COMPREHENSIVE NUTRITION ASSESSMENT OF TRIBAL POPULATION IN ATTAPPADI TALUK, KERALA - A RAPID EXPLORATORY STUDY

ICMR-National Institute of Nutrition
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Comprehensive Nutrition Assessment of Tribal Population in *Attappadi* Taluk, Kerala:

A Rapid Exploratory Study

ICMR-NATIONAL INSTITUTE OF NUTRITION (NIN)
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Sincerely,

Authors

ABBREVIATIONS

ANC	Antenatal care
ARDS	Acute Respiratory Distress Syndrome
ARI	Acute Respiratory Infection
ASHA	Accredited Social Health Activist
AWW	Anganwadi Worker
BMI	Body Mass Index
CED	Chronic Energy Deficiency
CHC	Community Health Centre
CNNS	Comprehensive National Nutrition Survey
DMO	District Medical Officer
ICDS	Integrated Child Development Services
IEC	Institutional Ethical Committee
IFA	Iron Folic Acid
ITDP	Integrated Tribal Development Project
IYCF	Infant and Young Child Feeding
JHI	Junior Health Inspector
JPHN	Junior Public Health Nurse
LBW	Low Birth Weight
LPG	Liquified Petroleum Gas
LSG	Local Self Government
MAD	Minimum Acceptable Diet
MAM	Moderate Acute Malnutrition
MDD	Minimum Diet Diversity
MDM	Mid-day Meal
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MUAC	Mid-Upper Arm Circumference
NFHS	National Family Health Survey
NPNL	Non-pregnant and non-lactating
NRC	Nutrition Rehabilitation Centre
NRLM	National Rural Livelihood Mission
PDS	Public Distribution System
PHC	Primary Health Centre
PNC	Postnatal care
PO	Project Officer
PRIs	Panchayati Raj Institutions
RDA	Recommended Dietary Allowance
RDI	Recommended Dietary Intake
SAC	Scientific Advisory Committee
SAM	Severe Acute Malnutrition
SDG	Sustainable Development Goal
THR	Take-home Ration
TT	Tetanus Toxoid

EXECUTIVE SUMMARY

Poor nutrition has been one of the most severe health issues that several indigenous people worldwide experience. India has over 100 million tribal populations, and they are one of our country's most underserved segments of the population. The ICMR-NIN has conducted a community-based cross-sectional study in *Attappadi* which is one of the tribal inhabitations in India with a high burden of malnutrition and poor health outcomes. In this survey, we evaluated the nutritional status of young children (0 to 59 months), children (5 to 9 years), adolescent girls (10 to 19 years), currently pregnant women (15 to 49 years), and lactating mothers (of children 0 to 11 months). This survey covered 480 households, 523 children (0-59 months), 150 adolescent girls (10-19 years), 40 pregnant women, and 110 lactating mothers from 20 tribal villages. Data collection was conducted between 16 May 2022 and 6 June 2022.

The sample households comprised 77.5% *Irula* tribes, 13.3% *Kurumba* tribes, and 9% *Muduga* tribes. In *Attappadi*, *Pucca* dwellings accounted for 49.2% of all households. Electricity was present in the majority of households (83.7%), and 74% of the households had sanitation facilities and were using them. Nuclear families (couples with children) are the dominant norm in the community. A large majority of the tribal households were either landless or had only marginal landholdings. MGNREGP was one of the primary sources of livelihood for about 89% of households. Access to PDS, ICDS, and MDM was almost universal. The prevalence of alcohol use was rampant in the community, with 46.8% of men and 1.9% of women consuming them at least once a week. Tobacco use was 48.8% and 37.1% respectively among men and women.

Among the children (0-59 months), the prevalence of underweight, stunting, and wasting was 48.3%, 40.9%, and 27.4%, respectively. Moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) were 7.6% and 19.8%, respectively. Overall, six in every 10 children included in the survey had anthropometric failures of any form. Among children (5-9 years), 35.5% were thin, and 4.2% were overweight/obese. The prevalence of thinness and overweight/obesity among adolescent girls (10-19 years) were 20.9% and 10.5%, respectively.

Of the total 40 pregnant women, 14 were of low height (<145 cm) or low weight (<39 kg), and two had both conditions. Among lactating mothers, 40% had chronic energy deficiency (BMI < 18.5 kg/m^2), and

15% had overweight/obesity (BMI ≥25 kg/m^2). Almost one-third (30.6%) of the adult population (age 18+) in the tribal hamlets of *Attappadi* were suffering from chronic energy deficiency (CED). The prevalence of CED was more among women (33.2%) than men (22.9%). The prevalence of overweight/obesity among adult tribal males and females was 12.2% and 13.4%, respectively.

Except for roots & tubers, the daily intake of all food groups (cereals & millet, pulses & legumes, green leafy vegetables, non-leafy vegetables, milk and milk product, fats & oils, and sugar, and jaggery) was insufficient to meet the Recommended Dietary Intake (RDI) among children (1-12 years). Adult men and women (sedentary and moderate) consumed sufficient amounts of pulses & legumes and roots & tubers. However, consumption of all other food groups was well below the RDI. For pregnant women and lactating mothers, most foods such as cereal and millet, non-leafy vegetables, milk & milk products were lower than the recommended levels.

Protein intake was found to be adequate among children (1-6 years). However, intake of most of other nutrients were deficient. The median dietary intake of calcium was much lower than the Recommended Dietary Allowance (RDA), leaving many children with calcium intake inadequacy. Many children needed more iron and Vitamin C in their diet. Dietary intakes of vitamin A, riboflavin, niacin, and thiamine needed to be increased. The children's diet was marginally inadequate to provide sufficient zinc and folate. Among children (7-12 years), the median intakes of various nutrients except for protein and total folate were lower than the RDA.

The median intakes of various nutrients except protein were lower than the recommended RDAs among adult males. For non-pregnant and non-lactating women of sedentary physical activity, intake was adequate for protein, energy, niacin, and folate. Among the pregnant women, the median intakes of all the nutrients except for vitamin C were less than the recommended RDAs. The intakes of calcium, iron, vitamin A, and free folic acid were grossly deficient as against their RDAs. The lactating mothers consume a diet that is marginally deficient in protein and energy and unacceptably deficient in fat, calcium, iron, vitamin A, thiamine, riboflavin, niacin, vitamin C, and folic acid.

The overall prevalence of anaemia in children (aged 12-59 months) was 91.2%. The prevalence was highest (97.7%) in the youngest children (12-23 months) with 16.7% severe anaemia. Anaemia is a

severe public health problem affecting almost all adolescent girls (96.6%) in the tribal population of *Attappadi*. Most adolescent girls have mild (53.4%) or moderate (42.1%) anaemia. The overall prevalence of anaemia among pregnant and lactating women was 86.8% and 80%, respectively.

One in every two tribal children (12-59 months) in *Attappadi* had iron deficiency (low serum ferritin). The burden of iron deficiency was higher among young children. A large number of children 12-59 months children (34.6%) in *Attappadi* had Vitamin B12 deficiency. One in every five tribal children in *Attappadi* was deficient in Vitamin D. For another 47.5% of children, the level of Vitamin D in the blood was insufficient. The highest prevalence of Vitamin D deficiency was found among children 47-59 months (25.8%). About 16% of children aged 12-59 months had folate deficiency, and 11.8% had vitamin A deficiency (VAD).

Close to 70% of mothers of children (0-35 months) reported that they put their children to breasts within one hour of delivery, and 85.4% fed yellow milk (colostrum). Among the children (0-5 months), 71.4% were exclusively breastfed. For 63.3% of children of 6-11 months, complementary feeding was started after six months.

More than 90% of the children (6-59 months) received the benefit of the supplementary nutrition programme from the ICDS. The majority (95.6%) of the mothers of children (6-35 months) reported that they get the take-home ration (THR) for their children regularly (once every month). The THR consumption among children was found to be almost universal (94.7%). Growth monitoring was found to be regular (once every month) for 72.5% of children (6-35 months) and 65.3% of children (36-59 months).

Only 50% of the children (6-35 months) and 44.6% (36-59 months) received IFA syrup. No consumption and partial consumptions were 82.3% among children (6-35 months) and 68.7% among children (36-59 months). It was found that only half (48.7%) of the children (36-59 months) received de-worming tablets in the last year. Among the children 9-35 months, 92.2% received at least one massive vitamin A supplementation the previous year. The proportion of children who received VAS was 86% for children (36-59 months).

Most mothers (63%) reported that they approach a government physician for healthcare if their children fall sick. Another 34.2% of mothers usually approach a private physician for health seeking for their children. It was found that 40.6% of the children (0-59 months) had any illness during the preceding two weeks of the survey. The common morbidities reported by the mothers for their children during the previous fortnight were fevers (27.6%), ARI (8.5%), diarrhea (5%), Dysentery (1.6%), and measles (1.4%).

Almost all (97.6%) of the currently pregnant women registered their pregnancy and started availing of ANC services. The proportion of pregnant women registered for ANC before 12 weeks of gestation was 85%, while 15% were registered after 12 weeks. Most pregnant women underwent ANC at a government hospital (75%), followed by a private hospital (25%). About 32% of the pregnant women made at least five ANC visits. All the pregnant women reported that they received advice from the ANC service provider regarding the importance of regular ANC visits, adding more green leafy vegetables to the diet, and compliance with IFA tablet consumption.

Nearly all mothers (97.8%) of children under 35 months old utilised ANC services during their last pregnancy, and 92% of those mothers had five or more ANCs. About 88% of women registered for ANC before 12 weeks of gestation. Close to 89% of women underwent ANC at government health facilities, while 10% of women underwent ANC at private hospitals. Tetanus Toxoid (TT) vaccination was given to all mothers included in the study during pregnancy, with 97.8% receiving two doses. IFA tablets were given to all the women, and the majority (93.3%) received them from a government facility. The majority of women who received IFA tablets (91%) had consumed ≥100 tablets. Almost all the women (98.5) received ICDS supplementary nutrition during their last pregnancy, and the supply of THR was regular (98.1%). Many of these women reported sharing the THR with their family members. Close to two-thirds (65.8%) of deliveries were normal and most deliveries (97.9%) occurred in health facilities. Most (96%) of the mothers reported that the birth weights of their new-borns were recorded. Of them, 99% of mothers reported that the birth weight was recorded on the day of delivery. The proportion of new-borns with low birth weight (LBW) was 41.4%. The mean birth weight of the children was 2.53 Kg. Of all women, 72.5% received cash benefits under JSY and special assistance from ITDP. Despite the relatively better functioning of the nutrition and health services, the tribal communities in *Attappadi* experience poor nutrition, and health outcomes.

FACT SHEET

No.	Indicators	
	Household characteristics	**N=480**
1	Households with *Pucca* houses (%)	49.2
2	Households with tap water (%)	44.6
3	Households using clean fuel for cooking (%)	30.8
4	Households that use a sanitation facility (%)	74.4
5	Households with electricity (%)	83.7
6	Households covered under MGNREGP (%)	88.5
7	Households covered under PDS (%)	95.8
8	Households receiving any services from ICDS (%)	90.6
	Substance use among the population (>14 years)	**N= 1120**
9	The proportion of the population (≥15 years) using alcohol (%)	21.8
10	The proportion of the population (≥15 years) using tobacco (%)	42.3
	Nutritional status of children (0-59 months)	**N=516**
11	Children who are underweight (WAZ <-2SD) (%)	48.3
12	Children who are stunted (HAZ <-2SD) (%)	40.9
13	Children who are wasted/MAM (WHZ <-2SD) (%)	27.4
14	Children who are severely underweight (WAZ <-3SD) (%)	15.5
15	Children who are severely stunted (HAZ <-3SD) (%)	13.0
16	Children who are severely wasted (WHZ <-3SD) (%) (Children with Severe Acute Malnutrition)	7.6
	Nutritional status of children (5-9 years)	**N=48**
17	Children who are thin (BAZ<-2SD) (%)	35.5
18	Children who are overweight/obese (BAZ >+2SD) (%)	4.2
	Nutritional status of adolescent girls (10-19 years)	**N=67**
19	Adolescent girls who are thin (BAZ<-2SD) (%)	20.9
20	Adolescent girls who are overweight/obese (BAZ >+2SD) (%)	10.5
	Nutritional status of lactating mothers	**N=100**
21	Women with BMI <18.5 Kg/m^2 [Underweight] (%)	40.0
22	Women with BMI ≥ 25 Kg/m^2 [Overweight/obese] (%)	15.0
	Nutritional status of adult males (≥19 years)	**N=131**
23	Men with BMI <18.5 Kg/m^2 [Underweight] (%)	22.9
24	Men with BMI ≥ 25 Kg/m^2 [Overweight/obese] (%)	12.2
	Nutritional status of adult females (≥19 years)	**N=388**
25	Women with BMI <18.5 Kg/m^2 [Underweight] (%)	33.2
26	Women with BMI ≥ 25 Kg/m^2 [Overweight/obese] (%)	13.4
	Anaemia among children (12-59 months)	**N=419**
27	Children who are anaemic (Hb <11 g/dl) (%)	91.2
28	Children who are severely anaemic (Hb <7 g/dl) (%)	5.2
	Anaemia among adolescent girls (10-19 years)	**N=88**
29	Adolescent Girls who are anaemic (Hb <12 g/dl) (%)	96.6
30	Adolescent Girls who are severely anaemic (Hb <7 g/dl) (%)	1.1
	Anaemia among pregnant women	**N=38**
31	Pregnant Women who are anaemic (Hb <11 g/dl) (%)	86.8

32	Pregnant Women who are severely anaemic (Hb <7 g/dl) (%)	2.6
	Currently pregnant women at nutritional risk	**N=38**
33	Pregnant women with severe anaemia (%)	2.6
34	Pregnant women with height <145 cm or weight <39 kg (%)	36.8
	Anaemia among lactating mothers	**N=75**
35	Lactating Mothers who are anaemic (Hb <12 g/dl) (%)	80.0
36	Lactating Mothers who are severely anaemic (Hb <7 g/dl) (%)	0
	Micronutrient deficiency among children (12-59 months)	**N=398**
37	Iron deficiency (Serum ferritin <12 ng/mL) (%)	49.9
38	Folate deficiency (Serum erythrocyte folate < 151 ng/ml) (%)	15.7
39	Vitamin B12 deficiency (Serum Vit B12 < 203 pg/nl) (%)	34.6
40	Vitamin D deficiency (Serum 25 (OH) concentration < 12 ng/mL) (%)	19.9
41	Vitamin A deficiency (Serum retinol concentration < 20 mg/dL) (%)	11.8
	Infant and Young Child Feeding Practices (IYCF)	**N=275**
42	Initiation of breastfeeding within 1 hour (%) among children (0-35 months)	69.5
	Exclusive breastfeeding (6-11 months)	**N=49**
43	Children (0-5 months) were exclusively breastfed (%)	63.3
44	Initiation of complementary feeding before 6 months (%)	36.7
	Diet Diversity and Minimum Acceptable Diet among Children (6-23 months)	**N=141**
45	Children with Minimum Diet Diversity (DDS ≥4) (%)	70.2
46	Children with Minimum Acceptable Diet (%)	50.3
	Birthweight of children (0-35 months)	**N=275**
47	Birthweight < 1500g (%)	3.1
48	Birthweight 1500g – 2499g (%)	38.3
49	The mean birth weight of the children (gms)	2530
	Children's access to health and nutrition services	
50	Children (9-35 months) received at least 1Vit-A supplementation (%)	92.2
51	Children (36-59 months) received vitamin A supplementation (%)	86.0
52	Adolescent girls received IFA tablets in the last 12 months (%)	70.0
53	Adolescent girls received deworming tablets in the 12 months (%)	52.3
	Average food and nutrient intakes	
54	Intake of cereal & millets among children (1-3 years) (gms/day)	127.7
55	Intake of milk & milk products among children (1-3 years) (ml/day)	25.8
56	Intake of protein among children (1-3 years) (gms/day)	20.8
57	Energy intake among children (1-3 years) (Kcal/ day)	711.0
58	Intake of cereal & millets among children (4-6-year) (gms/day)	165.4
59	Intake of milk & milk products among children (4-6 years) (ml/day)	41.1
60	Intake of protein among children (4-6 years) (gms/ day)	30.4
61	Energy intake among children (4-6 years) (Kcal/ day)	983.9
62	Intake of green leafy vegetables among pregnant women (gms/day)	53.4
63	Energy intake among pregnant women (Kcal/day)	1949.9

CHAPTER 1

INTRODUCTION AND METHODOLOGY

1.1 Introduction

Poor nutrition is one of the most severe health issues that most indigenous people worldwide experience [1]. Greater unmet needs for health and social services along with extreme poverty, environmental degradation, contamination of the ecosystems, loss of land, and reduced access to traditional food sources and health systems are highlighted as the primary reasons for high levels of morbidities and malnutrition among this population [2, 3]. Recognizing the need, Agenda 2030 promises to *leave no one behind*, and focus has been given to the strong engagement of indigenous peoples in achieving Sustainable Development Goals (SDGs).

India has over 100 million tribal populations, which accounts for 8.6% of the total population [4]. Despite special treatment guaranteed by the Constitution of India, tribal peoples remain one of the most undernourished and underserved segments of the Indian population. The latest available data reveals a high prevalence of stunting (40.2%), wasting (23.1%), and underweight (39.4%) among tribal children (0-59 months), affecting their survival, growth, learning, and performance in school and productivity as adults [5]. The prevalence of chronic nutrition deprivation was significantly high among the tribal children as compared to their non-tribal counterparts.

