a significantly higher likelihood of malnutrition ($B = 1.34$, $p < .001$). The odds ratio (OR = 3.80) suggests that the odds of child malnutrition increase by 3.8 times for each additional household member. Birth order is also a strong predictor. A higher birth order significantly increases the risk of malnutrition ($B = 1.25$, $p < .001$), with an odds ratio (OR = 3.50), indicating that later born children are more likely to be malnourished than first born children. Conversely, the birth interval between siblings has a protective effect against

malnutrition. A longer birth interval significantly reduces malnutrition risk ($B = -1.67$, $p < .001$). The odds ratio ($OR = 0.19$) suggests that children with a longer birth interval are significantly less likely to experience malnutrition. The model fit statistics indicate a moderate to strong explanatory power, with $R^2 = 0.51$ of McFadden, $R^2 = 0.45$ of Cox & Snell, and $R^2 = 0.65$ of Nagelkerke, suggesting that personal factors explain a substantial proportion of malnutrition variability.

The binary logistic regression analysis emphasises the significant role of personal factors in child malnutrition among tribal communities in Attappadi. Tribal identity, household size, birth order, and birth interval are key determinants. Children from the Muduga tribe, larger families, and higher birth orders face an increased risk of malnutrition, while a longer birth interval acts as a protective factor. These findings highlight the importance of family planning, maternal health education, and targeted nutritional interventions to mitigate malnutrition risks among tribal children.

The analysis of internal factors highlights the significant influence of socio-economic, maternal, and personal determinants on malnutrition among tribal children under five in Attappadi. The socio-economic determinants, such as level of education, occupational status, and household income, were strongly associated with the nutritional status of children, thus confirming the role of economic factors and limited access to education in sustaining malnutrition. The maternal determinants of age, health awareness, and nutrition knowledge are also significant predictors. Mothers with higher awareness and better nutrition status had children with improved nutrition, reflecting the intergenerational linkage between maternal health and child nutrition. Personal factors such as the birth order and birth Interval of the child contributed to variations in malnutrition prevalence across different groups. The overall findings emphasise the need for policy specific interventions to reduce poverty, improve maternal education and health, and account for the socio-cultural environments of tribal populations. Household-level improvements are essential to best fight malnutrition and nutritional inequality among tribal children in the region.

4.3 External Factors of Malnutrition

The nutritional status of children in Attappadi tribal communities cannot be explained by individual or household-level constraints alone; extrinsic structural and cultural context factors more or less determine it. Environmental, institutional, and cultural determinants play a significant role in contributing to children's under five malnutrition. Environmental conditions such as the quality of drinking water, availability of sanitation facilities, and household cleanliness directly affect exposure to disease and the ability of the human body to absorb nutrients. At the institutional level, access to healthcare, Anganwadi centres, immunisation, nutrition programs, and the Public Distribution System (PDS) significantly impact a family's ability to secure adequate health and food support. Similarly, cultural norms and beliefs such as dietary taboos during pregnancy and traditional feeding practices strongly shape maternal and child nutrition behaviours and care seeking patterns.

To assess the influence of external factors, this study utilised Likert scale questions to gather information on community perceptions and behaviours concerning environmental conditions, access to public services, and cultural practices. The collected data were analysed through Chi-square tests to study associations, and multiple linear regression models were applied to identify predictive patterns related to malnutrition among children. It aims to identify the most influential external factors contributing to malnutrition and to inform context sensitive, multi sectoral policy responses.

4.3.1 Environmental Factors of Malnutrition

Environmental conditions have a major role in the nutritional status of children, especially in poor tribal regions like Attappadi. Continued exposure to contaminated drinking water, unhygienic toilet facilities, and insanitary living conditions may lead to repeated infections, gastroenteritis, and impaired nutrient utilisation in children. All such adverse conditions compromise immunity and interfere with development at critical periods. Understanding the environmental backdrop is essential to assessing how health risks accumulate beyond individual control. This study includes environmental factors to identify key sanitation and hygiene related vulnerabilities contributing to malnutrition, informing targeted

public health interventions in tribal hamlets.

4.3.1.1 Distribution of Tribal Children based on Availability of Better Quality water

Table 4.24 displays the perspectives of tribal households in Attappadi concerning the availability of better quality water, classified by tribal group. The level of agreement was assessed using a Likert scale ranging from ‘Strongly Agree’ to ‘Strongly Disagree’.

Table 4.24
Distribution of Tribal Children based on Availability of Better Quality water

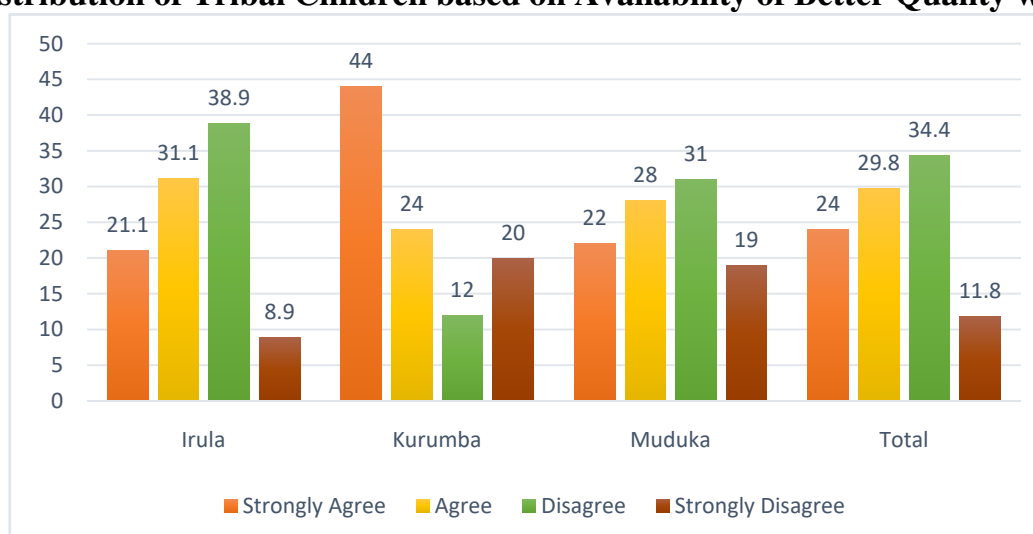
Availability of Better Quality Water	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	95 (21.1)	33 (44.0)	22 (22.0)	150 (24.0)
Agree	140 (31.1)	18 (24.0)	28 (28.0)	186 (29.8)
Disagree	175 (38.9)	9 (12.0)	31 (31.0)	215 (34.4)
Strongly Disagree	40 (8.9)	15 (20.0)	19 (19.0)	74 (11.8)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=41.217 \cdot df=6 \cdot \text{Cramer's } V=0.182 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that the Irula tribe, 21.1% strongly agreed and 31.1% agreed that better quality water was available, while a significant proportion (38.9%) disagreed and 8.9% strongly disagreed. In contrast, a notably higher percentage of Kurumba respondents (44.0%) strongly agreed about better water availability, 24.0% agreed, 12.0% disagreed, and 20.0% strongly disagreed. The Muduga tribe showed a more even distribution: 22.0% strongly agreed, 28.0% agreed, 31.0% disagreed, and 19.0% strongly disagreed. Overall, 24.0% of all respondents strongly agreed that better quality water was available, 29.8% agreed, while a larger segment (34.4%) disagreed, and 11.8% strongly disagreed. These figures indicate that although some tribal populations perceive better quality water access, many remain dissatisfied, especially in the Irula and Muduga communities.

Figure 4.8
Distribution of Tribal Children based on Availability of Better Quality water



Source: Primary Data

The result of the chi-square test confirms a statistically significant association between tribal identity and perceptions of availability of water quality ($\chi^2(6) = 41.217$, $p < .001$), with a Cramer's V value of 0.182, indicating a moderate relationship. It suggests disparities in perceived access to quality water among the different tribal groups in Attappadi. The Irula and Muduga tribes show greater dissatisfaction, and the Kurumba tribe shows comparatively higher levels of satisfaction. These findings emphasise the need for targeted water quality improvement initiatives and equitable access to clean water across all tribal hamlets in the region.

4.3.1.2 Distribution of Tribal Children based on the Availability of Improved Sanitation Facilities

Table 4.25 presents the distribution of tribal children in Attappadi based on their households access to improved sanitation facilities, as perceived by the respondents. The opinions of mothers of tribal children were collected using a five point Likert scale, which included the options such as Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The responses are disaggregated by tribal group - Irula, Kurumba, and Muduga - to highlight inter-tribal disparities in sanitation access and quality.

Table 4.25
Distribution of Tribal Children based on the Availability of
Improved Sanitation Facility

Improved Sanitation Facility	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	162 (36.0)	7 (9.3)	24 (24.0)	193 (30.9)
Agree	41 (9.1)	1 (1.3)	4 (4.0)	46 (7.4)
Disagree	95 (21.1)	37 (49.3)	26 (26.0)	158 (25.3)
Strongly Disagree	152 (33.8)	30 (40.0)	46 (46.0)	228 (36.5)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=47.657 \cdot df=6 \cdot \text{Cramer's } V=0.195 \cdot \text{Fisher's } p=0.000$				

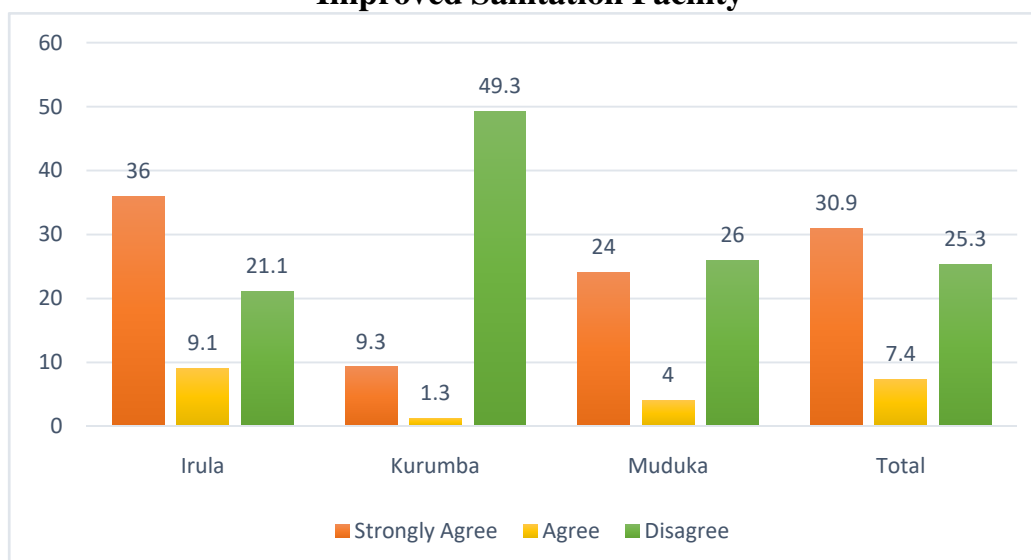
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among Irula households, 36% of respondents strongly agreed that improved sanitation facilities were available, while 33.8% strongly disagreed. About 21.1% disagreed, and only 9.1% agreed. In contrast, among the Kurumba tribe, only 9.3% strongly agreed and a mere 1.3% agreed, whereas a significant proportion disagreed (49.3%) or strongly disagreed (40.0%) with improved sanitation. The Muduga tribe showed a similar pattern of deprivation, with 46.0% strongly disagreeing and 26.0% disagreeing, while only 24.0% strongly agreed and 4.0% agreed. Across the three tribal groups, 36.5% of respondents strongly disagreed with having improved sanitation facilities, while 30.9% strongly agreed. Additionally, 25.3% expressed disagreement, and only 7.4% agreed with the statement. It indicates significant dissatisfaction with sanitation infrastructure in tribal households.

The result of the chi-square test ($\chi^2 = 47.657$, $df = 6$, $p = .000$) indicates a statistically significant association between tribal identity and access to improved sanitation facilities.

Figure 4.9
Distribution of Tribal Children based on the Availability of Improved Sanitation Facility



Source: Primary Data

The Cramer's V value of 0.195 suggests a moderate association. The analysis reveals considerable inter-tribal variation in access to improved sanitation facilities in Attappadi, with the Kurumba and Muduga tribes having poorer access than the Irula tribe. The statistically significant results emphasise the need for targeted interventions to address sanitation disparities among marginalised tribal communities in Attappadi.

4.3.1.3 Distribution of Tribal Children based on the Cleanliness of Household Premises

Table 4.26 presents the distribution of tribal children in Attappadi based on perceptions of their mothers about the cleanliness of household premises, disaggregated by tribal group: Irula, Kurumba, and Muduga. Responses were gathered using a Likert type scale comprising five levels of agreement - Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree - to assess household hygiene conditions. Cleanliness of living environments plays an important role in forming child health and nutrition, particularly in tribal settings. Inadequate sanitation and hygiene practices may exacerbate risks of infection and undernutrition in tribal areas.

Table 4.26
Distribution of Tribal Children based on the Cleanliness
of Household Premises

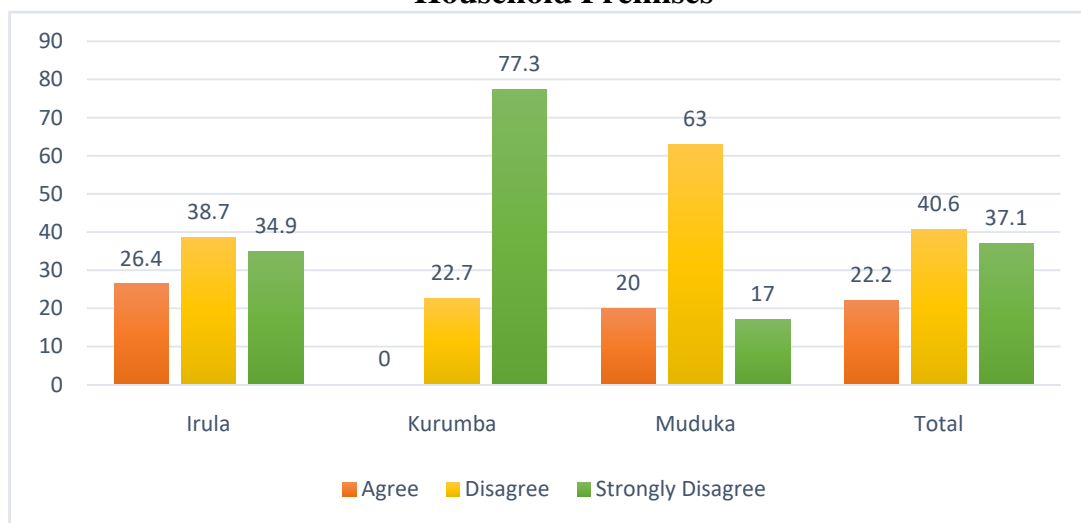
Cleanliness of Household Premises	Tribe			Total
	Irula	Kurumba	Muduga	
Agree	119 (26.4)	0 (0)	20 (20.0)	139 (22.2)
Disagree	174 (38.7)	17 (22.7)	63 (63.0)	254 (40.6)
Strongly Disagree	157 (34.9)	58 (77.3)	17 (17.0)	232 (37.1)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=83.360 \cdot df=4 \cdot \text{Cramer's } V=0.258 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

It is clear from the table that no respondent selected a neutral or strongly agree position, indicating a clear directional perception toward the cleanliness of their living environment. The findings show notable inter-tribal differences in perceived household cleanliness. Among Irula respondents, 26.4% agreed that their households were clean, 38.7% disagreed, and 34.9% strongly disagreed. In contrast, none of the Kurumba mothers agreed with the statement; 22.7% disagreed, and 77.3% strongly disagreed, showing a general dissatisfaction with household cleanliness within this group. Among Muduga respondents, 20.0% agreed, 63.0% disagreed, and 17.0% strongly disagreed.

Figure 4.10
Distribution of Tribal Children based on the Cleanliness of
Household Premises



Source: Primary Data

The result of the Chi-square test ($\chi^2 = 83.360$, $df = 4$, $p = .000$) explains a

statistically significant association between tribal identity and perception of household cleanliness. The Cramer's V value of 0.258 explains a moderate association, showing that the level of satisfaction with household cleanliness varies considerably across tribal groups. It suggests that tribal affiliation significantly influences the perceptions of cleanliness of the household among mothers of sample children in Attappadi. Addressing such environmental determinants is essential for improving hygiene and reducing the burden of childhood malnutrition in tribal communities.

4.3.1.4 Multiple Linear Regression Model on Environmental Factors Influencing Underweight (Weight-for-age) Tribal Children in Attappadi

The model presented in Table 4.27 examines the influence of selected environmental factors on underweight (weight-for-age) among tribal children in Attappadi. The dependent variable is the underweight status of the child, and the independent variables include access to better quality water, improved sanitation facilities, and cleanliness of household premises. The regression equation for the model is specified as:

$$UW_i = \beta_0 + \beta_1 BQW + \beta_2 ISF + \beta_3 CHP + \varepsilon_i$$

Where, UW_i - Nutritional status of the child (Underweight), β_0 - Constant term, $\beta_1 BQW$ – Better quality water, $\beta_2 ISF$ - Improved sanitation facility, $\beta_3 CHP$ – Cleanliness of premises, and ε_i - Error term.

The results of the analysis are presented in Table 4.27.

Table 4.27
Influence of Environmental Factors on Underweight (Weight-for-age)
Tribal Children in Attappadi

Predictor	B	SE	t	p
(Intercept)	5.728002	1.046	5.477	<.001**
Better quality water	-0.52963	1.005	-0.526	0.599
Improved sanitation facility	1.648343	0.785	2.099	0.0362*
Cleanliness of the Household Premises	0.88428	0.978	0.904	0.366
<i>Multiple R² = .03492, Adjusted R² = 0.030838</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The multiple linear regression model accounts for approximately 3.5% of the variance in the underweight status (weight-for-age) of tribal children ($R^2 = .03492$; Adjusted $R^2 = .03084$), indicating that the environmental factors considered offer limited explanatory power. The intercept is statistically significant ($B = 5.7280$, $p < .001$), suggesting a baseline underweight score significantly different from zero when all independent variables are absent.

Among the independent variables, improved sanitation facility ($B = 1.6483$, $p = .0362$) shows a statistically significant association at the 5% level and a positive association with underweight status. This counterintuitive result may indicate that access to improved sanitation alone, without corresponding improvements in hygiene behaviour or other conditions, does not guarantee reduced underweight levels; it may reflect transitional or incomplete sanitation improvements. The other two environmental factors - better quality water ($B = -0.5296$, $p = .5985$) and cleanliness of household premises ($B = 0.8843$, $p = .3663$) - do not show statistically significant associations with underweight status.

These findings suggest that although environmental improvements are critical, their isolated impact on nutritional outcomes may be limited without a comprehensive and integrated approach. While the model explains a modest proportion of the variation in underweight status, the significance of improved sanitation facilities as a predictor emphasises the importance of environmental infrastructure. However, the lack of significance for other factors and the unexpected direction of effect for sanitation show the complexity of environmental influences on child nutrition. Interventions should be multi-pronged, integrating access with behavioural change, hygiene education, and broader health promotion measures.

4.3.1.5 Multiple Linear Regression Model on Environmental Factors Influencing Stunting (Height for Age) Among Tribal Children in Attappadi

The model in Table 4.28 examines the influence of selected environmental factors on stunting among tribal children in Attappadi. The dependent variable is the stunting (height-for-age) status of the child, and the independent variables include access to better quality water, improved sanitation facilities, and the cleanliness of household premises. The regression equation is specified as follows:

$$ST_i = \beta_0 + \beta_1 BQW + \beta_2 ISF + \beta_3 CHP + \varepsilon_i$$

Where, ST_i - Nutritional status of the child (stunting), β_0 - Constant term, β_1 BQW – Better quality water, β_2 ISF - Improved sanitation facility, β_3 CHP – Cleanliness of household premises, and ε_i - Error term.

The results of the analysis are presented in Table 4.28.

Table 4.28
Influence of Environmental Factors on Stunting (Height for Age)
Among Tribal Children in Attappadi

Predictor	B	SE	t	p
(Intercept)	10.044	0.602	16.677	<.001**
Better quality water	-1.510	0.579	-2.608	0.009*
Improved sanitation facility	1.152	0.452	2.547	0.011*
Cleanliness of the Household Premises	1.658	0.563	2.944	0.003*
Multiple R ² = 0.049022, Adjusted R ² = 0.044428				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The intercept is highly significant ($B = 10.0436$, $p < .001$), indicating a strong baseline level of stunting when environmental predictors are held constant. All three environmental predictors show statistically significant associations with stunting. Better quality water is negatively associated with stunting ($B = -1.5100$, $p = .0093$), showing that children with access to safer and cleaner water sources are less likely to be stunted (*significant at the 1% level*). It highlights the protective role of water quality in supporting child growth.

Improved sanitation facilities are positively associated with stunting ($B = 1.1516$, $p = .0111$). Although statistically significant, the positive relationship suggests the presence of complex interactions or transitional effects where sanitation improvements may not yet be translating into better health outcomes due to poor hygiene behaviour or inadequate facility use (*significant at the 5% level*). Cleanliness of household premises also shows a positive and significant

relationship with stunting ($B = 1.6584$, $p = .0034$), a result that may reflect similar transitional dynamics or measurement interpretations (*significant at the 1% level*). It could also indicate that cleanliness alone cannot reduce stunting without addressing structural issues like overcrowding or chronic undernutrition.

Even though the overall explanatory power of the model is limited, the statistical significance of all three environmental predictors reinforces the crucial role of living conditions in shaping child nutrition outcomes. Improved access to better water quality reduces stunting, while the relationships with sanitation and household cleanliness suggest more integrated and behaviorally oriented health interventions. Programs must move beyond infrastructure to include education, sustained behaviour change, and targeted support for vulnerable families in tribal communities.

4.3.2 Institutional Factors Influencing Malnutrition

Institutional support mechanisms such as Healthcare, Anganwadi services, immunisation, Nutrition programs, and the Public Distribution System (PDS) serve as lifelines for families facing poverty and food insecurity. In remote tribal areas like Attappadi, the presence, quality, and reach of these institutions critically affect how effectively families meet the nutritional and health needs of children. By including institutional factors in this study, we aim to evaluate the performance and utilisation of these systems and their role in preventing or perpetuating malnutrition. This understanding is vital for improving policy implementation and strengthening services where needed most.

4.3.2.1 Distribution of Tribal Children Based on Access to Healthcare Services

Table 4.29 presents the distribution of tribal children in Attappadi based on the perception of their mother towards access to healthcare services, disaggregated by tribal group - Irula, Kurumba, and Muduga. Although responses were collected using a five point Likert scale, only three categories - Agree, Disagree, and Strongly Disagree - were reported.

Table 4.29
Distribution of Tribal Children Based on Access to Healthcare Services

Access to Healthcare Services	Tribe			Total
	Irula	Kurumba	Muduga	
Agree	171 (38.3)	35 (46.7)	26 (26.0)	232 (37.3)
Disagree	124 (27.7)	39 (52.0)	52 (52.0)	215 (34.6)
Strongly Disagree	152 (34.0)	1 (1.3)	22 (22.0)	175 (28.1)
Total	447 (100)	75 (100)	100 (100)	622 (100)
$\chi^2=52.669 \cdot df=4 \cdot \text{Cramer's } V=0.206 \cdot \text{Fisher's } p=0.000$				

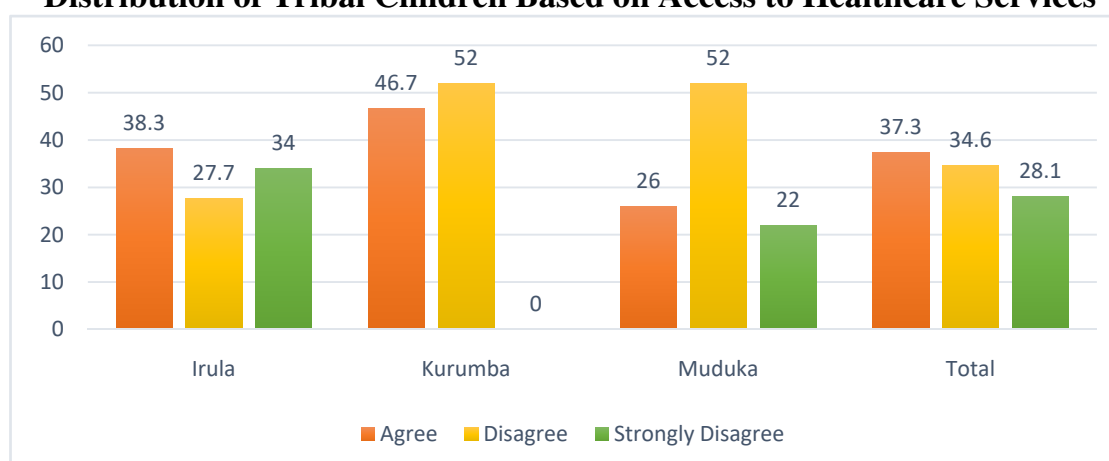
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among Irula mothers, 38.3% agreed they had access to healthcare services, 27.7% disagreed, and 34.0% strongly disagreed. In the Kurumba group, 46.7% agreed, 52.0% disagreed, and only 1.3% strongly disagreed, indicating that most dissatisfaction in this group was expressed moderately rather than strongly. 26.0% respondents from the Muduga tribe agreed, 52.0% disagreed, and 22.0% strongly disagreed, showing higher dissatisfaction.

The chi-square test ($\chi^2 = 52.669$, $df = 4$, $p = .000$) reveals a statistically significant association between tribal identity and perceived access to healthcare services. The Cramer's V value of 0.206 indicates a moderate association, suggesting that the disparities in access perceptions are meaningfully related to tribal affiliation. The absence of extreme positive responses (Strongly Agree) and neutral options emphasises the polarised nature of healthcare access in tribal hamlets, highlighting the urgent need for inclusive and equitable healthcare outreach in these remote communities.

Figure 4.11
Distribution of Tribal Children Based on Access to Healthcare Services



Source: Primary Data

4.3.2.2 Distribution of Tribal Children Based on Access to Anganwadi Services

Table 4.30 illustrates the distribution of tribal children in Attappadi based on perceptions of mothers on their access to Anganwadi services, classified by tribal identity - Irula, Kurumba, and Muduga. Although responses were collected using a five-point Likert scale, only four categories - Strongly Agree, Agree, and Disagree - were reported. Access to Anganwadi services is vital to early childhood care, providing supplementary nutrition, immunisation, health check-ups, and preschool education, especially critical in marginalised tribal regions.

Table 4.30
Distribution of Tribal Children Based on Access to Anganwadi Services

Access to Anganwadi Services	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	428 (95.1)	48 (64)	81 (81.0)	557 (89.1)
Agree	11 (2.4)	20 (26.7)	2 (2.0)	33 (5.3)
Disagree	11 (2.4)	7 (9.3)	17 (17.0)	35 (5.6)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=114.798 \cdot df=4 \cdot \text{Cramer's } V=0.303 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

An overwhelming majority of Irula respondents (95.1%, n = 428) strongly agreed that they had access to Anganwadi services, followed by 2.4% (n = 11) who agreed and 2.4% (n = 11) who disagreed. Among the Muduga tribe, 81.0% (n = 81) strongly agreed, 2.0% (n = 2) agreed, and 17.0% (n = 17) disagreed. However, the

Kurumba tribe showed a lower level of strong agreement, with only 64.0% (n = 48) strongly agreeing, 26.7% (n = 20) agreeing, and 9.3% (n = 7) disagreeing.

The chi-square test statistic ($\chi^2 = 114.798$, $df = 4$, $p = .000$) indicates a statistically significant relationship between tribal group and perceived access to Anganwadi services. The Cramer's V value of 0.303 suggests a moderately strong association between tribal affiliation and accessibility of these services. The findings show a generally high access to Anganwadi services across all tribal groups in Attappadi, especially among the Irula. A relatively lower satisfaction among Kurumba and Muduga respondents shows intra-tribal disparities that warrant targeted intervention. Strengthening outreach and ensuring equitable quality of services across all tribal hamlets is essential for advancing early childhood development in the region.

4.3.2.3 Distribution of Tribal Children Based on Access to the Immunisation Program

Table 4.31 presents the distribution of tribal children in Attappadi based on reports of mothers on access to the government immunisation program, categorised by tribe - Irula, Kurumba, and Muduga. Although the original tool was a five point Likert scale, the responses collapsed into two categories - Agree and Disagree - due to the absence of responses in the Neutral, Strongly Agree, and Strongly Disagree categories. Access to immunisation is a critical component of child survival and public health, especially in underserved tribal populations.

Table 4.31
Distribution of Tribal Children Based on Access to the Immunisation Program

Access to the Immunisation Program	Tribe			Total
	Irula	Kurumba	Muduga	
Agree	421 (93.6)	59 (78.7)	86 (86.0)	566 (90.6)
Disagree	29 (6.4)	16 (21.3)	14 (14.0)	59 (9.4)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=19.565 \cdot df=2 \cdot \text{Cramer's } V=0.177 \cdot \text{Fisher's } p=0.000$				

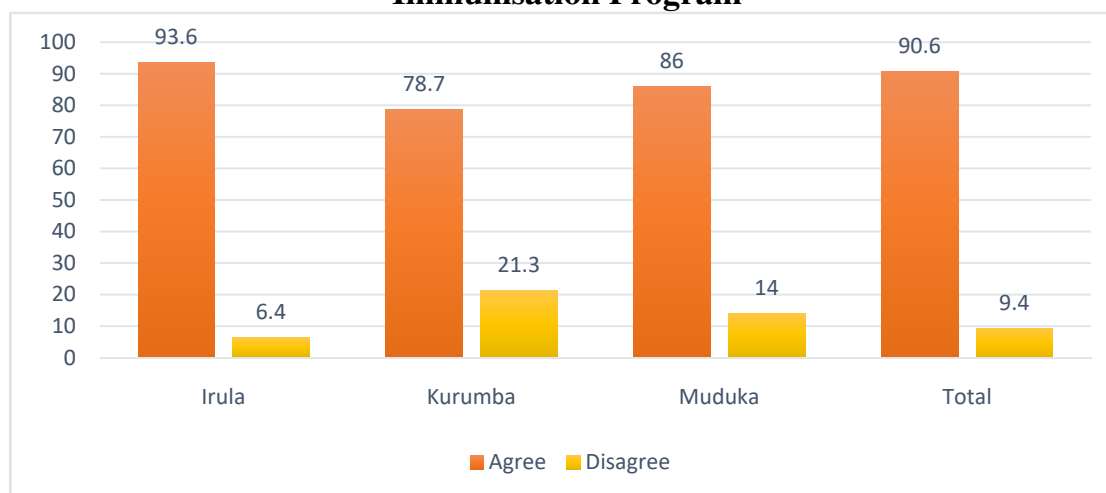
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that most respondents across all three tribal groups reported

positive access to immunisation services. Among Irula respondents, 93.6% agreed that their children had access to the immunisation program, with only 6.4% disagreeing. In the Kurumba group, 78.7% reported agreement, while 21.3% disagreed. For the Muduga tribe, 86.0% (n = 86) agreed and 14.0% disagreed. The chi-square test ($\chi^2 = 19.565$, $df = 2$, $p = .000$) indicates a statistically significant association between tribal identity and reported access to immunisation services. The Cramer's V value of 0.177 suggests a small to moderate strength of association, meaning tribal affiliation plays a meaningful role in determining immunisation access.