Kerala has been successful in improving the living standards of significant portions of its population. The state is often appreciated for its impressive social sector development that can be matched with that of many developed countries [6, 7]. Kerala has the country’s highest literacy rate and lowest fertility, neonatal, and infant mortality rates [4, 8]. However, despite the significant socioeconomic advancement, policymakers continue to be concerned about the marginalisation of indigenous tribes. Despite multiple coordinated initiatives to address the issues of poverty, malnutrition, and infant mortality, Kerala's indigenous community has not received the advantages of the state's socioeconomic improvement in proportion to their numbers. [9].

The recent National Family Health Survey shows deteriorating nutrition status in the tribal population. Severe deficiencies of nutrients during significant periods of growth and development will have long-term health impacts on the tribal population. This may increase the non-communicable disease burden, reduce human productivity, and perpetuate social and economic backwardness among the tribal population.

Kerala has a 4.2 lakh tribal population [4]. The tribal community has the highest rates of undernutrition, with one-third (33.2%) of children under five being stunted compared to the general children (23.4%) [5]. There have been 136 neonatal and infant deaths between 2012 and 2021 in *Attappadi* Taluk [10]. which is a high number in a State with the lowest neonatal and infant mortality rates in the country. The irony is that this enormous number of deaths occurs in the state with the lowest rates of infant and neonatal mortality in the nation. Concerning the high prevalence of malnutrition and neonatal and infant mortality, the Indian Council of Medical Research-National Institute of Nutrition (ICMR-NIN) Hyderabad conducted a comprehensive nutrition assessment survey in 2022. This survey aimed to evaluate the nutritional status of young children (0 to 59 months), children (5 to 9 years), adolescent girls (10 to 19 years), currently pregnant women (15 to 49 years), and lactating mothers of children (0 to 1 year). This study also evaluated the dietary habits of the population.

1. 2 Objectives

This survey aimed to evaluate the nutritional status of young children (0 to 59 months), children (5 to 9 years), adolescent girls (10 to 18 years), currently pregnant women (15 to 49 years), and lactating mothers of children (0 to 1 year). This study also evaluated the dietary habits of the population.

The specific objectives of the study were as follows:

1. To assess the nutritional status of children under five years in terms of anthropometry, anaemia, and micronutrient deficiencies
2. To assess the nutritional status of children (5-9 years) in terms of anthropometry
3. To evaluate the nutritional status of adolescent girls (10-19 years) in terms of anthropometry and anaemia

4. To examine the nutritional status of currently pregnant women and lactating mothers of children (0-1 year)
5. To assess the Infant and Young Child Feeding (IYCF) practices in the community.
6. To understand the access of tribal children, adolescent girls, pregnant women, and lactating mothers to various government health and nutrition services
7. To explore the diet pattern of the tribal population in the *Attappadi* Taluk.

1.3 Methodology

1.3.1 Study design

This community-based cross-sectional study adopted a quantitative and prevalence approach and a descriptive and analytical character.

1.3.2 Estimation of sample size

As per the previous nutritional assessment of children (0-59 months) in *Attappadi* by the ICMR-NIN in 2013, the prevalence of underweight (WAZ <-2SD) was 48.5%. For the current study, we estimated the sample size with a 95% Confidence Interval (CI), 20% relative precession, 15% non-response rate, and a design effect 2. We arrived at 340 children (0-59 months) as the required sample size. However, it has been decided to include at least 400 children given the probable rejection rate for collecting blood samples (to examine their micronutrient status) from children (12-59 months). It has also been planned to collect information from adolescent girls, pregnant women, and lactating mothers from the selected households with at least one child (0-59 months).

1.3.3 Selection of villages

The research team accessed the list of villages (192 villages) from the Integrated Tribal Development Project (ITDP), *Attappadi*, which is the nodal agency for coordinating interdepartmental programmes for tribal development. A total of 20 villages *(Ooru)* were randomly selected for data collection. Of these villages, ten villages reported infant deaths, and ten reported no infant deaths during the last three years (between 1 January 2019 and 1 April 2022).

1.3.4 Selection of households

From each selected village, 20 households with at least a child (0-59 months) were selected for data collection. Prior to the data collection, in each select village, the research team conducted house listing to identify households having at least one eligible child. House listing was carried out with the help of the Anganwadi worker (AWW) and Accredited Social Health Activist (ASHA) of the respective villages. From the list, 20 households with at least one eligible child were selected for data collection using a simple random sampling method. In a situation where the selected village had less than 20 children (0-59 months), data collection was extended to the adjoining village to get sufficient number of children.

1.3.5 Investigations/research tools

Investigations at the household level		
Research tool	**Respondent**	**Information collected**
Household Schedule (pre-tested and pre-coded)	Head of the household	1. Socio-economic and demographics • Religion, Tribe, Type of family, Land possession, Occupation, Income • Family size, age, sex, physiological status, • Education, occupation, and substance use habit of the members of the household • Type of house, Source of drinking water, Availability/use of sanitation facility, Availability of electricity, Fuel used for cooking, etc. 2. Nutritional anthropometry • Height, Weight, and Mid-upper arm circumference 3. Diet-24-hour diet recall for all members of the household
Children Schedule (0-59 months)	Mothers	• Demographics • Antenatal care service practice • Feeding practices • Access to ICDS services • Immunization details • Infant and Young Child Feeding (IYCF) practices • Child caring and WASH practices • Incidence of short-term morbidities and health seeking • Height/length, weight, and MUAC • Haemoglobin status • Subclinical micronutrient status (Vitamin-A, Vitamin-D, Vitamin B12, Iron, and folate)
Adolescent girls Schedule (10-19 years)	Adolescent girls (10-19 years)	• Demographics • Access to nutrition services • WASH practices • Height and weight • Haemoglobin status

Pregnant women schedule	Currently pregnant women	• Demographics • Antenatal care service practice • Height and weight • Haemoglobin status

1.3.6 Data collection

Data collection was conducted between 16 May 2022 and 6 June 2022. A team consisted of seven members (one scientist, two technical officers, one assistant research scientist, one nurse, one biochemist, and one lab technician) from NIN involved in the data/sample collection process. A senior scientist of the NIN made field visits to monitor and ensure the quality of data collection such as anthropometric measurements, clinical examination, diet survey, and blood sample collection.

1.3.7 Measurement of anthropometry

The height/length, weight, and MUAC of all the members of the selected households (present at the time of the survey) were measured and recorded by trained staff. The research team used standardised instruments and methods for measuring height/length, weight, and MUAC. Height/ length (cm) was recorded nearest 2 mm, and weights (kg) nearest 100g. The weight was measured using the Seca 813 digital scale. The height was measured with the Seca 213 stadiometer. The Seca 417 infantometer was used to measure the recumbent length of children under two years or less than 85 cm. For MUAC measurement, Seca 201 measurement tape was used.

1.3.8 Blood sample collection for testing of anaemia

Haemoglobin status was measured by the Haemocue method on children, adolescent girls, pregnant women, and lactating mothers. For this, a finger prick blood sample of 20µL was collected and dropped on an Hb strip. Trained medical lab technicians were involved in the collection of blood samples.

1.3.9 Blood sample collection for testing sub-clinical micronutrient status

For testing the sub-clinical micronutrient status among children (12-59 months), 5 ml of venous blood was collected into a vacutainer tube. After collection, the vacutainer tubes were marked with the child's ID and placed in cool boxes without direct contact with the ice packs. It is then

transported to the *Agali* Community Health Centre (CHC) at appropriate temperatures. At the CHC, the blood samples were centrifuged for 12 minutes at 2500 RPM and aliquoted into 1.8 micro litter storage vail for laboratory testing. Serum samples were stored in the refrigerator at -20ºC. The blood samples for serum retinol were stored in amber colour storage vail (1.8 micro litter) and then covered with aluminium foil to protect from light exposure. The samples were then transported to the ICMR-National Institute of Nutrition (NIN), DPHN laboratory, Hyderabad. For this analysis, we used ABBOTT ARCHITECT I-1000 SR IMMUNO ANALYSER for testing of Vitamin B12, folate, serum ferritin, and Vitamin D. HPLC method was used for Vitamin A testing.

1.3.10 Food and nutrient intakes of individuals

A diet survey was conducted among 25% of the selected households using the 24-hour dietary recall method. This structured interview was intended to capture detailed information about all foods and beverages consumed by the household members in the past 24 hours, from midnight to midnight the previous day.

1.4 Ethical clearance

This study was approved by the Scientific Advisory Committee (SAC) of the National Institute of Nutrition (NIN), Hyderabad. Ethical clearance was also obtained from the NIN's Institutional Ethics Committee (IEC). Regulatory permissions were obtained from Department of Health, Government of Kerala (C4/4885/2022 DMO(H)-PALAKKAD dated 26-04-2022) as well as the local administrations in *Attappadi.* Written informed consent was taken from the parents of the selected children. For other target groups, such as adolescent girls, pregnant women, and lactating mothers, consent was obtained from the head of the household and the individual.

1.5 Training and standardisation of investigators.

Nutritionists, Social Workers, and Medical Lab Technicians were trained and standardised in the survey methodology at NIN before the survey. The training included collecting socio-demographic information, anthropometric measurements, clinical examination for signs of nutritional deficiency, 24-hour re-call diet survey methodology, and blood samples. During the training, emphasis was given to achieving the maximum intra and inter-individual agreement with respect to all the measurements.

1.6 Data analysis and preparation of reports

1.6.1 Anthropometric measurements

The WHO child growth standards [11, 12] were used to categorize children into different grades of nutritional status. The Z scores were generated for height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age (WAZ) for children (0-59 months) using the WHO-Anthro software. Likewise, Z score for BMI-for-age (BAZ) was also generated for children (5-9 years) and adolescent girls (10-19 years) in Anthro-plus software. The adolescent girls were categorized into various grades of nutritional status using BMI Z-scores according to WHO Reference values. The nutritional status of lactating women and other adult population was assessed based on body mass index (BMI) classification, which is the ratio of weight in kg/ square of height in mts. They were categorized into different nutritional grades as per classification suggested by the WHO consultative group [13] as given below:

Table 1: Malnutrition and reference cut-offs used for analysis

Measures	**Reference cut-offs**		
	Severe	**Moderate**	**Overweight/ obesity**
Children (0-59 months)			
Stunting (HAZ)	<-3SD	<- 2SD	
Wasting (WHZ)	<-3SD	<- 2SD	>+ 2SD
Underweight (WAZ)	<-3SD	<- 2SD	
MUAC	<11.5 cm	<12.5 cm	
Children (5-9 years)			
Stunting (HAZ)	<-3SD	<- 2SD	
Underweight (WAZ)	<-3SD	<- 2SD	
BMI-for-age (BAZ)	<-3SD	<- 2SD	>+ 1 SD
Adolescent girls (10-19 years)			
Stunting (HAZ)	<-3SD	<- 2SD	
BMI-for-age (BAZ)	<-3SD	<- 2SD	>+ 1 SD
Lactating mothers and other adult populations (≥18 years)			
BMI	**WHO Classification**		
<18.5 kg/m^2	Underweight/Chronic Energy Deficiency		
18.5 – 24.9 kg/m^2	Normal		
25.0 – 29.9 kg/m^2	Over-weight		
≥ 30.0 kg/m^2	Obesity		
	Asian Classification		
<18.5 kg/m^2	Underweight/Chronic Energy Deficiency		
18.5 – 22.9 kg/m^2	Normal		
23.0 – 27.5 kg/m^2	Overweight		
≥27.5 kg/m^2	Obesity		

1.6.2 Anaemia measurements

The WHO haemoglobin cut-off values [14] were considered for classifying children, adolescent girls, pregnant women, and lactating mothers as anaemic and normal. The details of the WHO cut-off values are given below:

Table 2: The WHO Haemoglobin cut-off values used for analysis

Physiological groups	Degree of Anaemia (Hb level g/dl)			
	Normal	Mild	Moderate	Severe
Children (12-59 months)	≥ 11.0	10.0 -10.9	7.0 - 9.9	<7.0
Children (5-9 years)	≥11.5	11.0 -11.4	8.0 -10.9	<8.0
Adolescent girls (10-19 years)	≥ 12.0	11.0 -11.9	8.0 -10.9	<8.0
Lactating mothers	≥ 12.0	11.0 -11.9	8.0 - 10.9	<8.0
Pregnant women	≥ 11.0	10.0 -10.9	7.0 - 9.9	<7.0

1.6.3 Micronutrient measurements

The WHO [15, 16] and Institute of Medicine [17] cut-off values were considered for classifying children with deficiencies of iron, Vitamin A, Vitamin D, Vitamin B12, and folate. The details of the WHO cut-off values are given below:

Table 3: Cut-off values used for the analysis of Micronutrient deficiencies

	Parameter	Reference cut-off
Iron deficiency	Serum ferritin	< 12 µg/l
Vitamin A deficiency	Serum retinol concentration	< 20 µg/dL
Vitamin D deficiency	Serum 25(OH)D concentration	<12ng/mL (30 nmol/L)
Vitamin B12 deficiency	Serum vitamin B12	< 203 pg/ml
Folate deficiency	Serum erythrocyte folate	< 151 ng/ml

1.6.4 Food and nutrient intakes

The average daily intake of different foods by individuals was calculated according to age, sex, physiological status, and physical activity status. The nutrient composition of the foods consumed by the individuals was computed using Indian Food Composition Tables (IFCT) and Nutritive Value of Indian Foods. The mean intake of foods and median intakes of various nutrients were compared with the 'Recommended Dietary Intakes for Indians' [18] and 'Recommended Dietary Allowances for Indians' [19], respectively, as suggested by the ICMR Expert Committee.

All the analysis has been carried out using the Stata-14 statistical software package developed by StataCorp.15 Summary and descriptive statistics were used to assess the prevalence and associations of outcome variables if any.

CHAPTER 2

SAMPLE COVERAGE AND SOCIO-ECONOMIC CHARACTERISTICS OF THE HOUSEHOLDS

2.1 Study location

Located in the Western Ghats at an elevation of 750 meters above sea level, *Attappadi* Taluk is in the Palakkad district of Kerala. *Agali*, *Puthur*, and *Sholayur* Grama Panchayaths make up the area covering 745 square Kilometres. Agriculture, farm labour, employment under the Mahatma Gandhi National Rural Employment Scheme (MGNREGS), and the collection of forest produce are the primary sources of livelihood for the tribal people in this area. Although *Attappadi* is known as one of Kerala's tribal heartlands, most of the population there now comprises migrants from other places of Kerala and Tamil Nadu. Three major tribal communities—the *Mudugars, Irulars,* and *Kurumbars*—live in *Attappadi*. According to the 2011 Census, these tribal groups collectively had 30,332 people spread across 192 hamlets (*Ooru*).

There are two Primary Health Centres (PHCs), one Community Health Centre (CHC), and one Tribal Specialty Hospital in *Attappadi* Taluk. Three Nutritional Rehabilitation Centers (NRCs) are functional to provide care and management of children (<5 years) with Severe Acute Malnutrition (SAM). There are also a few private health facilities in the region. 172 community kitchens were established to address hunger and ensure food security in 192 tribal settlements. These efforts complement the various services the Departments of Health, Department of Women and Child Development, Social Justice, the National Rural Life Mission (NRLM), and Local Self-Governments provide. Particular attention has been given to promoting traditional agricultural practices and the cultivation of ethnic food crops, especially millet.

Table 4: Tribal population in Palakkad district and Mannarkad sub-district according to the Census 2011

Particulars	Palakkad n (%)			Mannarkad n (%)		
	Total	Male	Female	Total	Male	Female
Total population	48972	24314 (49.6)	24658 (50.4)	30332	15013 (49.5)	15319 (50.5)
Children (0-6 years)	5944 (12.1)	3061 (51.5)	2883 (48.5)	3774 (12.4)	1946 (51.6)	1828 (48.4)
Households	12858			8138		

2.2 Sample coverage

The survey covered 2,001 persons of different ages and physiological status from 480 households residing in *Attappadi* Taluk. Of the total population covered, 523 (277 boys and 246 girls) were children 0-59 months, 150 were adolescent girls (10-19 years), 40 were pregnant women, and 110 were lactating mothers. **Table 5** presents the sample coverage for socio-economic profile, anthropometry measurements, haemoglobin estimation, and micronutrient profiling.

2.3 Socio-economic characteristics of the households

Table 6 presents the distribution of socio-economic characteristics of the selected households. The sample households comprised 77.5% *Irula* tribes, 13.3% *Kurumba* tribes, and 9% *Muduga* tribes. Most (98.9%) households belonged to the Hindu religion, and the remaining 1.1% were Christians. Nuclear families (couples with children) form the highest percentage of households (74.2%), followed by extended nuclear families (18.8%). The average family size was 4.5 persons per household. The literacy rate among household heads was 74.6%. More than one-third (37.4%) of them had 9 to 12 years of schooling. Only 5% of household heads had completed more than 12 years of education.

The primary income source for most households (71.3%) was daily wage work. Nearly 10% of household heads worked in the professional or service sector. The data demonstrates that "cultivation" and "gathering of forest products" are no longer a source of income for tribal

households in *Attappadi* Taluk. Close to one-third (33.1%) of the households covered in the survey did not possess any land, and 48.8% per cent of households have marginal land of <2.5 acres. The remaining 18.1% of households possess more than 2.5 acres of land.