Figure 4.12
Distribution of Tribal Children Based on Access to the Immunisation Program



Source: Primary Data

There is high access to immunisation programs among tribal children in Attappadi, particularly within the Irula community. However, the relatively lower agreement rates among Kurumba and Muduga respondents highlight the need for improved outreach and equity in program delivery. Ensuring consistent and culturally sensitive immunisation coverage across all tribal groups is essential to safeguarding child health in the region.

4.3.2.4 Distribution of Tribal Children Based on Access to Nutrition Program

Table 4.32 displays the distribution of tribal children in Attappadi according to perceptions of their mothers on access to the government nutrition program, disaggregated by tribal groups - Irula, Kurumba, and Muduga. Although responses

were collected using a five point Likert scale, only three categories - Strongly Agree, Agree, and Disagree - were reported. No responses were recorded under Neutral or Strongly Disagree. It indicates a highly polarised perception of nutrition program accessibility among tribal communities.

Table 4.32
Distribution of Tribal Children Based on Access to Nutrition Program

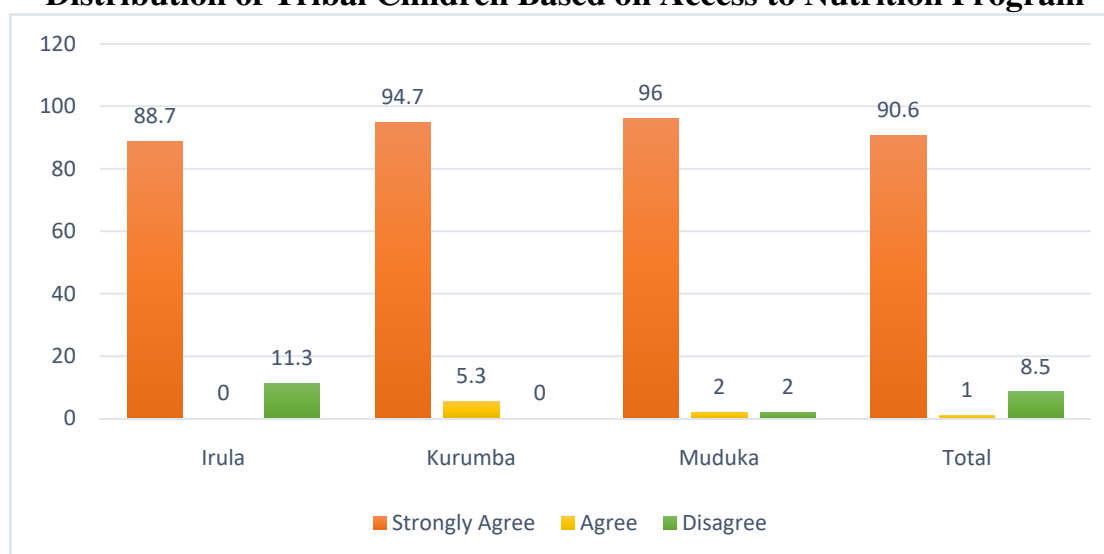
Access to Nutrition Program	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	399 (88.7)	71 (94.7)	96 (96.0)	566 (90.6)
Agree	0 (0)	4 (5.3)	2 (2.0)	6 (1.0)
Disagree	51 (11.3)	0 (0)	2 (2.0)	53 (8.5)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=36.666 \cdot df=4 \cdot \text{Cramer's } V=0.171 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that most respondents across all tribal groups strongly affirmed access to the nutrition program. Among Irula mothers, 88.7% strongly agreed with having access, while 11.3% disagreed. In the Kurumba group, 94.7% strongly agreed, with 5.3% agreeing. Notably, no Kurumba respondents disagreed. Among the Muduga tribe, 96.0% strongly agreed, while 2.0% reported agreement and disagreement. Among the Total, 90.6% strongly agreed, while 1.0% agreed and 8.5% disagreed.

Figure 4.13
Distribution of Tribal Children Based on Access to Nutrition Program



Source: Primary Data

The chi-square test value ($\chi^2 = 36.666$, $df = 4$, $p = .000$) indicates a statistically

significant relationship between tribal identity and access to the nutrition program. The Cramer's V of 0.171 suggests a small to moderate association, meaning that tribal affiliation plays a modest but meaningful role in shaping access to nutrition services. Even though the findings indicate overwhelmingly positive perceptions of access to nutrition programs among tribal households in Attappadi, a small proportion of Irula respondents expressed disagreement, suggesting that some gaps may persist within this group. This emphasises the need for targeted outreach and monitoring to ensure equitable access across all tribal communities.

4.3.2.5 Distribution of Tribal Children Based on Access to PDS

Table 4.33 presents the perceptions of mothers of tribal children in Attappadi regarding their access to the Public Distribution System (PDS), categorised by tribal groups - Irula, Kurumba, and Muduga. Although responses were collected using a five point Likert scale, only three categories - Strongly Agree, Agree, and Disagree - were reported. There were no responses under Neutral or Strongly Disagree, indicating a clarity in the views of respondents, either positively or negatively.

Table 4.33
Distribution of Tribal Children Based on Access to PDS

Access to PDS	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	442 (98.2)	64 (85.3)	99 (99.0)	605 (96.8)
Agree	8 (1.8)	9 (12.0)	1 (1.0)	18 (2.9)
Disagree	0 (0)	2 (2.7)	0 (0)	2 (2.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=40.615 \cdot df=6 \cdot \text{Cramer's } V=0.180 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that across all three tribal groups, access to PDS was perceived very positively. A striking 98.2% of Irula respondents strongly agreed they had access to PDS, with only 1.8% reporting agreement. No Irula respondents disagreed with the statement. Among Kurumba mothers, 85.3% strongly agreed, 12.0%

agreed, and 2.7% disagreed. This group shows slightly more variability in perception compared to the others. In the Muduga group, 99.0% strongly agreed, and only 1.0% agreed, with no disagreements reported.

The chi-square test ($\chi^2 = 40.615$, $df = 6$, $p = .000$) shows a statistically significant association between tribal identity and perceived access to PDS. Cramer's V value of 0.180 suggests a small to moderate strength of association, reflecting meaningful differences in perception among tribal groups. The findings show an overwhelmingly positive perception of access to PDS among tribal families in Attappadi, particularly among the Irula and Muduga communities. Although a small fraction of Kurumba respondents reported disagreement or lower levels of agreement, the overall data suggest that PDS has substantial reach and acceptance across all tribal segments. The significant association between tribe and PDS access calls for continued monitoring to ensure consistent service delivery, especially among smaller tribal groups.

4.3.3 Cultural Factors Influencing Malnutrition

Cultural beliefs and practices have an important role to play in child and maternal nutrition, particularly in traditional tribal communities with strong cultural practices. Pregnancy food taboos, culturally patterned feeding practices, and interpersonal norms against professional health seeking are generally a part of tribal community life. Depending on the nature and the timing, these beliefs will facilitate or interfere with nutritional outcomes. In the context of Attappadi, where traditional knowledge is involved in daily health decisions, a cultural approach is needed to identify underlying nutrition barriers. Cultural dimensions are incorporated in this study to learn more about how social norms affect health behaviours and enable culturally congruent sustainability interventions. Cultural factors are included in the study to show the association between the dependent and IV.

4.3.3.1 Distribution of Tribal Children Based on Food Habits Followed by Their Mothers During Pregnancy

Table 4.34 presents perceptions of mothers of tribal children in Attappadi regarding whether food habits followed during pregnancy are detached from cultural traditions. Although responses were collected using a five point Likert scale, only

four categories - Strongly Agree, Agree, Disagree, and Strongly Disagree - were reported. No responses were given in the Neutral category, suggesting that respondents held distinct opinions.

Table 4.34
Distribution of Tribal Children Based on Food Habits Followed by
Their Mothers During Pregnancy

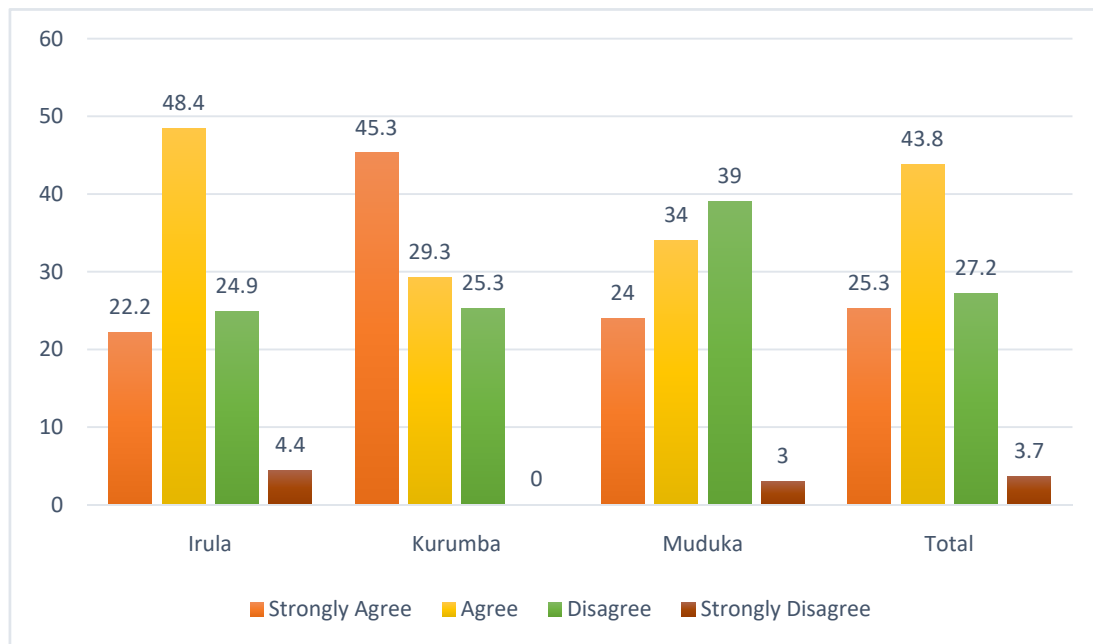
Food habits during pregnancy are not based on culture	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	100 (22.2)	34 (45.3)	24 (24.0)	158 (25.3)
Agree	218 (48.4)	22 (29.3)	34 (34.0)	274 (43.8)
Disagree	112 (24.9)	19 (25.3)	39 (39.0)	170 (27.2)
Strongly Disagree	20 (4.4)	0 (0)	3 (3.0)	23 (3.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=38.104 \cdot df=10 \cdot \text{Cramer's } V=0.175 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Among Irula respondents, the majority agreed (48.4%) that food habits during pregnancy are not based on culture, while 22.2% strongly agreed. A notable proportion (24.9%) disagreed, and a small fraction (4.4%) strongly disagreed. It indicates a mix of opinions within the Irula community, with a tilt toward agreement. Kurumba mothers strongly supported the statement, with 45.3% agreeing and 29.3% disagreeing. About 25.3% disagreed, and none strongly disagreed, highlighting a greater tendency to perceive food habits as culturally neutral during pregnancy. In contrast, Muduga respondents were more divided. Only 24.0% strongly agreed, and 34.0% agreed, while a higher proportion, 39.0% disagreed, and 3.0% strongly disagreed. It suggests cultural influence on pregnancy food practices may still be significant in the Muduga community.

Figure 4.14
Distribution of Tribal Children Based on Food Habits Followed by
Their Mothers During Pregnancy



Source: Primary Data

The result of the chi-square test reveals a statistically significant association between tribal group and opinion on the cultural basis of food habits during pregnancy ($\chi^2 = 38.104$, $df = 10$, $p = .000$). The Cramer's V value of 0.175 indicates a small to moderate association, implying meaningful differences in cultural perceptions across the tribal groups. The finding shows that while most tribal mothers in Attappadi believe that food habits during pregnancy are not culturally driven, this perception varies significantly across tribes. Kurumba respondents were most likely to view food habits as non-cultural, whereas Muduga mothers were more likely to recognise cultural influences. It emphasises the need for culturally sensitive nutritional interventions, particularly among communities where tradition still shapes dietary behaviour during pregnancy.

4.3.3.2 Distribution of Tribal Children Based on the Feeding Practice Followed by Their Mothers

Table 4.35 illustrates the opinions of mothers of tribal children in Attappadi regarding whether cultural beliefs influence child feeding practices. Although responses were collected using a five point Likert scale, only four categories - Strongly Agree, Agree, Disagree, and Strongly Disagree - were reported. However,

no respondents selected the Neutral category, indicating that participants held clear positions on the issue, either in agreement or disagreement.

Table 4.35
Distribution of Tribal Children Based on the Feeding Practice
Followed by Their Mothers

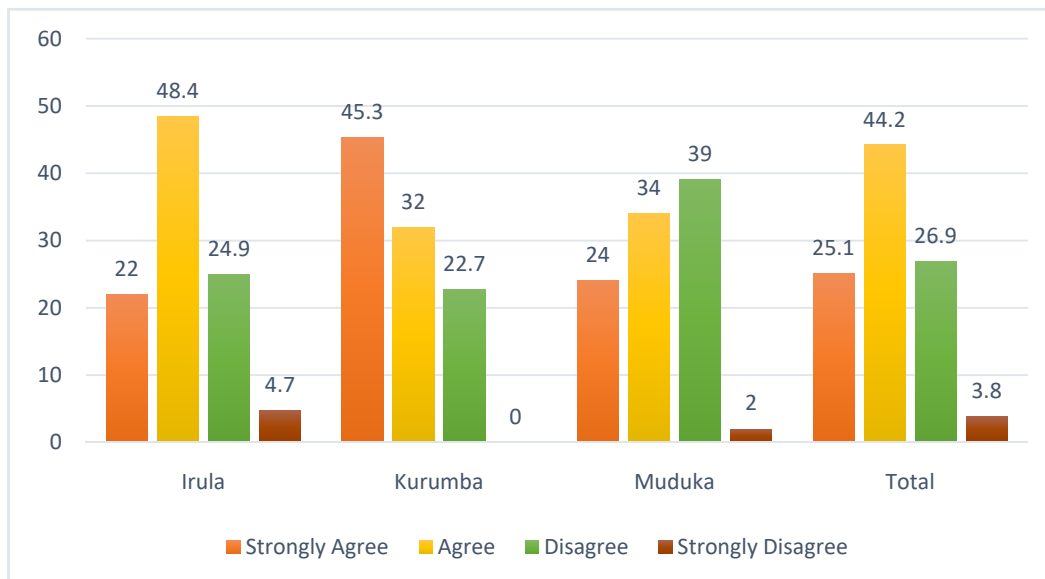
Feeding practices are not based on Cultural beliefs	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	99 (22.0)	34 (45.3)	24 (24.0)	157 (25.1)
Agree	218 (48.4)	24 (32.0)	34 (34.0)	276 (44.2)
Disagree	112 (24.9)	17 (22.7)	39 (39.0)	168 (26.9)
Strongly Disagree	21 (4.7)	0 (0)	3 (2.0)	24 (3.8)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=37.364 \cdot df=10 \cdot \text{Cramer's } V=0.173 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that nearly half of the Irula respondents (48.4%) agreed that feeding practices are not based on cultural beliefs, while 22.0% strongly agreed. A significant portion (24.9%) disagreed, and 4.7% strongly disagreed, indicating a mixed perception with a greater inclination toward agreement. The Kurumba community expressed the highest level of agreement with the statement. About 45.3% strongly agreed and 32.0% agreed that feeding practices are not rooted in cultural traditions. Only 22.7% disagreed, and none strongly disagreed, suggesting that cultural beliefs play a smaller role in feeding decisions among Kurumba mothers. In contrast, Muduga respondents were more divided. While 34.0% agreed and 24.0% strongly agreed with the statement, 39.0% disagreed, and 3.0% strongly disagreed. It highlights the more substantial cultural influence on feeding practices within the Muduga community.

Figure 4.15
Distribution of Tribal Children Based on the Feeding Practice
Followed by Their Mothers



Source: Primary Data

The result of the chi-square test indicates a statistically significant association between tribal affiliation and perception of cultural influence on feeding practices ($\chi^2 = 37.364$, $df = 10$, $p = .000$). Cramer's V value of 0.173 suggests a small to moderate strength of association, confirming noticeable inter-tribal differences in perception. The analysis reveals tribal variations in how cultural beliefs influence feeding practices during early childhood. Kurumba mothers most frequently reported that feeding practices are not culturally driven, whereas many Muduga respondents viewed culture as an important determinant. It shows the need for culturally tailored nutrition education strategies in Attappadi, especially in communities where traditional beliefs still shape child feeding behaviours.

4.3.3.3 Distribution of Tribal Children Based on the Influence of Social Norms on Seeking Professional Healthcare

Table 4.36 outlines the views of mothers of tribal children in Attappadi on whether community-level social norms act as barriers to seeking professional healthcare. Their opinions were measured through a five point Likert scale. Notably, none of the respondents opted for the Neutral category, suggesting that participants expressed clear positions on the issue.

Table 4.36
Distribution of Tribal Children Based on the Influence of
Social Norms on Seeking Professional Healthcare

Social norms do not affect the seeking of professional healthcare.	Tribe			Total
	Irula	Kurumba	Muduga	
Strongly Agree	99 (22.0)	34 (45.3)	24 (24.0)	157 (25.1)
Agree	225 (50.0)	28 (37.3)	41 (41.0)	294 (47.0)
Disagree	105 (23.3)	13 (17.3)	33 (33.0)	151 (24.2)
Strongly Disagree	21 (4.7)	0 (0)	2 (2.0)	23 (3.7)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=31.275 \cdot df=10 \cdot \text{Cramer's } V=0.158 \cdot \text{Fisher's } p=0.000$				

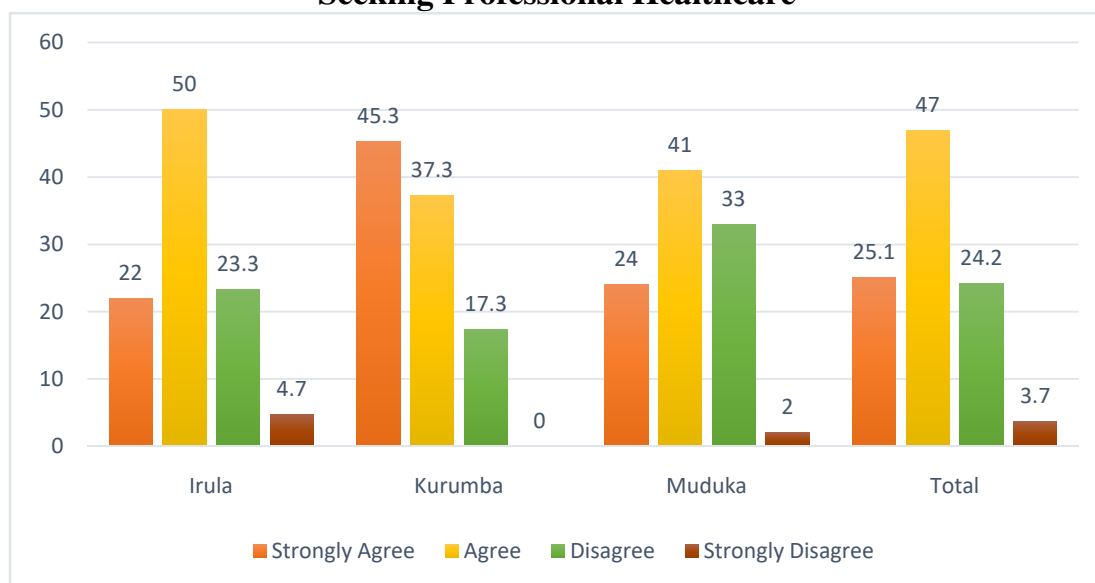
Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among the Irula tribe, half of the respondents (50.0%) agreed that social norms do not affect their decision to seek professional healthcare, and 22.0% strongly agreed. However, nearly one fourth (23.3%) disagreed, and 4.7% strongly disagreed, suggesting acceptance and concern about social barriers.

The Kurumba tribe showed stronger affirmation, with 45.3% strongly agreeing and 37.3% agreeing with the statement. Only 17.3% disagreed, and no respondents strongly disagreed. It indicates that most Kurumba respondents perceive social norms as having little influence on healthcare seeking behaviour. 41.0% of respondents from the Muduga tribe agreed, and 24.0% strongly agreed that social norms do not obstruct seeking professional healthcare. However, 33.0% disagreed and 2.0% strongly disagreed, showing a more divided viewpoint. Social norms still pose challenges to professional healthcare access in the Muduga community.

Figure 4.16
Distribution of Tribal Children Based on the Influence of Social Norms on Seeking Professional Healthcare



Source: Primary Data

The result of the chi-square test shows a statistically significant association between tribal affiliation and perceptions of social norms influence on healthcare seeking behaviour of mothers ($\chi^2 = 31.275$, $df = 10$, $p = .000$). The Cramer's V value of 0.158 indicates a small to moderate effect size, demonstrating some variation across tribal groups. Most tribal mothers in Attappadi believe that social norms do not hinder them from using professional healthcare services. However, notable inter-tribal differences exist. While Kurumba respondents showed the highest agreement, the Muduga tribe expressed more concerns about the role of social norms. These insights highlight the importance of addressing tribe specific barriers in health awareness and outreach programs.

The analysis of external factors - encompassing environmental, institutional, and cultural determinants - highlights significant influence on the nutritional status of tribal children in Attappadi. Among environmental factors, the availability of sanitation facilities was significantly associated with underweight and stunting, indicating the impact of poor hygiene and recurrent infections on child growth. Even though the drinking water quality and household cleanliness did not show statistical significance, their broader public health relevance cannot be dismissed. Institutional variables such as access to immunisation and nutrition programs were

also linked to stunting, suggesting these services reach vulnerable children but may require enhanced coverage and effectiveness. However, the lack of significance for healthcare access, Anganwadi services, and PDS highlights persistent quality, targeting, and utilisation issues. Cultural factors, including dietary restrictions during pregnancy, healthcare and traditional feeding practices, emphasise the influence of beliefs on nutrition behaviours. Notably, social norms restricting professional healthcare seeking emerged as a key barrier. In conclusion, external factors are an interlinked system perpetuating malnutrition in tribal settings. Addressing these challenges demands a multi-pronged approach that improves infrastructure, ensures service quality, and promotes culturally sensitive behavioural change. Sustainable improvements in tribal child nutrition depend on removing these structural and cultural obstacles through coordinated public health and community-based efforts.

4.4 Conclusion

Chapter 4 discussed the interrelated determinants of malnutrition among tribal children below five years in Attappadi, where internal and external determinants were highlighted. The internal evaluation established that socio-economic determinants such as the income of parents, educational level, occupation, and alcohol consumption of the father of the child were determining factors in nutrition. Maternal characteristics like age, health and nutrition awareness, and personal factors including birth order and spacing, further shape child malnutrition, emphasising the critical role of household dynamics and maternal well-being. On the other hand, the assessment of external factors demonstrated the importance of broader structural and cultural influences. Environmental sanitation and poor sanitation facilities were strongly linked with undernutrition. Institutional strategies such as immunisation and nutrition programs affected child development. Cultural beliefs, particularly those that limit access to healthcare and traditional feeding beliefs, were the cause of persistent poor nutrition habits. Together, these findings highlight that an interplay of individual, household, institutional, and cultural elements sustains child malnutrition in tribal areas. Addressing malnutrition in such a context requires integrated strategies - targeting poverty, empowering mothers,

strengthening public services, and promoting culturally appropriate behavioural change. The evidence suggests that sustainable improvements in tribal child nutrition must tackle internal vulnerabilities and external structural barriers.

CHAPTER 5

HOUSEHOLD DEPRIVATION AND NUTRITIOUS STATUS

5.1 Introduction

Malnutrition is a widespread public health issue among children of different tribes, particularly in economically backward regions like Attappadi. The socio-economic status of households is closely related to the health condition of the children. We must understand the interdependencies between household deprivation and malnutrition to formulate effective intervention programs. The present chapter comprehensively analyses the association between household deprivation and child malnutrition among tribal children in Attappadi. The analysis employs the Household Deprivation Score (HDS) developed by Srinivasan and Mohanty, which integrates three core dimensions of deprivation - economic assets, social amenities, and living conditions - reflecting the overall socio-economic status of households (Srinivasan & Mohanty, 2004). The chapter is organised into three sections: the distribution of tribal children based on household deprivation, the association between household deprivation and malnutrition indicators (wasting, underweight, and stunting), and the association between total household deprivation and malnutrition indicators. It assesses how different levels of deprivation - Abject Deprivation (AD), Moderate Deprivation (MD), Just Above Deprivation (JAD), and Well Above Deprivation (WAD) - affect child growth and development, and also the association between household deprivation and the nutritional status of tribal children under five in Attappadi.

5.2 Household Deprivation Score

Household deprivation refers to the lack of essential socio-economic resources that define the living standards of a household. This chapter investigates the relationship between nutritional status and household deprivation levels of a child to examine the extent of malnutrition among children under five across different Household Deprivation Score (HDS) categories. The HDS, based on the index developed by Srinivasan and Mohanty, measures deprivation across three dimensions such as basic economic possessions, basic amenities of life, and basic communication with the world. Unlike traditional economic indicators such as total expenditure, per capita income, or the living standard index, HDS focuses on the absence of specific assets and facilities within a household. HDS is constructed using nine binary

variables across three dimensions. The first dimension includes housing conditions, land ownership, and access to regular wage employment. The second dimension assesses access to electricity, drinking water, and toilet facilities. The third dimension considers household literacy, ownership of communication devices, and community participation. Households are classified into four deprivation categories based on their total score, such as Abject Deprivation (AD) for those lacking all nine indicators, Moderate Deprivation (MD) for those possessing 1 to 3, Just Above Deprivation (JAD) for those with 4 to 6, and Well Above Deprivation (WAD) for those possessing 7 to 9 indicators. The AD and MD categories collectively represent the most deprived households. The concept of abject poverty, introduced by the United Nations in 1995, represents the most extreme form of deprivation, characterised by severe food shortages, safe drinking water, sanitation, healthcare, shelter, and education. This chapter examines how varying levels of household deprivation impact the nutritional well-being of tribal children in Attappadi.

5.2.1 The Relationship Between Household Deprivation and the Nutritious Status of Tribal Children

Understanding the correlation of household deprivation with the distribution of children under five years of age living in tribal households in Attappadi is crucial in administering socio-economic disparities affecting their nutrition. The Household Deprivation Score (HDS) classifies households based on three dimensions - basic economic possessions, amenities, and communication - into four categories: Acute Deprivation (AD), Moderate Deprivation (MD), Just Above Deprivation (JAD), and Well Above Deprivation (WAD). The study seeks to determine whether household deprivation levels significantly influence the distribution of tribal children and their nutritional outcomes, including wasting, underweight, and stunting. The hypothesis for the chi-square test to show the relationship between household deprivation status and the nutritional status of tribal children in Attappadi is given below.

- H_0 : There is no significant association between household deprivation status and the nutrition status (wasting, underweight, and stunting) of tribal children in Attappadi.

- H₁: There is a significant association between household deprivation status and the nutritional status (wasting, underweight, and stunting) of tribal children in Attappadi.

Hypothesis Test Results

5.2.1.1 Distribution of Tribal Children in Attapadi Based on Household Deprivation

The study of household deprivation scores among children under five in Attappadi is essential to identify the most deprived tribal groups - Irula, Muduga, and Kurumba - and address socio-economic inequalities affecting their nutritional status. Based on the Household Deprivation Score of nine socio-economic indicators, the households are divided into four categories (AD, MD, JAD, and WAD). A Chi-square test was conducted to assess the association between household deprivation status and the distribution of tribal children among the Irula, Kurumba, and Muduga tribes. The Test yielded a Chi-square value (χ^2) of 49.967 with 6 degrees of freedom (df = 6). The strength of association, measured using Cramer's V, was 0.200, indicating a moderate relationship between the variables. The Fisher's Test produced a p-value of 0.000, SS at the 1% level ($p < 0.01$). Since the p-value is less than 0.05, the null hypothesis (H₀) is rejected, confirming a significant association between household deprivation and the distribution of tribal children in Attappadi. Table 5.1 shows the relationship between household deprivation and the nutritional status of tribal children (in Attappadi.

Table 5. 1
Distribution of Tribal Children in Attapadi Based on Household Deprivation

Household Deprivation Level	Tribe			Total
	Irula	Kurumba	Muduga	
AD	5 (1.1)	5 (6.7)	2 (2.0)	12 (1.9)
MD	113 (25.1)	42 (56.0)	32 (32.0)	187 (29.9)
JAD	332 (73.8)	27 (36.0)	65 (65.0)	424 (67.9)
WAD	0 (0)	1 (1.3)	1 (1.0)	2 (0.3)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=49.967 \cdot df=6 \cdot \text{Cramer's } V=0.200 \cdot \text{Fisher's } p=0.000$				

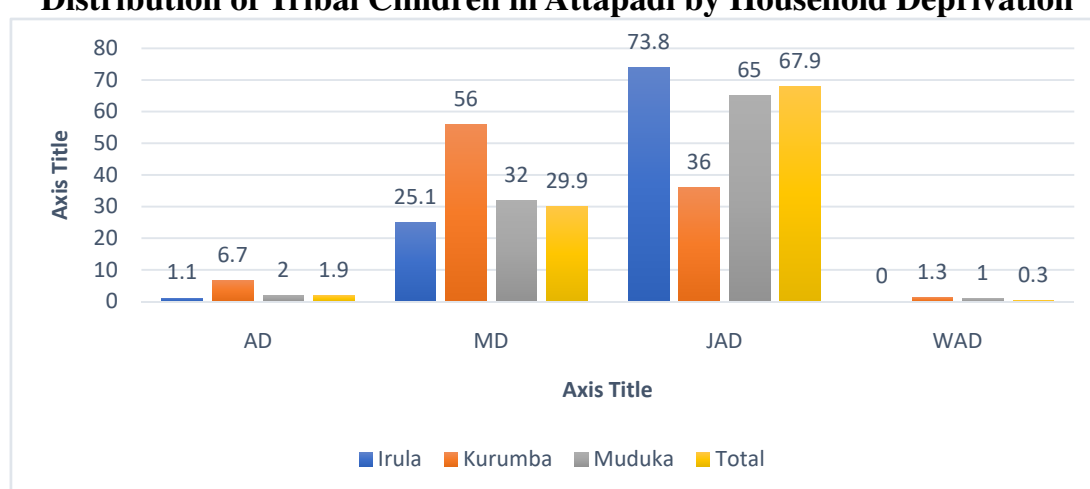
Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 5.1 shows significant variations among the three tribal groups. Among Irula

households, the majority (73.8%) fall under the JAD category, followed by 25.1% in MD, and only 1.1% experience AD. Kurumba households have the highest proportion in the MD category (56%), with 36% in JAD and 6.7% in AD. Muduga households show 65% in JAD, 32% in MD, and 2% in AD. The WAD category is minimal across all tribes, with only two households (0.3%) attaining this level. The findings indicate that Kurumba households face the highest deprivation levels, while Irula and Muduga households predominantly fall under the JAD category. It is also depicted in Figure 5.1.

Figure 5.1
Distribution of Tribal Children in Attapadi by Household Deprivation



Source: Primary Data

5.2.1.2 Distribution of Wasted Tribal Children in Attappadi by Household Deprivation

The table explains the distribution of wasted tribal children based on household deprivation in Attappadi. Wasting, measured as weight-for-height, is categorised into severe malnutrition, moderate malnutrition, and normal nutritional status. The analysis considers how deprivation levels impact the prevalence of malnutrition among tribal children.

The Chi-square test for wasting status and household deprivation produced a χ^2 value of 277.199 with 6 degrees of freedom. The Cramer's V score of 0.471 suggests a strong relationship between these variables. The Fisher's Exact Test yielded a p-value of 0.000, confirming a statistically significant association ($p < 0.01$). The null hypothesis (H_0) is rejected, indicating that household deprivation significantly influences wasting among tribal children. Table 5.2 pictures the

relationship between household deprivation and nutrition status based on wasting among Tribal Children in Attappadi.

Table 5.2
Distribution of Wasted Tribal Children in Attappadi by
Household Deprivation

Household Deprivation	Wasting (Weight-for-height)			Total
	Severe Malnutrition	Moderate Malnutrition	Normal	
AD	1 (3.7)	1 (0.3)	10 (4.9)	12 (1.9)
MD	25 (92.6)	33 (8.4)	129 (63.5)	187 (29.9)
JAD	1 (3.7)	359 (90.9)	64 (31.5)	424 (67.9)
WAD	0 (0)	2 (0.5)	0 (0)	2 (0.3)
Total	27 (100)	395 (100)	203 (100)	625 (100)
$\chi^2=277.199 \cdot df=6 \cdot \text{Cramer's } V=0.471 \cdot \text{Fisher's } p=0.000$				

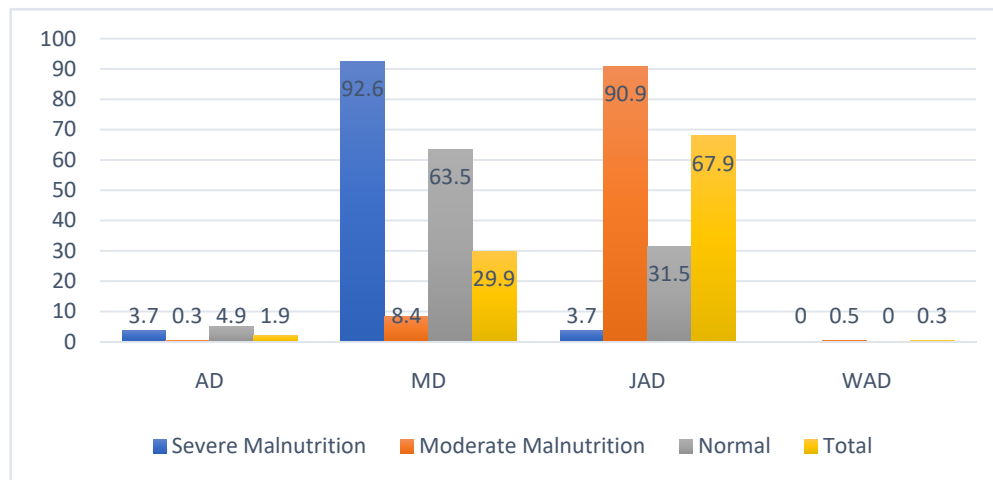
Note: Figures in brackets indicate percentages.

Source: Primary Data

Severe wasting was highest (92.6%) in the MD category, and moderate wasting was most prevalent (90.9%) among children in the JAD category, highlighting the vulnerability of children in moderately deprived households.

Table 5.2 shows that children in AD households, 3.7% suffer from severe malnutrition, while 0.3% face moderate malnutrition. In MD households, the prevalence of severe malnutrition is significantly higher (92.6%), with 8.4% experiencing moderate malnutrition. JAD households show the highest percentage of moderate malnutrition (90.9%), though severe cases are minimal (3.7%). WAD households report negligible malnutrition levels. The chi-square test ($\chi^2 = 277.199$, $df = 6$, $p = 0.000$) confirms a statistically significant association between household deprivation and wasting levels. It is also depicted in Figure 5.2

Figure 5.2
Distribution of Wasted Tribal Children by Household Deprivation



Source: Primary Data

The findings demonstrate that children from MD households are most vulnerable to severe malnutrition, emphasising the imperative for targeted nutritional interventions. Improving food security programs and expanding healthcare access may mitigate hunger and enhance child health outcomes in indigenous communities.

5.2.1.3 Distribution of Underweight Tribal Children in Attappadi by Household Deprivation

The table explains the distribution of wasted tribal children based on household deprivation in Attappadi. Wasting, measured as weight-for-height, is categorised into severe malnutrition, moderate malnutrition, and normal nutritional status. The analysis considers how deprivation levels impact the prevalence of malnutrition among tribal children.

The Chi-square test for wasting status and household deprivation produced a χ^2 value of 277.199 with 6 degrees of freedom. The Cramer's V score of 0.471 suggests a strong relationship between these variables. Fisher's Test produced a p-value of 0.000, confirming a statistically significant association. H_0 is rejected, indicating that household deprivation significantly influences wasting among tribal children. Table 5.3 pictures the relationship between household deprivation and nutrition status based on wasting among Tribal Children in Attappadi.

Table 5.3
Distribution of Underweight Tribal Children in Attappadi by Household Deprivation

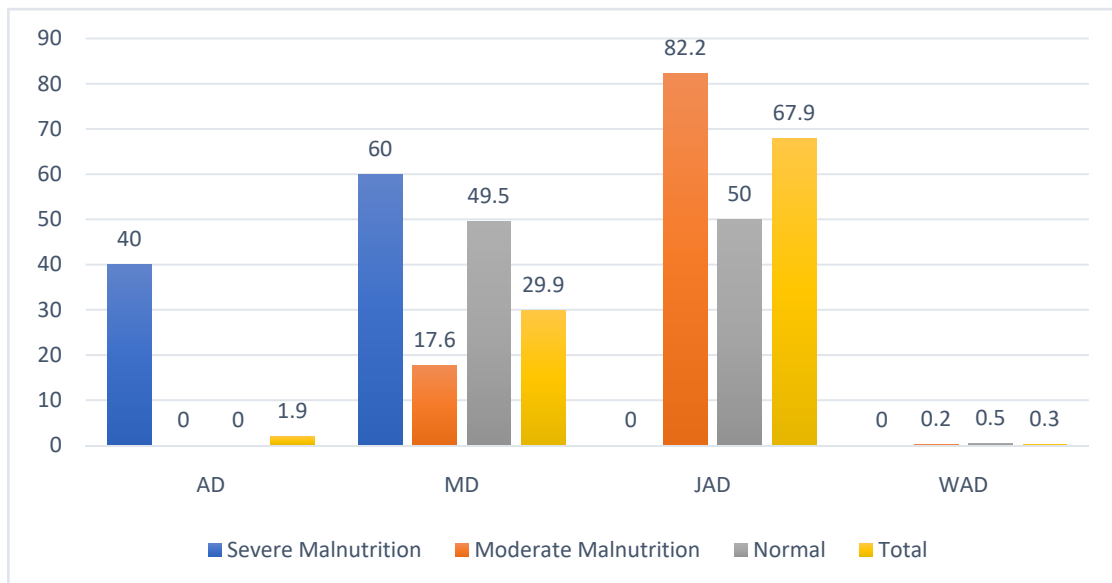
Household Deprivation	Underweight (Weight-for-age)			Total
	Severe Malnutrition	Moderate Malnutrition	Normal	
AD	12 (40)	0 (0)	0 (0)	12 (1.9)
MD	18 (60.0)	69 (17.6)	100 (49.5)	187 (29.9)
JAD	0 (0)	323 (82.2)	101(50.0)	424 (67.9)
WAD	0 (0)	19 (0.2)	1 (0.5)	2 (0.3)
Total	30 (100)	393 (100)	202 (100)	625 (100)
$\chi^2=49.933 \cdot df=6 \cdot \text{Cramer's } V=0.200 \cdot \text{Fisher's } p=0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data Analysis

Severe wasting was highest (92.6%) in the MD category, and moderate wasting was most prevalent (90.9%) among children in the JAD category, highlighting the vulnerability of children in moderately deprived households. Table 5.3 shows that of children from AD households, 3.7% suffer from severe malnutrition, while 0.3% face moderate malnutrition. In MD households, the prevalence of severe malnutrition is significantly higher (92.6%), with 8.4% experiencing moderate malnutrition. JAD households show the highest percentage of moderate malnutrition (90.9%), though severe cases are minimal (3.7%). WAD households report negligible malnutrition levels. The chi-square test ($\chi^2 = 277.199$, $df = 6$, $p = 0.000$) confirms a statistically significant association between household deprivation and wasting levels. It is also depicted in Figure 5.3

Figure 5.3
Distribution of Underweight Tribal Children in Attappadi by Household Deprivation



Source: Primary Data

The findings reveal that MD children are at the most significant risk of severe malnutrition and, therefore, require special nutrition interventions. Improving food security programs and expanding access to curative healthcare can reduce hunger and improve child health in indigenous populations.

5.2.1.4 Distribution of Stunted Tribal Children in Attappadi by Household Deprivation

Stunting, a critical measure of chronic malnutrition, is influenced by socio-economic factors, including household deprivation. The present study examines the distribution of stunted tribal children based on household deprivation in Attappadi. The analysis categorises households into four deprivation levels (AD, MD, JAD, and WAD) and assesses the prevalence of severe and moderate stunting across these categories.

The Chi-square test for stunting status yielded $\chi^2 = 13.011$ with 6 degrees of freedom and a Cramer's V value of 0.102, indicating a weak association. The Fisher's Test produced a p-value of 0.029, statistically significant at the 5% level ($p < 0.05$). Thus, the null hypothesis (H_0) is rejected, confirming that household deprivation significantly influences stunting among tribal children. Table 5.4 pictures the relationship between household deprivation and nutrition status based

on stunting among Tribal Children in Attappadi.

Table 5.4
Distribution of Stunted Tribal Children by Household Deprivation

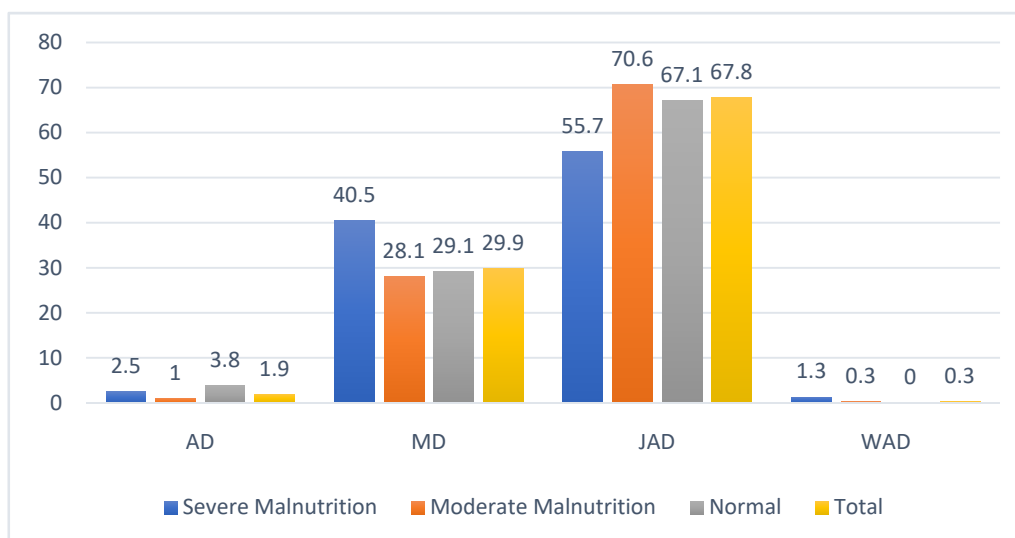
Household Deprivation	Stunting (Height for Age)			Total
	Severe Malnutrition	Moderate Malnutrition	Normal	
AD	2 (2.5)	4 (1)	6 (3.8)	12 (1.9)
MD	32 (40.5)	109 (28.1)	46 (29.1)	187 (29.9)
JAD	44 (55.7)	274 (70.6)	106 (67.1)	424 (67.8)
WAD	1 (1.3)	1 (0.3)	0 (0)	2 (0.3)
Total	79 (100)	388 (100)	158 (100)	625 (100)
$\chi^2=13.011 \cdot df=6 \cdot \text{Cramer's } V=0.102 \cdot \text{Fisher's } p=0.029$				

Note: Figures in brackets indicate percentages.

Source: Primary Data Analysis

Table 5.4 shows that children from abjectly deprived (AD) households, 2.5% experience severe stunting and 1% suffer from moderate stunting. In moderately deprived (MD) households, 40.5% of children experience severe stunting, while 28.1% are moderately stunted. The majority of stunted children belong to the just above deprivation (JAD) category, with 55.7% experiencing severe stunting and 70.6% facing moderate stunting. The well above deprivation (WAD) group shows minimal stunting (1.3% severe, 0.3% moderate). The study found that 79 children (12.6%) are severely stunted, 388 (62.1%) are moderately stunted, and only 158 (25.3%) have normal height-for-age. These results highlight that stunting is prevalent even in less deprived households, suggesting long-term nutritional deficiencies. It is also depicted in Figure 5.4.

Figure 5.4
Distribution of Stunted Tribal Children in Attappadi by Household Deprivation



Source: Primary Data

Addressing this issue requires targeted interventions, such as increased access to nutritional assistance, improved sanitation, and maternal education programs.

Strengthening social welfare schemes to enhance food security and healthcare services can help mitigate stunting and improve child health outcomes in Attappadi.

5.2.1.5 Distribution of Tribal Children in Attappadi by Household Deprivation and Presence of Feeding Mother

The presence of a feeding mother is a crucial determinant in providing adequate nutrition and overall health for a child. This research considers the relationship between the degree of household deprivation and the existence of a feeding mother among tribal children under five years old in Attappadi. The Household Deprivation Score (HDS) classifies households into four categories - deprivation (AD), moderate deprivation (MD), just above deprivation (JAD), and well above deprivation (WAD) - based on socio-economic factors.

The Chi-square test for household deprivation and the presence of feeding mothers resulted in $\chi^2 = 5.027$ with 3 degrees of freedom. The Cramer's V value of 0.090 indicates a weak relationship. The Fisher's Exact Test yielded a p-value of 0.115, which is not statistically significant ($p > 0.05$). Thus, the null hypothesis (H_0) is not rejected, indicating that household deprivation does not have a significant

association with the presence of feeding mothers. Table 5.5 shows the relationship between household deprivation and nutrition status based on the presence of feeding the mother among Tribal Children in Attappadi.

Table 5.5
Distribution of Tribal Children in Attappadi by Household Deprivation
and Presence of Feeding Mothers

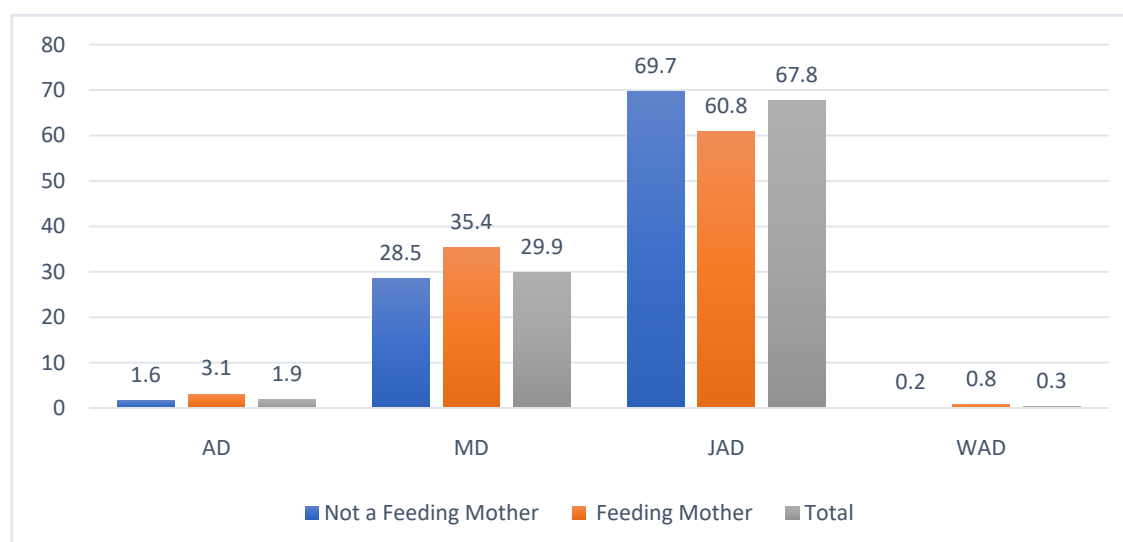
Household Deprivation	Feeding Mother		
	No	Yes	Total
AD	8 (1.6)	4 (3.1)	12 (1.9)
MD	141 (28.5)	46 (35.4)	187 (29.9)
JAD	345 (69.7)	79 (60.8)	424 (67.8)
WAD	1 (0.2)	1 (0.8)	2 (0.3)
Total	495 (100)	130 (100)	625 (100)
$\chi^2=5.027 \cdot df=3 \cdot \text{Cramer's } V=0.090 \cdot \text{Fisher's } p=0.115$			

Note: Figures in brackets indicate percentages.

Source: Primary Data Analysis

The table shows the distribution of feeding mothers across different household deprivation levels. Among the sample of 625 children, 495 (79.2%) do not have a feeding mother, while 130 (20.8%) do. The highest percentage of feeding mothers is found in the MD category (35.4%), followed by JAD (60.8%), while AD accounts for only 3.1%. However, more children without feeding mothers were found in the JAD (69.7%) and MD (28.5%) categories, suggesting that household deprivation may still influence maternal presence indirectly through socio-economic constraints. The WAD category, with only two households, shows an equal distribution. The data indicate that although families experiencing moderate to slight disadvantage have a comparatively more significant percentage of feeding moms, a substantial number of children in impoverished households are devoid of maternal assistance. It is also depicted in Figure 5.5

Figure 5.5
Distribution of Tribal Children in Attappadi
By Household Deprivation and Presence of Feeding Mother



Source: Primary Data

Mitigating socio-economic inequalities and improving maternal health interventions in poverty pockets is vital to improving child nutrition and health outcomes. The research identifies a strong correlation between deprivation at the household level and the distribution of tribal children across tribes and nutritional status in terms of wasting, underweight, and stunting. The strongest association was found in the case of wasting (Cramer's $V = 0.471$), followed by moderate associations for overall distribution (Cramer's $V = 0.200$) and underweight status (Cramer's $V = 0.200$). Stunting showed a weak but significant association (Cramer's $V = 0.102$). However, no such robust correlation existed between deprivation at the household level and the presence of feeding mothers. These findings demarcate the underlying influence of socio-economic determinants in deciding the intensity of child malnutrition in Attappadi. It is essential to design policy interventions for households with moderate and acute deprivation to reduce nutritional disparities among tribal children.

5.2.2 Regression Model on Association Between Household Deprivation and Nutritious Status of Tribal Children in Attappadi

Household deprivation is a crucial determinant of child health and nutrition, particularly among marginalised communities such as tribal populations. The socio-economic status of households determines, to a great extent, exposure to adequate

nutrition, health facilities, and hygiene. Malnutrition in all its forms - wasting, underweight, and stunting - is a significant threat to the physical and mental development of children. The present section investigates the association between household deprivation and malnutrition among tribal children under five in Attappadi. Multiple linear regression models are employed to assess the impact of household deprivation categories on wasting, underweight, and stunting episodes. The household deprivation categories are classified into four groups such as Abject Deprivation (AD), Moderate Deprivation (MD), Just Above Deprivation (JAD), and Well Above Deprivation (WAD). These categories represent different levels of socio-economic vulnerability, with the expectation that higher deprivation levels contribute to poor nutritional outcomes. Abject Deprivation (AD) is the baseline category against which other categories are compared. Regression coefficients for MD, JAD, and WAD indicate the variation in malnutrition outcomes across children in Abject Deprivation households. Regression models help identify what deprivation categories significantly influence the nutritional status of children, offering valuable information on the socio-economic determinants of malnutrition in the study region.

5.2.2.1 Multiple Linear Regression Model on Association Between Household Deprivation and Wasting (Weight-for-Height) Among Tribal Children in Attappadi

The multiple linear regression model explores the association between household deprivation and the wasting status (weight-for-height) of tribal children under five years in Attappadi. Wasting is the dependent variable, representing acute malnutrition, while household deprivation categories (MD, JAD, and WAD) serve as independent variables. The regression model is specified as

$$WS_i = \beta_0 + \beta_1 md + \beta_2 jad + \beta_3 wad + \varepsilon_i$$

Where, WS_i – Wasting (Weight-for-height) status of the child, β_0 – Constant term $\beta_1 md$ – Moderate Deprivation, $\beta_2 jad$ – Just Above Deprivation, $\beta_3 wad$ – Well Above Deprivation, and ε_i – Error term.

Table 5.6
Association between Household Deprivation and Wasting (Weight-for-height)
Among Tribal Children in Attappadi

Predictor	B	SE	t	p
(Intercept)	0.10167	1.56649	0.065	0.948
MD	0.06737	1.61597	0.042	0.967
JAD	1.99133	1.5885	1.254	0.21
WAD	1.47833	4.14455	0.357	0.721
<i>Multiple R² = .0268, Adjusted R² = .0221</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The intercept (B = 0.10167, $p = .948$) is not statistically significant, indicating no meaningful wasting base when household deprivation is absent. Among the independent variables, none exhibits a statistically significant association with wasting. Moderate deprivation (B = 0.06737, $p = .967$), just above deprivation (B = 1.99133, $p = .210$), and well above deprivation (B = 1.47833, $p = .721$) all have p -values well above the conventional significance threshold of .05. These findings suggest that variations in household deprivation levels are not significantly associated with the acute malnutrition status of tribal children as measured by wasting.

The overall model fit is weak, with an R^2 of .0268 and an Adjusted R^2 of .0221, indicating that only about 2.2% of the variance in wasting is explained by the household deprivation categories in the model. This low explanatory power implies that other factors not captured in this model may play a more substantial role in influencing wasting outcomes. The analysis suggests that while household deprivation is a relevant contextual factor, it does not independently predict wasting status among tribal children in Attappadi. Therefore, future interventions to reduce acute malnutrition should also consider other determinants such as immediate health conditions, dietary intake, and disease burden.

5.2.2.2 Multiple Linear Regression Model on Association between Household Deprivation and Underweight (Weight-for-age) Among Tribal Children in Attappadi

The association between household deprivation and underweight (weight-for-age)

tribal children in Attappadi has been analysed using the multiple linear regression model. The dependent variable in this model is the underweight (weight-for-age) of tribal children, while the independent variables are different categories of household deprivation. The independent variables include moderately deprived (MD), just above deprivation (JAD), and well above deprivation (WAD). The purpose of this analysis is to identify the influence of household deprivation categories on the underweight status of tribal children under five years old.

$$UW_i = \beta_0 + \beta_1 md + \beta_2 jad + \beta_3 wad + \varepsilon_i$$

Where, UW_i – Underweight (Weight-for-age) status of the child, β_0 – Constant term $\beta_1 md$ – Moderate Deprivation, $\beta_2 jad$ – Just Above Deprivation, $\beta_3 wad$ – Well Above Deprivation, and ε_i – Error term.

Table 5.7
Association between Household Deprivation and Underweight (Weight-for-age) Tribal Children in Attappadi

Predictor	B	SE	t	p
(Intercept)	6.469	2.613	2.476	0.014*
MD	1.769	2.695	0.656	0.512
JAD	4.746	2.649	1.791	0.074.
WAD	2.236	6.913	0.323	0.747
<i>Multiple R² = .02545, Adjusted R² = .02074</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

As displayed in Table 5.7, the intercept value of 6.469 (p = .014) indicates the expected underweight score for children when no household deprivation is reported. The coefficient for moderately deprived (MD) households is 1.769 (p = .512), suggesting an insignificant association with underweight status. Similarly, the coefficient for households well above deprivation (WAD) is 2.236 (p = .747), which also shows no significant impact. However, the coefficient for the just above deprivation (JAD) category is 4.746 with a p-value of .074, which is marginally significant at the 10% level. It implies that children from JAD households are more likely to be underweight compared to those from the reference group (most

deprived). However, the evidence is insufficient to claim statistical significance at the conventional 5% level.

The multiple R-squared value of .025 indicates that only 2.5% of the variance in underweight status is explained by the household deprivation categories included in the model. The adjusted R-squared value of .021 slightly decreases, accounting for the number of predictors. These low R^2 values suggest the model has limited explanatory power, indicating that other unobserved factors may play a greater role in determining underweight status among tribal children. The regression result indicated that the model was not statistically significant, $F(3, X) = ns$, $R^2 = .025$, Adjusted $R^2 = .021$. Among the predictors, only the JAD category approached significance ($B = 4.746$, $p = .074$), suggesting a potential relationship at the 10% level. The overall low R^2 values reflect limited predictive power, highlighting the need to incorporate additional variables such as dietary practices, health access, and maternal characteristics in future models to explain variations in underweight status better.

5.2.2.3 Multiple Linear Regression Model on Association between Household Deprivation and Stunting (Height for Age) Among Tribal Children in Attappadi

The regression model examines the association between household deprivation and stunting (height-for-age) among tribal children under five in Attappadi. The dependent variable in this model is stunting, while the independent variable is household deprivation, categorised into moderately deprived (MD), just above deprivation (JAD), and well above deprivation (WAD). The model tries to uncover how various levels of household deprivation affect stunting in children. The model tries to uncover how various levels of household deprivation affect stunting in children.

$$ST_i = \beta_0 + \beta_1 md + \beta_2 jad + \beta_3 wad + \varepsilon_i$$

Where, β_0 – Constant term, $\beta_1 md$ – Moderate Deprivation, $\beta_2 jad$ – Just Above Deprivation, $\beta_3 wad$ – Well Above Deprivation, and ε_i – the Error term.

Table 5.8
Association between Household Deprivation and Stunting (Height for Age)
Among Tribal Children in Attappadi

Predictor	B	SE	t		p
(Intercept)	8.947	1.523	5.874		< .001***
MD	3.706	1.571	2.359		0.019*
JAD	4.327	1.544	2.802		0.005**
WAD	1.213	4.029	0.301		0.763
<i>Multiple R² = .01524, Adjusted R² = .01048</i>					

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression results show a significant association between household deprivation and stunting. The intercept is 8.947 (p < .001), indicating the expected stunting score for acutely deprived households. The coefficient for MD is 3.706 (p = .019), suggesting that children from moderately deprived households have significantly higher stunting levels compared to those from acutely deprived households. Likewise, the coefficient for JAD is 4.327 (p = .005), indicating that children from just above deprivation households also experience significantly higher stunting. However, the WAD category (B = 1.213, p = .763) does not show a statistically significant relationship with stunting, indicating that well-above-deprivation households do not differ significantly from acutely deprived households in this regard.

The Multiple R-squared value of the model is 0.015, and the Adjusted R-squared is 0.010, indicating that the household deprivation categories explain only about **1.5%** of the variance in stunting outcomes. While the model demonstrates statistically significant coefficients for MD and JAD, the overall explanatory power of the regression is low, suggesting that other unmeasured factors also contribute to chronic malnutrition among tribal children in this setting. These findings emphasise that stunting - an indicator of long-term nutritional deficiency - is significantly associated with moderate and marginal deprivation rather than acute or extreme deprivation alone. This pattern highlights the need for sustained nutritional and developmental interventions that reach beyond the poorest households and address

the needs of families hovering just above acute deprivation thresholds. Public health policies should integrate multi-dimensional strategies, including targeted food supplementation, maternal nutrition education, and improved access to essential services, to mitigate chronic undernutrition among tribal children in Attappadi.

5.2.3 Regression Model on Association Between Total Household Deprivation and Nutritious Status of Tribal Children in Attappadi

Malnutrition among tribal children remains a critical public health issue in tribal communities, particularly in underdeveloped regions like Attappadi. The socio-economic conditions of households play a significant role in determining the nutritional status of children. The present section shows the results of regression models that examine the association between Total Household Deprivation Score (THD) and three significant child indicators of malnutrition - wasting (weight-for-height), underweight (weight-for-age), and stunting (height for age). The Total Household Deprivation Score is constructed based on three dimensions of deprivation, namely economic, social, and living conditions. It is the independent variable, while child malnutrition indicators act as dependent variables. The analysis aims to understand how household deprivation influences the likelihood of malnutrition outcomes, providing valuable insights for targeted policy interventions in tribal areas.

5.2.3.1 Simple Linear Regression Model on Association between Total Household Deprivation and Wasted (Weight-for-height) Tribal Children in Attappadi

The simple linear regression model investigates the association between total household deprivation and wasting (weight-for-height) among tribal children in Attappadi. The dependent variable is wasting, measured by the weight-for-height z-score, while the independent variable is total household deprivation, which reflects the overall deprivation score of the household. The regression equation is:

$$WS_i = \beta_0 + \beta_1 THD + \varepsilon_i$$

Where, WS_i – Wasting (Weight-for-height) status of the child, β_0 – Constant term, $\beta_1 THD$ – Total Household Deprivation, and ε_i – Error term.