2.4 Housing and household facilities

Table 7 presents the distribution of housing and household facilities in the selected households. The type of house was considered to be an index of the household's economic status. In *Attappadi*, *Pucca* dwellings accounted for 49.2% of all households, while *Semi-pucca* and *Kutcha* houses comprised 30.4% and 20.4%, respectively. Most houses were constructed under the government housing scheme for the tribal population. At the time of the survey, the two primary sources of drinking water were streams (34.4%) and taps (44.6%). The remaining households were drawing drinking water from the open well (8.5%), pond/tank (8.3%), and tube well (4.2%). Most households (68.8%) used firewood as cooking fuel. The proportion of households using liquefied petroleum gas (LPG) was 30.6%. The majority of households (87.1%) had a separate room for the kitchen in their homes. Electricity was present in the majority of households (83.7%). Seventy-four per cent of the households had sanitation facilities and were in use. However, despite sanitation facilities being available, 10% of the households were not using them. The toilet facility was not available for 15% of the tribal households in *Attappadi*.

2.5 Participation in social security programmes

Mahatma Gandhi National Rural Employment Guarantee Programme (MGNREGP) was one of the primary sources of income for about 89% of households. Nearly all (95.8%) households were protected from food insecurity by being covered by the Public Distribution System (PDS). Of the households selected, 90.6% had at least one beneficiary of the Integrated Child Development Services (ICDS) program, and 57% had at least one child availing the benefit of the Mid-day-meal (MDM) programme. (See **Table 8**).

2.6 Prevalence of substance use among the tribal population

This survey captured substance use among the members (aged ≥15 years) of the surveyed households. The prevalence of alcohol and tobacco use (daily or at least once a week) among the population aged ≥15 years was 21.8% and 42.3%, respectively. The prevalence of alcohol use was 46.8% for men and 1.9% for women. Tobacco use (mostly in the form of chewing) was 48.8% for men and 42.3% for women. (See **Table 9**).

CHAPTER 3
NUTRITIONAL STATUS OF THE POPULATION

3.1 Introduction

Nutritional status is a reflection of the health condition of an individual or of a population. It also reflects the performance of a country's economic, social, and health sectors. Good nutritional status can only be achieved and sustained when individuals have adequate availability and accessibility to sufficient food; and its proper utilisation. Nutrition plays a critical role in human resource development since deficiencies in essential nutrients lead to malnutrition, affecting an individual's mental and physical state and resulting in poor health and work performance. In addition, hungry and malnourished children may have mild to severe learning disabilities, resulting in poor school performance, losing many working hours in adulthood, and earning less. Women who are unhealthy and malnourished at the time of conception are more likely to have pregnancy complications and poor birth outcomes. This section covers the nutrition status of the tribal population in *Attappadi*. Nutrition status in terms of anthropometry is presented for children (0-59 months), children (5-9 years), adolescent girls (10-19 years), pregnant women, lactating mothers, and other adult populations (≥ 18 years).

3.2 Nutritional anthropometry

3.2.1 Anthropometry of children 0-59 months

The nutritional status of children aged 0-59 months in *Attappadi* is shown in **Tables 10 to 13** and **Figure 1 to 3**. **Table 10** shows the mean height (cm), weight (kg), and MUAC (cm) for boys and girls by age. The mean height of boys and girls aged 0-11 months was 67.1 cm and 62.2 cm, respectively. Similarly, it was 76.0 cm and 75.5 cm for boys and girls aged 11-23 months. After 24 months, there was no difference in the mean heights between boys and girls. The mean weight of boys and girls in the 0-11 months age group was 7.0 kg and 5.8 kg, respectively. The mean weight was 8.8 kg and 8.5 kg for boys and girls aged 12-23 months. In the 48-59 months age group, the mean weight was 13.3 kg for both sexes. The mean MUAC for boys aged 0-11 months and 48-59 months was 13.7 cm and 17.7 cm, respectively. In girls, it was 12.9 cm and 14.8 cm at ages 0-11 months and 48-59 months, respectively.

Figure 1: Prevalence of Underweight, Stunting, and Wasting among children (0-59 months) by age in months

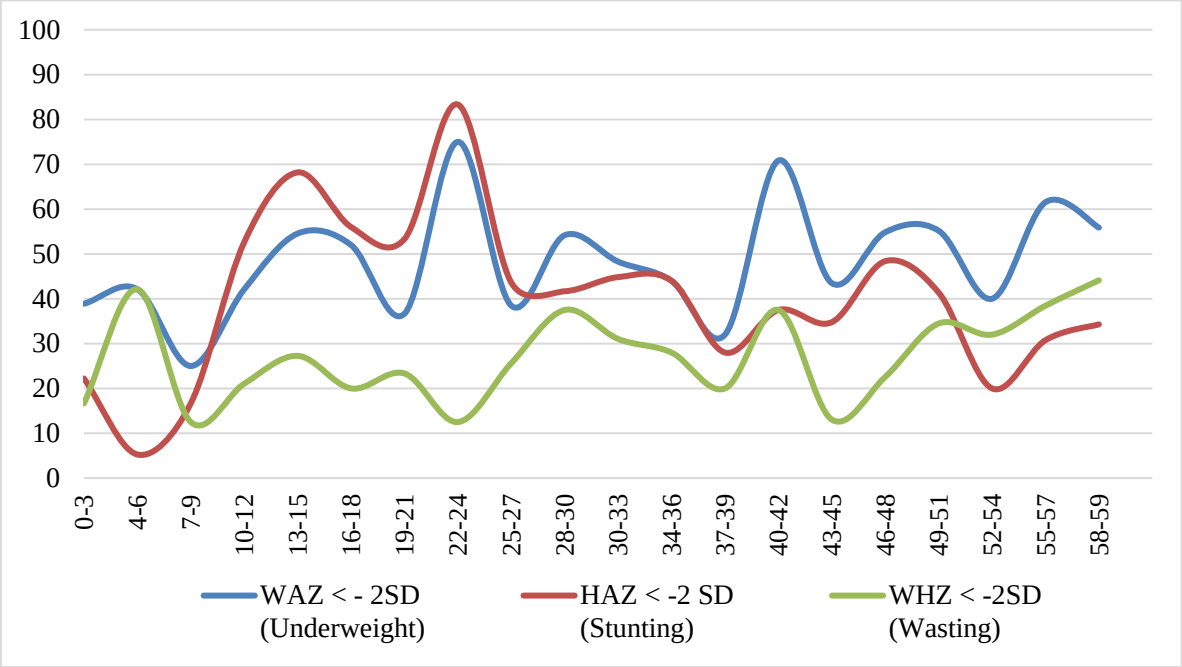


Table 11 presents the prevalence of underweight, stunting, and wasting among tribal children 0-59 months in *Attappadi*. Among the children (0-59 months), the prevalence of underweight, stunting, and wasting was 48.3%, 40.9%, and 27.4%, respectively. Sixteen out of every 100 children (0-59 months) had severely underweight, 13 had long-term nutrition deficiency (stunted growth), and eight had acute under-nutrition (wasting). The prevalence of total underweight among children (0-11 months) was 37.7%, with 26% moderately underweight and 11.7% severely underweight. Almost four in every 10 tribal infants in *Attappadi* have a low height for their age (stunted growth).

The overall prevalence of stunting among tribal children (0-11 months) was 23.4%, with 15.6% moderate and 7.8% severe stunting. The prevalence of wasting among these children was 22.1% (13% moderate acute malnutrition (MAM) and 9.1% severe acute malnutrition (SAM). **Table 12** presents the sex-wise prevalence of under-nutrition among children (0-59 months). The prevalence of underweight was 49.1% for boys and 47.5% for girls. Boys (42.1%) had a higher rate of stunted growth than girls (39.7%). Boys were more likely than girls to waste, at a rate of 29.3% versus 25.2%.

Figure 2: Prevalence (%) of under-nutrition among children (< 5 years) by sex

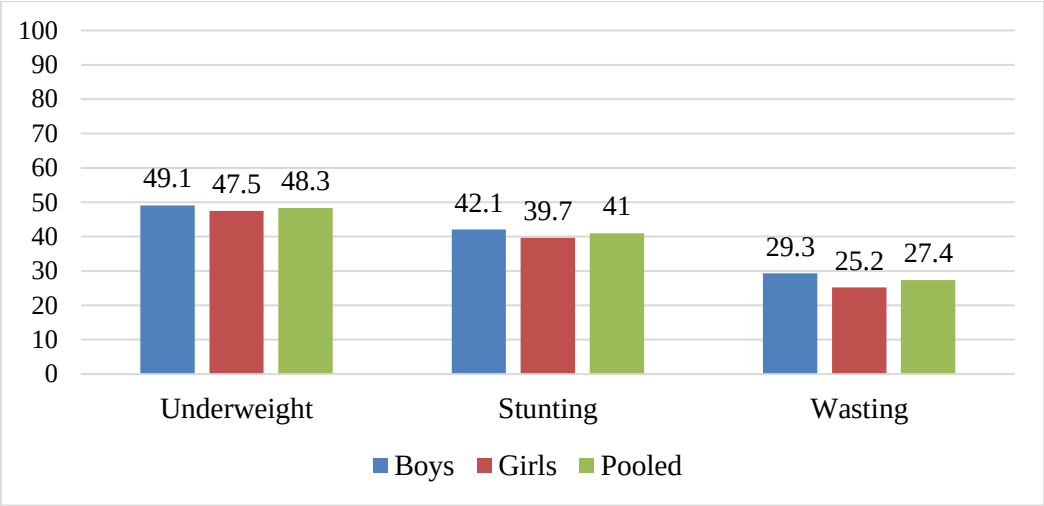


Figure 3: Prevalence (%) of under-nutrition among children by age (in months)

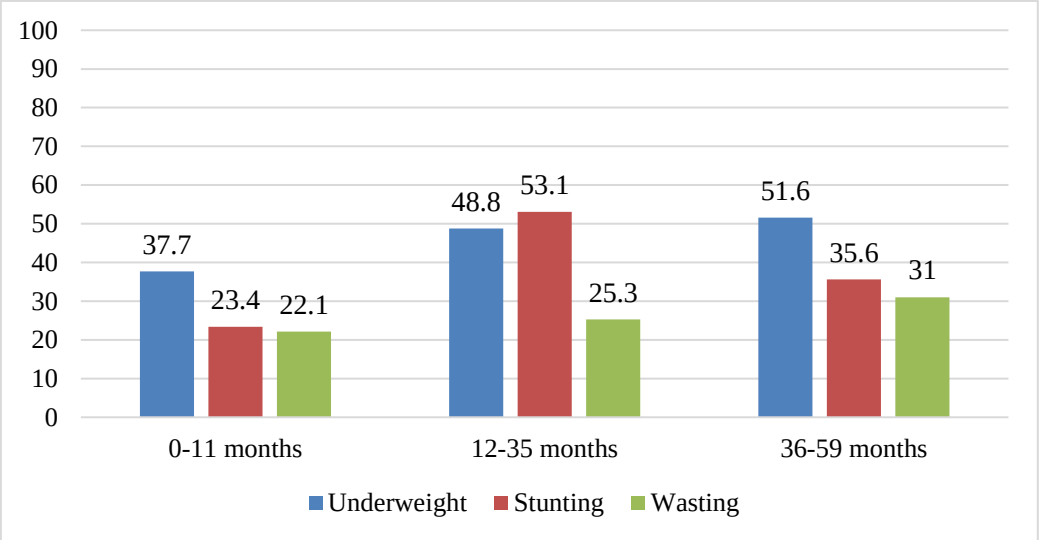
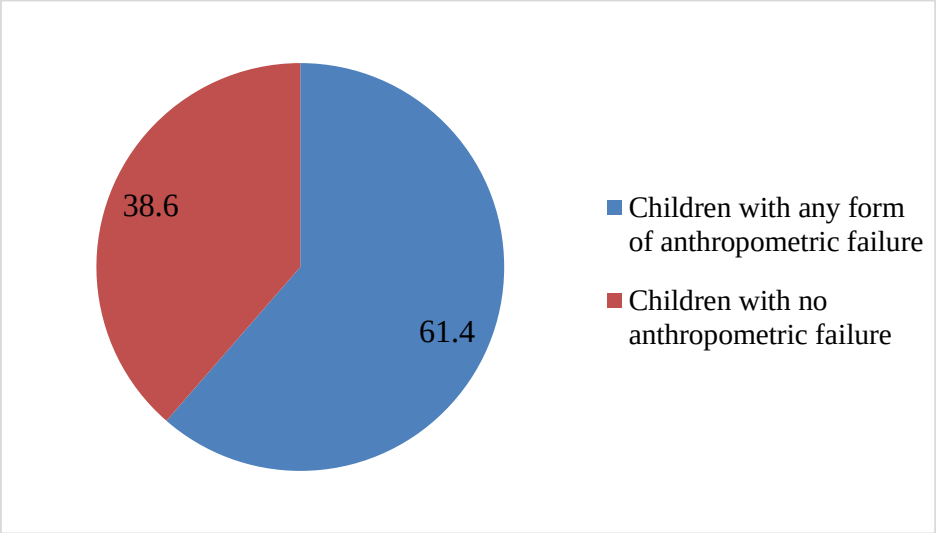


Figure 4 depicts the percentage of tribal children (0-59 months) in *Attappadi* who experience any form of anthropometric failure. Among the total number of children (516) included in the survey, 61.4% (317) had anthropometric failures of any form. Of the children with any anthropometric failure, 12.6% (65) experience stunting, wasting, and underweight. Another 11.8% (61 children) experience wasting and underweight, followed by 8.9% (46 children) with only stunting. There are 26 children (5%) who experience only underweight and 15 children (2.9%) with only wasting.

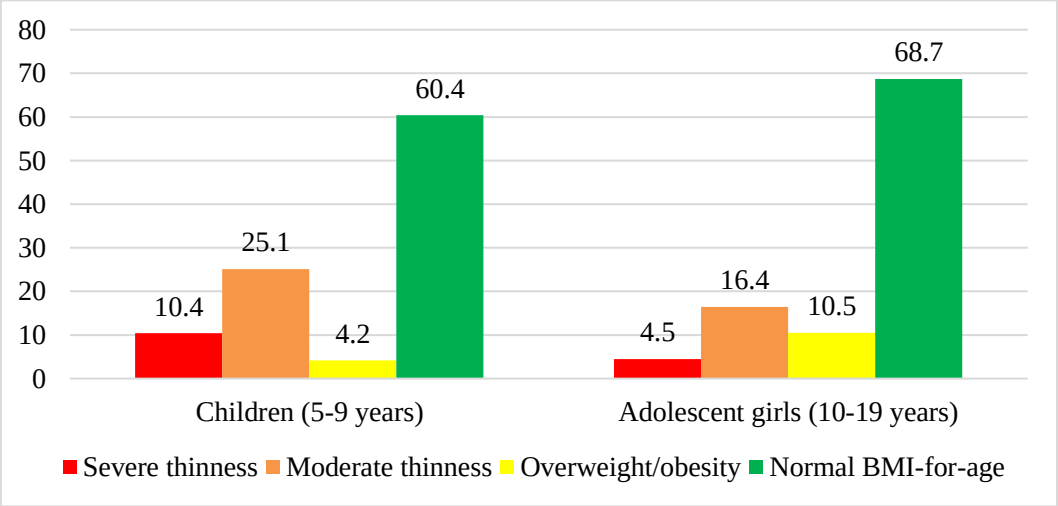
Figure 4: Prevalence (%) of any form of anthropometric failure among children (< 5 years)



3.2.2 Anthropometry of children 5-9 years

The nutrition status of children (5-9 years) and adolescent girls (10-19 years) was assessed using BMI-for-age (BAZ) scores. BAZ scores were generated for 48 children (5-9 years). **Table 14** and **Figure 5** present the prevalence of thinness (BAZ <-2SD) and overweight (BAZ >+1SD) among children (5-9 years). It was found that 35.4% of these children were thin (10.4% had severe thinness, and 25% had moderate thinness). The prevalence of overweight/obesity among children (5-9 years) was 4.2%.

Figure 5: Prevalence of thinness and overweight/obesity among children (5-9 years) and adolescent girls (10-19 years) in *Attappadi*



3.2.3 Anthropometry of adolescent girls (10-19 years)

The prevalence of thinness and overweight/obesity among adolescent girls is shown in **Table 14** and **Figure 5.** The prevalence of thinness among adolescent girls was 20.9%. The prevalence was high (25.6%) among young adolescent girls (10-14 years) as compared to older adolescent girls (12.5%). The prevalence of overweight/obesity among adolescent girls was 10.5%. Overall, this indicates that in every ten adolescent girls in *Attappadi*, two have a low BMI, and one experience overweight/obesity.

Figures 6A to 8B show the mean height and weight of children (6-59 months) and adolescent girls (10-19 years).