Table 5.9
Association between Total Household Deprivation and Wasted (Weight-for-height) Tribal Children in Attappadi

	Estimate	Std. Error	t value	p
(Intercept)	-0.5169	0.5195	-0.995	0.320
Total HD	0.4698	1.11E-01	4.224	< .001***
<i>Multiple R² = .02784, Adjusted R² = .03581</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression coefficient for total household deprivation is $B = 0.4698$, $SE = 0.111$, $t(398) = 4.224$, $p < .001$, indicating a statistically significant positive relationship. It suggests that as total household deprivation increases, wasting among children also increases. The intercept is -0.5169 , which is not statistically significant ($p = .320$), implying that the model does not reliably predict wasting when household deprivation is absent.

The model explains approximately 2.8% of the variance in wasting, as reflected in the Multiple $R^2 = .02784$ and the Adjusted $R^2 = .02628$, indicating a small effect size. Although the explained variance is limited, the significant association emphasises the importance of addressing household deprivation to combat acute malnutrition. These findings suggest that targeted interventions to reduce multi-dimensional household deprivation could contribute to lowering wasting rates and improving the short-term nutritional status of tribal children in Attappadi.

5.2.3.2 Simple Linear Regression Model on Association between Total Household Deprivation and Underweight (Weight-for-age) Tribal Children in Attappadi

Table 5.10 presents the simple linear regression model examining the association between total household deprivation and underweight (weight-for-age) among tribal children in Attappadi. The dependent variable in this model is underweight, while the independent variable is the total household deprivation score. The regression equation is specified as:

$$UW_i = \beta_0 + \beta_1 THD + \varepsilon_i$$

Where, UW_i – Underweight (Weight-for-age) status of the child, β_0 – Constant term, $\beta_1 THD$ – Total Household Deprivation, and ε_i – Error term.

Table 5.10
Association between Total Household Deprivation and Underweight (Weight-for-age) Tribal Children in Attappadi

	Estimate	Std. Error	t value	P
(Intercept)	6.6243	0.8637	7.67	< .001***
Total HD	0.8483	0.1849	4.587	< .001***
<i>Multiple R² = .03267, Adjusted R² = .03112</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression coefficient for total household deprivation is $B = 0.8483$, $SE = 0.1849$, $t(398) = 4.587$, $p < .001$, indicating a statistically significant and positive relationship. It suggests that for every one unit increase in household deprivation, the underweight score of a child increases by approximately 0.85 units. The intercept of 6.6243 is also statistically significant ($p < .001$), suggesting that the expected underweight score is approximately 6.62 in the absence of household deprivation.

The model explains 3.3% of the variance in underweight scores among tribal children (Multiple $R^2 = .03267$) and the Adjusted $R^2 = .03112$, reflecting a small but meaningful effect. Although the explained variance is modest, the statistically significant association reveals the relevance of household deprivation as a contributing factor to undernutrition. These findings emphasise the need for multisectoral interventions that address socio-economic deprivation to reduce the prevalence of underweight in tribal children. Improving household living standards through targeted development policies could serve as a critical step toward enhancing the nutritional outcomes of this vulnerable population.

5.2.3.3 Simple Linear Regression Model on Association between Total Household Deprivation and Stunting (Height for Age) Tribal Children in Attappadi

The association between total household deprivation and stunting (height for age) among tribal children in Attappadi has been analysed using a simple linear regression model. The dependent variable is stunting, which is categorised as

stunted or usual based on height-for-age indicators. The independent variable is total household deprivation, measured through the composite Household Deprivation Score (HDS).

$$ST_i = \beta_0 + \beta_1 THD + \varepsilon_i$$

here, ST_i – Stunting (Height for Age) status of the child, term, $\beta_1 THD$ – Total Household Deprivation, and ε_i – Error term.

Table 5.11
Association Between Household Deprivation and Stunting (Height for Age)
Among Tribal Children (0-59 Months) in Attappadi

	Estimate	Std. Error	t value	P
(Intercept)	11.3835	0.5043	22.575	< .001***
Total HD	0.3796	0.108	3.516	< .001***
<i>Multiple R² = .01945, Adjusted R² = .01788</i>				

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression coefficient for total household deprivation is $B = 0.3796$, $SE = 0.1080$, $t(398) = 3.516$, $p < .001$, indicating a statistically significant and positive relationship. It suggests that the stunting score is expected to rise by approximately 0.38 units for every one unit increase in household deprivation. The intercept is 11.3835 ($p < .001$), indicating that the predicted stunting score is approximately 11.38 without household deprivation.

The model explains 1.9% of the variance in stunting scores among tribal children (Multiple $R^2 = .01945$), with an Adjusted R^2 of .01788, indicating a small but statistically significant effect. Despite the modest proportion of variance explained, the results highlight that household deprivation is a significant predictor of stunting. The findings explain the importance of addressing multi-dimensional household disadvantages, such as inadequate income, poor housing, and limited access to basic amenities, to reduce stunting rates in tribal populations. Policymakers should prioritise improving the living conditions of deprived households to combat chronic undernutrition in Attappadi.

The results of the regression models emphasise the significant association between Total Household Deprivation Score (THD) and malnutrition indicators among tribal children in Attappadi. The findings reveal that household deprivation significantly contributes to the prevalence of wasting, underweight, and stunting among children below five years. The positive and statistically significant coefficients in the three models suggest that higher levels of deprivation are consistently associated with poorer nutritional outcomes. Wasting, an acute form of malnutrition, shows a strong positive relationship with household deprivation, indicating that children from highly deprived households are more vulnerable to short-term nutritional deficiencies. Conversely, being underweight, which is an indicator of both acute and chronic malnutrition, has a positive correlation with household deprivation, indicating the long-term effect of a poor environment on the weight status of the children. Stunting, an indicator of chronic malnutrition, has a robust positive correlation with household deprivation, indicating the long-term effect of poor socio-economic status and poor diet.

The study reveals that it is imperative to tackle household deprivation to improve the nutritional well-being of Attappadi tribal children. Targeted interventions to enable access to food, healthcare, sanitation, and education are the need of the hour to break the vicious cycle of malnutrition among such children. Integrated interventions merging poverty alleviation programs, nutrition support programs, and community-based healthcare programs are necessary to reverse the ill effects of household deprivation on the health of children. The study points to the urgent need for comprehensive policies that address the underlying socio-economic determinants of malnutrition, paving the way for sustainable improvements in the well-being of tribal children in Attappadi.

5.3 Conclusion

The analysis in this chapter highlights the crucial influence of household deprivation on the nutritional outcomes of tribal children in Attappadi. Many children reside in households facing multiple economic, social, and environmental deprivations. Wasting showed the strongest association with deprivation ($V = 0.471$ of Cramer), while underweight and overall distribution showed moderate

associations ($V = 0.200$ of Cramer). Stunting had a weaker but significant link ($V = 0.102$ of Cramer). No significant association was found with the presence of feeding mothers. Regression results confirm that higher household deprivation significantly predicts poorer nutritional outcomes. Acute malnutrition reflects immediate deprivation, while stunting indicates long-term socio-economic disadvantage. The findings show the need for a multi-dimensional approach combining poverty alleviation, nutritional schemes, and community-based interventions. Expanding access to food, healthcare, sanitation, and education, along with strengthening social safety nets, is essential to combat malnutrition and uplift the health and well-being of tribal children in Attappadi.

CHAPTER 6

ASSOCIATION BETWEEN NUTRITIONAL STATUS AND NUTRITIONAL FACTORS

6.1 Introduction

The nutritional status of children is intricately linked to a range of dietary and health related factors, especially in vulnerable communities like tribal populations. This chapter examines the association between nutritional status, measured in terms of stunting, wasting, and underweight, and various nutritional factors among tribal children aged 0–59 months in Attappadi, Kerala. Factors such as breastfeeding practices, dietary diversity, meal frequency, and maternal nutrition are considered to understand their influence on child growth outcomes. Identifying these associations is essential for formulating effective, culturally relevant interventions to reduce malnutrition in tribal communities.

6.2 Eating Habits of Tribal Children in Attappadi

Dietary habits of Children are central to their development, growth, and health. Proper nutrition during childhood is essential for brain development and immune function and for averting malnutrition complications such as stunting, wasting, and underweight. Evaluating the dietary intake of children gives them essential nutritional information and identifies possible deficiencies or imbalances. Detailed analysis of what children are eating, such as a variety of foods and nutrient consumption, is crucial to interpret their effect on the health outcomes of children. The 24-hour dietary recall and seven-day food frequency questionnaire efficiently measure dietary intake and food selection. The study aims to determine significant deficiencies in the diets of children by comparing their diet intake to accepted nutritional guidelines and suggesting ways of improving their diet.

Eating habits were assessed through a face to face interview with each participant using a questionnaire. A 24-hour dietary recall on all food and beverages consumed by the child the day before the survey, from waking up to bedtime, was collected. The quantities of food consumed were measured using a weighing scale.

Table 6.1
Indian Food Groups

Sl. No.	Food groups	Food Items
1	Cereals and Millets	Rice, wheat, millet and other cereals, etc.
2	Pulses/nuts	Lentils, green gram, chickpeas, rajma, cowpea, etc.
3	Vegetables	Seasonal vegetables
4	Nuts, oil seeds, Oils and fats	Peanuts, walnuts, almonds, pistachios, hazelnuts, other nuts, vegetable oils, etc.
5	Green leafy vegetables (GLV)	Seasonal GLV
6	Fruits	Seasonal fruits
7	Dairy	Milk, curd and butter milk
8	Roots and tubers	Beetroot, radish, carrot, tapioca, potato, etc.
9	Flesh food items	Marine fish, poultry and lean cut meat
10	Spices & Herbs	Turmeric, ginger, mustard, cumin, coriander, etc.

Source: ICMR - NIN. (2024). Dietary guidelines for Indians (p. 5). Hyderabad.

6.2.1 Prevalence of Deficiency in Daily Intake of Various Food Groups (g/day) by Tribal Children in Attappadi

Table 6.2 examines the prevalence of deficiency in the daily intake of various food groups among tribal children in Attappadi across three age groups: <12 months, 12 - 35 months, and >35 months. The table compares the intake with the Recommended Dietary Intake (RDI) to assess the nutritional adequacy of these diets for children. This analysis helps identify critical gaps in dietary intake and informs targeted nutritional interventions.

Table 6.2
Prevalence of Deficiency in Daily Intake of Various Food Groups (g/day) by Tribal Children in Attappadi

Food Groups	<12 Months	12 - 35 Months	>35 Months
	RDI Deficiency %	RDI Deficiency %	RDI Deficiency %
Cereals & Millets (g)	5.6	41.8	25.2
Pluses (g)	50	80.2	81
Vegetables (g)	94.8	84.2	91
Nuts & Oils seeds (g)	91.4	95.3	93
Green Leafy Vegetables (g)	99	97.6	98.6
Fruits (g)	98.8	97.3	97.3
Dairy (ml)	87.5	87.1	89.5
Roots & Tubers (g)	3	11.2	40.2
Fats & Oils (g)	99	99.5	99.5

Source: Primary Data

Very severe deficit (>50%)	Severe deficit (30 to 50%)	Moderate deficit (10 - 29%)	Marginal deficit (<10%)	No deficit (≥RDA)
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Table 6.2 indicates severe deficiencies in the intake of micronutrient rich foods such as green leafy vegetables (97.6% - 98.6%), fruits (97.3% - 98.8%), and fats and oils (99% - 99.5%) across all age groups. Pulses also exhibit a significant deficiency (80.2% - 81%), limiting protein intake. However, cereals and millets show comparatively lower deficiency, with only 5.6% of children under 12 months having inadequate intake, though this increases to 41.8% and 25.2% in older groups. Similarly, root and tuber intake is relatively better in the youngest group (3% deficiency) but worsens with age. Milk and milk product intake deficiencies remain consistently high (87.1% and 89.5%). These findings highlight an urgent call for diversification of diets and increasing access to nutrient dense foods, particularly among older children, to prevent malnutrition and maximise growth.

6.2.2. Prevalence of Deficiency in Daily Intake of Various Nutrients by Tribal Children in Attappadi

Table 6.3 examines the prevalence of different nutrient deficiencies among tribal children between 0 and 59 months living in Attappadi and categorised into three age groups (<12 months, 12 - 35 months, and >35 months). The table identifies

gaps in the required nutrients compared to the Recommended Dietary Allowance (RDA), reflecting significant food consumption gaps critical for healthy growth and development.

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Table 6.3
Prevalence of Deficiency in Daily Intake of Various Nutrients by Tribal Children in Attappadi

Nutrients	<12 Months	12 - 35 Months	>35 Months
	Deficiency %	Deficiency %	Deficiency %
Protein(g)	7.6	-	-
Calcium(mg)	93.4	90.9	89.0
Iron(mg)	78.3	58.75	57.1
Fat(g)	48.0	70.5	60.5
Energy(Kcal)	69.1	60.9	55.3
Vitamin-A(μg)	97.2	95.1	94.6
Thiamin(mg)	50	57.1	55.6
Riboflavin(mg)	83.3	90.9	92.3
Niacin(mg)	72	68.6	65.6
Vitamin C(mg)	92	80.7	79.1
TotalFolate(μg)	70.2	67.1	58.7
Zinc(mg)	80	72.7	71.1

Source: Primary Data

Very severedeficit(>50%)	Severedeficit (30to 50%)	Moderatedef icit(10 - 29%)	Marginaldefici t(<10%)	No deficit(≥RDA)
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Table 6.3 reveals a high prevalence of deficiencies in key micronutrients among tribal children in Attappadi. Vitamin A deficiency is still of grave concern across all age groups, with 97.2% of children under 12 months and more than 94% in older age groups not achieving the RDA. Calcium deficiency is no less severe (89.0% - 93.4%), adversely affecting bone health and development. Energy deficiency remains high, affecting 69.1% of infants and declining with age (55.3% in >35 months). Fat deficiency is also prominent (48.0% - 70.5%), which may impact cognitive development. Deficiencies in riboflavin (83.3% - 92.3%), zinc (71.1% - 80%), and iron (57.1% - 78.3%) are also a cause of concern, which is likely to result in anaemia and compromised immunity. While protein deficiency is relatively low (7.6%) among infants and zero among older age groups, deficiency in thiamin, niacin, and Folate is still a cause of concern, and severity decreases as age advances. The above findings emphasise the urgent need for nutrition focused interventions to address micronutrient deficiencies, particularly vitamin A, calcium, and iron, to improve the health outcomes of tribal children.

6.3 Child Food Consumption Score (CFCS)

The Child Food Consumption Score (CFCS) is a frequency weighted diet diversity score used to assess the food security of children based on dietary diversity, food frequency, and the nutritional significance of different food groups. It is a composite indicator widely used by the World Food Program (WFP) and its partners to measure food security at the household level. The CFCS is determined using a seven day recall of food consumption, capturing the frequency of consumption of nine food groups by the child. Each food group is assigned a standard weight based on nutrient density and energy value. The CFCS is computed using the following formula.

$$CFCS = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8 + a_9X_9$$

Where 'X' represents the number of days a particular food group was consumed in the past week (7 days), and 'a' is the weight assigned to that food group. The total CFCS is a continuous variable ranging from 0 to 112 and is classified into three categories: Low food consumption (CFCS 0-37.3), Limited food consumption (CFCS 37.4 - 75), and Acceptable food consumption (CFCS >75). The CFCS

evaluates household food security by evaluating dietary quantity and quality, allowing policymakers and organisations to create successful nutrition interventions. The weight given for each food group is given below.

Table 6.4
Indian Food Groups with Weightage

Sl. No.	Food groups	Food Items	Weightage
1	Cereals and Millets	Rice, wheat, millet and other cereals, etc.	1
2	Pulses	Lentils, green gram, chickpeas, rajma, cowpea, etc.	1
3	Vegetables and GLV	Seasonal vegetables	1
4	Nuts	Peanuts, walnuts, almonds, pistachios, hazelnuts, and other nuts	3
5	Oils and fats	Oils, butter, etc.	0.5
6	Fruits	Seasonal fruits	1
7	Dairy	Milk, curd and butter milk	4
8	Roots and tubers	Beetroot, radish, carrot, tapioca, potato, etc.	1
9	Flesh food items	Marine fish, poultry and lean cut meat	4
10	Spices & Herbs	Turmeric, ginger, mustard, cumin, coriander, etc.	0.5

Source: Adapted from <https://doi.org/10.1155/2022/1431743>

The CFCS is categorised into low, moderate, and high. Unfortunately, no children are in the high consumption category within the sample. Therefore, the present study was reduced to two categories: low consumption and moderate consumption.

6.3.1 The Association Between Child Food Consumption Score (CFCS) and Nutrition Status of Tribal Children in Attappadi

The Child Food Consumption Score (CFCS) is crucial for assessing dietary diversity and food security among tribal children (Fungo et al., 2023). An analysis of the occurrence of CFCS across various tribal groups in Attappadi reveals the nutritional deficit in the region. The following section explains the connection between CFCS and the leading nutritional indicators, i.e., wasting, underweight, and stunting. Following an assessment of these trends, the study determines the

impact of low food intake on malnutrition among children and highlights the importance of targeted nutritional interventions. Hypothesis for the chi-square test to show the relationship between Child Food Consumption Score (CFCS) and nutrition status of tribal children in Attappadi is given below.

- Null Hypothesis (H_0): There is no significant association between the nutrition status of children in Attappadi and their Child Food Consumption Score (CFCS).
- Alternative hypothesis (H_1): There is a significant association between the nutrition status of children in Attappadi and their Child Food Consumption Score (CFCS).

A Chi-square s test was conducted to assess the relationship between the nutrition status of children and their CFCS.

Hypothesis Test Results:

6.3.1.1 Distribution of Tribal Children in Attappadi by CFCS

The Child Food Consumption Score (CFCS) is a useful measure to determine the dietary consumption pattern, food diversity intake, and food security status of children. CFCS distribution analysis among Attappadi tribal children helps reveal nutritional inequalities among tribal communities. Table 6.6 shows the distribution of CFCS among the Irula, Kurumba, and Muduga tribes, showcasing the variation in food consumption patterns. A Chi-square test assessed the relationship between the tribal group affiliation and food consumption patterns (CFCS). The null hypothesis Null Hypothesis (H_0) stated that there is no significant association between the two variables, while the alternative hypothesis (H_1) suggested a significant association.

The Chi-square test results ($\chi^2 = 28.566$, $df = 2$, Cramer V = 0.214, $p = 0.000$) indicate a statistically significant association between tribe and CFCS category. The rejection of H_0 suggests that tribal group affiliation influences food consumption patterns, with the Kurumba and Muduga tribes having a higher proportion of children in the low CFCS category. Table 6.6 shows the relationship between Child Food Consumption Score (CFCS) and tribal group affiliation among tribal children

in Attappadi.

Table 6.5
Distribution of Tribal Children in Attappadi by CFCS

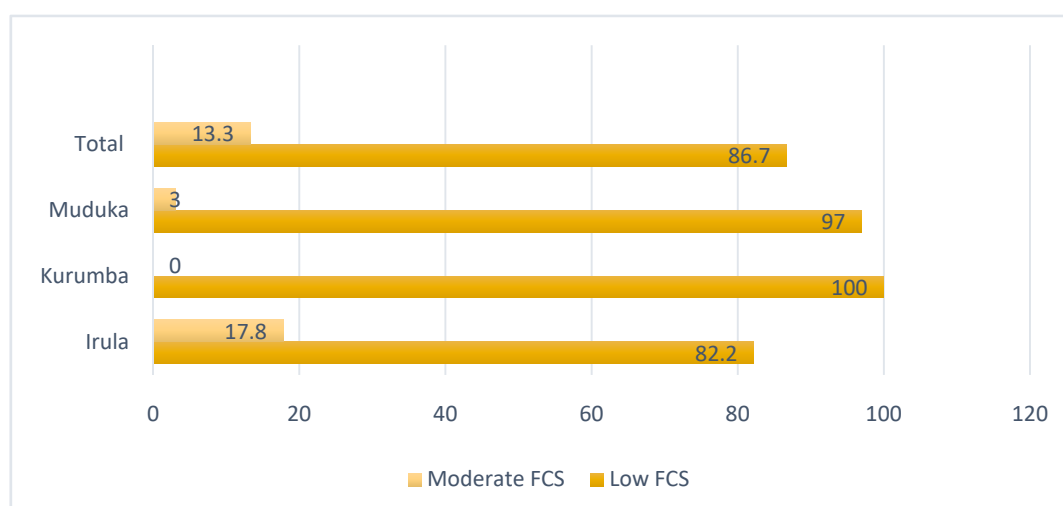
CFCS Category	Tribe			Total
	Irula	Kurumba	Muduga	
Low	370 (82.2)	75 (100)	97 (97.0)	542 (86.7)
Moderate	80 (17.8)	0 (0)	3 (3.0)	83 (13.3)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2 = 28.566 \cdot df = 2 \cdot \text{Cramer } V = 0.214 \cdot p = 0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.5 reveals a significant disparity in food consumption among tribal children in Attappadi, with 86.7% of children falling into the low food consumption category. The Kurumba community is the most affected, as 100% of its children have low dietary diversity, followed by 97% of Muduga children and 82.2% of Irula children. Merely 13.3% of children possess a moderate Child Food Consumption Score (CFCS), with no representation from the Kurumba tribe. It is also depicted in Figure 6.1.

Figure 6.1
Distribution of Tribal Children in Attappadi by CFCS



Source: Primary data

These communities are in danger of malnutrition, stunting, and ill health due to acute food shortages and poor diets. Socio-economic restrictions, geographical

isolation, and limited access to nutrient rich diets cause this difference. These issues require targeted nutrition initiatives, better food assistance, and culturally appropriate diets. Community-based nutrition education, food distribution, and sustainable agriculture can improve the diets of Attappadi tribal children.

6.3.1.2 Distribution of Wasted (Weight-for-height) Tribal Children in Attappadi by CFCS

Child Food Consumption Score (CFCS) is a key indicator of dietary diversity and food security, reflecting food intake frequency and nutritional quality. Analysing the association with wasting (weight-for-height) among tribal children in Attappadi helps identify the impact of poor dietary intake on malnutrition and informs targeted nutrition interventions. A Chi-square test was conducted to assess the relationship between the nutrition status of children (wasting) and their CFCS. For wasting, the Chi-square test yielded $\chi^2 = 25.714$, $df = 2$, Cramer V = 0.203, and Fisher's p-value = 0.000. It indicates a statistically significant relationship between wasting and the CFCS category, leading to rejection of the null hypothesis (H_0). Children with low CFCS scores exhibit higher rates of wasting. Table 6.7 shows the relationship between Child Food Consumption Score (CFCS) and wasting (weight-for-height) among tribal children in Attappadi.

Table 6.6
Distribution of Wasted Tribal Children in Attappadi by CFCS

CFCS Category	Wasting (Weight-for-height)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
Low	27 (100)	322 (81.5)	193 (95.1)	542 (86.7)
Moderate	0 (0)	73 (18.5)	10 (4.9)	83 (13.3)
Total	27 (100)	395 (100)	203 (100)	625 (100)
$\chi^2 = 25.714 \cdot df = 2 \cdot \text{Cramer } V = 0.203 \cdot \text{Fisher } P = 0.000$				

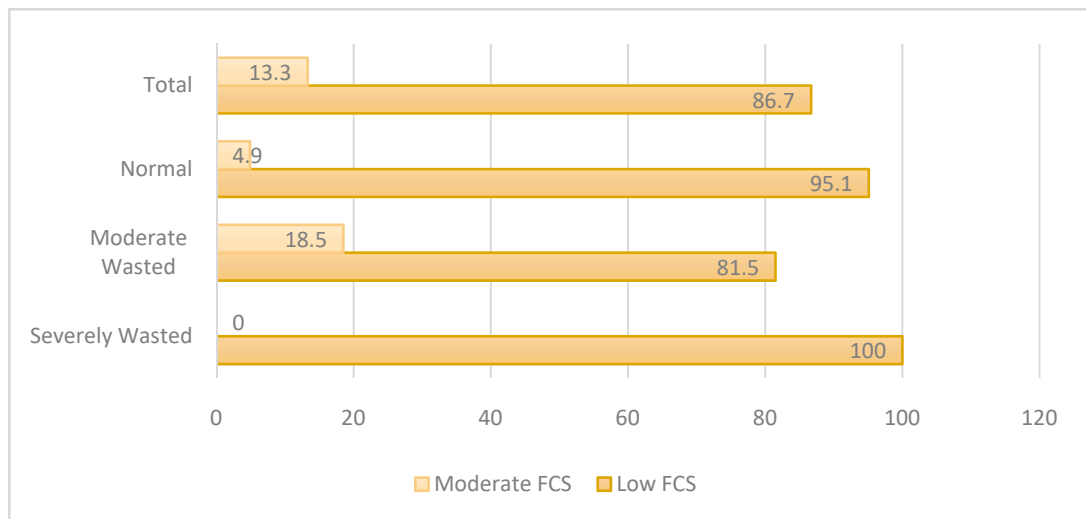
Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.6 shows that 86.7% of children fall into the low food consumption category, with a higher prevalence of malnutrition among this group. Among children with low CFCS, 100% are severely wasted, 95.1% are standard, and 81.5% of moderately wasted children belong to this category. In contrast, only 13.3% of children have moderate CFCS; 18.5% are moderately wasted, 4.9% are

standard, and none are severely wasted. It is also depicted in Figure 6.2.

Figure 6.2
Distribution of Wasted Tribal Children in Attappadi by CFCS



Source: Primary data

These results stress the strong association between poor dietary intake and malnutrition. More decisive community-based interventions, nutrient dense food accessibility, and government supported feeding programs can reduce waste and enhance child health in Attappadi.

6.3.1.3 Distribution of Underweight (Weight-for-age) Tribal Children in Attappadi by CFCS

The table presents the distribution of underweight tribal children aged 0-59 months in Attappadi based on the Child Food Consumption Score (CFCS). The CFCS categories are divided into low and moderate levels, with the nutritional status of children classified as severe malnutrition, moderate malnutrition, or normal based on weight-for-age criteria. A Chi-square test was conducted to assess the relationship between the nutrition status of children (wasting) and their CFCS.

The Chi-square test results for underweight status and CFCS yielded $\chi^2 = 33.737$, $df = 2$, Cramer V = 0.232, and Fisher's p-value = 0.000. The findings confirm a strong association, rejecting the null hypothesis (H_0). Underweight prevalence is significantly higher among children with low CFCS scores. Table 6.8 shows the relationship between Child Food Consumption Score (CFCS) and underweight (weight-for-age) among tribal children in Attappadi.

Table 6.7
Distribution of Underweight Tribal Children in Attappadi by CFCS

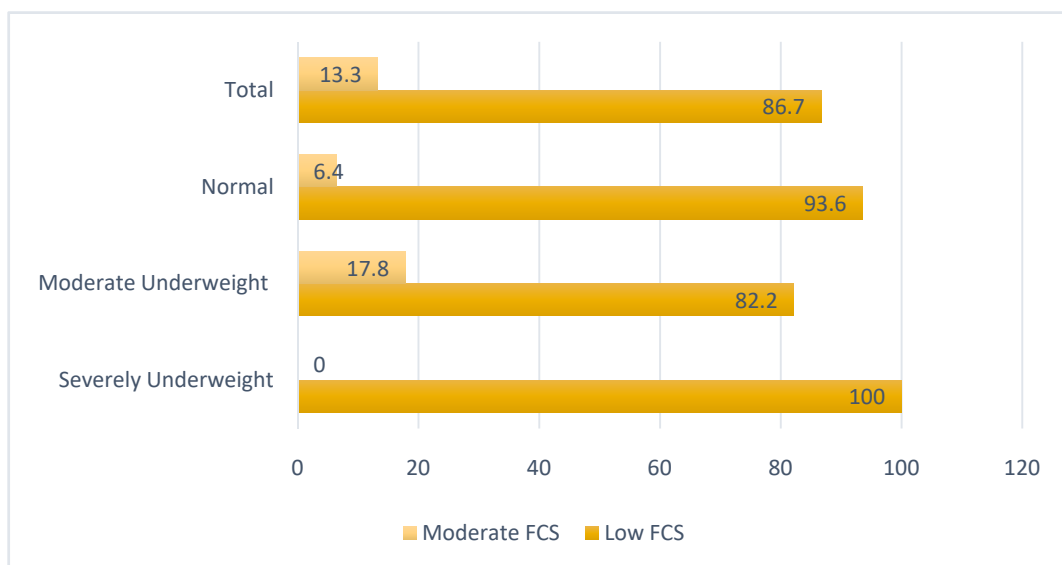
CFCS Category	Underweight (Weight-for-age)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
Low	30 (100)	323 (82.2)	189 (93.6)	542 (86.7)
Moderate	0 (0)	70 (17.8)	13 (6.4)	83 (13.3)
Total	30 (100)	393 (100)	202 (100)	625 (100)
$\chi^2=33.737 \cdot df = 2 \cdot \text{Cramer } V = 0.232 \cdot \text{Fisher } P = 0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.7 shows that malnutrition is more prevalent among children with low CFCS. All children (100%) experiencing severe malnutrition belonged to the low CFCS category. Additionally, 82.2% of those with moderate malnutrition and 93.6% of children with normal nutritional status were also in the low CFCS group. Conversely, no cases of severe malnutrition were reported among children with moderate CFCS. Among this group, 17.8% experienced moderate malnutrition, while 6.4% had a normal nutritional status. The data suggest that while a low CFCS is linked to higher malnutrition rates, some children with low CFCS still maintain normal nutritional status, emphasising the complex relationship between dietary patterns and malnutrition. It is also depicted in Figure 6.3.

Figure 6.3
Distribution of Underweight Tribal Children in Attappadi by CFCS



Source: Primary data

6.3.1.4 Distribution of Stunted Tribal Children in Attappadi By CFCS

The Child Food Consumption Score (CFCS) is an essential measure of dietary diversity and food security, providing insights into the reasons for stunting among tribal children. Analysing the association between CFCS and stunting (height-for-age) among tribal children in Attappadi helps assess the impact of CFCS on long-term growth and development. A Chi-square test was conducted to assess the relationship between the nutrition status of children (stunting) and their CFCS.

The Chi-square test for stunting and CFCS resulted in $\chi^2 = 15.963$, $df = 2$, Cramer $V = 0.160$, and $p = 0.000$. The statistically significant result leads to rejection of H_0 , suggesting that stunting is more prevalent in children with lower CFCS scores. Table 6.8 shows the relationship between the Child Food Consumption Score (CFCS) and stunting (height-for-age) among tribal children in Attappadi.