Figure 6A: Mean height of children (6-59 months) in *Attappadi*

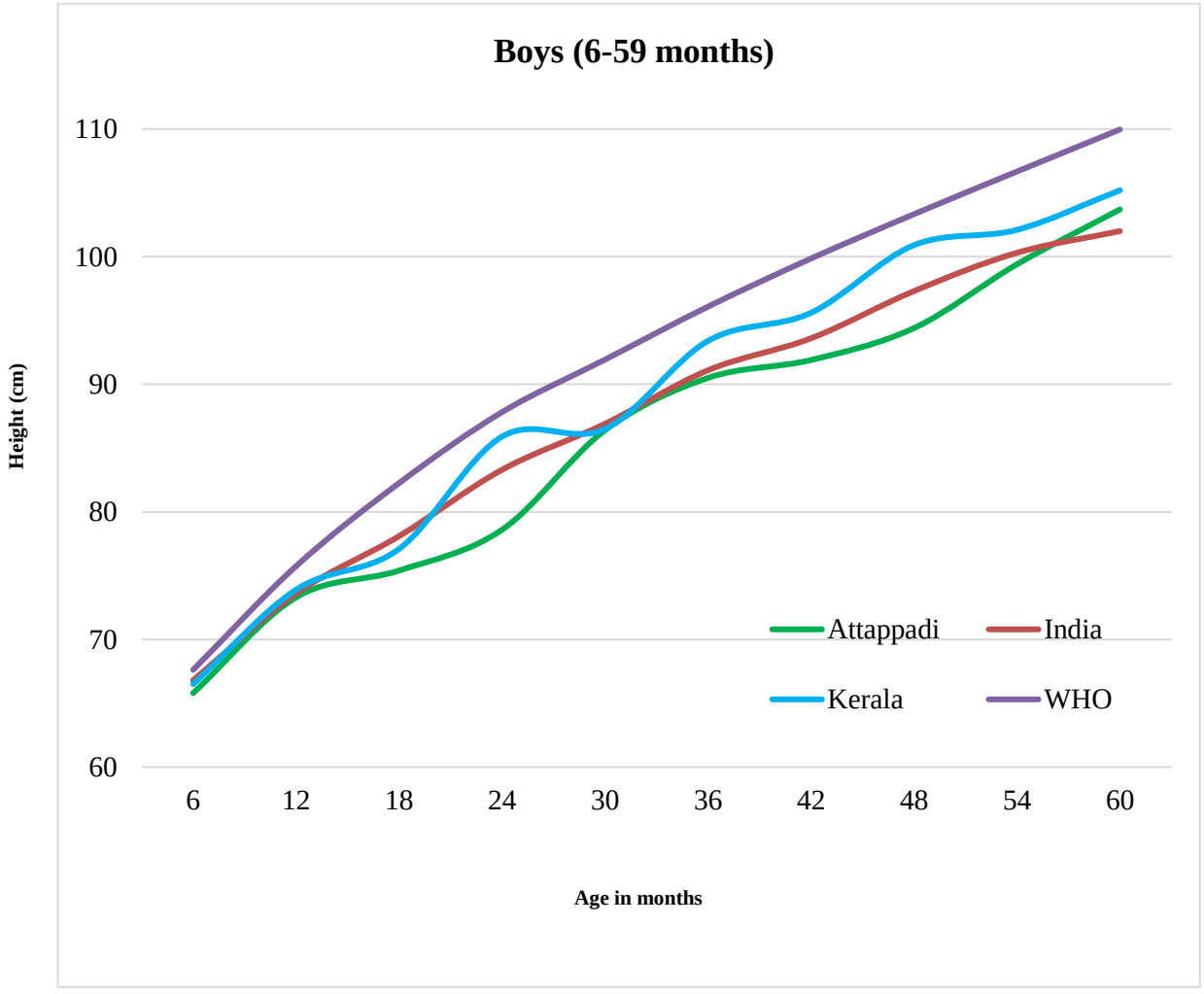


Figure 6B: Mean height of children (6-59 months) in *Attappadi*

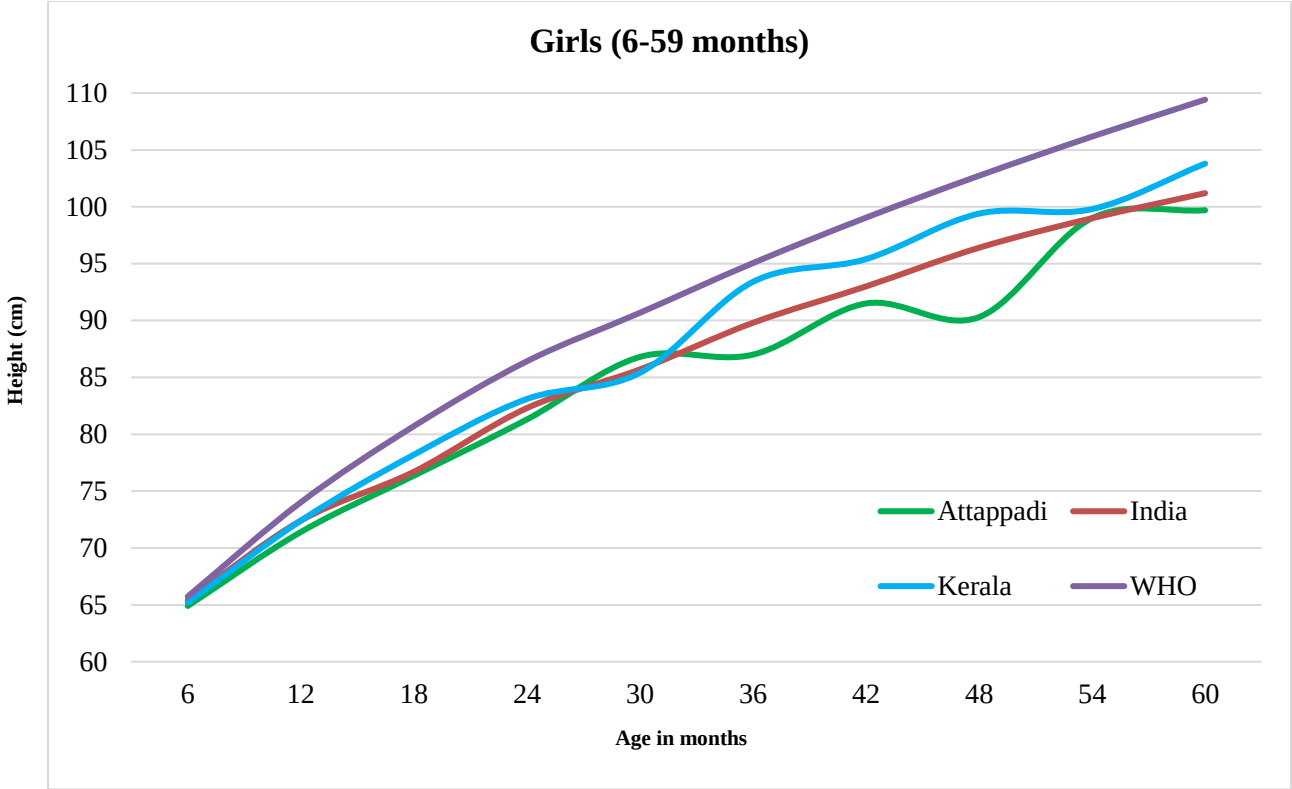


Figure 7A: Mean weight of children (6-59 months) in *Attappadi*

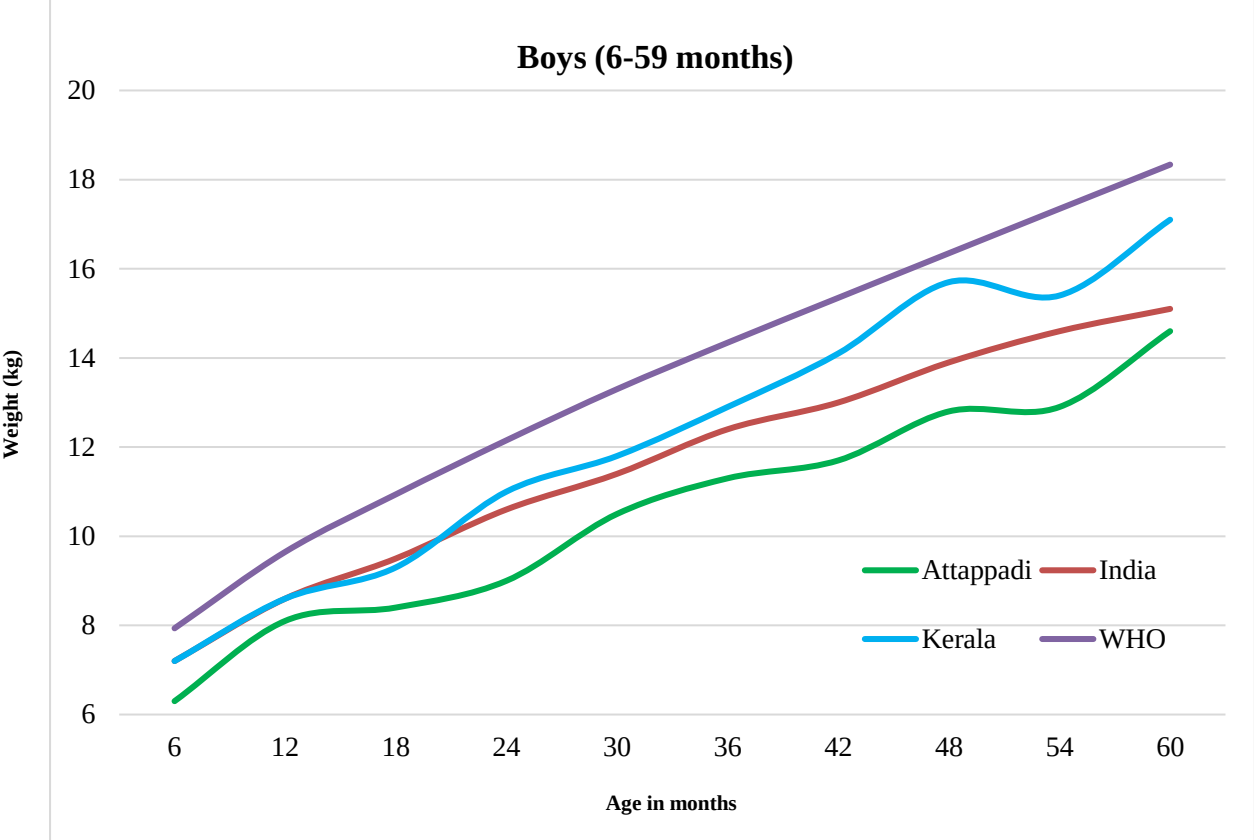
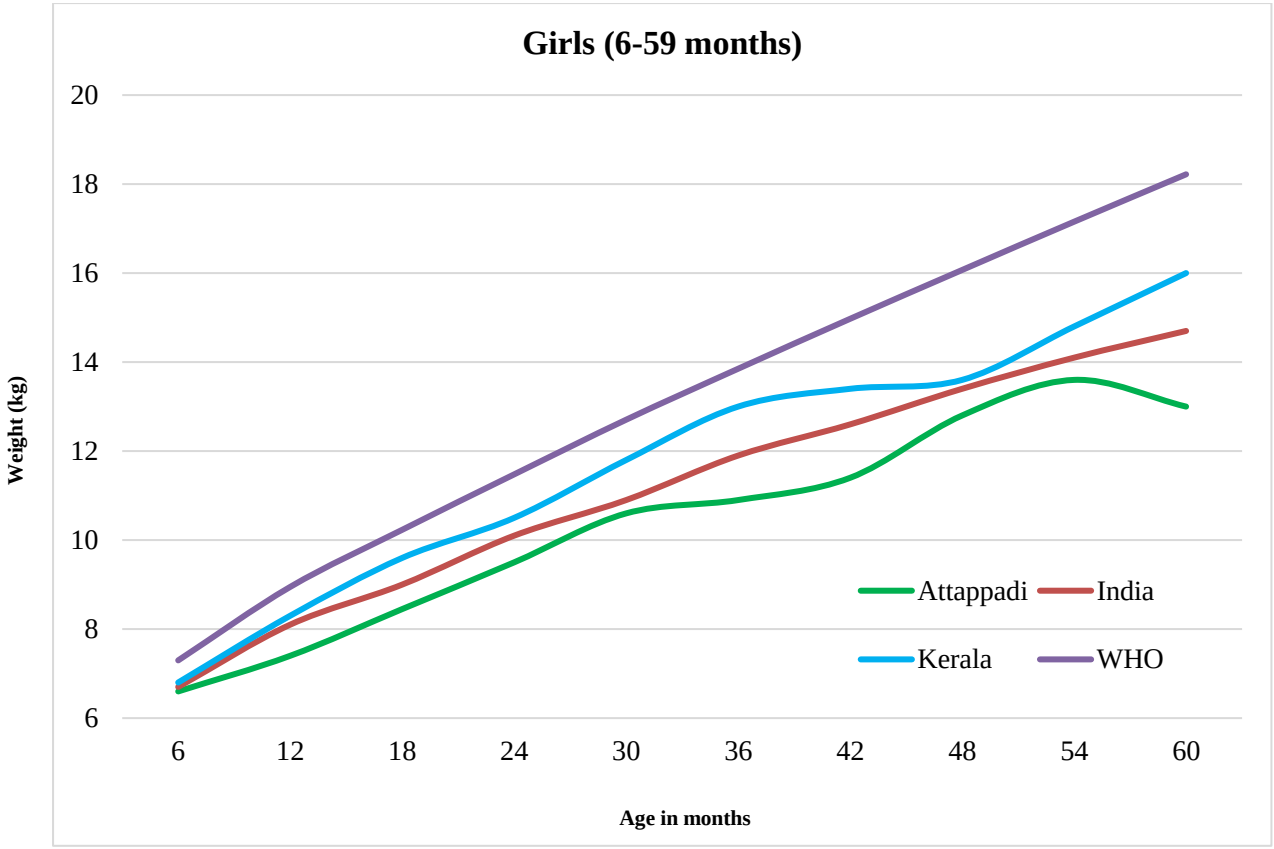


Figure 7B: Mean weight of children (6-59 months) in *Attappadi*



Note: Figure 6A to 7B are based on height and weight from the present study (*Attappadi*), NFHS-5 (for India and Kerala), and WHO (2007 growth standard).

Figure 8A: Mean height of adolescent girls (10-19 years) in *Attappadi*

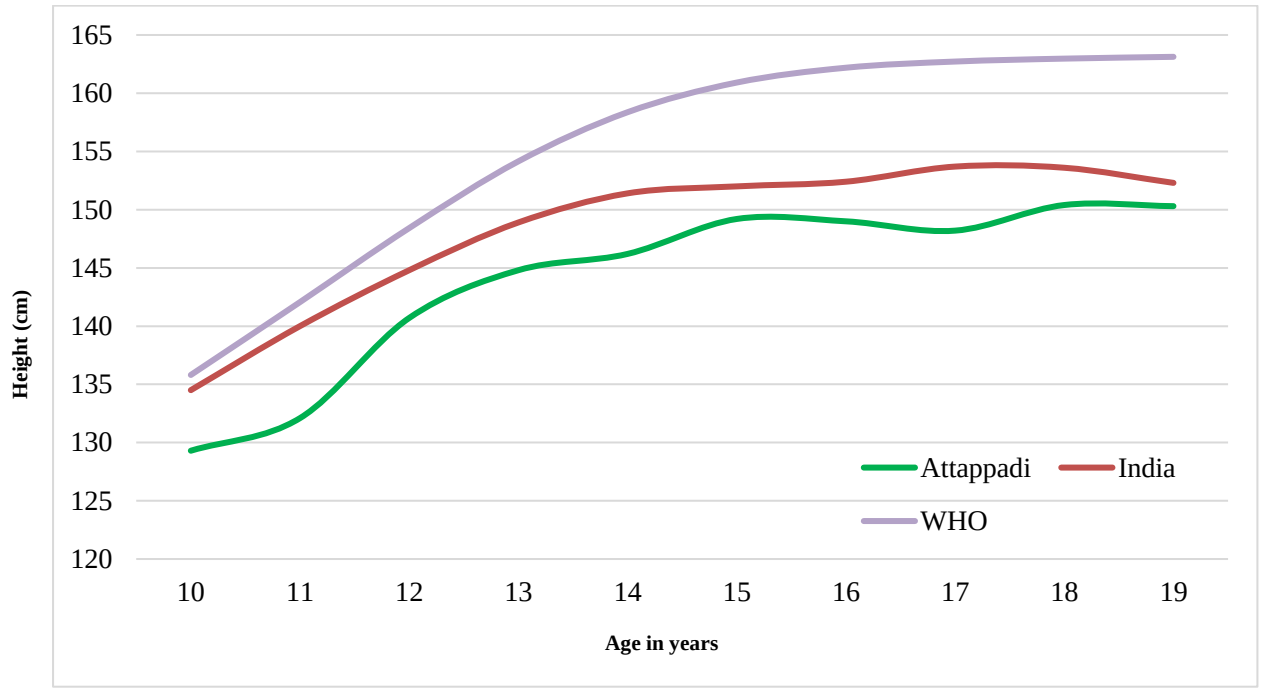
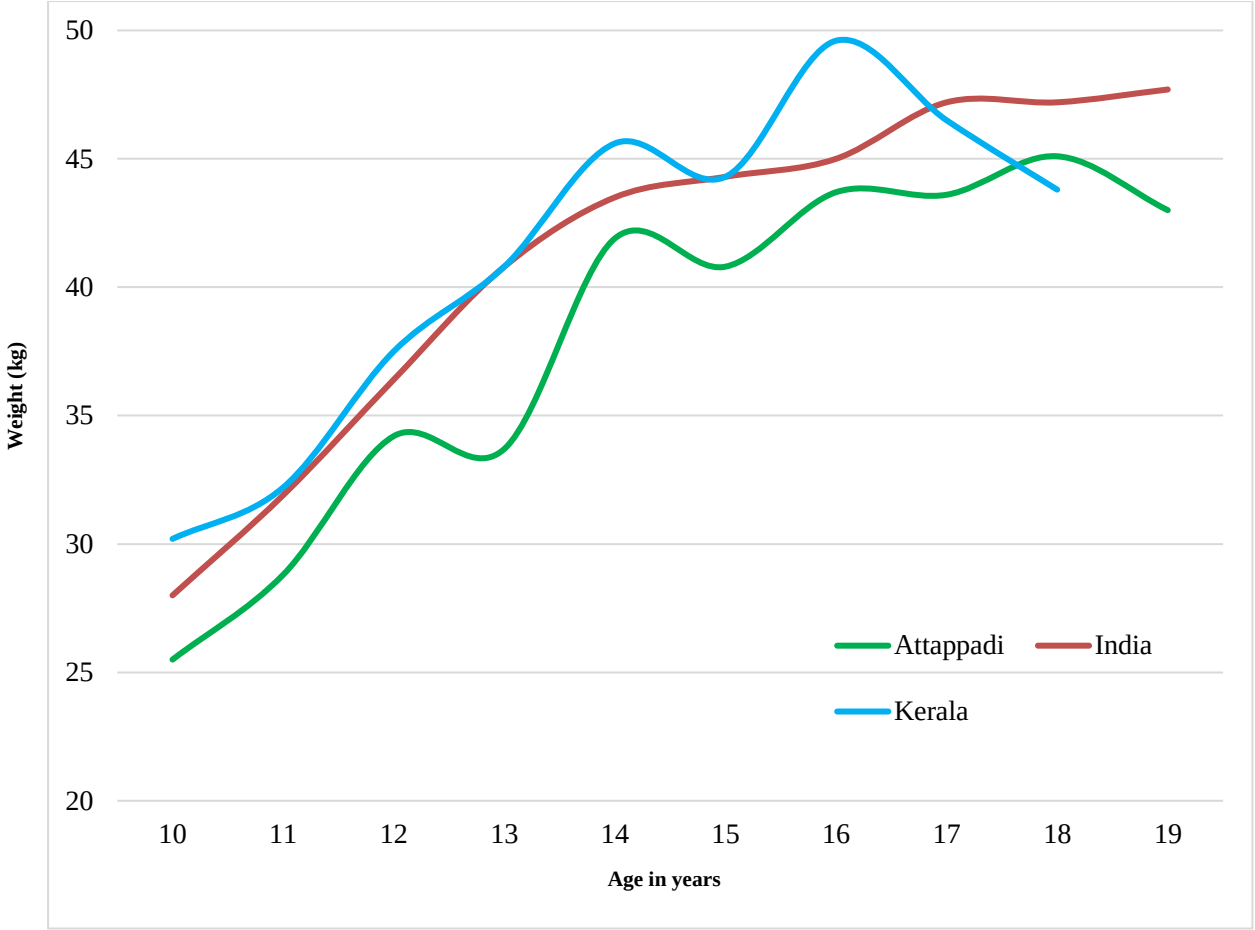