Table 6.8
Distribution of Stunted Tribal Children in Attappadi by CFCS

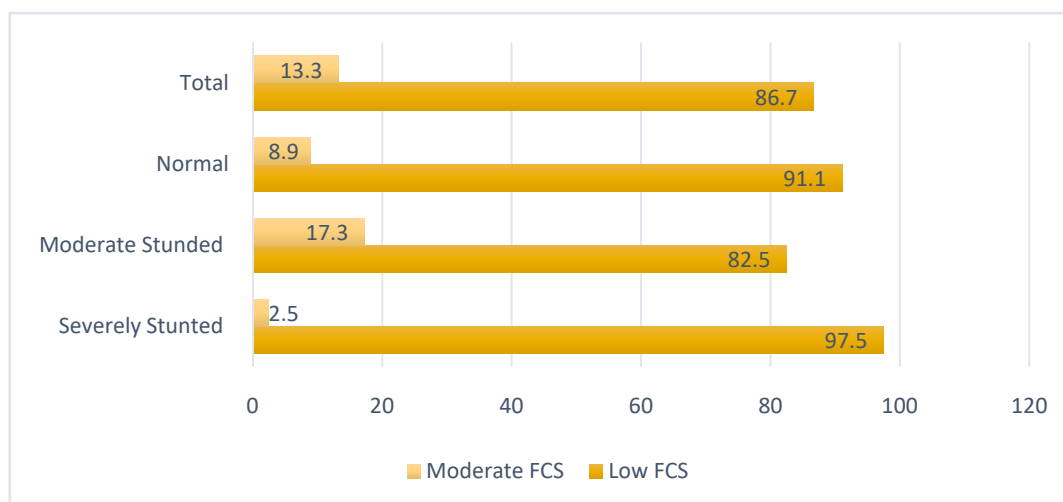
CFCS Category	Stunting (Height-for-age)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
low	77 (97.5)	321 (82.7)	144 (91.1)	542 (86.7)
Moderate	2 (2.5)	67 (17.3)	14 (8.9)	83 (13.3)
Total	79 (100)	388 (100)	158 (100)	625 (100)
$\chi^2 = 15.963 \cdot df = 2 \cdot \text{Cramer } V = 0.160 \cdot \text{Fisher } P = 0.000$				

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.8 presents that among children in the low FCS category (86.7%), 97.5% suffer from severe stunting, 82.7% from moderate stunting, and 91.1% are classified as normal height. Only 2.5% of mild FCS (13.3%) have severe stunting, 17.3% moderate, and 8.9% average height. Stunting increases with less nutritional diversity, stressing the need for better nutrition. Nutrition sensitive policy, dietary diversity, and food security can reduce stunting in Attappadi tribal children. It is also depicted in Figure 6.4.

Figure 6.4
Distribution of Stunted Tribal Children in Attappadi by CFCS



Source: Primary data

6.3.1.5 Distribution of Tribal Children in Attappadi Based on CFCS and Presence of Breastfeeding Mothers

The Child Food Consumption Score (CFCS) serves as a critical measure of dietary diversity and food security, reflecting the nutritional status of households. Analysing the association between CFCS and the presence of feeding mothers among tribal children in Attappadi helps assess the influence of maternal presence on dietary diversity and food security. A Cs test was conducted to examine the relationship between the Child Food Consumption Score (CFCS) and the presence of breastfeeding mothers. The test yielded a Chi-square value (χ^2) of 0.644 with 1 degree of freedom (df = 1). The effect size, measured in terms of P (ϕ), was found to be 0.038, indicating a weak relationship between the two variables. Interestingly, the p-value was at 0.422, which fails to reach ss at the 5% level ($p > 0.05$). Since the p-value exceeds 0.05, we fail to reject the null hypothesis (H_0), confirming no significant association between the CFCS and the presence of breastfeeding mothers among tribal children in Attappadi. It suggests that breastfeeding status does not significantly impact the food consumption score. Table 6.9 presents the association between the Child Food Consumption Score (CFCS) and the presence of feeding mothers among tribal children in Attappadi.

Table 6.9
Distribution of Tribal Children in Attappadi by CFCS and Presence of Breastfeeding Mothers

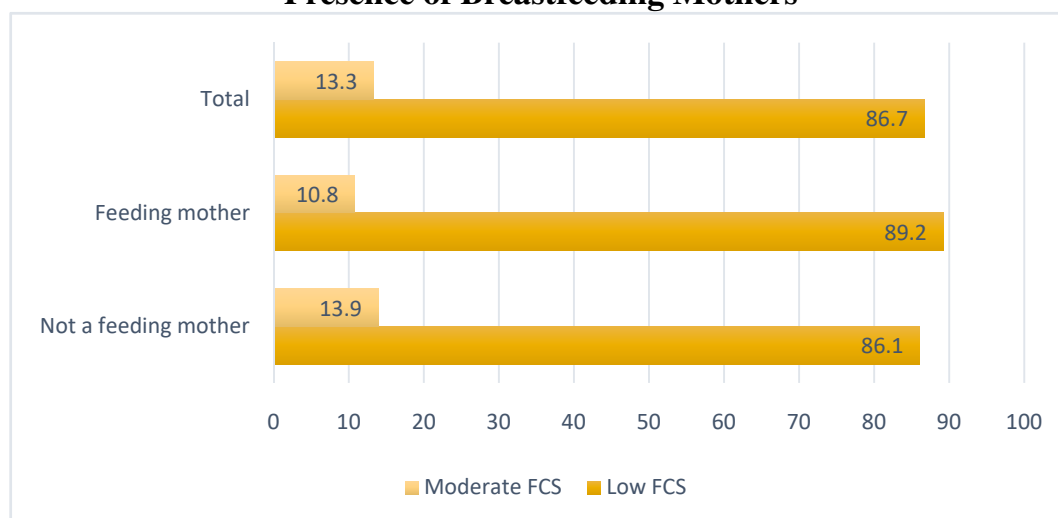
CFCS Category	Feeding mother		
	No	Yes	Total
Low	426 (86.1)	116 (89.2)	542 (86.7)
Moderate	69 (13.9)	14 (10.8)	83 (13.3)
Total	495 (100)	130 (100)	625 (100)
$\chi^2 = 0.644 \cdot df = 1 \cdot \varphi = 0.038 \cdot p = 0.422$			

Note: Figures in brackets indicate percentages.

Source: Primary Data

The table shows that among households in the low CFCS category (86.7%), 86.1% do not have a feeding mother present, while 89.2% have one. In contrast, within the moderate CFCS category (13.3%), 13.9% lack a feeding mother, and 10.8% have one. A larger number of feeding mothers in households with lower CFCS suggests food insecurity despite their presence. Attappadi needs more nutritional interventions, maternal support programs, and food security activities to increase dietary diversity and child nutrition. It is also depicted in Figure 6.5.

Figure 6.5
Distribution of Tribal Children in Attappadi by CFCS and Presence of Breastfeeding Mothers



Source: Primary data

Chi-square tests indicating the relationship of the Child Food Consumption Score (CFCS) with key nutritional indicators among Attappadi tribal children show a highly significant relationship between CFCS with tribal groups ($p = 0.000$), wasting ($p = 0.000$), underweight ($p = 0.000$), and stunting ($p = 0.000$) indicating

children with low dietary diversity are at risk of malnutrition. Children who were severely wasted, underweight, and stunted were mainly in the low CFCS group, indicating the role of poor food consumption in malnutrition. Kurumba and Muduga children contained fewer CFCS than Irula children, which indicates tribal inequality in food diversity. No association of CFCS with the availability of breastfeeding women ($p = 0.422$) was found, indicating that complementary feeding and food quality are important determinants of child nutrition. The findings reinforce the call for focused nutritional food security and diversity interventions.

6.3.2 Regression Model on Association Between Child Food Consumption Score (CFCS) and Nutritious Status

The simple linear regression model is applied to examine the association between the Child Food Consumption Score (CFCS) and the nutritional status of tribal children in Attappadi. The CFCS, a diversity and frequency measure of food consumption, is the independent variable. In contrast, measures of child malnutrition, such as wasting, underweight, and stunting, are assumed to be dependent variables. The BMI of the mothers is also examined to determine the nutritional effect on the mother. The model helps to assess how varying levels of food consumption influence child nutrition, providing critical insights into the role of dietary diversity in combating malnutrition among tribal communities.

6.3.2.1 Simple Linear Regression Model on Association Between CFCS and Wasting (Weight-For-Height) Among Tribal Children in Attappadi

The simple linear regression model has been applied to analyse the association between the Child Food Consumption Score (CFCS) and wasting (weight-for-height) among tribal children in Attappadi. The CFCS has been categorised into two levels: low consumption and moderate consumption. The dependent variable in the model is wasting (weight-for-height), while the independent variable is the CFCS, with low consumption serving as the baseline category. The regression equation is:

$$WS_i = \beta_0 + \beta_1 mcfcs + \varepsilon_i$$

Where, WS_i – Wasting (Weight-for-height) status of the child, β_0 – Constant term, $\beta_1 mcfcs$ – Moderate Child Food Consumption Score and ε_i – Error term.

Table 6.10
Association Between CFCS and Wasting (Weight-For-Height)

Among Tribal Children in Attappadi

CFCS	B	SE	t	p
(Intercept)	1.2523	0.2346	5.338	< .001***
Moderate Consumption	1.6958	0.6437	2.634	0.009**

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.10 reveals that the intercept value is 1.2523, showing the baseline level of wasting among children with low CFCS. The regression coefficient of moderate CFCS consumption is 1.6958, statistically significant at the 1% level (p = 0.00864). This positive association suggests that children with moderate CFCS consumption have a higher wasting rate than those with low CFCS consumption. The result reveals the vulnerability of tribal children to wasting, even with moderate food consumption, pointing towards the need for improving the dietary intake quantity and quality among tribal households. Strengthening food security programs and nutritional interventions may help to enhance dietary diversity and combat wasting among tribal children in Attappadi.

6.3.2.2 Simple Linear Regression Model on Association Between CFCS and Underweight (Weight-for-age) Tribal Children in Attappadi

The association between the Child Food Consumption Score (CFCS) and underweight (weight-for-age) among tribal children in Attappadi is analysed through a simple linear regression model. Underweight, measured using the weight-for-age index, is the dependent variable, while CFCS categories (low consumption and moderate consumption) are independent variables. The baseline category is low consumption, compared with the moderate consumption category. The regression equation is:

$$UW_i = \beta_0 + \beta_1 mcfcs + \varepsilon_i$$

Where, UW_i – Underweight (weight-for-age) status of the child, β_0 – Constant term, $\beta_1 mcfcs$ – Moderate Child Food Consumption Score, and ε_i – Error term.

Table 6.11
Association Between CFCS and Underweight (Weight-for-age) Tribal Children in Attappadi

CFCS	B	SE	t	p
(Intercept)	9.6439	0.3879	24.859	< .001***
Moderate Consumption	4.3771	1.0645	4.112	< .001***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.11 shows the simple linear regression model on the association between CFCS and underweight among tribal children. The regression equation indicates that the intercept value is 9.6439, representing the expected weight-for-age index when the CFCS category is low consumption. The moderate consumption category has a positive and statistically significant effect on underweight, with an estimated coefficient of 4.3771 ($p < 0.001$). This result suggests that children with moderate food consumption have a better nutritional outcome than those with low food consumption. The result shows the importance of improving the pattern of food consumption to reduce underweight prevalence among tribal children. Strengthening food security and dietary diversity programs can be a key strategy to enhance the nutritional well-being of tribal children in Attappadi.

6.3.2.3 Simple Linear Regression Model on Association Between CFCS and Stunting (Height-for-Age) Among Tribal Children in Attappadi

The association between the Child Food Consumption Score (CFCS) and stunting (height-for-age) among tribal children in Attappadi is analysed in the model. The dependent variable is stunting (height-for-age), and the independent variable is CFCS, categorised into low and moderate consumption. The baseline category is low consumption. The regression equation is:

$$ST_i = \beta_0 + \beta_1 mcfcs + \varepsilon_i$$

Where, ST_i – Stunting (height-for-age) status of the child β_0 – Constant term, $\beta_1 mcfcs$ – Moderate Child Food Consumption Score and ε_i – Error term.

Table 6.12
Association Between CFCS and Stunting (Height-for-age)
Among Tribal Children in Attappadi

CFCS	B	SE	t	p
(Intercept)	12.5433	0.2225	56.368	< .001***
Moderate Consumption	3.3996	0.6106	5.567	< .001***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The results in Table 6.12 indicate that moderate consumption significantly influences stunting among tribal children. The intercept value ($\beta = 12.5433$, $p < 0.001$) represents the expected height-for-age score when the CFCS is at its baseline category (low consumption). The regression coefficient for moderate consumption is positive ($\beta = 3.3996$, $p < 0.001$), showing that children with moderate food consumption have a higher height-for-age score than those with low consumption. This result implies that an improvement in dietary diversity through moderate food consumption positively affects the height-for-age status of tribal children. Therefore, promoting diversified and adequate food consumption is essential in mitigating stunting among tribal children in Attappadi.

6.3.2.4 Simple Linear Regression Model on Association Between CFCS and BMI of Mothers of Tribal Children in Attappadi

The association between the Child Food Consumption Score (CFCS) and the Body Mass Index (BMI) of mothers of tribal children in Attappadi is analysed using a simple linear regression model. The BMI of mothers is the dependent variable, while the CFCS categories serve as the independent variable. The low consumption category is taken as the baseline for comparison.

$$BMIm_i = \beta_0 + \beta_1 mcfcs + \varepsilon_i$$

Where, $BMIm_i$ – Body Mass Index (BMI) status of mothers of tribal children, β_0 – Constant term, $\beta_1 mcfcs$ – Moderate Child Food Consumption Score and ε_i – Error term.

Table 6.13
Association Between CFCS and BMI of Mothers of
Tribal Children in Attappadi

CFCS	B	SE	t	p
(Intercept)	15.482	0.2499	61.956	< .001***
Consumption Moderate	1.6581	0.6857	2.418	0.0159 *

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.13 presents the regression results showing that moderate food consumption statistically significantly influences maternal Body Mass Index (BMI). The regression coefficient for moderate consumption is 1.6581, indicating that mothers in the moderate consumption category have a higher BMI than those in the low consumption group. The p-value of 0.0159 confirms that this association is statistically significant at 5% level. These findings emphasise the importance of dietary diversity in enhancing maternal nutritional status. Promoting diversified food intake through targeted nutritional interventions may improve maternal BMI and overall health, improving child feeding practices and outcomes.

The chi-square test results reveal the relationship between the Child Food Consumption Score (CFCS) and malnutrition among tribal children in Attappadi. Poor food consumption scores exhibited higher rates of wasting, underweight, and stunting among tribal children in Attappadi. It suggests that inadequate and monotonous diets are key contributors to undernutrition. Disparities in patterns of food consumption across tribal groups further highlight the need for targeted and culturally appropriate nutrition programs to improve dietary diversity and ensure food security.

The simple linear regression analysis confirms an association between CFCS and child nutritional status. Children with moderate CFCS demonstrated improved outcomes concerning underweight and stunting when compared to those with low CFCS. However, the positive association between moderate CFCS and wasting suggests that dietary intake alone may be insufficient to prevent acute malnutrition,

emphasising the need for improved food quality, not just quantity or frequency. The link between CFCS and maternal BMI illustrates the interconnection between maternal nutrition and child well-being. Improving the dietary diversity of mothers can have a cascading effect on the nutritional outcomes of children.

In summary, these findings emphasise the central role of food consumption patterns in determining maternal and child nutritional well-being in tribal communities. Implementing effective food security programs that promote balanced and diverse diets and integrating nutrition education initiatives are important to address malnutrition. Strengthening these interventions will substantially enhance health outcomes among the tribal population in Attappadi, ensuring long-term improvements in maternal and child nutrition.

6.4 Child Dietary Diversity Score (CDDS)

The child Dietary Diversity Score (CDDS) indicates the quality of diet and nutritional adequacy of children. It highlights child dietary diversity, considering the variety of food groups consumed over the past 24 hours. The present study uses a 24-hour recall method, where food consumption is categorised into ten food groups given by the ICMR-National Institute of Nutrition (NIN) dietary guidelines for Indians. Each food group gets a score of 1 (if consumed in the past 24 hours) or zero if not consumed in the past 24 hours of data collection.

$$\text{CDDS} = A + B + C + D + E + F + G + H + I + J$$

The score of a child will be 0 to 10, which is the total number of food groups the child consumes. Children are then classified into three categories: Poor Dietary Diversity (CDDS 0-3), Moderate Dietary Diversity (CDDS 4-6), and High Dietary Diversity (CDDS 7-10). Higher CDDS values indicate better diet quality and improved micronutrient intake (Ruel, 2003 & Kennedy et al., 2011).

CDDS is structured similarly to the Household Dietary Diversity Score (HDDS), incorporating the consumption of 10 food groups. The Household Dietary Diversity Score (HDDS), introduced by the Food and Nutrition Technical Assistance (FANTA) project, is a broader measure assessing household-level food security and economic access to diverse foods (Swindale & Bilinsky, 2006). A dietary diversity score (DDS) has been considered as an indicator of diet quality associated inversely

with the risk of chronic diseases. It is also an approximate measurement of the nutritional adequacy of the diet at the individual level.

6.4.1 The Association Between Child Dietary Diversity Score (CDDS) And Nutritious Status of Tribal Children in Attappadi

Dietary diversity is a significant predictor of the adequacy of nutrition and diet quality in children. Child Dietary Diversity Score (CDDS) measures the variety of food intake over 24 hours, and it reflects the extent to which children meet their nutritional needs. This section illustrates the distribution of CDDS among tribal children in Attappadi, categorised by significant variables such as tribe type, nutritional status indicators (wasting, underweight, and stunting), and the presence of breastfeeding mothers. CDDS pattern analysis is significant in detecting inequalities in food consumption and detecting groups at higher risk of malnutrition. Through dietary diversity and nutritional status assessment, this study aims to detect areas where nutritional interventions can be used to maximise the health and well-being of tribal children. Hypothesis for the chi-square test to show the relationship between the Child Dietary Diversity Score (CDDS) and the nutrition status of tribal children in Attappadi are given below.

- Null Hypothesis (H_0): There is no significant association between the Child Dietary Diversity Score (CDDS) and the nutrition status (wasting, underweight, and stunting) of tribal children in Attappadi.
- Alternative hypothesis (H_1): There is a significant association between the Child Dietary Diversity Score (CDDS) and the nutrition status (wasting, underweight, and stunting) of tribal children in Attappadi.

A Chi-square test was performed to assess the association between the Child Dietary Diversity Score (CDDS) and the nutrition status based on nutrition indicators among tribal children aged 0-59 months in Attappadi. The test results are given below.

6.4.1.1 Distribution of Tribal Children in Attappadi Based on CDDS

Dietary diversity is a key indicator of the nutritional status of a child, reflecting the variety and quality of food consumed. The dietary diversity scores among tribal children in Attappadi are categorised into high, moderate, and poor. The study

categorises tribal children into Irula, Kurumba, and Muduga to analyse how dietary diversity varies across tribal communities.

A Chi-square test was performed to assess the association between Child Dietary Diversity Score (CDDS) and tribe type among children aged 0-59 months from Attappadi. The test yielded a Chi-square value (χ^2) of 21.533 with 4 degrees of freedom ($df = 4$). The strength of association, measured using Cramer's V, was 0.131, indicating a weak to moderate relationship between the variables. The Fisher's Exact Test yielded a p-value of 0.000, statistically significant at the 1% level ($p < 0.01$). As the p-value is smaller than 0.05, the null hypothesis (H_0) is rejected and indicates a significant relationship between CDDS and tribe type. It indicates that dietary diversity significantly differs across various tribal populations and that there is greater dietary diversity among Irula children than among Kurumba and Muduga children, indicating possible disparities in dietary consumption and nutrition access. The association between the Child Dietary Diversity Score (CDDS) and the type of tribe among children in Attappadi is depicted in Table 6.14.

Table 6.14
Distribution of Tribal Children Based on CDDS

CDDS Category	Tribe			Total
	Irula	Kurumba	Muduga	
High Dietary Diversity	28 (6.2)	0 (0)	0 (0)	28 (4.5)
Moderate Dietary Diversity	326 (72.4)	46 (61.3)	69 (69)	441 (70.5)
Poor Dietary Diversity	96 (21.3)	29 (38.7)	31 (31)	156 (25.0)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2 = 21.533 \cdot df = 4 \cdot \text{Cramer } V = 0.131 \cdot \text{Fisher } p = 0.000$				

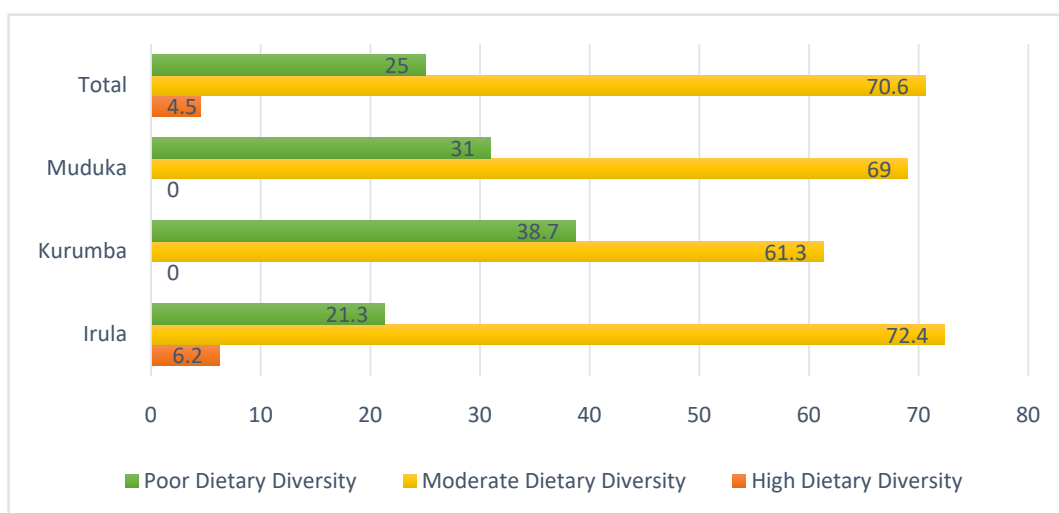
Note: Figures in brackets indicate percentages.

Source: Primary Data

The distribution of Child Dietary Diversity Score (CDDS) based on the type of tribe reveals variations among the three tribal communities. Among Irula children, the majority (72.4%) exhibit moderate dietary diversity, while 21.3% have poor dietary diversity, and only 6.2% achieve high dietary diversity. In the Kurumba

community, 61.3% of children fall under the moderate dietary diversity category, while 38.7% are in the poor dietary diversity group, with none reaching high dietary diversity. Similarly, among Muduga children, 69% exhibit moderate dietary diversity, 31% show poor dietary diversity, and none are categorised under high dietary diversity. These results indicate that high dietary diversity is predominantly observed among Irula children, while Kurumba and Muduga children have no representation in this category. Poor dietary diversity is more prevalent among Kurumba and Muduga children than Irula children, suggesting significant disparities in dietary patterns across tribal groups. It is also depicted in Figure 6.6.

Figure 6.6
Distribution of Tribal Children Based on CDDS



Source: Primary data

Findings show that dietary diversity is not uniformly distributed among the three tribes, with the Irula children having a more diversified diet than the Kurumba and Muduga children. Interventions to enhance nutrition in dietary diversity among the Kurumba and Muduga children need to bridge the gaps and improve the overall level of nutrition.

6.4.1.2 Distribution of Wasted (Weight-for-height) Tribal Children Based CDDS

Table 6.16 aims to explore how different levels of dietary diversity correspond to the nutritional status of children, categorised into severe malnutrition, moderate malnutrition, and normal weight-for-height.

A Chi-square test was performed to assess the association between Child Dietary

Diversity Score (CDDS) and wasting (weight-for-height) among tribal children aged 0-59 months in Attappadi. The test produced a Chi-square value (χ^2) of 136.991 with 4 degrees of freedom ($df = 4$). The association strength, measured using Cramer's V, was 0.331, indicating a moderate relationship between CDDS and wasting. The Fisher's Exact Test yielded a p-value of 0.000, which is highly significant at the 1% level ($p < 0.01$). Since the p-value is below 0.05, the null hypothesis (H_0) is rejected, confirming a statistically significant association between CDDS and wasting. The findings indicate that children with low dietary diversity have more severe malnutrition and a higher prevalence of moderate malnutrition. Children with good or moderate dietary diversity have better nutritional status. This finding highlights the importance of dietary diversity in preventing wasting and improving overall child nutrition. The association between the Child Dietary Diversity Score (CDDS) and wasting (weight-for-height) among tribal children in Attappadi is presented in Table 6.15.

Table 6.15
Distribution of Wasted (Weight-for-height) Tribal Children Based on CDDS

CDDS Category	Wasting (Weight-for-height)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
High Dietary Diversity	0 (0)	19 (4.8)	9 (4.4)	28 (4.5)
Moderate Dietary Diversity	12 (44.4)	338 (85.6)	91 (44.8)	441 (70.5)
Poor Dietary Diversity	15 (55.6)	38 (9.6)	103 (50.7)	156 (25.0)
Total	27 (100)	395 (100)	203 (100)	625 (100)
$\chi^2 = 136.991 \cdot df = 4 \cdot \text{Cramer } V = 0.331 \cdot \text{Fisher } p = 0.000$				

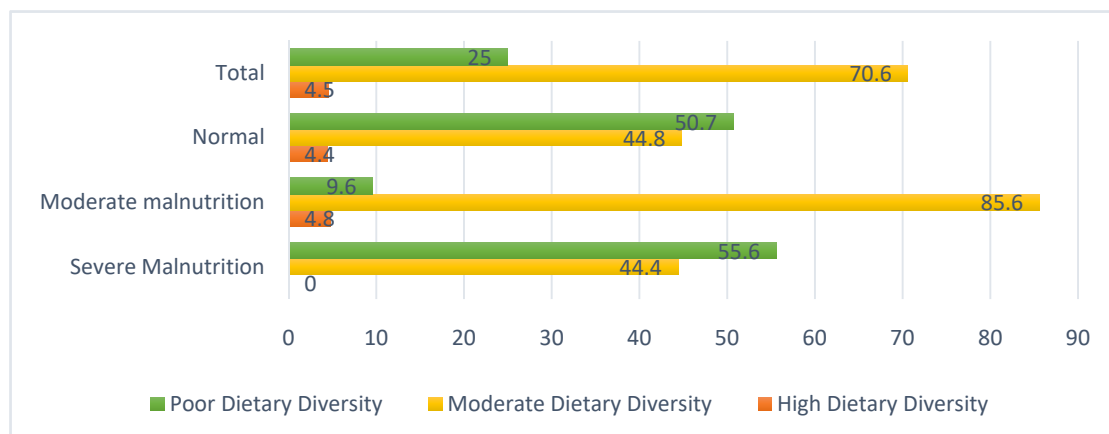
Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.15 illustrates the Child Dietary Diversity Score (CDDS) distribution based on wasting (weight-for-height) among tribal children in Attappadi. The findings are

consistent with the conclusion that no severely wasted children had high dietary diversity, whereas a low percentage of moderately wasted children had high dietary diversity. More severely wasted children had poor dietary diversity, which indicates a higher rate of malnutrition in those with low dietary intake. Moderately wasted children were primarily defined by their dietary diversity, which was moderate, and this indicated that dietary diversity positively influences their nutritional status. The control group had a balanced distribution, with most volunteers having moderate dietary diversity and a small percentage having poor dietary diversity. This pattern emphasises the importance of enhancing dietary diversity to mitigate the risk of wasting among tribal children in the region. It is also depicted in Figure 6.7.

Figure 6.7
Distribution of Wasted (Weight-for-height) Tribal Children Based on CDDS



Source: Primary data

The findings indicate that poor dietary diversity is more prevalent among severely malnourished children, highlighting the critical role of dietary diversity in preventing wasting. The results emphasise the necessity of promoting diverse and nutrient-rich diets to mitigate acute malnutrition among tribal children in Attappadi.

6.4.1.3 Distribution of Underweight Tribal Children Based on CDDS

Table 6.17 presents the association between Child Dietary Diversity Score (CDDS) and Underweight (Weight-for-age) among tribal children in Attappadi. The table categorises children into three groups based on their dietary diversity and examines how dietary patterns are distributed across severe malnutrition, moderate malnutrition, and normal nutritional status.

A Chi-square test was conducted to determine the association between Child

Dietary Diversity Score (CDDS) and underweight (weight-for-age) among tribal children aged 0-59 months in Attappadi. The test produced a Chi-square value (χ^2) of 25.978 with 4 degrees of freedom ($df = 4$). As indicated by Cramer's V, the association strength was 0.144, suggesting a weak but significant relationship between CDDS and underweight. The Fisher's Exact Test yielded a p-value of 0.000, which is highly significant at the 1% level ($p < 0.01$). Since the p-value is below 0.05, the null hypothesis (H_0) is rejected, confirming a statistically significant association between CDDS and underweight. The results indicate that children with poor dietary diversity are more likely to experience severe and moderate underweight, whereas those with higher dietary diversity exhibit better weight-for-age status. It emphasises the role of dietary diversity in improving child nutrition and reducing underweight prevalence. It is presented in Table 6.16.

Table 6.16
Distribution of Underweight (Weight-for-age) Tribal Children Based on CDDS

CDDS Category	Underweight (Weight-for-age)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
High Dietary Diversity	0 (0)	21 (5.3)	7 (3.5)	28 (4.5)
Moderate Dietary Diversity	14 (46.7)	232 (59.1)	195 (96.5)	441(70.5)
Poor Dietary Diversity	16 (53.3)	140 (35.6)	0 (0)	156 (25.0)
Total	30 (100)	393 (100)	202 (100)	625 (100)
$\chi^2 = 25.978 \cdot df = 4 \cdot \text{Cramer } V = 0.144 \cdot \text{Fisher } p = 0.000$				

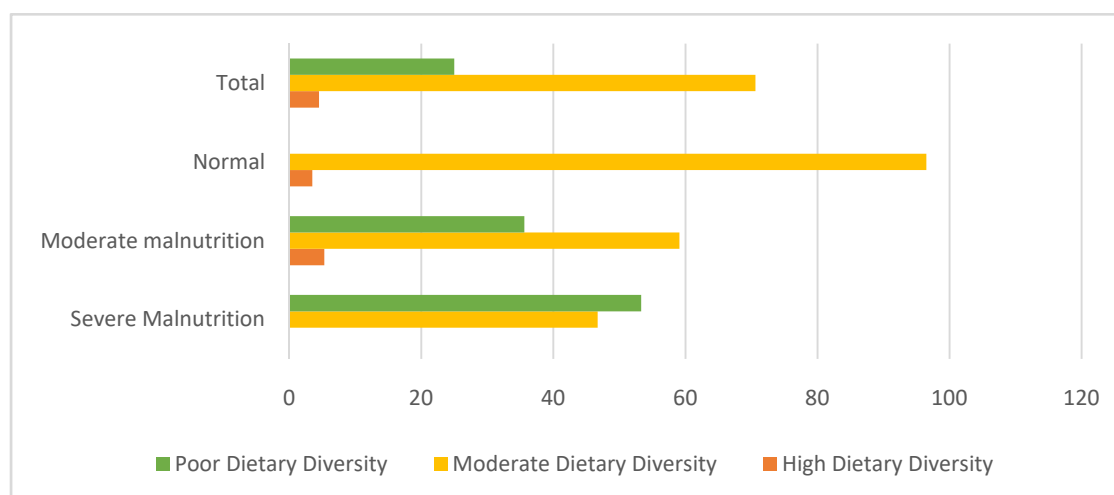
Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.16 shows that the majority (53.3%) belonged to the poor dietary diversity group, indicating that inadequate dietary diversity is strongly associated with severe malnutrition. The remaining 46.7% of severely underweight children fell under the moderate dietary diversity group. In contrast, no children with high dietary diversity were observed in this category, suggesting the protective role of higher dietary diversity. In the case of moderate underweight, the highest proportion (59.1%) belonged to the moderate dietary diversity group, followed by 35.6% from

the poor dietary diversity group and only 5.3% from the high dietary diversity group. It highlights that moderate dietary diversity reduces the severity of undernutrition but does not entirely prevent it. Among children with normal weight, the majority (96.5%) belonged to the moderate dietary diversity group, and 3.5% were from the high dietary diversity group.

Figure 6.8
Distribution of Underweight (Weight-for-age) Tribal Children Based on CDDS



Source: Primary data

In contrast, no children from the poor dietary diversity group achieved a normal nutritional status. The analysis indicates that poor dietary diversity is significantly associated with severe and moderate underweight among tribal children in Attappadi. It is also depicted in Figure 6.8.

6.4.1.4 Distribution of Stunted (Height-for-age) Tribal Children Based on CDDS

Table 6.18 represents the association between the Child Dietary Diversity Score (CDDS) and stunting (Height-for-age) among tribal children in Attappadi. The table aims to explore how different levels of dietary diversity are distributed across varying degrees of malnutrition, reflecting the impact of diet quality on growth of children. A Chi-square test was performed to examine the association between Child Dietary Diversity Score (CDDS) and stunting (height-for-age) among tribal children aged 0-59 months in Attappadi. The test yielded a Chi-square value (χ^2) of 8.180 with 4 degrees of freedom (df = 4). The association strength, measured by Cramer's V (0.081), indicates a weak relationship between CDDS and stunting. The

Fisher's Exact Test p-value is 0.094, which exceeds the 0.05 threshold, indicating that the relationship is not statistically significant at the 5% level. Since the p-value is greater than 0.05, we fail to reject the null hypothesis (H_0). It suggests that dietary diversity is not significantly associated with stunting among tribal children in the sample. While poor dietary diversity is prevalent among stunted children, other factors may play a more dominant role in influencing height-for-age outcomes. It is also presented in Table 6.17.

Table 6.17
Distribution of Stunted (Height-for-age) Tribal Children Based on CDDS

CDDS Category	Stunting (Height-for-age)			Total
	Severe Malnutrition	Moderate malnutrition	Normal	
High Dietary Diversity	2 (2.5)	14 (3.6)	12 (7.6)	28 (4.5)
Moderate Dietary Diversity	52 (65.8)	285 (73.5)	104 (65.8)	441 (70.5)
Poor Dietary Diversity	25 (31.6)	89 (22.9)	42 (26.6)	156 (25.0)
Total	79 (100)	388 (100)	158 (100)	625 (100)
$\chi^2 = 8.180 \cdot df = 4 \cdot \text{Cramer } V = 0.081 \cdot \text{Fisher } p = 0.094$				

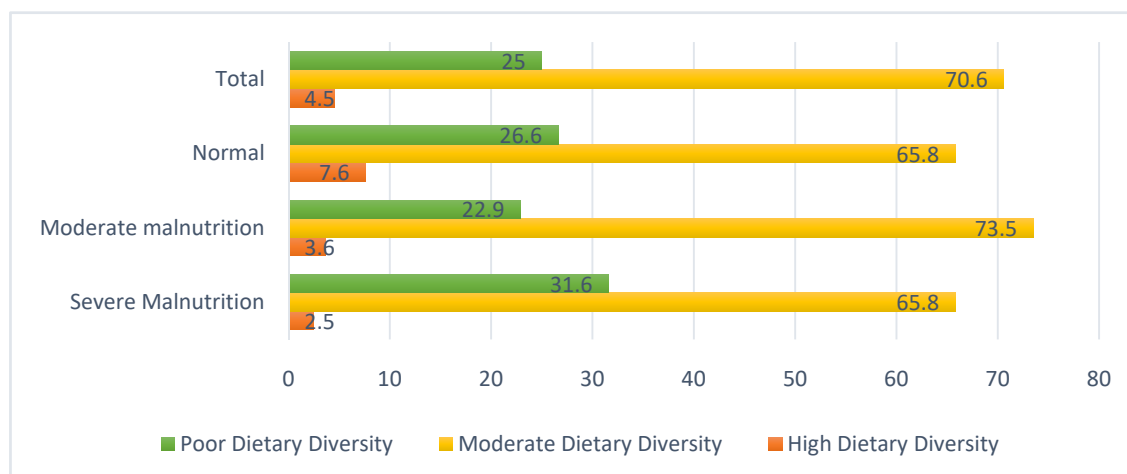
Note: Figures in brackets indicate percentages.

Source: Primary Data

In the severe stunting category, children with poor dietary diversity account for 31.6%, while those with moderate dietary diversity constitute 65.8%. Only 2.5% of children with high dietary diversity are severely stunted, indicating that better dietary diversity is associated with a lower prevalence of severe stunting. Among the moderately stunted children, the majority (73.5%) belong to the moderate dietary diversity group, followed by 22.9% in the poor dietary diversity group. In comparison, only 3.6% of children belong to the high dietary diversity group. It shows that moderate dietary diversity plays a significant role in reducing moderate stunting. For the standard category, 65.8% of children are in the moderate dietary diversity group, while 26.6% belong to the poor dietary diversity group. Only 7.6%

of children with high dietary diversity fall into the standard category, suggesting that higher dietary diversity contributes to improved growth outcomes. It is also depicted in Figure 6.9.

Figure 6.9
Distribution of Stunted (Height-for-age) Tribal Children Based on CDDS



Source: Primary data

The findings show a positive relationship between dietary diversity and the nutritional status of tribal children. Low dietary diversity is related to higher stunting levels, and moderate and high dietary diversity significantly affect the height-for-age values of children. It highlights the need to promote diversified food habits to combat chronic malnutrition among Attappadi tribal children.

6.4.1.5 Distribution of Tribal Children with Breastfeeding Mothers based on CDDS

Maternal dietary patterns strongly predict nutritional status and subsequent health outcomes of a child. Diversity of foods is an essential indicator of nutritional adequacy among mothers and children, and diverse food intake patterns are directly associated with better micronutrient status and developmental trends. The table explains the association between the CDDS and the presence of breastfeeding mothers among tribal children in Attappadi. This analysis helps to understand how the presence of breastfeeding mothers influences dietary diversity and nutritional outcomes of children.

A Chi-square test was conducted to study the association between the Child Dietary Diversity Score (CDDS) and the presence of breastfeeding mothers among tribal

children aged 0-59 months in Attappadi. The test produced a Chi-square value (χ^2) of 8.904 with 2 degrees of freedom ($df = 2$). The strength of the association, measured by Cramer's V (0.119), indicates a weak relationship between these variables. The p-value of 0.012 is less than 0.05, suggesting a statistically significant association between dietary diversity and the presence of a breastfeeding mother, indicating that the presence of a breastfeeding mother influences the dietary diversity of tribal children. It is also presented in Table 6.18.

Table 6.18
Distribution of Tribal Children with Breastfeeding Mothers based on CDDS

CDDS Category	Presence of Feeding Mother		
	No	Yes	Total
High Dietary Diversity	16 (3.2)	12 (9.2)	28 (4.5)
Moderate Dietary Diversity	356 (71.9)	85 (65.4)	441 (70.5)
Poor Dietary Diversity	123 (24.8)	33 (25.4)	156 (25.0)
Total	495 (100)	130 (100)	625 (100)
$\chi^2 = 8.904 \cdot df = 2 \cdot \text{Cramer } V = 0.119 \cdot \text{Fisher } p = 0.012$			

Note: Figures in brackets indicate percentages.

Source: Primary Data

Table 6.18 reveals that among children without feeding mothers, 3.2% have high dietary diversity, 71.9% have moderate dietary diversity, and 24.8% have poor dietary diversity. In contrast, among children with feeding mothers, 9.2% have high dietary diversity, 65.4% have moderate dietary diversity, and 25.4% have poor dietary diversity. The higher percentage of children with high dietary diversity in the presence of feeding mothers suggests a positive influence on the dietary diversity score. However, poor dietary diversity is observed in both groups, indicating that feeding mothers alone may not improve dietary diversity without proper nutritional knowledge and resources. The analysis reveals that the presence of feeding mothers is associated with better dietary diversity among tribal children in Attappadi. However, additional interventions, such as nutritional education and support, are essential to ensure children receive a balanced diet, particularly in

resource constrained settings.

The Chi-square analysis of CDDS among tribal children in Attappadi reveals significant associations with tribe type, wasting, underweight, and breastfeeding mothers, while the relationship with stunting is insignificant. Poor dietary diversity is more prevalent among the Kurumba and Muduga tribes. Higher dietary diversity is linked to lower wasting and underweight prevalence. Breastfeeding mothers positively influence dietary diversity.

6.4.2 Regression Models on the Association Between CDDS and Nutritious Status of Tribal Children in Attappadi

Child malnutrition remains a pressing concern in tribal communities, with dietary diversity playing a crucial role in determining nutritional outcomes. This study employs regression models to examine the relationship between the Child Dietary Diversity Score (CDDS) and key anthropometric indicators among tribal children in Attappadi. The dependent variables include wasting (weight-for-height), underweight (weight-for-age), stunting (height-for-age), and the BMI of both children, and the independent variable is CDDS. A simple linear regression model is used to examine the effect of CDDS on the nutritional status of these children and presents thoughtful perspectives on the role of dietary diversity in enhancing the overall well-being and health of children in the study location.

6.4.2.1 Simple Linear Regression Model on Association Between CDDS and Wasting (Weight-for-height) Among Tribal Children in Attappadi

Dietary diversity is a key determinant of child nutrition, reflecting the variety of foods consumed and nutrient adequacy. This study examines the association between the average Dietary Diversity Score (DDS) and wasting (weight-for-height) among tribal children in Attappadi to understand how dietary diversity impacts acute malnutrition. Wasting, a critical indicator of acute malnutrition, is considered the dependent variable, while the independent variable is the 24-hour dietary diversity score. The regression equation is as follows:

$$WS_i = \beta_0 + \beta_1 Acdds + \varepsilon_i$$

Where, WS_i – Wasting (Weight-for-height) status of the child, β_0 – Constant term, $\beta_1 Acdds$ – Average Child Dietary Diversity Score, and ε_i – Error term.

Table 6.19
Association Between CDDS and Wasting (Weight-for-height)
Among Tribal Children in Attappadi

CDDS	B	SE	t	p
(Intercept)	-1.6276	0.842	-1.933	0.054.
24-hour Dietary Diversity	0.6293	0.1649	3.817	< .001***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

The regression results indicate that the intercept value is -1.6276, with a standard error of 0.842 and a t-value of -1.933, which is statistically significant at the 10% level (p = 0.053). The 24-hour dietary diversity score is positively associated with wasting, with an estimated 0.6293. This relationship is statistically significant at the 1% level (p < 0.001), implying that increased dietary diversity is significantly linked to a higher probability of wasting among tribal children. It emphasises the importance of not only dietary diversity but also the overall nutritional quality and sufficiency of the diet.

6.4.2.2 Simple Linear Regression Model on Association Between CDDS and Underweight (Weight-for-age) Among Tribal Children in Attappadi

The present model investigates the association between the Child Dietary Diversity Score (CDDS) and underweight (weight-for-age) among tribal children in Attappadi. The dependent variable is underweight (weight-for-age), while the independent variable is the 24-hour average dietary diversity score, the average CDDS. The simple linear regression model is expressed as:

$$UW_i = \beta_0 + \beta_1 Acdds + \varepsilon_i$$

Where, UW_i – Underweight (weight-for-age) status of the child, β_0 – Constant term, $\beta_1 Acdds$ – Average Child Dietary Diversity Score, and ε_i – Error term.

Table 6.20
Association Between CDDS and Underweight (Weight-for-age)
Among Tribal Children in Attappadi

CDDS	B	SE	t	p
(Intercept)	5.2815	1.4048	3.76	0.00019***
24 Hour Dietary Diversity	1.0019	0.2751	3.642	0.0003***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.20 presents the regression results. The intercept value (5.2815) is statistically significant (p < 0.001), indicating that when the dietary diversity score is zero, the underweight score remains at 5.28 units. The coefficient for the 24-hour diet diversity score is positive (1.0019) and statistically significant at 1% level (p < 0.001), implying that an increase in dietary diversity is associated with an increase in weight-for-age scores. It indicates that children with better dietary diversity have less probability of being underweight. The results emphasise the role of dietary diversity in addressing underweight issues among tribal children in Attappadi. The positive relationship between CDDS and nutritional outcomes highlights the role of balanced dietary intake in combating undernutrition.

6.4.2.3 Simple Linear Regression Model on Association Between CDDS and BMI of Tribal Children in Attappadi

The association between the average Child Dietary Diversity Score (CDDS) and Body Mass Index (BMI) of tribal children in Attappadi is analysed in this model. The dependent variable is the BMI of the tribal children, while the independent variable is the average CDDS, measured by 24-hour dietary diversity. The baseline for comparison is high dietary diversity. The regression equation is expressed as:

$$BMIC_i = \beta_0 + \beta_1 Acdds + \varepsilon_i$$

Where, $BMIC_i$ – Body Mass Index of the child, β_0 – Constant term, $\beta_1 Acdds$ – Average Child Dietary Diversity Score and ε_i – Error term.

Table 6.21
Association Between CDDS and BMI of Tribal Children in Attappadi

CDDS	B	SE	t	p
(Intercept)	9.8125	0.873	11.24	< 0.001***
24-hour Dietary Diversity	1.1936	0.1709	6.983	< 0.001***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.21 illustrates that the intercept value is 9.8125, indicating the estimated BMI of tribal children when the dietary diversity score is zero. The coefficient for average CDDS is 1.1936, which implies that for each unit increase in dietary diversity, the BMI of children increases by 1.19 units. This relationship is SS at a 1% level (p < 0.001). It shows a strong positive relation between dietary diversity and BMI among tribal children. It suggests that children with better dietary diversity tend to have higher BMI, reflecting better nutritional outcomes and reinforcing the significance of diversified food intake in combating malnutrition.

The findings from the Simple linear regression models emphasise the role of dietary diversity in addressing malnutrition among tribal children in Attappadi. The positive association between average CDDS and nutritional indicators such as wasting, underweight and BMI of children highlights the importance of a diversified diet in improving child health outcomes. However, the limited influence of average CDDS on stunting suggests that dietary diversity alone may not be sufficient to combat chronic malnutrition.

6.5 Child Food Insecurity Access Scale (CFIAS) Score

The Child Food Insecurity Access Scale Score (CFIAS) is a scale of the level of food insecurity in children, that is, their capacity to access adequate nourishment. It assesses food insecurity by considering the perspectives of judgments of caregivers about susceptibility and behavioural responses of their child to the unavailability of food resources. This scale emphasises food access rather than food utilisation or nutritional quality. CFIAS is structured similarly to the Household Food Insecurity

Access Scale (HFIAS) (Coates et al., 2007), incorporating nine occurrence questions that capture progressively severe experiences of food insecurity. Each occurrence question is followed by a frequency of occurrence question to determine whether the condition rarely happened (once or twice), sometimes (three to ten times), or often (more than ten times) in the past four weeks (30 days) before the survey. Each child receives a CFIAS score by summing the responses to the nine frequency of occurrence questions (range: 0 - 27). A higher score indicates a greater level of child food insecurity. Children are then classified into four categories: Highly food Secure (CFIAS 0-6), Medium Food Secure (CFIAS 7-13), Low Food Secure (CFIAS 14-20), and Food insecure (CFIAS 21-27). CFIAS is used to assess the relationship between child food insecurity and malnutrition, including indicators like wasting, underweight, and stunting. The average CFIAS score is computed by summing all individual CFIAS scores and dividing by the number of samples in the study.

Average CFIAS Score = Sum of CFIAS scores in the sample/ total number of children in the sample.

6.5.1 Association Between CFIAS Score and Nutritious Status of Tribal Children in Attappadi

Food insecurity is a strong predictor of child malnutrition, especially in vulnerable groups like the tribal community in Attappadi. The Child Food Insecurity Access Scale (CFIAS) measures the food insecurity level of a child and its impact on the nutritional status of a child. This section employs simple linear regression models to analyse the association between the average CFIAS score and major indicators of child undernutrition, such as wasting, underweight, and stunting.

6.5.1.1 Distribution of Tribal Children Based on CFIAS Score

The table presents the distribution of Child Food Insecurity Access Scale (CFIAS) scores among tribal children in Attappadi, categorised by tribe: Irula, Kurumba, and Muduga. The CFIAS measures the extent of food insecurity experienced by children based on assessments of caregivers, using a scale ranging from 0 to 27. This score is derived from nine questions capturing the frequency of food access difficulties over the past 30 days. The scores are grouped into four categories:

Highly Food Secure (0–6), Medium Food Secure (7–13), Low Food Secure (14–20), and Food Insecure (21–27). The table not only highlights the prevalence of food insecurity by tribe but also provides the chi-square test results to determine the statistical significance of the observed differences.

Table 6.22
Distribution of Tribal Children Based on CFIAS Score

CFIAS	Tribe			Total
	Irula	Kurumba	Muduga	
High Food Security	23 (5.1)	0 (0)	2 (2.0)	25 (4.0)
Medium Food Security	245 (54.4)	17 (22.7)	27 (27.0)	289 (46.2)
Low Food Security	139 (30.9)	37 (49.3)	54 (54.0)	230 (36.8)
Food Insecure	43 (9.6)	21 (28)	17 (17)	81 (13.0)
Total	450 (100)	75 (100)	100 (100)	625 (100)
$\chi^2=110.988 \cdot df=36 \cdot \text{Cramer } V=0.298 \cdot \text{Fisher } p=0.000$				

Note: Figures in brackets indicate percentages.

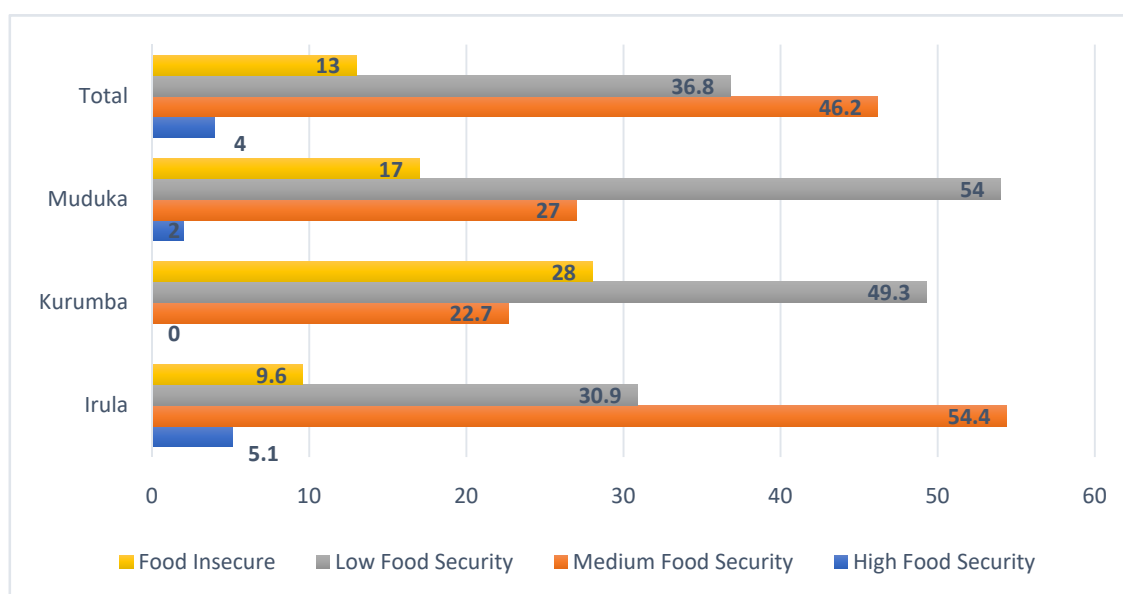
Source: Primary Data

The results reveal considerable variation in child food insecurity across tribal groups in Attappadi. Among Irula children, the majority (54.4%) are medium food secure, followed by 30.9% in the low food secure category. Only 5.1% are highly food secure, while 9.6% fall into the food insecure group. It indicates that most Irula children have moderate access to food, but a significant portion experience reduced access to food or complete insecurity. In the Kurumba tribe, the pattern shifts markedly. Nearly half (49.3%) of Kurumba children fall in the low food secure category, and 28% classified as food insecure. Notably, no child in this group is highly food secure, and only 22.7% fall under the medium food secure category. These figures suggest a substantially higher level of food insecurity among Kurumba children than their Irula counterparts. Among Muduga children,

the highest proportion (54.0%) also falls within the low food secure group, and 17% are food insecure. Only 2% are categorised as highly food secure, while 27.0% fall into the medium food secure range. The data indicate that the Muduga tribe, like the Kurumba, faces heightened vulnerability to child food insecurity.

In the sample of 625 children, 46.2% are medium food secure, 36.8% are low food secure, and 13% are food insecure. Alarming, only 4% of children are highly food secure, emphasising widespread challenges in achieving adequate child nutrition in the Attappadi region. The chi-square test ($\chi^2 = 110.988$, $df = 36$, $p = .000$) confirms a statistically significant association between tribal affiliation and level of child food insecurity. The Cramer's V value of 0.298 suggests a moderate effect size, indicating that tribal identity is meaningful in determining food security levels.

Figure 6.10
Distribution of Tribal Children Based on CFIAS Score



Source: Primary data

The analysis shows critical disparities in food access across tribal groups. Although most children are categorised as either medium or low food secure, children from the Kurumba and Muduga tribes experience markedly higher levels of food insecurity compared to their Irula counterparts. The complete absence of high food security among Kurumba children is especially concerning. The statistically significant association between tribal identity and food security status ($p < .001$) shows the need for tribe specific nutritional interventions tailored to the distinct

circumstances of each group.

6.5.1.2 Simple Linear Regression Model on Association Between CFIAS Score and Wasting (Weight-for-height) Among Tribal Children in Attappadi

The association between child food insecurity and nutritional status, particularly wasting (weight-for-height), among tribal children in Attappadi has been analysed using a simple linear regression model. The dependent variable is wasting (weight-for-height), while the independent variable is the average Child Food Insecurity Access Scale (CFIAS) score. The regression equation is represented as:

$$WS_i = \beta_0 + \beta_1 acfias + \varepsilon_i$$

Where, WS_i – Wasting (Weight-for-height) status of the child β_0 – Constant term $\beta_1 acfias$ – Average Child Food Insecurity Access Scale (CFIAS) score and ε_i – Error term.

Table 6.23
Association Between CFIAS Score and Wasting (Weight-for-height) Among Tribal Children in Attappadi

CFIAS Score	B	SE	t	p
(Intercept)	0.44102	0.50227	0.878	0.380
Average CFIAS Score	0.12617	0.05504	2.292	0.022*

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.23 presents the results of the simple linear regression model. The average CFIAS score measures food insecurity and shows a positive and significant association with wasting among children ($\beta = 0.12617$, $p = 0.0222$). It indicates that as food insecurity increases, the prevalence of wasting among tribal children increases and suggests that children in food insecure households are more vulnerable to acute malnutrition. The intercept value of 0.44102 is not statistically significant, indicating that other contributing factors may influence wasting among children. The results show the importance of addressing food insecurity as a critical factor in reducing acute malnutrition among tribal children. Doubling of food distribution through the Public Distribution System (PDS) and access to nutritious food could alleviate the risk of wasting among children in the study area.

6.5.1.3 Simple Linear Regression Model on Association Between CFIAS Score and Underweight (Weight-for-age) Among Tribal Children in Attappadi

The simple linear regression model has been applied to examine the association between the Child Food Insecurity Access Scale (CFIAS) Score and underweight (Weight-for-age) among tribal children under five years in Attappadi. The dependent variable is underweight (Weight-for-age), while the independent variable is the Average CFIAS Score. The model is represented as:

$$UW_i = \beta_0 + \beta_1 acfias + \varepsilon_i$$

Where, UW_i – Wasting (Weight-for-height) status of the child, β_0 – Constant term $\beta_1 acfias$ – Average Child Food Insecurity Access Scale (CFIAS) score and ε_i – Error term.

Table 6.24
Association Between CFIAS Score and Underweight (Weight-for-age)
Among Tribal Children in Attappadi

CFIAS Score	B	SE	t	p
(Intercept)	7.77718	0.83357	9.33	< 0.001***
Average CFIAS Score	0.29799	0.09134	3.262	0.001**

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.24 shows the results of the regression model. The intercept value (7.77718) is positive, indicating the underweight status of children when the CFIAS Score is zero. The average CFIAS score is positively associated with underweight, with a 0.29799 estimate. It means that for every one unit increase in the average CFIAS score, underweight increases by 0.29799 units. The association is significant at the 1% level (p-value = 0.001**). The findings indicate that higher levels of food insecurity are linked to a greater prevalence of underweight among tribal children. Targeted interventions such as supplementary nutrition programs and income generating activities can mitigate the adverse effects of food insecurity on the nutritional outcomes of children in the study area.

6.5.1.4 Simple Linear Regression Model on Association Between CFIAS Score and Stunting (Height-for-age) Among Tribal Children in Attappadi

The relationship between the Coping Food Insecurity Access Scale (CFIAS) Score and Stunting (Height-for-age) among tribal children in Attappadi is examined

through the simple linear regression model. Stunting, represented by height-for-age, is the dependent variable, while the independent variable is the Average CFIAS Score. The regression equation is:

$$ST_i = \beta_0 + \beta_1 acfias + \varepsilon_i$$

Where, ST_i – Stunting (Height-for-age) status of the child, β_0 – Constant term $\beta_1 acfias$ – Average Child Food Insecurity Access Scale (CFIAS) score, and ε_i – Error term

Table 6.25
Association Between CFIAS Score and Stunting (Height-for-age)
Among Tribal Children in Attappadi

CFIAS Score	B	SE	t	p
(Intercept)	11.04892	0.47974	23.031	< 0.001***
Average CFIAS Score	0.23687	0.05257	4.506	< 0.001***

Note. B = regression coefficient; SE = standard error; t = t-value; p = p-value. **p < .001 (highly significant), *p < .01 (very significant), p < .05 (significant), +p < .10 (marginally significant), p > .10 (not significant).

Source: Primary Data

Table 6.26 illustrates a significant positive association between the Average CFIAS Score and stunting among tribal children (Estimate = 0.23687, p = < 0.001***). The positive coefficient suggests that an increase in food insecurity is only significantly correlated with a higher prevalence of stunting among children. This outcome emphasises the long-term impact of food insecurity on child growth and development. Addressing food insecurity through comprehensive nutrition support programs and community-based interventions is essential to reducing stunting rates among tribal children in Attappadi.

The relation between the Child Food Insecurity Access Scale (CFIAS) and the nutritional status of tribal children living in Attappadi illustrates the decisive role of food insecurity in child malnutrition. This observation emphasises the need for targeted interventions to improve food security by increasing access to quality foods, improving social welfare programs, and nutritional supplementation through community-based interventions. Strengthening initiatives like the Public Distribution System (PDS) and promoting dietary diversity can play a vital role in

reducing malnutrition among vulnerable tribal children in the region. There is no significant association between food insecurity, as measured by CFIAS, and the BMI of mothers in the study area.

6.6 Conclusion

The present chapter highlights a significant association between the nutritional status of tribal children in Attappadi and their dietary diversity and food consumption patterns. The analysis reveals widespread deficiencies in the intake of micronutrient rich foods, with alarming levels of vitamin A, calcium, iron, and zinc deficiencies, particularly among older children. The Child Food Consumption Score (CFCS), Child Dietary Diversity Score (CDDS) and Child Food Insecurity Access Scale (CFIAS) are strongly correlated with undernutrition indicators such as wasting, stunting, and underweight. Although dietary diversity positively influences nutritional outcomes, its explanatory power remains modest, indicating the need for multi-dimensional interventions. These findings emphasise the importance of implementing integrated, nutrition sensitive strategies, including food security enhancement, targeted supplementation, maternal education, and improved healthcare access, to combat malnutrition and support the long-term well-being of tribal children in Attappadi.

CHAPTER 7

SUMMARY, FINDINGS, AND POLICY IMPLICATIONS

7.1 Summary

The present study, titled ‘Dimensions of Malnutrition Among Tribal Children in Attappadi Block Panchayat, Palakkad District, Kerala, explores the complex, multifactorial dimensions of malnutrition affecting tribal children aged 0-59 months. Although India has a vast body of national-level data on child malnutrition, localised and community-driven research remains scarce, especially among indigenous tribal groups with distinct socio-cultural, dietary, and livelihood contexts. This research bridges that gap by analysing how structural deprivation, traditional food systems, and dietary diversity influence the nutritional outcomes among children from the Irula, Muduga, and Kurumba tribes in the Attappadi region.

The study emphasises how financial instability, deprivation at the household level, restricted healthcare access, and poor dietary intake collectively influence the nutritional status of children. Although government programs such as ICDS and Poshan Abhiyan are designed to address malnutrition, their broad-based approaches frequently fail to meet the unique and context-specific nutritional requirements of the tribal population. To provide a more contextually relevant understanding, this study adopted a mixed methods approach, primarily emphasising quantitative analysis while incorporating qualitative insights from community stakeholders to illuminate socio-cultural and behavioural drivers of malnutrition.

A community-based cross-sectional design gathered data from 625 children selected through stratified random sampling across 25 tribal hamlets. Quantitative data collection tools included a structured questionnaire covering household demographics and socio-economic factors, three dietary assessment tools such as Child Dietary Diversity Score (CDDS), Child Food Consumption Score (CFCS), and Child Food Insecurity Access Score (CFIAS), and WHO standard anthropometric measurements to assess stunting, wasting, and underweight prevalence using Z scores.

Food intake data were collected using 24-hour, 7-day, and 30-day recall periods, and nutrient values were analysed using the Indian Food Composition Tables (IFCT) in line with ICMR-NIN dietary guidelines (2020). The study utilised the

Household Deprivation Score (HDS) framework to explore the relationship between various dimensions of poverty and child nutritional status. Quantitative data were analysed using R Studio, employing descriptive statistics, Chi-square tests, correlation analysis, and regression models (logistic, multiple, and simple linear).