Figure 8B: Mean weight of adolescent girls (10-19 years) in *Attappadi*

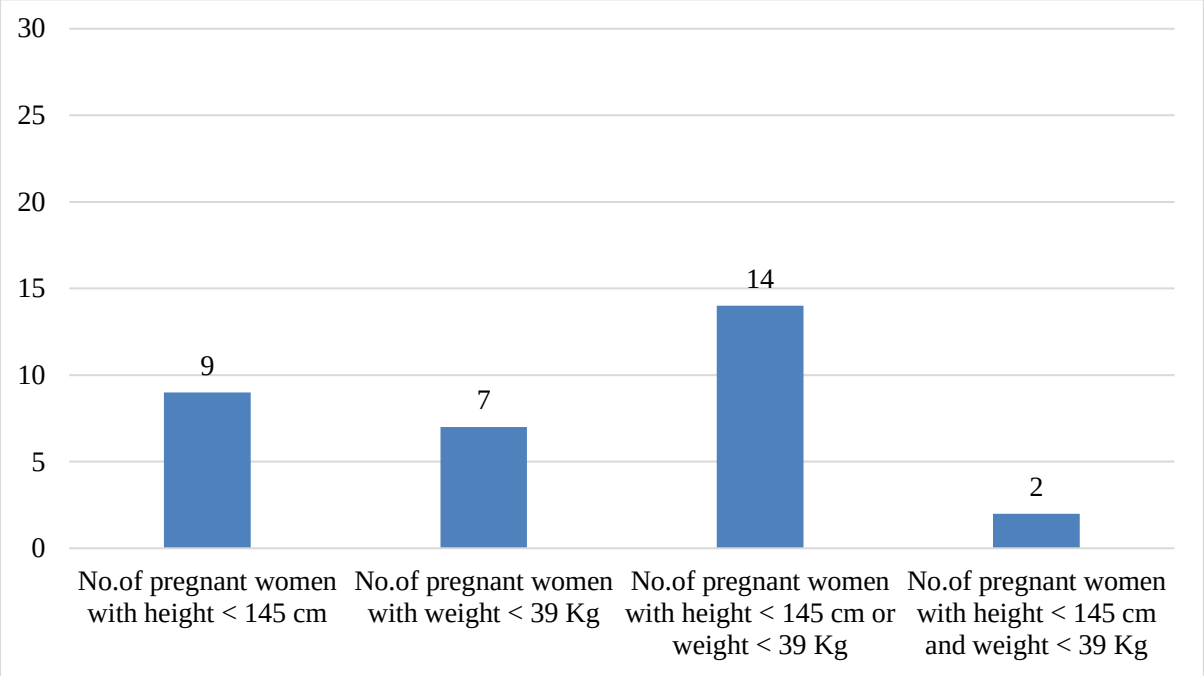


Note: Figure 8A and 8B are based on height and weight from the present study (*Attappadi*), CNNS-2016-18 (for India and Kerala), and WHO (2007 growth standard).

3.2.4 Anthropometry of pregnant women

The mean height, weight, and MUAC of pregnant women are presented in **Table 15.** Among the 40 pregnant women, the mean height, weight, and MUAC were 150.0 cm, 48.2 kg, and 23.0 cm, respectively**.** Pregnant women can be categorized as "at risk" of complications during pregnancy based on their height and weight. The number of pregnant women 'at risk' in terms of low height (<145 cm) was 9, and low weight (<39 kg) was seven. Of the total pregnant women, 14 were of low height or low weight, and two had both the conditions of low height and low weight. (See **Figure 9**).

Figure 9. Number of pregnant women nutritionally at risk in *Attappadi* (N=40)



3.2.5 Anthropometry of lactating mothers

The mean height, weight, and MUAC of lactating mothers were 149.8 cm, 45.5 kg, and 23.5 cm, respectively (See **Table 15**). According to the WHO classification of BMI, the prevalence of chronic energy deficiency (CED) (BMI < 18.5 kg/m^2) among lactating mothers was 40%. The prevalence of overweight/obesity among lactating mothers in *Attappadi* was 15% (as per the WHO classification) and 22% (as per the Asian cut-off). (**Table 16**).

3.2.6 Anthropometry of the adult population

The nutrition status of adult males and females (excluding pregnant and lactating mothers) in *Attappadi* was assessed using BMI. According to the WHO classification of BMI, 30.6% of the population ≥ 18 years of age living in the tribal hamlets of *Attappadi* were underweight or suffering from chronic energy deficiency. The prevalence of CED was 22.9% for males and 33.2% for females. The prevalence of overweight/obesity among adult tribal males was 12.2% as per WHO BMI classification and 26% as per the Asian BMI cut-off. For females, it was 13.1% and 25.5%, respectively. (See **Table 17**)

CHAPTER 4

FOOD AND NUTRIENT INTAKE OF THE POPULATION

4.1. Introduction

A healthy diet prevents individuals from all forms of malnutrition, and it protects people from infections and a range of non-communicable diseases [20]. A healthy diet contains macronutrients and micronutrients in appropriate proportions [21]. Macronutrients provide the energy required for the cellular processes for daily functioning [22] and micronutrients facilitate normal growth, development, metabolism, and physiologic functioning [23]. This chapter deals with the dietary patterns in terms of the mean intake of foods and nutrients of the tribal population in *Attappadi*. Diet pattern was assessed using data from the 24-hour dietary recall method. We analysed the nutrient content of the food and liquids eaten by the household members in the last 24 hours by matching the food data with nutrient information from a food composition database. The mean daily intake of foods and consumption of nutrients by children, adolescent boys and girls, adults (males and females), non-pregnant and non-lactating (NPNL) women, and pregnant and lactating women are presented in this chapter.

4.2 Food intakes of the population

4.2.1. Food and nutrient intake at the household level

The average consumption of foodstuffs (g/CU/day) at the household level is presented in **Table 18**. Cereals and millet were the staple food for the majority of households. The two food groups that are consumed sufficiently were pulses and legumes (71g against RDI of 40g/day) roots and tubers (110g against RDI of 50g). The median intakes of various nutrients (CU/day) are presented in **Table 19**. Except for thiamine, vitamin C, and dietary folate, all other nutrients were not meeting the RDA. Out of 80 households, 72 households meet ≥70% of the RDA for protein and thiamine, 63 households meet ≥70% of the RDA for energy, 58 households meet ≥70% of the RDA for Vitamin C, 26 households meet ≥70% of the RDA for Calcium, and 25 households meet ≥70% of the RDA for vitamin A.

4.2.2 Food intakes of children (1-3 years)

The mean daily intakes (g/day) of all the foods except for roots & tubers among children (1-3 years) residing in *Attappadi* were lower than the recommended daily intakes (RDIs). The average daily intake of cereals & millet (127.7 g/day) was insufficient to meet the RDI (175g/day). Children (1-3 years) were deficient in cereals and millet by 27%. The average consumption of pulses & legumes was 31g/day, which was lower than the recommended level of 35g (deficiency of 11%). The average consumption of green leafy vegetables (GLV), a rich source of micronutrients, was also much lower (5.8g) than the RDI of 40g. Children were not even consuming one-third of the RDI of GLVs (deficiency of 86%) (See **Table 20**).

Among children (1-3 years), the average consumption of non-leafy vegetables was only 11.5g/day as against the RDI of 20g, and this creates a deficiency of 43%. However, the average intake of roots & tubers (35g) was higher than the recommended level of 10g. The milk and milk product consumption were only marginal (25.8ml against the RDI of 300ml), creating a huge deficiency of 91%. In the case of fats & oils (5.9g against the RDI of 25g), sugar, and jaggery (10g against the suggested RDI of 30g), the consumption was less among children (1-3 years).

4.2.3 Food intakes of children (4-9 years)

In general, the average intake of most of the foods was less than the RDI except for roots, tubers and pulses. The average intake of cereals & millets was 166g/day, which was less than the suggested level of 270g/day. The average intake of pulses & legumes was 36g/day. Similarly, the intake of green leafy vegetables was 15.7/day as against the recommended level of 50g, which was deficient by 69%. The mean intake of roots and tubers was 63g/day, which was higher than the suggested 20g/day. The consumption of milk & milk products was merely 41 ml/day compared to the suggested level of 250 ml/day was deficient by 83%. The average consumption of fats & oils was grossly low (8.5g/day) compared to the suggested 25 g/day (66% deficit). The intake of sugar & jaggery was about 15.4g/day as against the suggested level of 40g/day, which was less than compared to the RDI at 62%. For children (7-9 years), the average intake of cereals & millet, pulses & legumes, GLVs, other vegetables, milk, and milk products are presented in **Table 20**.

4.2.4 Food intakes of children (10-12 years)

In general, the average intake of most of the foods was less than the RDI except for pulses& legumes and roots& tubers. The average intake of cereals & millets was 244g/day, which was less than the suggested level of 420g/day for boys (240g against suggested levels of 380g/day for girls). The average intake of pulses & legumes was found to be at a sufficient level for both boys and girls. However, the intake of green leafy vegetables was 11g/day as against the recommended level of 50g for boys and 21g against the suggested 50g/day for girls shows a considerable deficiency in the consumption of GLVs for boys and girls. The mean intake of roots and tubers was 50g/day (for boys) and 106g/day for girls was more than the suggested levels. The milk & milk product consumption was merely one ml/d for boys, making the deficit 100%. In the case of girls, the consumption was merely 33ml/d against the suggested 250 ml/day was deficient by 87%. The average consumption of fats & oils was grossly low (6.6/day) compared to the suggested level of 22g/day (70% deficit) for boys and 12g/day with 43% deficient for girls. The intake of sugar & jaggery was about 19ml/day as against the suggested level of 45ml/day for boys and 23.4g/day against 45g with 48% deficient among 10-12-year girls (See **Table 20**).

4.2.5 Food intakes of adult men and women

Adult men (sedentary and moderate) in *Attappadi* consume sufficient amounts of pulses & legumes and, roots & tubers. The food intake pattern of sedentary and moderate women was also the same. Women were sufficiently consuming pulses & legumes, roots & tubers, and other vegetables. Consumption of all other food groups was well below the RDI for adult men and women. For pregnant women and lactating mothers, most foods such as cereal and millet, non-leafy vegetables, milk & milk products were lower than the recommended levels (See **Table 21 & 22**) as per the RDI for NPNL women.

4.3. Nutrient intakes of the population

The median intake and standard deviation (SD) of various nutrients (per day) among individuals of different age and physiological groups are presented in **(Table 23-33)**.

4.3.1 Nutrient intakes of children (1-3 years)

The overall median intakes of various nutrients except for protein were lower than the recommended RDAs among 1-3year children. Similarly, the intake of the majority of the nutrients such as Fat, Calcium, Iron, Vitamin-A, and Riboflavin, was less than the required quantity. Protein intake was found to be adequate. However, fat and energy intakes were found to be deficient by 73% and 36%, respectively. The median dietary intake of calcium (129.5mg) was much lower than the RDA of 500mg, leaving 74% of children with calcium intake inadequacy. Many children were not getting sufficient iron (deficit of 45%) and Vitamin C (deficit of 52%) through their diet. Three in every four children ate a diet deficient in Vitamin A and Riboflavin. Intakes of Niacin and Thiamine were also insufficient (deficit of 44% and 29%, respectively). The children's diet was marginally inadequate to provide sufficient Zinc and Folate (deficiency of 12% and 6% respectively).

4.3.2 Nutrient intakes of children (4-6 years)

Generally, the overall median intakes of various nutrients except for protein and folate were lower than the recommended RDAs among 4-6year children. Similarly, the intakes of the majority of the nutrients such as Fat, Calcium, Vitamin A, Riboflavin, and Vitamin C were insufficient among children. The median daily intake of Protein (30.4g/day) was more than the RDA showing that children were consuming adequate amounts of protein. However, the median intake of total fat and energy was lower than the RDA. Nearly 72% of children did not meet the RDA of total fat, and 28% did not meet the required energy. The median dietary intakes of calcium and iron were also well below the RDA. Calcium and iron intake were inadequate for 69% and 45% of these children **(Table 24)**.

Vitamin A: The median intake of Vitamin A (104.2µg/day) was much lower than the RDA of 510µg. About 80% of children were deficient as they did not meet RDA of vitamin A.

Thiamine: The median intake of thiamine (0.6mg) was less than the RDA of 0.9mg. The proportion of children not meeting RDA for thiamine was about 33%.

Riboflavin: The median intake of riboflavin (0.4mg) was below the recommended level of 1.3mg. The majority (69.2%) of children were not meeting their RDA for riboflavin.

Niacin: The median intake of Niacin was only 5.3 mg as against the RDA of 9 mg. About 41% of the children were not meeting their RDA for Niacin.

Vitamin C: The median daily intake of vitamin C (26.7mg) was lower than the RDA of 35mg. The proportion of children not consuming the RDA for vitamin C was about 24%.

Total folate: The median intake of total folate was 147.5µg/day against the RDA of 135µg.

Zinc: The median daily intake of Zinc (3.8mg) was lower than the RDA of 2.7mg. The proportion of children not consuming the RDA for vitamin C was about 16%.

4.3.3 Nutrient intakes of children (7-9 years)

In general, the overall median intakes of various nutrients except for protein and total folate were lower than the recommended RDAs among 7-9year children. Similarly, the intakes of most nutrients such as Fat, Calcium, Vitamin A, and Riboflavin are not even reach up to 50 per cent of RDAs (**Table 25**).

Protein: The median daily intake of protein (38.4g/day) among 7-9-year children was relatively higher than the RDA of 23g. All the children were consuming adequate amounts of protein.

Total Fat: The median intake of total fat was 20.8g/day, which was lower than the RDA of 48g, which shows a deficit of 57% of children not meeting the RDA.

Energy: The median daily consumption of energy (1353 Kcal/day) was below the RDA of 1700 Kcal. About 20% of children not consuming of energy as per RDA.

Calcium: The median dietary intake of calcium (172.9mg) was much lower than the RDA of 650mg. However, the proportion of children not meeting RDI for calcium was about 73%.

Iron: The median intake of Iron (7.6mg) was about half the RDA. The proportion of children not meeting the RDA for iron was about 49%.

Vitamin A: The median intake of Vitamin A (159.9µg/day) was much lower than the RDA of 630g. About 75% of children were deficient as they were not meeting RDA for vitamin A.

Thiamine: The median intake of thiamine (0.7mg) was less than the RDA of 1.1mg. The proportion of children not meeting RDA for thiamine was about 36%.

Riboflavin: The median riboflavin intake (0.5mg) was below the recommended level of 1.6 mg. The majority (68.8%) of children were not meeting their RDA for riboflavin.