To enhance and provide context to the quantitative results, qualitative insights were gathered through focus group discussions and interviews with tribal mothers, fathers, community elders, Anganwadi workers, healthcare providers, and tribal promoters. Thematic analysis was conducted to uncover recurring patterns and key themes within the qualitative data, which highlighted concerns such as the breakdown of traditional food practices, cultural hesitancy toward specific nutritious foods, caregiving challenges rooted in gender roles, lack of trust in public healthcare systems, and systemic obstacles in accessing government welfare programs. These insights enriched the interpretation of statistical results and offered grounded, community-specific recommendations.

Aligned with the five primary research objectives, the study comprehensively evaluates child nutrition in Kerala and Attappadi, identifies the key socio-economic and demographic predictors of malnutrition, and investigates how household deprivation and food insecurity variables contribute to undernutrition. By combining empirical rigour with cultural sensitivity, the study proposes actionable, locally adaptable strategies to improve nutritional outcomes among tribal children.

Aligned with the five research objectives such as (1) to examine the nutritional status of children under five in Kerala, (2) to analyse the extent of malnutrition among tribal children in Attappadi, (3) to identify determinants of malnutrition, (4) to investigate the association between household deprivation and nutritional status, and (5) to examine the relationship between nutritional status and nutritional factors in the study area. Integrating empirical evidence with socio-cultural sensitivity offers actionable strategies to improve nutrition outcomes among tribal children, targeting both household-level and community-level interventions.

7.2 Summary of Major Findings

The sample population composition is a valuable source of information about the

socio-economic and nutritional condition of Attappadi tribal children. The results show that the Irula tribe forms the highest percentage of 72%, followed by Muduga at 16% and Kurumba at 12%. The trend is closely aligned with the overall population coverage of these tribes in Attappadi. As the Irula tribe represents nearly three-quarters of the sample, the findings primarily reflect the health and nutritional status of this group, emphasising the unique problems of the Muduga and Kurumba tribes.

Age distribution analysis shows that more than half (46.7%) of the children are above 35 months, with the Kurumba tribe having the highest proportion (52%) in this age group. The gender distribution indicates a slightly higher percentage of male children (53.6%) in the overall sample, with the Kurumba tribe exhibiting the highest proportion of male children (60%). The Muduga tribe has more female children (53%).

The economic conditions of tribal households reflect severe financial hardship, with 79.6% of families earning below Rs. 6,000 per month and a significant proportion (26.8%) earning less than Rs. 2,000, particularly among Kurumba households (41.3%).

In most tribal families, the mothers are the primary breadwinners, prominently among the Kurumba (58.7%) and Irula (56.2%) communities. The statistics also indicate that a high 72.2% of fathers are not engaged in income earning activities, thus increasing the economic burdens on the mothers and, in turn, affecting the nutritional levels of their children.

The sense of income sufficiency is extremely low, with only 4% of the households indicating that their income is enough. Among the Kurumba community, 84% strongly disagree that their income is enough, illustrating the extremely high economic vulnerability of this group. Maternal education levels exhibit significant disparities, with 97.3% of Kurumba mothers being illiterate, while Irula and Muduga mothers show slightly better educational attainment. Overall, 21.9% of mothers are illiterate, and only 2.1% have a degree level education, emphasising the need for targeted educational interventions.

Occupational patterns among mothers reveal that daily wage labour is the

predominant employment, with 65.4% of mothers engaged in this sector. Unemployment among mothers remains high, particularly in the Kurumba (40%) and Muduga (42%) tribes. Among fathers, 61.1% are unemployed, with 98.7% of Kurumba fathers lacking employment, exacerbating economic distress.

Housing conditions indicate disparities across tribal groups. Kutcha housing is most prevalent among the Kurumba tribe (44%), while Irula families have relatively better housing conditions. These housing inequalities may contribute to disparities in health and nutrition outcomes among tribal children.

The nutrition and health awareness levels of Irula mothers are moderate; however, the levels are extremely low in Kurumba and Muduga mothers. As many as 43.8% of the tribal mothers are not nutritionally aware, and the Kurumba and Muduga tribes record the highest level of nutritional unawareness. These results suggest the need for focused nutrition education interventions to improve child feeding practices and overall health in Attappadi.

7.2.1 The Prevalence of Wasting, Stunting, and Underweight

Wasting (weight-for-height) is found to be extremely high among tribal children in Attappadi, with a combined prevalence of 67.5%. Among different tribal groups, Kurumba and Muduga children exhibit the highest prevalence (72%) compared to Irula children (65.7%). Severe wasting is most prevalent among Kurumba children (20%), followed by Muduga (10%) and Irula (0.5%), whereas moderate wasting is highest among Irula (65.3%), followed by Muduga (62%) and Kurumba (52%). Normal growth is observed in only 32.5% of children, with the Irula children marginally improving at 34.2% for the Kurumba and Muduga at 28%. The prevalence of wasting among Kurumba and Muduga societies is a broad indicator of the necessity for targeted nutritional interventions, which include augmented health and nutrition programs to address acute malnutrition.

When analysed by gender, the overall wasting prevalence is 36.8%, with males (24.32%) being more affected than females (12.48%). However, it is more prevalent in women (2.73%) than men (1.6%), whereas it is much more prevalent in men (22.72%) than women (9.76%). These gender differences call for gender responsive nutrition programs to successfully counter malnutrition.

Age-wise, children aged 12-35 months exhibit the highest prevalence of wasting (78.7%), including 5.4% severely wasted and 73.3% moderately wasted. The prevalence is lower among children under 12 months (64.5%), with 1.1% suffering from severe wasting, and is lowest among children above 35 months (59.2%), with 4.4% severely wasted. These trends emphasise the need for early-life nutrition interventions to prevent acute malnutrition.

The study showed that 67.4% of tribal children are underweight, indicating severe malnutrition. Among tribal groups, Kurumba children have the highest underweight prevalence (89.3%), followed by Muduga (69%) and Irula (63.8%) children. Severe underweight is most prevalent among Kurumba children (24.0%), compared to Muduga (10%) and Irula (4.5%), while moderate underweight affects 65.3% of Kurumba, 59% of Muduga, and 63.3% of Irula children. Normal weight-for-age is lowest among Kurumba children (10.7%), whereas 31% of Muduga and 36.2% of Irula children exhibit normal weight-for-age. High underweight prevalence among the Kurumba tribe necessitates specialised nutritional care, including child health and food security programs.

Gender analysis reveals that girls (74.1%) are more underweight than boys (62.1%). Severe underweight is almost even across sexes (5.2% among girls and 4.5% among boys), but moderate underweight is much higher among girls (69.0%) than boys (57.6%). It indicates that tribal girls are more nutritionally disadvantaged, and therefore, gender specific nutrition interventions are needed to enhance food intake and well-being.

In terms of age, the highest prevalence of underweight is among children aged 12-35 months (80.4%), followed by children under 12 months (63.4%) and those above 35 months (58.6%). Severe underweight is most common in the 12-35 month age group (6.2%), compared to 4.3% in infants under 12 months and 3.8% in children over 35 months. Moderate underweight is also highest among the 12-35 month group (74.2%), compared to 59.1% among infants and 54.8% in children above 35 months. Targeted interventions during the early years are essential to prevent underweight and associated health risks.

The study also reports a high prevalence of stunting (height-for-age) among tribal

children in Attappadi, at 74.7%. The Kurumba tribe (81.3%) and Muduga tribe (81%) exhibit the highest prevalence, followed by Irula children (72.2%). Severe stunting is most prominent among Muduga (14%) and Irula (12.2%) children, while Kurumba exhibits the lowest severe stunting rate (1.9%). Moderate stunting affects 60% of Irula, 68% of Kurumba, and 67% of Muduga children.

Only 25.3% of children show normal growth, the highest percentage being in the Irula group at 27.8% and the lowest in the Kurumba group at 18.7%. The results show the prevalence of long-term chronic malnutrition, and it is essential to have ongoing dietary and healthcare interventions to avoid stunting in these populations. Gender analysis shows stunting is far higher in females (84.8%) than in males (65.9%). Severe stunting is found in 14.1% of females and 11.3% of males, and moderate stunting is found in far higher percentages of females (70.7%) than males (54.6%). Normal growth is found in only 34.1% of males and 15.2% of females, reflecting the higher nutritional risk of girls. Normal development is seen in children, with the highest proportion being in Irula (27.8%) and the lowest in Kurumba (18.7%). These results show that long-term nutrition and health interventions must be implemented to avert stunting in these groups.

Gender analysis indicates that stunting is more prevalent in females (84.8%) than in boys (65.9%). Severe stunting is observed in 14.1% of girls and 11.3% of boys, while moderate stunting is much more prevalent in girls (70.7%) than in boys (54.6%). Normal development is observed in only 34.1% of boys and 15.2% of girls, reflecting higher nutritional risk in girls. These findings emphasise the urgent need for maternal nutrition programs, improved child feeding practices, and healthcare initiatives to reduce stunting disparities.

The age-wise distribution of stunting shows that 71.0% of children below 12 months experience severe stunting, whereas all children in the 12-35 month group (100%) exhibit moderate stunting, reflecting prolonged nutritional deprivation. Among children older than 35 months, 55.1% are stunted, with 4.5% severely affected. The decreasing trend of severe stunting with age suggests the potential for catch up growth but also indicates continued exposure to risk factors in infancy. Given the critical importance of the first 1,000 days of life in preventing stunting,

targeted maternal and child healthcare interventions, improved dietary diversity, and socio-economic support are essential to addressing the long-term effects of chronic malnutrition.

The analysis of the correlation between wasting, underweight, and stunting among tribal children in Attappadi reveals distinct yet interconnected patterns of malnutrition. The correlation between underweight and stunting is moderate and positive ($r = 0.327$), indicating that children with lower weight-for-age are likelier to exhibit shorter height-for-age. It suggests that chronic malnutrition contributes to overall weight deficiency, reflecting the long-term impact of nutritional deprivation on child growth.

A strong positive correlation is observed between wasting and underweight ($r = 0.957$), signifying that children experiencing acute malnutrition (low weight-for-height) are also highly likely to exhibit low weight-for-age. This strong correlation points to the link between these two forms of malnourishment, citing that interventions for acute malnourishment can reduce overall weight deficit.

On the other hand, the correlation between wasting and stunting is very weak ($r = 0.042$), which indicates that these two indicators are two different dimensions of malnutrition with poor overlap. This weak correlation indicates that, despite wasting being the indicator of acute malnutrition, stunting is an indicator of chronic nutritional deficiency and growth retardation over time. The findings indicate that children with wasting need not necessarily have stunted growth. The strong correlation between wasting and underweight indicates the necessity of immediate redress to acute malnutrition so that it may not be aggravated. The moderate correlation between underweight and stunting indicates that continued nutritional intervention is necessary to reduce chronic undernutrition. The weak relationship between wasting and stunting indicates that there are several risk factors for these disorders and, therefore, the necessity of specific interventions to provide redress to both immediate and long-term nutritional deficiencies among tribal children in the region. Strengthening healthcare programs, improving dietary diversity, and ensuring early childhood nutritional interventions are critical steps in addressing malnutrition comprehensively.

7.2.2 Determinants of Malnutrition

The analysis of malnutrition among tribal children under five years in Attappadi reveals that internal and external determinants play a significant role in shaping nutritional outcomes. Internal factors include household economic conditions, maternal characteristics, family structure, tribal identity, and child specific variables, while external factors encompass environmental conditions, access to institutional services, and cultural practices. Together, these factors influence undernutrition, stunting, underweight, and other measures of child nutritional status.

Among internal determinants, household income emerged as a key protective factor, with higher income substantially reducing the likelihood of malnutrition. Children from lower income families were more vulnerable, while the identity of the household breadwinner did not significantly influence outcomes. Tribal identity also mattered: Muduga children had higher odds of malnutrition compared to Irula children, while Kurumba children showed increased vulnerability, albeit not statistically significant. Family size and birth order affected nutritional risk, with larger families and later born children at greater risk, whereas longer birth intervals provided a protective effect. Maternal characteristics played a pivotal role; higher maternal education, health awareness, and income significantly reduced malnutrition risk, while maternal employment showed a protective effect, suggesting caregiving practices influence nutritional outcomes more than access to services alone. In contrast, paternal education and parental alcohol consumption had a limited direct impact. However, socio-economic marginalisation among fathers, low engagement in salaried employment, and land ownership disparities indirectly contributed to poor nutritional outcomes. Child specific factors such as birth order and individual characteristics showed weaker associations, indicating that socio-economic and maternal factors predominantly drive nutritional status.

External determinants further highlighted the importance of context in child nutrition. Environmental factors significantly affected outcomes, including safe drinking water, improved sanitation, and household cleanliness. Regression analysis indicated that access to better quality water reduced stunting,

demonstrating its protective effect. However, improved sanitation and household cleanliness showed unexpected positive associations with stunting and underweight, reflecting the complexity of infrastructural and behavioural interactions. Institutional access to healthcare, Anganwadi centres, immunisation, nutrition programs, and the Public Distribution System (PDS) provided critical structural support. However, limited or uneven access heightened nutritional risk in remote tribal hamlets. Cultural factors, such as traditional beliefs, dietary taboos, and customary feeding practices, influenced maternal and child nutrition behaviours, indirectly shaping dietary diversity and care seeking patterns.

Overall, the findings reveal that malnutrition among tribal children in Attappadi is multifactorial, driven by internal household level factors and external environmental, institutional, and cultural determinants. While household income, maternal education and awareness, and tribal identity were the most influential internal factors, access to safe water, sanitation, and institutional services emerged as key external contributors. These results highlight the need for holistic, multi-sectoral interventions combining economic empowerment, maternal education, environmental infrastructure, behaviour change, and culturally sensitive nutrition programs to effectively reduce malnutrition and promote equitable growth and development among tribal children in the region.

7.2.3 Household Deprivation and Nutritious Status

The findings of this research establish strong correlations between the household level of deprivation and child nutritional status, aged less than five years, and belonging to tribal communities in Attappadi. The findings show inequalities in deprivation levels among the three most dominant tribal communities - Irula, Muduga, and Kurumba - and their implications on rates of child malnutrition, for example, the rates of wasting, underweight, and stunting.

The distribution of household deprivation across the three tribal groups shows that the majority of Irula households (73.8%) fall under the Just Above Deprivation (JAD) category, with 25.1% in the Moderately Deprived (MD) category and only 1.1% in the Abjectly Deprived (AD) category. Kurumba households have the highest proportion in the MD category (56%), while 36% fall into JAD, and 6.7%

experience AD. Muduga households primarily fall under JAD (65%), followed by MD (32%) and AD (2%). The Well Above Deprivation (WAD) category is negligible across all groups (0.3%). The chi-square test confirms a statistically significant association between deprivation levels and tribal groups. The results indicate that Kurumba households face the highest deprivation levels, whereas Irula and Muduga households are predominantly categorised under JAD. These disparities emphasise the need for targeted government interventions to improve socio-economic conditions in tribal communities through better education, economic opportunities, and essential services such as potable water and sanitation. The Chi-square test for wasting status and household deprivation produced a χ^2 value of 277.199 with 6 degrees of freedom. The Cramer's V score of 0.471 suggests a strong relationship between these variables. The Fisher's Exact Test yielded a p-value of 0.000, confirming a statistically significant association ($p < 0.01$). The null hypothesis (H_0) is rejected, indicating that household deprivation significantly influences wasting among tribal children.

The distribution of wasted children (0-59 months) based on household deprivation explains that among children from AD households, 3.7% suffer from severe malnutrition, while 0.3% experience moderate malnutrition. The highest prevalence of severe wasting is found among MD households (92.6%), while JAD households report 90.9% moderate malnutrition. The chi-square test statistically defines significant correlations between household deprivation and wasting levels. The findings reveal that the most at risk are children from MD homes, and need urgent interventions such as enhancing food security programs and enhancing healthcare access.

The Chi-square test assessed the association between underweight and domestic deprivation, which recorded a χ^2 of 49.933 with 6 degrees of freedom. The Cramer's V of 0.200 indicates a moderate relationship between the concerned variables. Fisher's Test also provided a p-value of 0.000, indicating statistical significance at 1%. The null hypothesis (H_0) is thus rejected, and a significant relationship exists between household deprivation and the underweight condition. In AD households, 40% of children are underweight. In MD households, 60%

experience severe underweight, and 17.6% fall into the moderate category. JAD households report lower severe underweight cases, with 82.2% showing moderate underweight and 50% classified as normal weight. WAD households show minimal underweight cases (0.2%).

The Chi-square test for stunting status yielded $\chi^2 = 13.011$ with 6 degrees of freedom and a Cramer's V value of 0.102, indicating a weak association. The p-value of Fisher's Test was 0.029, which is significant at a 5% level ($p < 0.05$). Thus, the null hypothesis (H_0) is rejected, confirming that household deprivation significantly influences stunting among tribal children. Among AD households, 2.5% of children experience severe stunting, while 1% are moderately stunted. In MD households, 40.5% suffer from severe stunting, with 28.1% in the moderate category. The highest proportion of stunted children is observed in JAD households, with 55.7% severely stunted and 70.6% moderately stunted. The WAD group has minimal cases (1.3% severe, 0.3% moderate). The results indicate that stunting is significantly prevalent among children from MD and JAD households, highlighting the need for enhanced nutritional assistance, improved sanitation, and maternal education programs to mitigate stunting rates.

The Chi-square test for household deprivation and the presence of feeding mothers resulted in $\chi^2 = 5.027$ with 3 degrees of freedom. The Cramer's V value of 0.090 indicates a weak relationship. The Fisher's Exact Test yielded a p-value of 0.115, which is not statistically significant ($p > 0.05$). Thus, the null hypothesis (H_0) is not rejected, indicating that household deprivation does not have a significant association with the presence of feeding mothers. The data on feeding mothers across deprivation levels indicate that 79.2% of children do not have a feeding mother, while 20.8% do. The highest proportion of feeding mothers is found in MD households (35.4%), followed by JAD households (60.8%). The chi-square test indicates no statistically significant association between deprivation levels and the presence of a feeding mother.

The regression estimates the association between household deprivation and wasting. The findings indicate that none of the household deprivation categories has a statistically significant impact on wasting. The coefficients for MD (0.06737),

JAD (1.99133), and WAD (1.47833) are all insignificant, implying that other factors such as dietary diversity, healthcare access, and environmental conditions may contribute more to wasting among tribal children. Table 6.7 examines the relationship between household deprivation and underweight. The coefficient for MD (1.769) is not significant, while the coefficient for JAD (4.746) suggests a weak significance at the 10% level. The WAD category (2.236) does not significantly affect underweight status. These findings imply that children from JAD households are at greater risk of being underweight, but further investigation is required to establish stronger associations. The association between household deprivation and stunting demonstrates significant effects for MD (coefficient = 3.706) and JAD (coefficient 4.327). The WAD category does not significantly influence stunting levels. These results emphasise the need for targeted nutritional interventions, improved household food security, and awareness programs to reduce stunting among tribal children.

The findings on total household deprivation and its association with malnutrition indicators. The household total deprivation coefficient is 0.4698, reflecting a highly positive correlation with wasting. Similarly, the underweight coefficient is 0.8483, indicating that deprivation levels at the household level are related to higher underweight among tribal children. The regression results in Table 7.13 confirm a strong correlation with stunting, with a coefficient of 0.38. All these findings establish the central role of household deprivation in influencing child malnutrition and indicate the imperative of holistic policy interventions for socio-economic development and nutritional well-being in tribal society.

7.2.4 Association Between Nutritional Status and Nutritional Factors

The findings of the study reveal significant deficiencies in the dietary intake of tribal children in Attappadi, particularly in micronutrient rich food groups. Severe deficiencies were noted in the consumption of green leafy vegetables (97.6%-98.6%), fruits (97.3%-98.8%), and fats and oils (99%-99.5%) across all age groups. Pulses, which are an essential source of protein, also experienced generalised deficiency (80.2%-81%), leading to possible protein energy malnutrition. Cereals and millets, however, experienced relatively lower deficiency, with just 5.6% of

children under 12 months experiencing poor intake; this deficiency rose in the case of older children (41.8% and 25.2%). Intake of root and tuber followed the same trend, being better in younger children (3% deficiency) but decreasing with age. Milk and milk products experienced high rates of deficiency (87.1%-89.5%), reflecting the need for diet diversification and enhanced access to nutrient rich foods, especially for older children.

Micronutrient deficiencies remain a pressing concern among tribal children in Attappadi. Vitamin A deficiency was critically high across all age groups, with 97.2% of children under 12 months and 94% of older children failing to meet the recommended dietary allowance (RDA). Calcium deficiency was also severe (89.0%-93.4%), posing potential risks for bone health. Riboflavin (83.3%-92.3%), zinc (71.1%-80%), and iron (57.1%-78.3%) deficiencies were also highly prevalent, which could lead to anaemia and weakened immune function. Although protein deficiency was relatively low (7.6%) in infants and absent among older children, deficiencies in thiamin, niacin, and folate were concerning, with a decline in severity as children aged. The findings highlight the need for nutrition oriented interventions to prevent vitamin A, calcium, and iron deficiencies and improve the general health and growth condition of tribal children.

The assessment of dietary intake practices shows widespread deficiencies in key micronutrients. The prevalence of energy deficiency remained high, affecting 69.1% of the infants, with a mild reduction with advancing age (55.3% in children aged > 35 months). In addition, fat deficiency was highly prevalent (48.0%-70.5%), which is likely to affect cognitive development. Finally, the uniformly poor calcium intake (87.9%-89.8%) is a significant risk for bone health related disorders. Iron (41.3%-67.5%), zinc (64.9%-97.6%), and vitamin A (88.5%-94.2%) deficiencies were equally concerning, with possible implications for anaemia and immune dysfunction. While folate and riboflavin deficiencies persisted, they were particularly evident among older children. Thiamin and niacin deficiencies also remained a concern. These findings point to the imperative need for personalised nutrition interventions to avert the deficiencies of macronutrients and micronutrients and provide the best growth and health for the tribal children in

Attappadi. The findings show a critical imbalance in the food consumption patterns of Attappadi tribal children. An overwhelming 86.7% of children fell into the low food consumption category, with the Kurumba tribe being the most affected (100% of children with low dietary diversity), followed by the Muduga tribe (97%) and the Irula tribe (82.2%). Only 13.3% of children had a moderate Child Food Consumption Score (CFCS), with no representation from the Kurumba tribe. The findings reflect a high-risk of malnutrition, stunting in growth, and adverse health outcomes from acute food and nutritionally poor diet deficiencies. Socio-economic barriers, distance, and limited access to nutrient rich foods worsen the disparities.

A strong relationship between CFCS and malnutrition indicators such as wasting, underweight, and stunting was evident in the findings. For wasting, the Chi-square test yielded $\chi^2 = 25.714$, $df = 2$, Cramer's $V = 0.203$, and Fisher's p -value = 0.000. It indicates a statistically significant relationship between wasting and the CFCS category, leading to rejection of H_0 . Children with low CFCS scores exhibit higher rates of wasting. Among children with low CFCS, 100% were severely wasted, 95.1% were normal, and 81.5% were moderately wasted. In contrast, among children with moderate CFCS, 18.5% were moderately wasted, 4.9% were normal, and none were severely wasted. The results reinforce the connection between inadequate nutritional consumption and malnourishment, necessitating efficient community-based interventions, enhanced access to food sources, and state backed nutritional interventions designed to reduce wasting and enhance child welfare in Attappadi. The Chi-square test results for underweight status and CFCS yielded $\chi^2 = 33.737$, $df = 2$, Cramer's $V = 0.232$, and Fisher's p -value = 0.000. The findings confirm a strong association, rejecting the null hypothesis (H_0). Underweight prevalence is significantly higher among children with low CFCS scores. Malnutrition was more prevalent among children with low CFCS, with 100% of severely malnourished children falling into this category. Additionally, 82.2% of moderately malnourished children and 93.6% of children with normal nutritional status were also in the low CFCS group. No cases of severe malnutrition were found among children with moderate CFCS, reinforcing the strong link between dietary diversity and malnutrition outcomes.

The Test yielded a Chi-square value (χ^2) of 8.180 with 4 degrees of freedom (df=4). The association strength, measured by Cramer's V (0.081), indicates a weak relationship between CDDS and stunting. The Fisher's Exact Test p-value is 0.094, which exceeds the 0.05 threshold, indicating that the relationship is not statistically significant at the 5% level. We fail to reject the null hypothesis (H_0) since the p-value exceeds 0.05. It suggests that dietary diversity is not significantly associated with stunting among tribal children in the sample. While poor dietary diversity is prevalent among stunted children, other factors may play a more dominant role in influencing height-for-age outcomes.

The Chi-square test for stunting and CFCS resulted in $\chi^2 = 15.963$, df = 2, Cramer's V = 0.160, and p = 0.000. The statistically significant result leads to rejection of H_0 , suggesting that stunting is more prevalent in children with lower CFCS scores. The Test produced a Chi-square value (χ^2) of 25.978 degrees of freedom (df = 4). As indicated by Cramer's V, the association strength was 0.144, suggesting a weak but significant relationship between CDDS and underweight. The Fisher's Exact Test yielded a p-value of 0.000, which is highly significant at the 1% level (p < 0.01). We reject the null hypothesis (H_0) since the p-value is below 0.05, confirming a statistically significant association between CDDS and underweight. The study also found that stunting was significantly associated with food consumption patterns. Among children with low FCS (86.7%), 97.5% suffered from severe stunting, 82.7% from moderate stunting, and 91.1% had normal height-for-age. In contrast, only 2.5% of children with moderate FCS experienced severe stunting, 17.3% experienced moderate stunting, and 8.9% had normal height-for-age. These results indicate the necessity for nutrition sensitive policies, enhanced food security, and diet diversity to lower stunting in tribal children of Attappadi.

A strong association was also observed between CFCS and the presence of feeding mothers in households. Among children in the low CFCS category, 86.1% did not have a feeding mother present, while 89.2% did. In the moderate CFCS group, 13.9% did not have a feeding mother, and 10.8% had a feeding mother. It indicates that food insecurity was a significant issue even in the feeding mother households. It necessitates better maternal nutrition programs, i.e., special food security

programs, and efforts to increase diet diversification to improve child nutrition in Attappadi.

Regression analysis confirmed the relationship between food consumption patterns and child malnutrition indicators. The regression coefficient for moderate CFCS consumption on wasting indicated that children with moderate CFCS had higher wasting levels than those with low CFCS. Similarly, the regression analysis for underweight showed a positive and significant relationship between moderate CFCS consumption and improved weight-for-age index. For stunting, moderate CFCS was positively associated with height-for-age scores, emphasising that improving dietary diversity positively impacts child growth.

In addition, CFCS and maternal BMI showed a high positive correlation, showing that various foods are crucial to enhancing maternal nutritional status. These findings highlight the interlink between maternal nutrition and child well-being, further highlighting the need to strengthen food security programs and promote diversified dietary intake to improve nutritional outcomes of children and mothers in Attappadi.

The analysis of the Child Dietary Diversity Score (CDDS) among the three tribal communities in Attappadi reveals notable differences in dietary patterns. Among Irula children, a majority (72.4%) exhibit moderate dietary diversity, while 21.3% fall into the poor dietary diversity category, and only 6.2% attain high dietary diversity. In comparison, Kurumba children show 61.3% in the moderate category and 38.7% in the poor category, with no representation in the high dietary diversity group. Similarly, Muduga children display 69% in the moderate category and 31% in the poor category, with none achieving high dietary diversity. These results indicate that Irula children enjoy relatively better dietary diversity, whereas Kurumba and Muduga remain disadvantaged, reflecting food access and consumption inequities. It emphasises the need for targeted interventions to improve dietary diversity among the Kurumba and Muduga groups.

The distribution of CDDS about wasting (weight-for-height) shows that severely wasted children are predominantly concentrated in the poor dietary diversity category, with none reporting high diversity. Moderately wasted children are

primarily represented in the moderate dietary diversity group, suggesting a positive role of food diversity in reducing wasting. Normal weight children were primarily concentrated in the moderate category, reinforcing the link between dietary diversity and nutritional resilience.

When examining underweight status, the findings reveal that 53.3% of severely underweight children fall under the poor dietary diversity group, while 46.7% fall under the moderate category, with none in the high diversity group. Among moderately underweight children, 59.1% had moderate dietary diversity, 35.6% poor, and 5.3% high. In contrast, nearly all children with normal weight (96.5%) exhibited moderate dietary diversity, with a small fraction (3.5%) in the high category. It highlights a strong association between poor dietary diversity and severe underweight, indicating that inadequate food variety intensifies nutritional vulnerability.

About stunting (height-for-age), the results show that 31.6% of severely stunted children belong to the poor dietary diversity group, 65.8% to moderate, and only 2.5% to high. Among moderately stunted children, 73.5% were in the moderate group, 22.9% in the poor group, and 3.6% in the high group. For children with normal height, 65.8% were in the moderate category, 26.6% in poor, and 7.6% in high. These findings suggest that better dietary diversity is associated with lower stunting, although moderate diversity alone is inadequate to eliminate growth faltering.

The regression analysis further clarifies these relationships. CDDS does not significantly influence wasting, indicating that factors beyond dietary diversity, such as socio-economic conditions and healthcare access, contribute to acute malnutrition. Similarly, the relationship between dietary diversity and underweight was not statistically significant. However, children with moderate or poor diversity were more likely to be underweight than those with high diversity. In the case of stunting, coefficients for moderate and poor dietary diversity were also insignificant, suggesting that chronic malnutrition is shaped more by broader socio-economic and environmental determinants than by dietary diversity alone.

Contrastingly, the regression findings highlight a significant relationship between

CDDS and Body Mass Index (BMI). Children with higher dietary diversity recorded better BMI scores, underscoring the importance of food variety in improving overall growth and health. It indicates that while dietary diversity alone may not fully address wasting and stunting, it plays a critical role in enhancing BMI and protecting against undernutrition.

The study reveals a clear pattern: Irula children demonstrate comparatively better dietary diversity, while Kurumba and Muduga remain disadvantaged. Poor dietary diversity is strongly linked to being underweight and contributes to wasting and stunting, though it is not the sole determinant. The absence of high dietary diversity among Kurumba and Muduga children highlights persistent inequalities in food access, pointing to the need for community-specific interventions that can improve dietary diversity and, in turn, enhance the nutritional outcomes of tribal children in Attappadi.