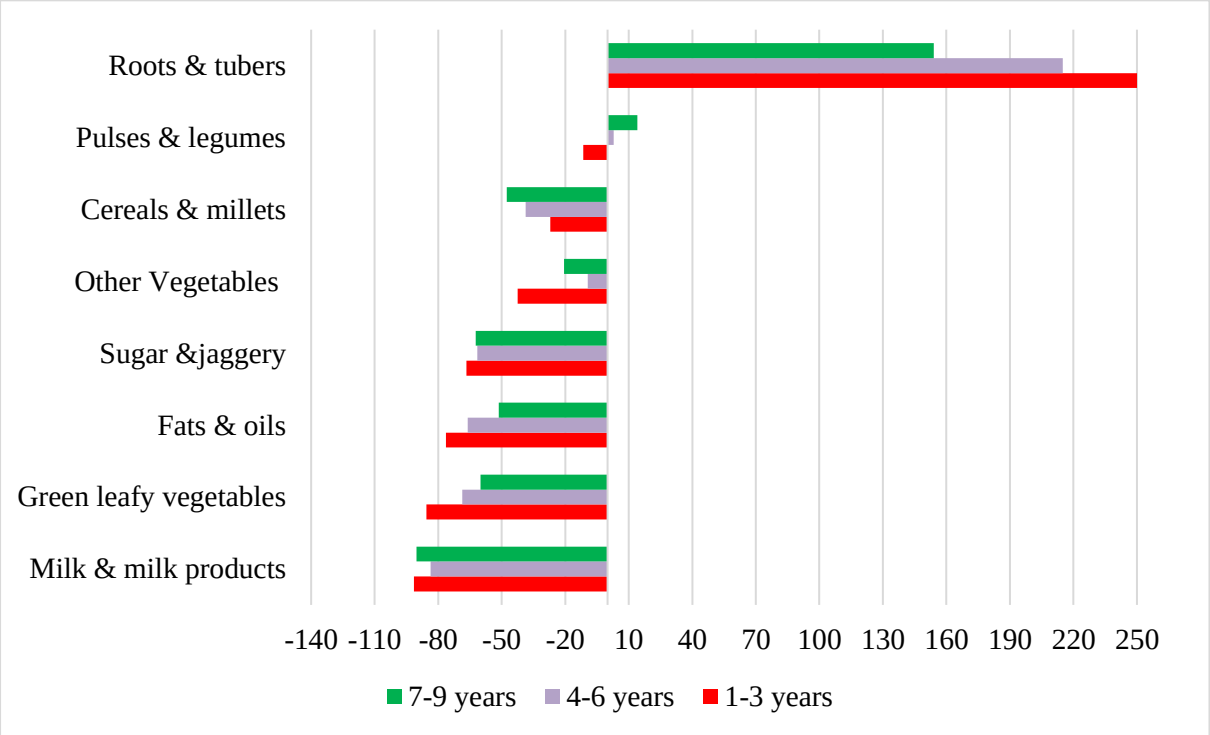
Niacin: The median intake of Niacin was only 7.4 mg as against the RDA of 11mg. About 33% of the children were not meeting their RDA for Niacin.

Vitamin C: The median daily intake of vitamin C (37.4mg) was lower than the RDA of 45mg. The proportion of children not consuming the RDA for vitamin C was about 17%.

Total folate: The median intake of total folate (213.3 µg/day) was against the RDA of 170µg found high.

Zinc: The median daily intake of Zinc (4.9mg) was lower than the RDA of 5.9mg. The proportion of children not consuming the RDA for vitamin C was about 17%.

Figure 10: Level of food intake in relation to RDI by tribal children (1-9 years) in *Attappadi*



Figures 10 to 13 depict the sufficiency/deficiency of the food group/nutrient intake for children, and adult men and women. The bars display the percentage of consumption in relation to the RDI/RDA. The food groups that are being consumed adequately are shown on the positive side of the graph, and those that are not being consumed enough are shown on the negative side. The number '0' in the middle

of the figure stands for RDI/RDA. The bar lengths on the positive and negative sides indicate the sufficiency (excess)/deficiency of intakes (in terms of percentage).

4.3.4 Nutrient intakes of children (10-12 years)

The overall median intakes of various nutrients except for protein and total folate were lower than the recommended RDAs among 10-12 years boys. For girls (10-12 years), protein intake was lower than the recommended RDAs. However, most nutrients such as Fat, Calcium, Iron, Vitamin A, and Riboflavin are not consumed by 50 per cent of RDAs (**Table 26 & 27**).

Protein: The median intake of 10-12-year boys (38g/day) was relatively higher than the RDA of 32g/day. Similarly, girls' intake was 51g against 33g/day. All the children were consuming adequate amounts of protein.

Total Fat: The median intake of total fat was 12.3/day for boys, which was lower than the RDA of 62g, which shows the deficit of 80% of children not meeting the RDA. Similarly, the median intake of total fat was 19.5/day for girls, which was lower than the RDA of 57g, which shows a deficit of 66% of children not meeting the RDA.

Energy: The median daily consumption of energy (1293 Kcal/day) for boys was below the RDA of 2220 Kcal. About 42% of children not consuming of energy as per RDA. In the case of girls, the median daily consumption of energy (1453 Kcal/day) was below the RDA of 2060 Kcal. About 30% of children not consuming of energy as per RDA.

Calcium: The median dietary intake of calcium (153.7mg/day) for boys was much lower than the RDA of 850mg/day, and the proportion of the boys not meeting RDI for calcium was about 82%. In the case of girls, the median dietary intake of calcium (333.5mg) was much lower than the RDA of 850mg/day, and the proportion of the girls not meeting RDI for calcium was about 61%.

Iron: The median intake of Iron (6.4mg) for boys was lower than the RDA, and the proportion of boys not meeting the RDA for Iron was about 60%. For girls, the median intake of Iron (10.6mg) was also lower than the RDA of 28mg/day. The proportion of girls not meeting the RDA for Iron was about 62%

Vitamin A: The median intake of Vitamin A (258 µg/day) for boys was much lower than the RDA of 770 µg. About 67% of boys were deficient as they did not meet RDA of vitamin A. Similarly, the median intake of Vitamin A (69.5 µg/day) for girls was much lower than the RDA of 790 µg. Most (91%) of girls were deficient as they did not meet RDA for vitamin A.

Thiamine: The median intake of thiamine (1mg) was less than the RDA of 1.5mg for boys and 0.8mg for girls against 1.4mg per day. About 43% of girls and 33% of boys are deficient in thiamine intake.

Riboflavin: The median riboflavin intake for boys (0.6mg/day) and girls (0.5 mg/day) was below the recommended levels. Most children (71% boys and 74% girls) were deficient in meeting their RDA for riboflavin.

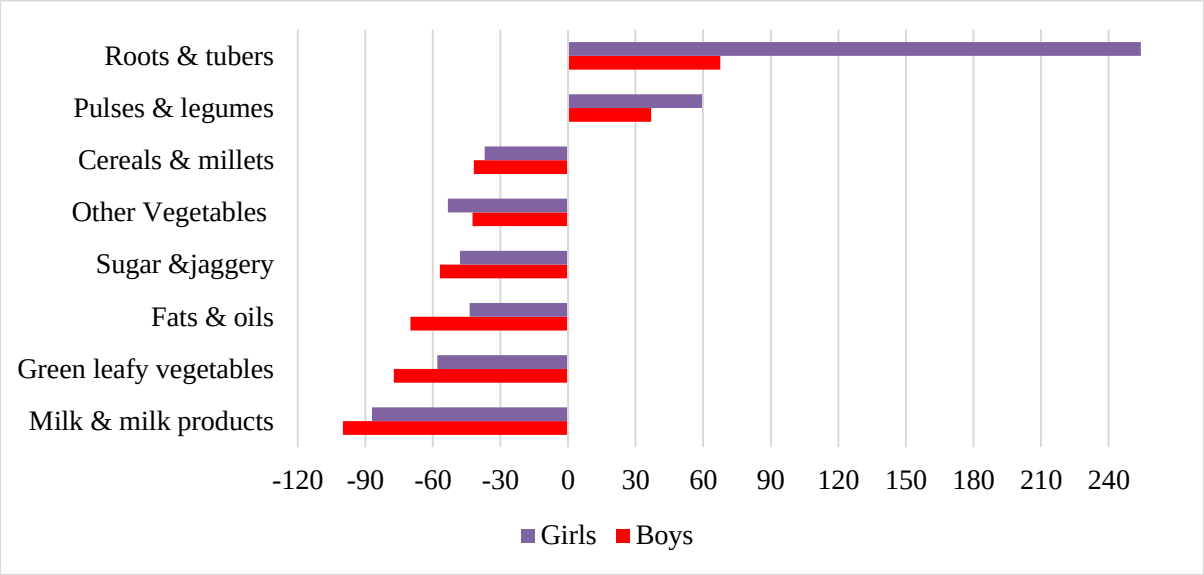
Niacin: The median intake of Niacin was only 7.7 mg as against the RDA of 15mg for boys and 7.6mg against 14 for girls. About 46% of the girls and 49% of the boys were children who were deficient in RDA for Niacin.

Vitamin C: The median daily intake of vitamin C (20.9mg for boys) was lower than the RDA of 55mg. However, girls are meeting the required amount of Vitamin C.

Total folate: The median intake of total folate (203 µg day) was against the RDA of 220µg among boys was observed less. However, in the case of girls, the median intake was observed to be sufficient for RDI.

Zinc: The median daily intake of Zinc (5.6mg for girls and 5.1mg for boys) was lower than the RDA. The proportion of boys not consuming the RDA for vitamin C was about 40%, and for girls, it was 34% of deficiency.

Figure 11: Level of food intake in relation to RDI by tribal children (10-12 years) in *Attappadi*



4.3.5 Nutrient intakes of adult men

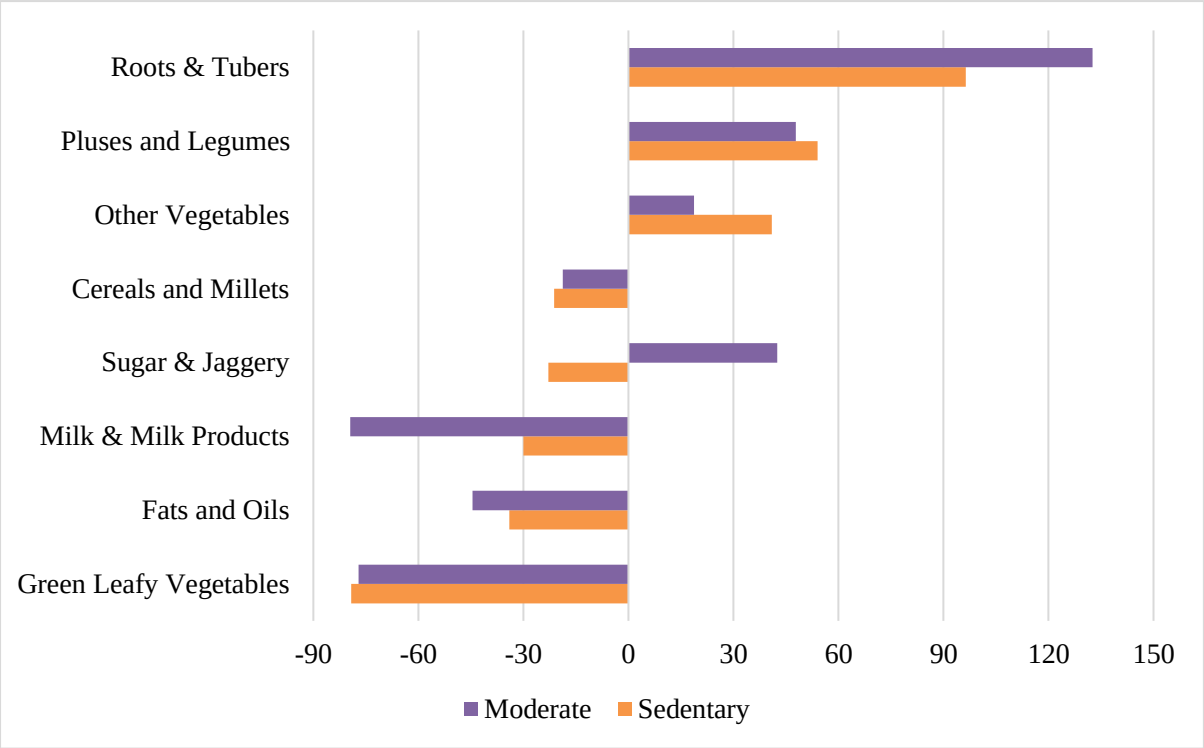
The median intakes of various nutrients except for protein were lower than the recommended RDAs among adult males. The intakes of the majority of the nutrients such as Calcium, Iron, Vitamin A, Riboflavin, and Vitamin C were deficient by more than 50%. However, energy intake (2056Kcal against 2110 Kcal for sedentary males) and 2199 Kcal for moderate males were observed near the RDA level (2710 Kcal) though it was deficient **Table 28 & 29**.

Figure 12: Level of food intake in relation to RDI by adult tribal men in *Attappadi*

4.3.6 Nutrient intakes of adult women

The median intakes of the nutrients were less than the recommended RDAs among non-pregnant and non-lactating women (sedentary) except for protein, energy, niacin, and folate. Of them, the intakes of calcium, iron, and vitamin A, were grossly deficient as against their RDAs ranging above 70 %. In the case of NPNL –moderate women, the nutrient deficiency was observed as more except, protein and folate. (See **Table 30 & 31**).

Figure 13: Level of food intake in relation to RDI by adult tribal women (NPNL) in *Attappadi*



4.3.7 Nutrient intakes of pregnant women

The median intakes of all the nutrients except for Vitamin C were less than the recommended RDAs among pregnant women. Further, the intakes of calcium, iron, vitamin A, and free folic acid were grossly deficient as against their RDAs of more than fifty per cent. (**Table 32**).

Protein: The median daily intake of protein among pregnant women (63.6g) was much below the RDA of 68g. The deficiency in consuming protein among pregnant women was about 7%.

Total Fat: The median intake of total fat (39g/day) was less than the RDA of 46g, with a 15% deficit in consuming total fat as per RDA.

Energy: The median daily energy consumption (1950 Kcal) was lower as compared to the RDA of 2010 Kcal as a marginal deficiency of 3%.

Calcium: Pregnant women's median daily calcium intake was about 426mg against the RDA of 1000mg, which shows a deficit of 57%.
Iron: The median daily intakes of iron (14.8mg) were much below the RDA of 27mg, and the deficiency was about 45%.

Vitamin A: The median intake of vitamin A (60.5µg/day) was much lower than the RDA of 900µg, which shows a deficiency of 93%.

Thiamine: The median intake of thiamine (1.6mg) among pregnant women was less than the RDA of 2mg, with about 20% of the deficit.

Riboflavin: The overall median intake of Riboflavin (0.7mg) was low compared to the recommended levels of 2.7mg.

Niacin: Pregnant women's median daily niacin intake (12.7mg) was lower than the RDA of 13.5mg, with a marginal deficit of 5.9%.

Vitamin C: The median daily intake of vitamin C (83.9mg) was found to be sufficient against the RDA.

Free folic acid: The median intake of free folic acid (279µg/day) was much below the RDA of 570µg, and half of the pregnant women were not meeting RDA for free folic acid.

4.3.8 Nutrient intakes of lactating mothers

The median intakes of all the nutrients were less than the recommended RDAs among lactating mothers. (**Table 33**).

Protein: The median daily protein intake among lactating mothers (57.6g) was below the RDA of 61g. The deficiency in consuming Protein among lactating mothers was about 6%.

Total Fat: The median intake of total fat (22g/day) was less than the RDA of 49g. About 55% of lactating mothers were deficient in consuming total fat, as per RDA.

Energy: The median daily energy consumption (1946 Kcal) was lower than the RDA of 2220 Kcal with a marginal deficiency of 12%.

Calcium: The median daily calcium intake among lactating mothers was about 280mg against the RDA of 1200mg, which shows a deficit of 77%.

Iron: The median daily intakes of iron (11.3mg) were much below the RDA of 23mg, and the deficiency was about 51%.

Vitamin A: The median intake of vitamin A (359µg/day) was much lower than the RDA of 950µg, which shows a deficiency of 62%.

Thiamine: The median intake of thiamine (1.3mg) among lactating mothers was less than the RDA of 2.1mg, with about 38% of the deficit.

Riboflavin: The overall median intake of riboflavin (0.7mg) was low compared to the recommended levels of 2.9mg.

Niacin: The median daily niacin intake (12.3mg) among lactating mothers was lower than the RDA of 16mg, with a deficit of 23%.

Vitamin C: The median daily intake of vitamin C (48.5mg) was found to be low against 115mg/day RDA.

Free folic acid: The median intake of free folic acid (254µg/day) was much below the RDA of 330µg, and about 23% of the lactating mothers were not meeting RDA for free folic acid.

The degree of daily consumption sufficiency/deficiency of nutrients with respect to their RDA is summarised in **Figure 14.** The positive numbers highlighted in green show adequate intake and compliance with the RDA. The intake that comes near reaching the RDA is indicated by figures that are negative but close to zero, which are highlighted in light green. This light green represents a marginal deficit in daily nutrient intake. White, yellow, and red are used to denote marginal, moderate, and severe deficiencies in daily intake of nutrients.