The findings highlight a significant association between household food insecurity, as measured by the Child Food Insecurity Access Scale (CFIAS), and the nutritional outcomes of tribal children in Attappadi. The simple linear regression results indicate that higher food insecurity levels are significantly associated with an increased prevalence of wasting among tribal children. The findings show that infants from food insecure households are likely to be affected by acute malnutrition. The value of the intercept coefficient is not statistically significant and implies that there must be other variables for the prevalence of wasting. These findings show the importance of intervention in enhancing food security and preventing acute malnutrition. Improving and strengthening current programs, such as the Public Distribution System (PDS) and mid-day meal schemes, may decrease food insecurity and enhance the health status of the children.

The regression also shows a robust positive correlation between food insecurity and underweight among children. The coefficient of the mean CFIAS score shows that with every one unit increase in food insecurity, there is a corresponding rise in the proportion of underweight children. This robust correlation statistically suggests that children in households that have high food insecurity are likely to be at risk of chronic malnutrition. To effectively implement this solution, special nutritional

interventions like supplementary feeding programs, income generating activities for tribal families, and increased access to locally available, nutrient dense foods must be undertaken.

Surprisingly, maternal BMI does not have a statistical association with food insecurity. This reflects that even though food insecurity significantly contributes to child malnutrition, it does not directly influence the nutritional status of mothers. Such findings are typical of the multidimensional nature of food insecurity and the variable impact on various demographic segments. Both maternal nutrition improvement and child malnutrition can demand a multidimensional intervention consisting of dietary diversification, enhanced access to healthcare facilities, and nutrition education programs. Overall, the findings reflect that food insecurity is a causative factor in child malnutrition in Attappadi, with significant implications for wasting and underweight in tribal children. Intervention in such a challenge demands a multidimensional intervention, which consists of policy strengthening on food security, social welfare policy promotion, and nutrition education at the community level.

7.3 Limitations of the study

1. The cross-sectional design limits causal inferences between malnutrition and related factors.
2. Self-reported data on diet, living conditions, and health behaviours may involve recall and social desirability bias.
3. Exclusion of some remote hamlets due to inaccessibility may affect generalisability.
4. Minor inconsistencies in anthropometric measurements could not be ruled out despite using standard tools.
5. The absence of clinical and biochemical assessments limits insights into micronutrient deficiencies.

7.4 Policy Recommendations

Based on the empirical findings of the study, which identified household income, maternal socio-economic characteristics, and food access as significant determinants of malnutrition among tribal children in Attappadi, the following policy

recommendations are proposed. These recommendations adopt a multisectoral, multilevel, and nutrition-sensitive framework to ensure sustainable and context-specific solutions.

7.4.1 Government Level Policy Recommendations

- Expand PDS baskets to include fortified rice, millets, pulses, eggs, and protein-rich foods.
- Ensure uninterrupted supply chains to remote tribal hamlets.
- Ensure real-time growth monitoring through digital tracking systems.
- Provide financial incentives to families adhering to:
 - Exclusive breastfeeding for six months,
 - Full immunisation schedules,
 - Regular growth monitoring visits.
- Encourage tribal households to cultivate nutrient-dense crops such as millets, pulses, and green leafy vegetables.
- Support small livestock farming (goat rearing, poultry) for protein access.
- Align MGNREGS with local food security objectives.
- Improve last-mile healthcare delivery through mobile health units.
- Introduce a comprehensive maternal nutrition and livelihood support programme targeted specifically at tribal mothers in Attappadi.

7.4.2 Community-Level Policy Recommendations

- Monitor child growth trends and oversee equitable food distribution.
- Use MGNREGS and NRLM platforms to promote collective farming.
- Support SHGs in producing millet-based weaning foods and low-cost fortified snacks.
- Train community volunteers as “Nutrition Ambassadors.”
- Provide emergency food assistance during lean seasons.
- Integrate vegetable gardens into Mid-Day Meal schemes.
- Conduct father-focused awareness programs on childcare and nutrition.

7.4.3 Household-Level Policy Recommendations

- Provide seed kits and training for growing iron- and protein-rich crops.

- Encourage cultivation of drumstick, spinach, legumes, and seasonal vegetables.
- Reinforce exclusive breastfeeding for six months.
- Promote timely and adequate complementary feeding practices.
- Ensure safe drinking water and toilet facilities.
- Promote culturally rooted dietary practices.

7.4.4 Institutional-Level Policy Recommendations

- Provide advanced training for Anganwadi workers and ASHAs on:
 - Early detection of malnutrition,
 - Nutrition counselling,
 - Maternal and child healthcare practices.
- Use digital health records for real-time malnutrition tracking.
- Promote referral mechanisms for severe acute malnutrition cases.
- Customise Take Home Ration (THR) packages to tribal nutritional requirements.

7.4.5 Political and Administrative Policy Recommendations

- Increase targeted funding for tribal nutrition programs.
- Ensure transparent utilisation of funds.
- Introduce real-time dashboards to track malnutrition indicators.
- Conduct third-party evaluations of nutrition programs.
- Integrate agriculture, health, tribal welfare, and rural development departments under a unified nutrition strategy.
- Digitise food distribution and social security delivery.
- Encourage community-level social audits.

The study highlights that malnutrition in Attappadi is not merely a health issue but a multidimensional socio-economic challenge. Addressing it requires coordinated policy convergence across governance levels. A sustainable reduction in tribal child malnutrition can be achieved through:

- Strengthening household income.
- Enhancing maternal socio-economic empowerment.

- Improving institutional service delivery and
- Promoting culturally rooted nutrition-sensitive policies.

A multi-component, evidence-based policy framework, grounded in local realities and supported by strong political commitment, is essential for achieving long-term nutritional security among tribal children in Attappadi.

7.5 Conclusion

This comprehensive study of malnutrition among tribal children under five years old in Attappadi Block Panchayat, Kerala, reveals a critical public health crisis requiring immediate intervention. The research, encompassing 625 children from Irula, Muduga, and Kurumba tribes, demonstrates alarming prevalence rates of wasting (67.5%), underweight (67.4%), and stunting (74.7%), with Kurumba and Muduga children experiencing the most severe malnutrition. The findings establish strong correlations between household deprivation and malnutrition indicators (wasting: $r = 0.4698$, underweight: $r = 0.8483$, stunting: $r = 0.38$) while identifying household income, tribal identity, maternal nutrition awareness, and dietary diversity as significant predictors. Severe deficiencies in micronutrient rich foods, particularly green leafy vegetables (97.6%-98.6%) and fruits (97.3%-98.8%), compound the nutritional crisis. The multi-factorial analysis reveals that 86.7% of children fall into low food consumption categories, with environmental and institutional factors significantly contributing to poor outcomes. These findings necessitate comprehensive, multi-sectoral interventions addressing poverty alleviation, nutrition education, food security enhancement, and healthcare system strengthening. The evidence calls for urgent government-level policy reforms, community-based nutrition programs, household-level dietary improvements, and institutional capacity building to address this humanitarian crisis and ensure the fundamental right to adequate nutrition for tribal children in Attappadi.

7.6 Addressing the Research Gap

The present study addresses critical gaps in research on malnutrition among tribal children under five in Attappadi, where previous studies have often treated tribal communities as homogeneous. Distinct tribes - Irula, Muduga, and Kurumba -

possess unique socio-cultural practices, dietary habits, and livelihoods that influence nutritional outcomes, yet tribe specific analyses remain scarce. National surveys like NFHS provide general trends but overlook community-specific issues, including the impact of household deprivation, traditional food systems, and local dietary practices.

This study adopts a tribe specific, mixed methods approach to examine the prevalence and determinants of malnutrition, integrating both internal and external factors. Internal determinants include household economic status, maternal education and awareness, family size, and child-specific characteristics. External determinants cover environmental conditions, access to health and nutrition services, and cultural practices. The research employs the Household Deprivation Score (HDS) to quantify household-level poverty. At the same time, the Child Dietary Diversity Score (CDDS), Child Food Consumption Score (CFCS), and Child Food Insecurity Access Scale (CFIAS) Score assess diet quality, food security, and nutrient adequacy.

Quantitative data were collected from 625 children across 25 tribal hamlets, complemented by qualitative insights from parents, community elders, tribal promoters, and Anganwadi workers. Regression analyses and Chi-square tests reveal inter-tribal differences in malnutrition and highlight the protective role of maternal education, household income, and safe water access. Cultural norms, partial sanitation improvements, and limited institutional support further influence outcomes.

By combining tribe specific analysis with dietary and food insecurity assessments, the study fills knowledge gaps. It informs targeted, context sensitive interventions, policies, and programs to reduce malnutrition among Irula, Muduga, and Kurumba children in Attappadi.

7.7 Contribution of the Researcher

This study presents a fascinating scholarly and policy relevant contribution in analysing the complex dimensions of malnutrition in tribal children in Attappadi, Kerala, a region relegated to the periphery of mainstream nutrition research. The researcher developed an integrated framework integrating socio-economic

deprivation, dietary diversity, food security, and indigenous practices for evaluating the nutritional status of children in the 0-59 months age group from three tribes: Irula, Muduga, and Kurumba. By employing tools such as the Child Dietary Diversity Score (CDDS), Child Food Consumption Score (CFCS), and Child Food Insecurity Access Scale (CFIAS) Score, the study offers an innovative methodological approach tailored to indigenous contexts. The effort of researchers in gathering primary data from hard-to-reach tribal hamlets, ensuring cultural sensitivity, and adopting robust statistical methods has contributed valuable empirical evidence to inform academic discourse and public health interventions. The findings provide a locally grounded, evidence-based foundation for designing targeted, culturally responsive nutrition and development policies for tribal populations in India.

7.8 Areas of Future Research

The present study provides valuable information regarding malnutrition in tribal children living in Attappadi; however, some areas still need investigation. First, longitudinal research is necessary to assess the long-term impact of household deprivation, dietary diversity, and health intervention on nutritional status in children. Second, future studies may incorporate biochemical assessments to identify micronutrient deficiencies that are not detectable by anthropometric measures alone. Third, comparative studies across different tribal regions in Kerala or India could help understand cultural, ecological, and regional variations in malnutrition. Fourth, the role of maternal mental health, intra-household food allocation, and paternal involvement in child nutrition remains an underexplored area. Ultimately, mixed method approaches that combine qualitative narratives with quantitative data may offer deeper insights into the cultural beliefs and indigenous knowledge systems that influence child feeding and health practices.

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APPENDIX

APPENDIX – I

CHILD MALNUTRITION SCHEDULE

Dear caretakers of children,

I am Rosy V O, a part-time research scholar in the Department of Economics, University of Calicut, Dr. John Mathai Centre, Aranattukara, Thrissur. As part of my doctoral study titled “Dimensions of Malnutrition Among Tribal Children in Attappadi Block Panchayat, Palakkad District, Kerala”, I am conducting this interview to collect primary data. Your information will be kept confidential and used exclusively for academic research. Participation in the study is optional, and you are free to discontinue your participation at any time without any obligation. The interview will take around 30 minutes. Your kind cooperation and consent are respectfully requested to support this

Section A: Household Identification

1. Panchayat Ward Number:
2. Household Number:
3. Name of the Respondent:
4. Religion: ☐ Hindu ☐ Christian ☐ Muslim ☐ Others (Specify):
5. Tribe: ☐ Irula ☐ Muduga ☐ Kurumba ☐ Others (Specify)
6. Type of House: ☐ Kutcha ☐ Semi-pucca ☐ Pucca
7. Type of Family: ☐ Joint ☐ Extended ☐ Nuclear
8. Family Size: ☐ 2–3 members ☐ 4–6 members ☐ More than 7 members
9. Land Ownership (in Acres): ☐ No Land ☐ <1.5 acres ☐ 1.5–3 acres ☐ >3 acre

Section B: Demographic Details of Household Members

Members	Age	Sex	Years of schooling	Occupation	Average monthly income
Mother of the child					
Father of the child					
Grandfather					
Grandmother					
Child 1					
Child 2					
Child 3					
Child 4					
Child 5					

Section C: Maternal and Childcare Practices

1. Age of Mother age at the time of childbirth (in years):
2. What is the birth order of your child? (e.g., 1st, 2nd, etc.):
3. What was the birth interval between this child and the previous one? (in years):
4. Did you avoid any specific foods during pregnancy? ☐ Yes ☐ No
5. If yes, specify:
6. Did you experience health problems during delivery? ☐ Yes ☐ No
7. If yes, specify:
8. Did you have sufficient breast milk to feed your child? ☐ Yes ☐ No
9. Have you received any information on infant/child feeding practices? ☐ Yes ☐ No
10. Number of times you breastfeed your child per day: ☐ <3 ☐ 4-6 ☐ 7-9 ☐ 10-2 ☐ >12
11. Duration of exclusive breastfeeding: ☐ <3 months ☐ 3-4 months ☐ 5-6 months ☐ >6 months
12. Are you aware of the importance of complementary feeding? ☐ Yes ☐ No
13. Age at which complementary feeding was started: ☐ <3 months ☐ 3-4 months ☐ 5-

6 months ☐ >6 months

14. Frequency of complementary feeding per day: ☐ Once ☐ 2–3 times ☐ 4–5 times ☐ Never

15. Duration of continued breastfeeding: ☐ <1 year ☐ 2 years ☐ >2 years

16. Did you receive advice from elders on complementary feeding? ☐ Yes ☐ No

17. Who takes care of the child in your absence? ☐ Mother/Father-in-law ☐ Elder Siblings ☐ Carry to Worksite ☐ Anganwadi Centre ☐ Others

18. Do you wash your hands after defecation? ☐ Yes ☐ No

19. Are you aware of basic health practices? ☐ Yes ☐ No

20. Are you aware of nutritional requirements for children? ☐ Yes ☐ No

21. Do you consume alcohol? ☐ Yes ☐ No

22. Does your husband (father of the child) consume alcohol? ☐ Yes ☐ No

23. Who is the main breadwinner in your household? ☐ Father ☐ Mother ☐ Grandfather ☐ Grandmother

24. Do you have access to healthcare services? ☐ Yes ☐ No

25. Does your household have access to electricity? ☐ Yes ☐ No

26. Is there a drinking water facility within your residence? ☐ Yes ☐ No

27. Does your household have a toilet facility within the premises? ☐ Yes ☐ No

28. Does your household own a: ☐ Radio ☐ Mobile Phone ☐ TV (tick all applicable)

29. Does any household member have regular wage employment? ☐ Yes ☐ No

30. Does any household member participate in community meetings? ☐ Yes ☐ No

Section D: Attitudinal Statements

Choose most suited: ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree)

1. Our income is sufficient for nutritional and health needs.
2. The education of the father helps ensure proper child nutrition.
3. Land size contributes to the nutrition and health of our child.
4. The education of the mother influences childcare positively.
5. The mother maintains hygiene in child care.
6. The mother is aware of essential child nutrition practices.
7. Feeding practices are age-appropriate for the child.

8. The child is in good health overall.
9. Birth spacing has helped improve child nutrition and care.
10. Birth order has impacted the nutritional status of child.
11. Our household has improved sanitation facilities.
12. We use safe and good-quality drinking water.
13. Our household environment is clean and hygienic.
14. We have access to healthcare in our area.
15. Our child benefits from Anganwadi services.
16. Our child has received full immunisation.
17. Our child receives support from the government nutrition schemes.
18. We regularly use the Public Distribution System (PDS).
19. Cultural beliefs did not restrict my diet during pregnancy.
20. Traditional norms do not influence child feeding.
21. Social norms do not prevent us from seeking healthcare.

Section E: Anthropometric Measurements

Member	Sex	Age(Months/years)	Height (cm)	Weight (kg)	MUAC (cm)
Child 1					
Child 2					
Child 3					
Child 4					
Child 5					
Mother of the child					
Father of the child					

Section F: Child Health in the Last 12 Months

Health issues	Always	3/Month	2/Month	1/Month	Occasionally	Never
Anemic						
Cough						

Fever						
Measles						
Diarrhea						
Acute Respiratory Infection						
Others (please specify)						

Section G: Dietary Intake of the Child

Food Groups	Daily	Weekly	Monthly
Cereals & Millets (g)			
Pluses (g)			
Vegetables (g)			
Nuts, Oils, Seeds, Fats & Oils (g)			
Green Leafy Vegetables (g)			
Fruits (g)			
Dairy (Milk, etc., in ml)			
Roots & Tubers (g)			
Flesh food (meat, fish) (g)			
Spices & herbs (g)			

APPENDIX II

INTERVIEW SCHEDULE – FOCUS GROUP DISCUSSION

1. Date of FGD:
2. Place:
3. Tribal Community:
4. General educational qualification of the participants
 - a.
 - b.
 - c.
 - d.
 - e.
5. Position/Designation of participants (e.g., Mother, Father, Health Worker, Anganwadi Teacher, Tribal Promoter, Elder)
 - a.
 - b.
 - c.
 - d.
 - e.
6. Type of employment (e.g., MGNREGA Worker, Farmer, Casual Labourer, Unemployed, Government Staff)
 - a.
 - b.
 - c.
 - d.
 - e.
7. Discussion Themes and Probing Questions
 - A. Community and Household Background
 - Can you tell us about your hamlet—its history, families, lifestyle, and changes over time?
 - What are the most common health problems children face here?

B. Causes and Perceptions of Malnutrition

- How do you understand the causes of malnutrition in your children?
- What changes have you seen in the nutritional condition of children over the years?

C. Traditional Food and Feeding Practices

- What kinds of foods were traditionally consumed? Are they still available?
- Why have certain foods (like millet and greens) disappeared from the diet?
- What are your beliefs about giving children eggs, meat, or IFA syrup?

D. Roles of Mothers and Fathers in Childcare

- How do you manage work and childcare?
- What responsibilities do fathers typically take regarding the care of young children?
- Do fathers help feed, take the child to the health centre, etc.?

E. Use and Effectiveness of Government Nutrition Programs

- Are you aware of ICDS, Take-Home Ration, Community Kitchens, NRC, or PDS schemes?
- How accessible and useful are these schemes in your daily life?
- Why do some mothers prefer private hospitals for delivery or check-ups?

F. Education, Early Marriage, and Empowerment of Women

- At what age do most girls marry here?
- Do women have a say in family decisions, work, or the health of their children?
- How can education and skill training help reduce malnutrition?

G. Challenges and Recommendations from the Community

- What difficulties do you face in accessing healthcare, nutrition, or livelihood?
- What should the government, health workers, or NGOs do to improve the nutrition of children in your village?
- What would you say if asked to suggest changes in these schemes?

APPENDIX – III

Table 1
WHO Region-Wise Stunting Prevalence Among Children
Under 5 Years (% height-for-age <-2 SD)

Year	Global	Africa	Americas	South-East Asia	Europe	Eastern Mediterranean	Western Pacific
1990	40.2	46.6	16.9	60.5	14.5	41.1	35.6
1991	39.6	46.7	17.0	59.3	14.1	39.6	35.0
1992	39.0	46.6	17.0	58.0	13.8	38.3	34.1
1993	38.2	46.3	16.8	56.6	13.4	37.1	33.0
1994	37.5	46.0	16.6	55.3	13.1	36.1	31.7
1995	36.7	45.6	16.2	53.9	12.7	35.2	30.1
1996	35.8	45.0	15.8	52.5	12.4	34.5	28.4
1997	35.0	44.4	15.3	51.2	11.9	33.9	26.6
1998	34.2	43.9	14.8	50.0	11.5	33.5	24.9
1999	33.5	43.4	14.3	49.0	11.1	33.3	23.3
2000	33.0	43.0	13.8	48.2	10.8	33.3	21.9
2001	32.5	42.7	13.4	47.6	10.4	33.4	20.7
2002	32.2	42.3	13.0	47.1	10.2	33.6	19.7
2003	31.8	42.0	12.7	46.6	9.9	33.9	18.6
2004	31.5	41.6	12.3	46.1	9.7	34.0	17.6
2005	31.1	41.1	12.0	45.6	9.4	34.1	16.8
2006	30.7	40.7	11.8	45.1	9.1	34.1	16.0
2007	30.1	40.1	11.4	44.4	8.8	34.0	15.3
2008	29.5	39.3	11.1	43.6	8.4	33.6	14.6
2009	28.7	38.4	10.7	42.6	8.1	33.1	13.8
2010	27.9	37.5	10.4	41.5	7.7	32.5	13.1
2011	27.1	36.6	10.0	40.3	7.3	31.8	12.4
2012	26.3	35.8	9.8	39.2	7.0	31.0	11.8
2013	25.7	35.1	9.6	38.1	6.8	30.2	11.4
2014	25.1	34.5	9.5	37.0	6.5	29.5	11.0
2015	24.6	34.0	9.4	36.1	6.3	28.9	10.8
2016	24.1	33.6	9.4	35.3	6.1	28.3	10.5
2017	23.7	33.2	9.3	34.4	5.9	27.7	10.3
2018	23.3	32.8	9.3	33.5	5.7	27.1	10.1
2019	23.0	32.3	9.3	32.6	5.5	26.5	9.9
2020	22.7	31.8	9.3	31.8	5.3	26.0	9.9
2021	22.5	31.4	9.2	30.9	5.1	25.5	9.8
2022	22.3	31.0	9.2	30.1	4.9	25.1	10.0

Source: Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Stunting: 1990-2020, <https://apps.who.int/gho/data/view.main.NUTWHOSTUNTINGv?lang=en>

Table 2
WHO Region-Wise Underweight Prevalence Among Children
Under 5 Years of Age (% weight-for-age <-2 SD)

Year	Global	Africa	America	South-East Asia	Eastern Mediterranean	Western Pacific
1990	24.5	28.5	4.3	48.8	22.7	16.0
1991	23.9	28.0	4.2	47.9	22.2	15.1
1992	23.4	27.5	4.0	47.1	21.8	14.2
1993	23.1	27.0	3.9	46.2	21.4	13.4
1994	22.8	26.5	3.8	45.3	21.0	12.6
1995	22.5	26.0	3.7	44.4	20.6	11.8
1996	22.3	25.5	3.6	43.5	20.1	11.1
1997	21.9	25.0	3.5	42.7	19.7	10.4
1998	21.5	24.6	3.4	41.8	19.4	9.8
1999	20.9	24.1	3.3	40.9	19.0	9.2
2000	20.5	23.6	3.2	40.1	18.6	8.6
2001	20.0	23.2	3.1	39.2	18.2	8.1
2002	19.6	22.7	3.0	38.4	17.8	7.6
2003	19.2	22.3	2.9	37.6	17.5	7.1
2004	18.8	21.9	2.8	36.7	17.1	6.7
2005	18.4	21.4	2.7	35.9	16.8	6.2
2006	18.0	21.0	2.7	35.1	16.4	5.8
2007	17.6	20.6	2.6	34.3	16.1	5.5
2008	17.1	20.2	2.5	33.5	15.7	5.1
2009	16.7	19.8	2.4	32.7	15.4	4.8
2010	16.2	19.4	2.4	31.9	15.1	4.5
2011	15.8	19.0	2.3	31.2	14.8	4.2
2012	15.3	18.6	2.2	30.4	14.4	3.9
2013	14.9	18.2	2.1	29.7	14.1	3.7
2014	14.5	17.9	2.1	28.9	13.8	3.4
2015	14.1	17.5	2.0	28.2	13.5	3.2
2016	13.7	17.1	2.0	27.5	13.2	3.0
2017	13.4	16.8	1.9	26.8	13.0	2.8
2018	13.1	16.4	1.8	26.1	12.7	2.6
2019	12.9	16.1	1.8	25.4	12.4	2.4
2020	12.6	15.7	1.7	24.8	12.1	2.3

Source: Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Underweight:1990-2020

Table 3
WHO Region-Wise Overweight Prevalence Among Children
Under 5 Years of Age 7(% weight-for-height >+2 SD)

Year	Global	Africa	Americas	South-East Asia	Europe	Eastern Mediterranean	Western Pacific
1990	5	4.3	6.1	2.6	6.9	6.4	6.1
1991	4.9	4.2	6.2	2.4	6.8	6.3	6.0
1992	4.8	4.2	6.3	2.3	7.1	6.2	5.9
1993	4.9	4.2	6.3	2.4	7.6	6.1	5.8
1994	4.9	4.2	6.4	2.5	8.0	6.1	5.7
1995	4.9	4.3	6.5	2.5	8.2	6.2	5.6
1996	5.0	4.5	6.6	2.6	8.3	6.3	5.6
1997	5.0	4.7	6.7	2.7	8.4	6.5	5.5
1998	5.1	4.9	6.8	2.7	8.4	6.7	5.5
1999	5.2	5.3	6.9	2.7	8.6	6.9	5.5
2000	5.3	5.6	7.0	2.7	8.7	7.1	5.5
2001	5.4	6.0	7.1	2.7	8.9	7.3	5.5
2002	5.5	6.3	7.2	2.7	9.1	7.5	5.5
2003	5.6	6.3	7.3	2.6	9.4	7.7	5.6
2004	5.6	6.2	7.4	2.6	9.6	7.9	5.6
2005	5.6	5.8	7.4	2.7	9.7	8.0	5.6
2006	5.6	5.4	7.5	2.7	9.9	8.0	5.7
2007	5.5	5.0	7.5	2.7	9.9	8.0	5.7
2008	5.5	4.6	7.6	2.8	9.9	7.9	5.8
2009	5.5	4.4	7.6	2.9	9.9	7.8	5.9
2010	5.5	4.2	7.7	3.0	9.7	7.6	6.0
2011	5.5	4.1	7.7	3.1	9.5	7.5	6.1
2012	5.5	4.0	7.8	3.2	9.3	7.3	6.3
2013	5.5	4.0	7.8	3.3	9.0	7.1	6.4
2014	5.5	3.9	7.9	3.4	8.7	7.0	6.6
2015	5.5	3.9	8.0	3.5	8.4	6.9	6.7
2016	5.5	3.9	8.0	3.6	8.1	6.8	6.9
2017	5.6	3.8	8.1	3.7	7.8	6.7	7.1
2018	5.6	3.8	8.1	3.7	7.5	6.6	7.3
2019	5.6	3.8	8.2	3.8	7.3	6.5	7.4
2020	5.6	3.8	8.3	3.8	7.2	6.4	7.6
2021	5.6	3.9	8.4	3.8	7.1	6.4	7.9
2022	5.6	3.9	8.5	3.8	7.1	6.3	8.1

Source: Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Overweight: 1990-2020

Table 4
WHO Region-Wise Wasting Prevalence Among Children
Under 5 Years of Age (% weight-for-height <-2 SD) in 2022

Region	Percentage
Global Level	6.8
Africa	5.5
Americas	0.8
South-East Asia	14.7
Eastern Mediterranean	6.9
Western Pacific	1.9

Source: Joint child malnutrition estimates (UNICEF-WHO-WB), Global Health Observatory data repository, Global and regional trends by WHO Regions, 1990-2020, Wasting: 2012-2020

Table 5
Average Daily Intake of Various Food Groups (g/day) Among
Tribal Children in Attappadi

Food Groups	<12 Months			12-35 Months			>35 Months		
	Mean	RDI	Deficiency %	Mean	RDI	Deficiency %	Mean	RDI	Deficiency %
Cereals & Millets (g)	23.6	25	5.6	93.1	160	41.8	74.8	100	25.2
Pluses (g)	6	12	50	11.9	60	80.2	9.5	50	81
Green Leafy Vegetables (g)	0.2	20	99	1.2	50	97.6	0.7	50	98.6
Other Vegetables (g)	1.3	25	94.8	15.8	100	84.2	9	100	91
Roots & Tubers (g)	19.4	20	3	44.4	50	11.2	29.9	50	40.2
Fruits (g)	0.5	40-60	98.8	2	75	97.3	1.6	60-75	97.3
Nuts & Oils seeds (g)	0.6	7	91.4	0.7	15	95.3	0.7	10	93
Milk & Milk Products (ml)	61.1	494	87.5	45.1	350	87.1	36.9	350	89.5
Fats & Oils	0.1	10	99	0.1	20	99.5	0.1	20	99.5

(g)									
Flesh Foods	0.9			1.8			1.8		
Spices and herbs	0.1			0.1			0.1		

Source: Primary Data

Table 6
Average Daily Intake of Various Nutrients by Tribal Children
(Aged 0-59 Months) in Attappadi

Nutrients	<12 Months			12-35 Months			>35 Months		
	Median	RDA	Deficiency %	Median	RDA	Deficiency %	Median	RDA	Deficiency %
Protein (g)	9.7	10.5	7.6	12.7	12.5	-	17.6	15.9	+10.7
Fat (g)	5.2			5.9			7.9		
Energy (Kcal)	209.9			433.5			608.0		
Calcium (mg)	19.8	300	93.4	40.9	450	90.9	60.7	550	89.0
Iron (mg)	1.3	6	78.3	3.3	8	58.75	4.7	11	57.1
Vitamin-A (µg)	9.9	350	97.2	19	390	95.1	27.6	510	94.6
Thiamin (mg)	0.2	0.4	50	0.3	0.7	57.1	0.4	0.9	55.6
Riboflavin (mg)	0.1	0.6	83.3	0.1	1.1	90.9	0.1	1.3	92.3
Niacin (mg)	1.4	5	72	2.2	7	68.6	3.1	9	65.6
Vitamin C (mg)	2.4	30	92	5.8	30	80.7	7.3	35	79.1
Total Folate (µg)	25.3	85	70.2	39.5	120	67.1	55.7	135	58.7
Zinc(mg)	0.5	2.5	80	0.9	3.3	72.7	1.3	4.5	71.1

Source: Primary Data

Table 7
Average Daily Intake of Various Nutrients by Tribal Children
Aged 0-59 Months in Attappadi

Food Groups	<12 Months			12-35 Months			>35 Months		
	Median	EAR	Deficiency %	Median	EAR	Deficiency %	Median	EAR	Deficiency %
Protein (g)	9.7	8.8	-	12.7	10.2	-	17.6	12.8	-
Fat (g)	5.2	10	48.0	5.9	20	70.5	7.9	20	60.5
Energy (Kcal)	209.9	680	69.1	433.5	1110	60.9	608.0	1360	55.3
Calcium (mg)	19.8			40.9	400	89.8	60.7	500	87.9
Iron (mg)	1.3	4	67.5	3.3	6	45.0	4.7	8	41.3
Vitamin-A (µg)	9.9	170	94.2	19	180	89.4	27.6	240	88.5
Thiamin (mg)	0.2			0.3	0.6	50.0	0.4	0.8	50.0
Riboflavin (mg)	0.1			0.1	0.8	87.5	0.1	1.1	90.9
Niacin (mg)	1.4	5	72	2.2	6	63.3	3.1	8.0	61.3
Vitamin C (mg)	2.4			5.8	24	75.8	7.3	27	73.0
Total Folate (µg)	25.3	71	64.4	39.5	97	59.3	55.7	111	49.8
Zinc(mg)	0.5	21	97.6	0.9	2.8	67.9	1.3	3.7	64.9

Source: Primary Data