Figure 14: Level of daily intake of nutrients in relation to RDA by children and pregnant women in *Attappadi*

Nutrients	Children (1-3 years)	Children 4-6 years	Pregnant Women
Protein (g)	66.4	90.0	-6.5
Fat (g)	-72.7	-71.7	-14.3
Energy (Kcal)	-35.9	-27.7	-3.0
Iron (mg)	-45.0	-50.0	-45.2
Thiamin (mg)	-28.6	-33.3	-20.0
Riboflavin (mg)	-72.7	-69.2	-74.1
Niacin (mg)	-44.3	-41.1	-5.9
Calcium (mg)	-74.1	-68.6	-57.4
Vitamin-C (mg)	-52.3	-23.7	19.9
Zinc(mg)	-12.1	-15.6	-36.6
Vitamin-A (µg)	-76.9	-79.6	-93.3
Total Folate (µg)	-5.8	9.3	-51.0

Very severe deficit (>50%)	Severe deficit (30 to 50%)	Moderate deficit (10-29%)	Marginal deficit (<10%)	No deficit (≥RDA)

CHAPTER 5
ANAEMIA AND MICRONUTRIENT DEFICIENCIES AMONG THE TRIBAL POPULATION

5.1 Introduction

Anaemia affects a third of the world's population [24, 25]. It is a condition in which individuals experience low haemoglobin (Hb) concentration that is insufficient to meet their physiological needs [14]. Anaemia is associated with increased morbidity and mortality in women and children [26, 27], poor birth outcomes [28, 29], decreased work productivity in adults [30], and impaired cognitive and behavioral development in children [31]. In India, 67% of children (6-59 months) and 57% of the women (15-49 years) were anaemic [5]. This chapter contains the prevalence of anaemia among children (12-59 months), adolescent girls (10-19 years), pregnant women, and lactating mothers of the tribal hamlets in *Attappadi*. This chapter also deals with micronutrient deficiencies among children (12-59 months).

5.2. Anaemia among the tribal population in *Attappadi*

5.2.1 Anaemia among children (12-59 months)

Table 34 presents the prevalence of anaemia in tribal children aged 12 to 59 months in *Attappadi*. The overall prevalence of anaemia in children (aged 12-59 months) was 91.2%. Of the anaemic children, 5.2% had severe anaemia, followed by moderate anaemia (57.8%) and mild anaemia (28.2%). The prevalence of anaemia was highest (97.7%) in the youngest children (12-23 months). The prevalence of anaemia decreases slightly as children get older. The youngest children (12-23 months) have a higher prevalence of severe anaemia (16.7%). Overall, anaemia is a widespread public health problem among tribal children in *Attappadi*.

5.2.2 Anaemia among adolescent girls (10-19 years)

Table 35 and **Figures 15 & 16** show the prevalence of anaemia in adolescent girls in *Attappadi*. Anaemia is a severe public health problem affecting almost all adolescent girls (96.6%) in the tribal population. Most adolescent girls have mild (53.4%) and moderate (42.1%) anaemia. Similarly, the prevalence of anaemia in adolescent girls aged 10-14 years and 15-19 years was about 95.8% and 97.5%, respectively.

Figure 15: Prevalence (%) of anaemia among adolescent girls in *Attappadi*

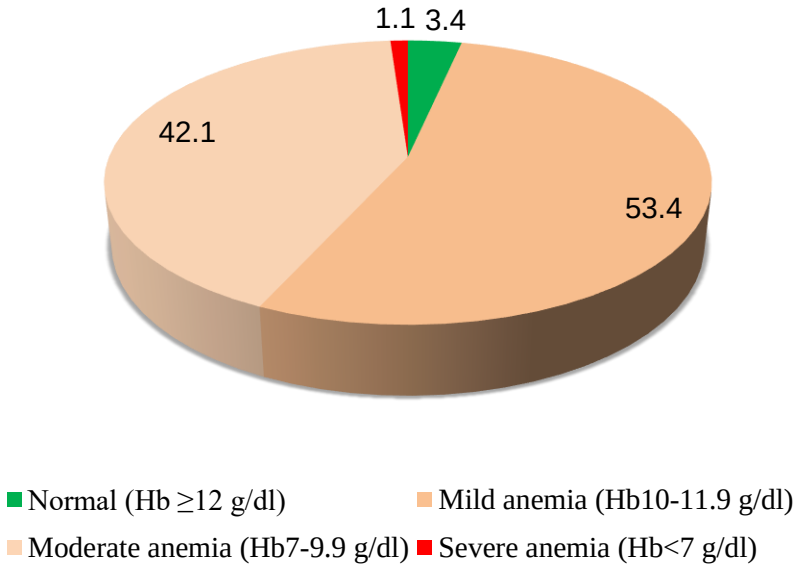
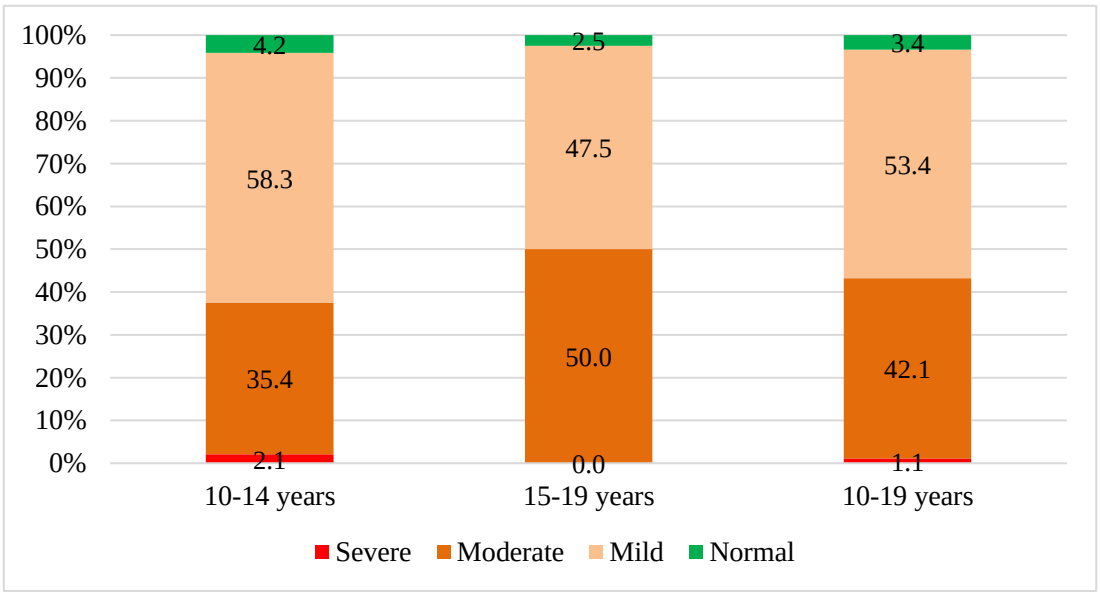


Figure 16: Prevalence (%) of anaemia among adolescent girls by age in *Attappadi*



5.2.3 Anaemia among pregnant women and lactating mothers

Table 35 and **Figures 17 & 18** show the prevalence of anaemia in pregnant and lactating women in *Attappadi*. The overall prevalence of anaemia among pregnant women was 86.8%. Of them, the proportion of pregnant women with severe anaemia was 2.6%, followed by mild anaemia (31.6%) and moderate anaemia (52.6%). The overall prevalence of anaemia in lactating women was 80%, with 41.3% moderate anaemia and 38.7% mild anaemia.

Figure 17: Prevalence (%) of anaemia among pregnant women in *Attappadi*

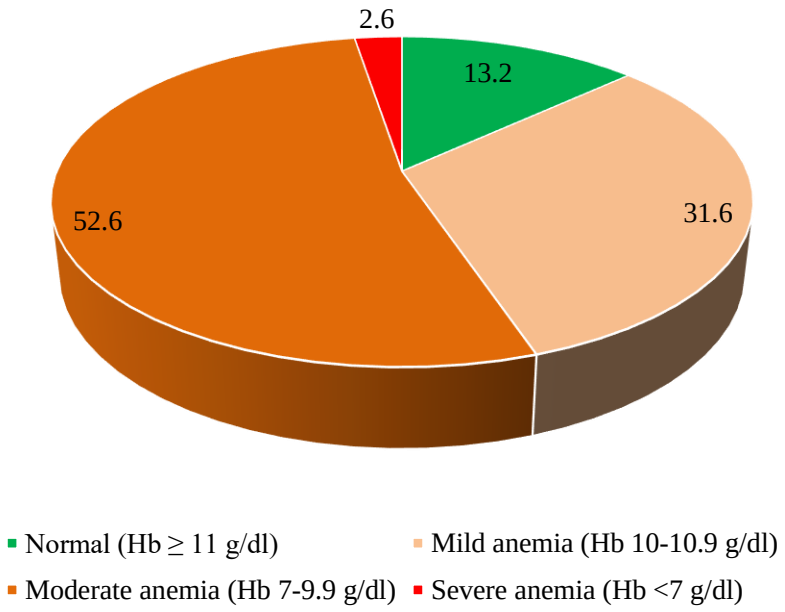
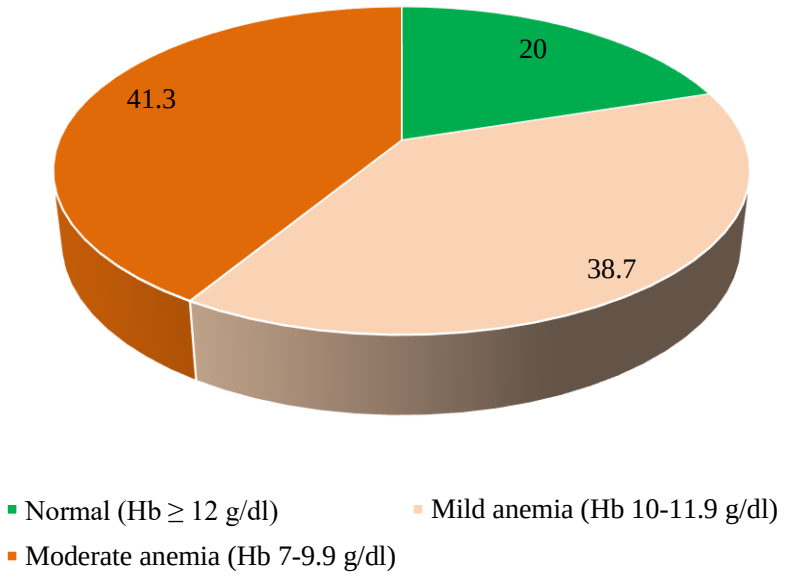


Figure 18: Prevalence (%) of anaemia among lactating mothers in *Attappadi*



5.3 Micronutrient deficiencies in children (12-59 months)

Micronutrients are essential for optimum growth and body functioning. The body requires Vitamins and minerals from external sources (food/supplementation) as it cannot produce them. Deficiencies of individual/multiple micronutrients in infants and children can lead to morbidity, mortality [26, 32, 33], impaired cognitive development, poor physical growth, and decreased work productivity in adulthood [34]. This section presents the prevalence of the following five micronutrient deficiencies among tribal children (12-59 months) in *Attappadi*.

1. Iron
2. Vitamin A
3. Folate
4. Vitamin B12
5. Vitamin D

Table 36 presents the proportion of children (12-59 months) with micronutrient deficiencies. One in every two tribal children in *Attappadi* had iron deficiency (low serum ferritin). Young children (12-23 months and 24-35 months) had a higher prevalence of iron deficiency (64.6% and 58.7% respectively) compared to children of 36-47 months (42.2%) and 47-59 months (39.8%). The prevalence of vitamin A deficiency (VAD) was 11.8% among pre-school children. The prevalence of VAD was almost the same (13.2% and 13.5% respectively) for age groups 12-23 months, 36-47 months, and 47-59 months. About 16% of children aged 12-59 months had folate deficiency. Prevalence folate deficiency was higher among children aged 47-59 months (19.5%) and 36-47 months (17.8%). Over one-third of children (12-59 months) (34.6%) in *Attappadi* had Vitamin B12 deficiency. Vitamin D is essential for bone health. Inadequate intake of foods that are rich in vitamin D and inadequate exposure to ultraviolet B (UVB) radiation from sunlight lead to growth faltering in children [35]. One in every five tribal children (12-59 months) *Attappadi* was deficient in Vitamin D (Serum 25 (OH) concentration < 12 ng/mL). Another 47.5%of children were having insufficient Vitamin D (Serum 25 (OH) concentration between 12 and 29.9ng/mL). The highest prevalence of Vitamin D deficiency was found among children 47-59 months (25.8%).

Figure 19: Proportion of boys and girls (12-59 months) with micronutrient deficiencies in *Attappadi*

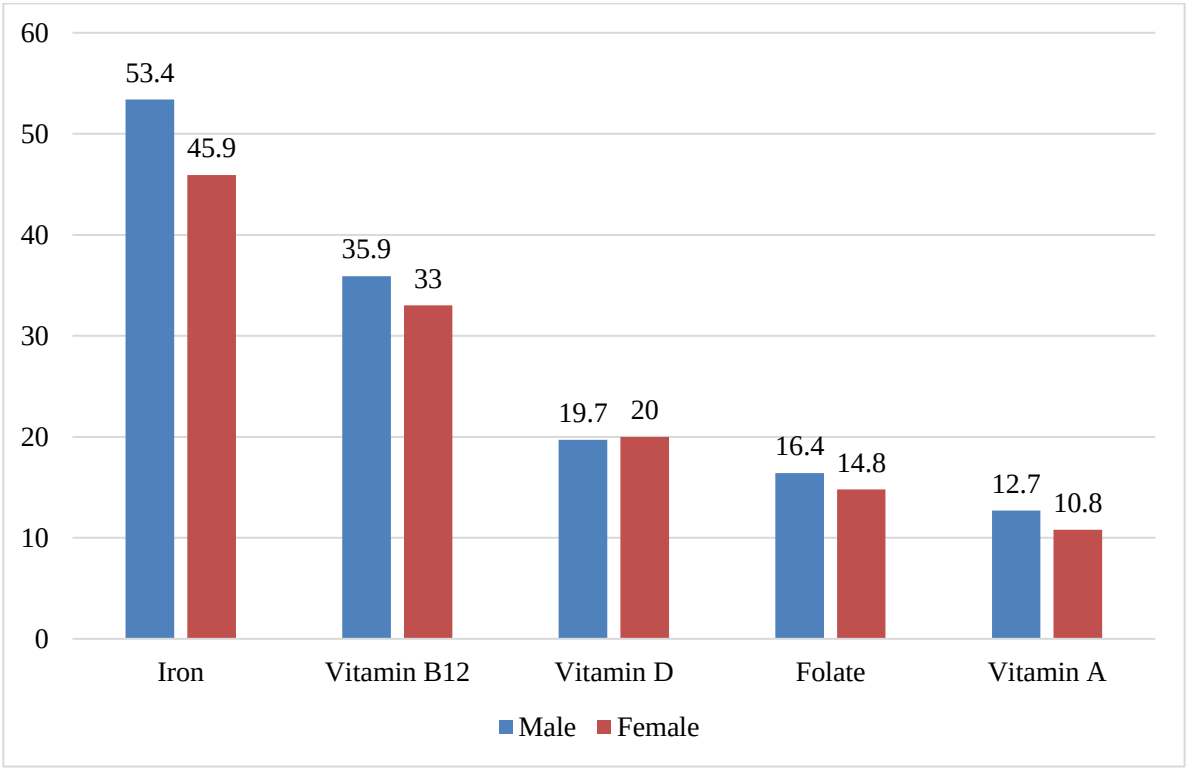
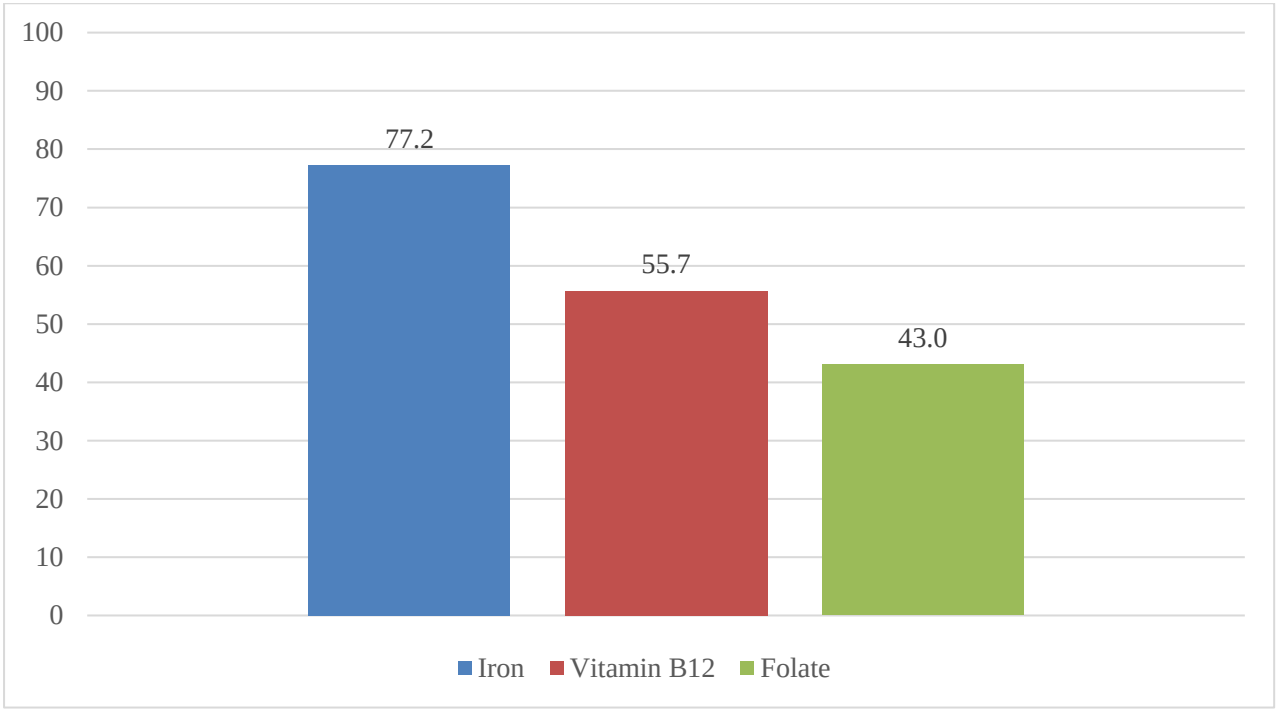


Figure 20: Prevalence of Iron, Vitamin B12, and Folate deficiencies among children (12-59 months) with Vitamin D deficiency (N=79)



CHAPTER 6
INFANT AND YOUNG CHILD FEEDING PRACTICES AND THE POPULATION'S ACCESS TO NUTRITION/HEALTH SERVICES

6.1 Introduction

Infancy is a period of immense potential to set the proper foundation for the baby's survival and physical and mental growth through proper care and sound nutrition [36, 37]. This is also a period of enormous vulnerability as poor nutrition can result in stunted growth, which may hinder the development of mental faculties, weaken the immune system, and increase susceptibility to infections and diseases [38, 39]. Hence, proper infant and young child feeding practices (IYCF) play a crucial role in the child's survival, growth, and development until two years of age and significantly impact their nutritional status during this phase and in the future [40, 41].

In 2002, the World Health Organization (WHO) and the United Nations International Children's Fund (UNICEF) adopted the Global Strategy for IYCF that include: (i) early initiation of breastfeeding (within 1 hour of birth), (ii) exclusive breastfeeding for the first six months; (iii) introduction of nutritionally adequate and safe (solid) complementary foods from 6 months of age and continued breastfeeding beyond two years of age [42, 43]. This chapter looks at the infant and young child feeding practices among the tribal population in *Attappadi*.

6.2 Demographic characteristics of children (0-59 months)

The demographic particulars of children under five years covered in this study are presented in **Table 37**. A total of 497 children were covered, where 275 were children 0-35 months, and 222 were children 36-59 months. Sex-wise, 53.9% (268) were boys, and 46.1% (229) were girls. The distribution of children (0-35 months) by birth order and the birth interval is given in **Table 38.** Most children (0-35 months) covered in the sample were of first or second birth

order. Of the 170 children (0-35 months) with birth orders of two or more, 18.8% had birth interval of 11 to 23 months, 22.5% had birth interval of 24 to 35 months, and 19.4% had birth interval of 36 to 47 months. A birth interval of greater than 48 months was observed among more than one-third (34.9%) of the children of birth order 2+.

6.3 Exclusive breastfeeding and initiation of complementary feeding

Early breastfeeding initiation (within one hour of birth) protects the newborn from acquiring infection and reduces newborn mortality. Information on the initiation of complementary feeding and the reasons for early initiation of complementary feeding are given in **Figures 21 & 22.** Among mothers of children (0-35 months), 69.5% reported that they put their children to breasts within one hour of delivery. Information on complementary feeding practices for children is provided in **Table 39**. Among the children (0-5 months), 71.4% were exclusively breastfed. For 63.3% of children of 6-11 months, complementary feeding was started after six months.

Figure 21. Initiation of complementary feeding (%) among children (6-11 months) in *Attappadi* (N=49)

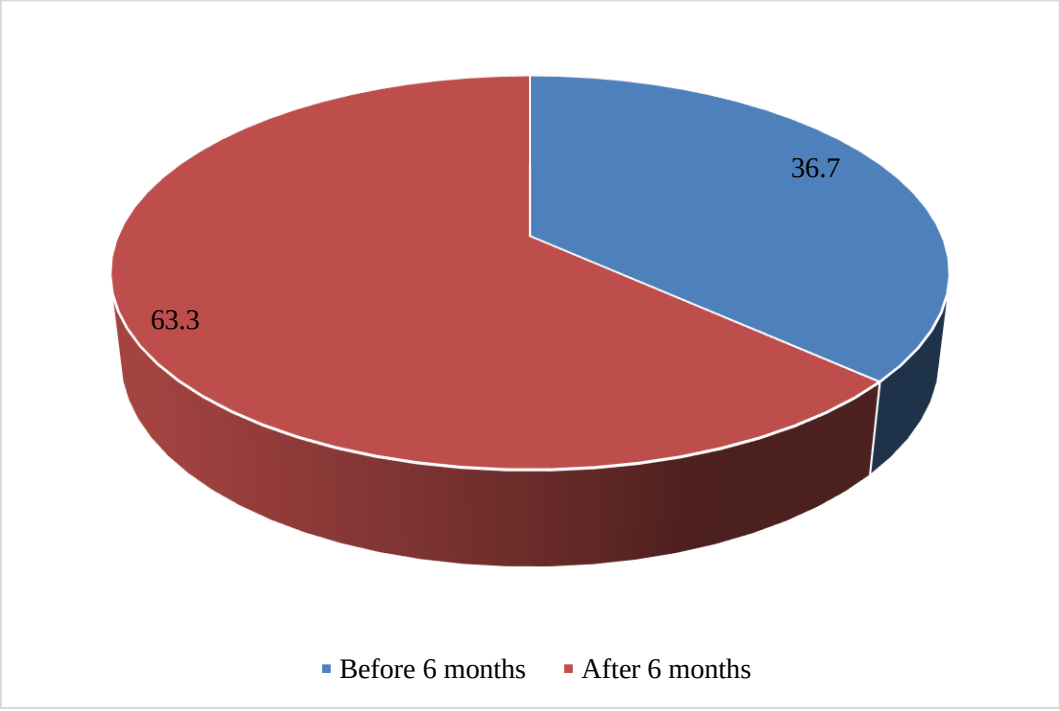
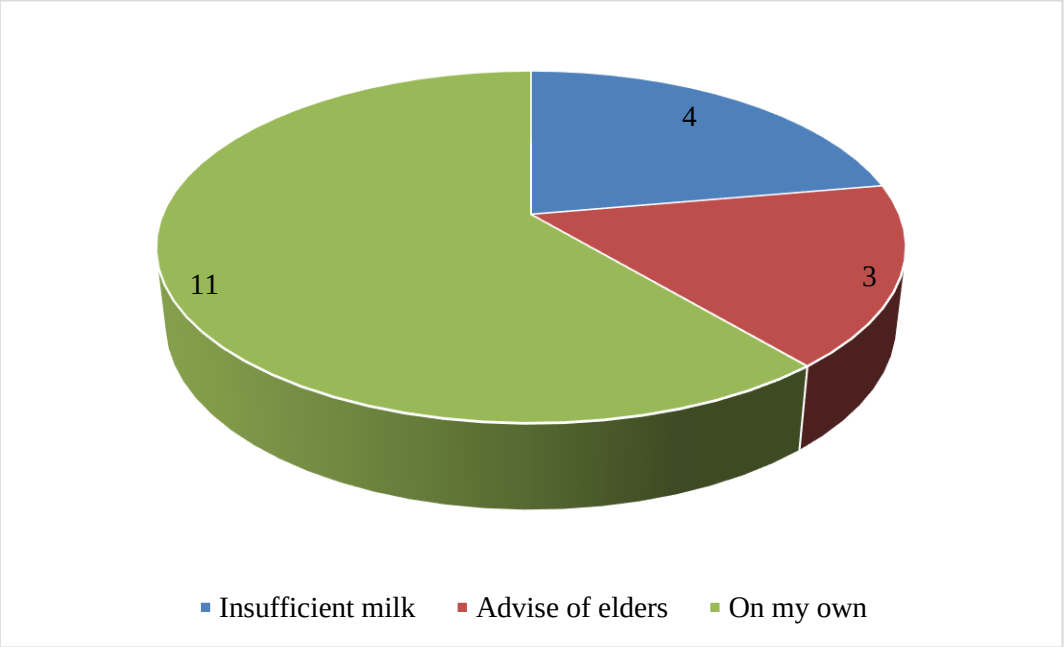


Figure 22. Reason for early initiation of complementary feeding among children (6-11 months) in *Attappadi* (N=18)



6.4 Current feeding practices for children (6-35 months)

Table 40 shows the type of complementary food given to the children, the food groups included in the child's diet, and the meal frequency. For children (12-35 months), the most commonly given food items were: homemade semi-solid food (38.6%), ICDS supplements (35%), homemade solid food (33.5%), processed food such as biscuits etc. (30.9%), and cow/goat/buffalo milk (17.8%). For children 6-11 months, the majority of the mothers (91.8%) give homemade semi-solid food, followed by ICDS supplement (65.3%) and homemade solid food (51%). The consumption of processed food, such as biscuits, etc. was also high among children (49%). Consumption of cow/goat/buffalo milk was 38.8% among children of 6-11 months.

The diet of the tribal children (6-11 months) in *Attappadi* was primarily cereal-based (98%). The mothers of these children reported that the diet includes green leafy vegetables (100%), pulses (65.3%), fruits (51%), etc. The food given to children (12-35 months) includes green leafy vegetables (100%), cereals (42.6%), pulses (40.1%), and other vegetables (38.6%). Most children had three or more meals daily (69.4% for children 6-11 months and 89.8% for children 12-35 months).

6.5. Minimum diet diversity (MDD) and minimum acceptable diet (MAD) among children (6-23 months)

MDD is the consumption of four or more food groups by children 6-23 months from the seven food groups, namely: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry, and organ meats); eggs; vitamin-A rich fruits and vegetables; other fruits and vegetables [44]. It is assumed that the consumption of four more food groups is required for higher dietary quality and to meet daily energy and nutrient requirements. WHO considers the cut-off of at least four of the seven food groups above because the consumption of at least four food groups would mean that in most populations, the child had a high likelihood of consuming at least one animal source food and at least one fruit or vegetable that day, in addition to a staple food (grain, root or tuber) [44]. Among the tribal children (6-23 months), 70.2% were able to meet the MDD defined by the WHO. On the other hand, almost 30% of children could not consume an adequately diverse diet.

The MAD indicator was expressed as a dichotomous variable categorized as "adequate minimum acceptable diet" and "inadequate minimum acceptable diet". A child who met both the minimum dietary diversity and the minimum meal frequency was categorized as "adequate minimum acceptable diet", and a child who did not meet either or both the minimum dietary diversity and the minimum meal frequency as "inadequate minimum acceptable diet". Minimum meal frequency is defined as two times for breastfed infants 6–8 months, three times for breastfed children 9–23 months, and four times for non-breastfed children 6–23 months [44]. Among the tribal children (6-23 months) in *Attappadi*, half of them (50.3%) were able to have MAD. **(See Table 41)**

6.6. Access and utilization of health and nutrition services for children

6.6.1 Access and utilization of ICDS services by children (6-59 months)

Table 42 presents the utilization of various service provisions of the ICDS by the children. More than 90% of the children (6-59 months) received the benefit of the supplementary nutrition programme from the ICDS. The majority (95.8%) of the mothers of children (6-35 months) reported that they get the take-home ration (THR) for their children regularly (once every month). The THR consumption among children was found to be almost universal (98.7%).

Monitoring children's growth (by comparing their weight with their age) every month is another mandate of the ICDS. Growth monitoring was found to be regular (three times in three months) for 72.5% of children (6-35 months) and 65.3% of children (36-59 months). Mothers of children 6-35 months and 36-59 months were asked about their children's weight monitoring frequency in the last three months. About 3% of mothers of 6-59 months reported that the AWW did not weigh their children

in the last three months. Of those children whose growth monitoring was done, 91.1% (children 6-35 months) and 86.6% (children 36-59 months) mothers reported that the AWW discussed their children's weight. The distribution of deworming tablets was also asked for children (36-59 months). It was found that only half of the children (48.7%) received deworming tablets in the last year.

Table 43 presents the status of Iron Folic Acid (IFA) supplementation among tribal children 6-59 months in the last 12 months. Only 50% of the children (6-35 months) and 44.6% (36-59 months) received IFA syrup. ANM/AWW supplied IFA syrup for the majority of these children. The two primary reasons for not receiving IFA syrup, according to the mothers of children (6-35 months), were 'lack of awareness of the importance of IFA' (55.8%) and 'not being offered by the service provider (34.2%). Of those who received IFA syrup, the majority received one bottle (75% of children 6-35 months and 57.6% of children 36-59 months). Only 14.4% children (6-35 months) and 26% children (36-59 months) were reportedly consumed 2 bottles of IFA syrup in the last one year.

6.6.2 Coverage of vitamin A supplementation (VAS)

National Programme for Prophylaxis against Nutritional Blindness (NPPNB) due to vitamin A deficiency was launched in 1970 by the Government of India. Under this programme, all children aged between 6 to 59 months should receive a massive biannual vitamin A supplementation. Thus, by the end of 5 years of age, all children should receive a total of 9 doses of vitamin A supplementation (VAS). The particulars of coverage of VAS among children 9-59 months during the previous year are provided in **Table 44.** Among the children 9-35 months, 92.2% received at least one massive vitamin A supplementation the previous year. The proportion of children (36-59 months) who received VAS was 86% for children. Most mothers (6 mothers) of children who did not receive VAS (7 children) were unaware of the importance of VAS. In most cases (91.5%), the VAS was administered at AWC or a sub-center. Similarly, most mothers reported that VAS was administered by either the ANM/LHV (94%).

6.6.3 Childcare and personal hygiene practices

Information collected from mothers regarding childcare and personal hygiene practices is summarised in **Table 45**. Childcare practice was collected only for children whose mothers go to work. Most mothers of children (0-35 months) who go to work carry their children to the work site (46%), while 40.5% keep the children with their grandparents. Among the mothers of children (36-59 months) who go to work, 35.7% carry the children to the work site, 29.7% leave them in the AWC, and 19.8% keep them with their grandparents or with other household members.

6.7. Short-term morbidities and health seeking

Table 46 presents the prevalence of short-term morbidities in children and overall health-seeking. Most mothers (63%) reported that they approach a government physician for healthcare if their children fall sick. Another 34.2% of mothers usually approach a private physician for health seeking for their children. It was found that 40.6% of the children (0-59 months) had any illness during the preceding two weeks of the survey. The common morbidities reported by the mothers for their children during the previous fortnight were fevers (27.6%), ARI (8.5%), diarrhoea (5%), dysentery (1.6%), and measles (1.4%).

6.8. Accesses and utilization of health and nutrition services for adolescent girls

6.8.1 Demographics of the adolescent girls (10-19 years)

Table 47 shows the basic demographics of the adolescent girls covered in the survey. Of the total 88 unmarried adolescent girls covered in the survey, 54.7% were 10-14 years, and 45.3% were 15-19 years. Among the adolescent girls, 28% did not attain menarche, and for others, the mean age at menarche was 12.4 years [CI: 12.10 – 12.70].

6.8.2 Access to nutrition services and WASH practices

Table 48 presents adolescent girls' access to nutrition services and WASH practices. The coverage of de-worming tablets was 52.3% among adolescent girls. In contrast, 47.7% of adolescent girls did not receive a de-worming tablet in the 12 months preceding the survey. Most often, AWW (48.9%) and the school teacher (46.7%) provided the de-worming tablet. Close to two-thirds (65.1%) of the adolescent girls reported that they washed their hands with soap after defecation, and 53.5% did so before having food.

Table 49 summarises adolescent girls' access to nutrition services and their utilization. Almost 70% of the tribal adolescent girls received IFA tablets in the last 12 months before the survey. Among those who did not receive were unaware of the scheme (57.7%) and never offered (42.3%). Most adolescent girls received IFA tablets from their school teacher (80%), followed by AWW/ANM (16.7%). Only 26.7% of adolescent girls received at least 30 IFA tablets in the previous 12 months. The mean age at first consumption of the IFA tablet was 11.6 years

CHAPTER 7
UTILISATION OF ANTENATAL AND POSTNATAL CARE SERVICES

7.1. Introduction

The World Health Organization (WHO) envisions a world where every pregnant woman and new-born receives quality care throughout pregnancy, childbirth, and the postnatal period. Within the continuum of reproductive health care, antenatal care (ANC) provides a platform for critical healthcare functions, including health promotion, screening and diagnosis, and disease prevention. It has been proved that by implementing timely and appropriate evidence-based practices, ANC can save the lives of mothers and children. ANC also allows communication with and supports women, families, and communities at a critical time in a woman's life. This chapter explores the utilisation of/access to the ANC and PNC services by the tribal women in *Attappadi*.

7.2. Currently pregnant women and ANC details

7.2.1 Demographics of the currently pregnant women

Table 50 presents the demographics of the currently pregnant women covered in the survey. The study involved a total of 41 pregnant women; the majority of them (51.3%) were older than 26 years. Almost 22% of pregnant women were married before 18 years, and the majority (56.1%) got married between 19 and 22 years of age. Only 10% of the pregnant women were below 20 years of age. By gestation age, 17.1% of the pregnant women were in their first trimester, 53.7% were in their second trimester, and 29.3% were in their third trimester. For 36.6% of these women, the current pregnancy was their first (primigravida), while for 17.1%, it was their second. Most currently pregnant women (43.9%) had no other living children, and 14.6% had more than three living children.

7.2.3 Particulars of ante-natal care (ANC) services

Particulars of the utilization of ANC services among currently pregnant women are presented in **Table 51**. Almost all (97.6%) of the pregnant women registered their pregnancy and started availing of ANC services. The proportion of pregnant women registered for ANC before 12 weeks of gestation was 85%. Most pregnant women underwent ANC at a government hospital (75%), followed by a private hospital (25%). About 32% of the pregnant women made at least five ANC visits.

Almost all the pregnant women registered for ANC underwent the investigations like physical examination (100%), weight recording (95%), urine examination (92.5%), haemoglobin estimation (92.5%), and Blood Pressure monitoring (80%). All the pregnant women reported that they received advice from the ANC provider regarding the importance of regular ANC visits, adding green leafy vegetables to the diet, and compliance with IFA tablet consumption.

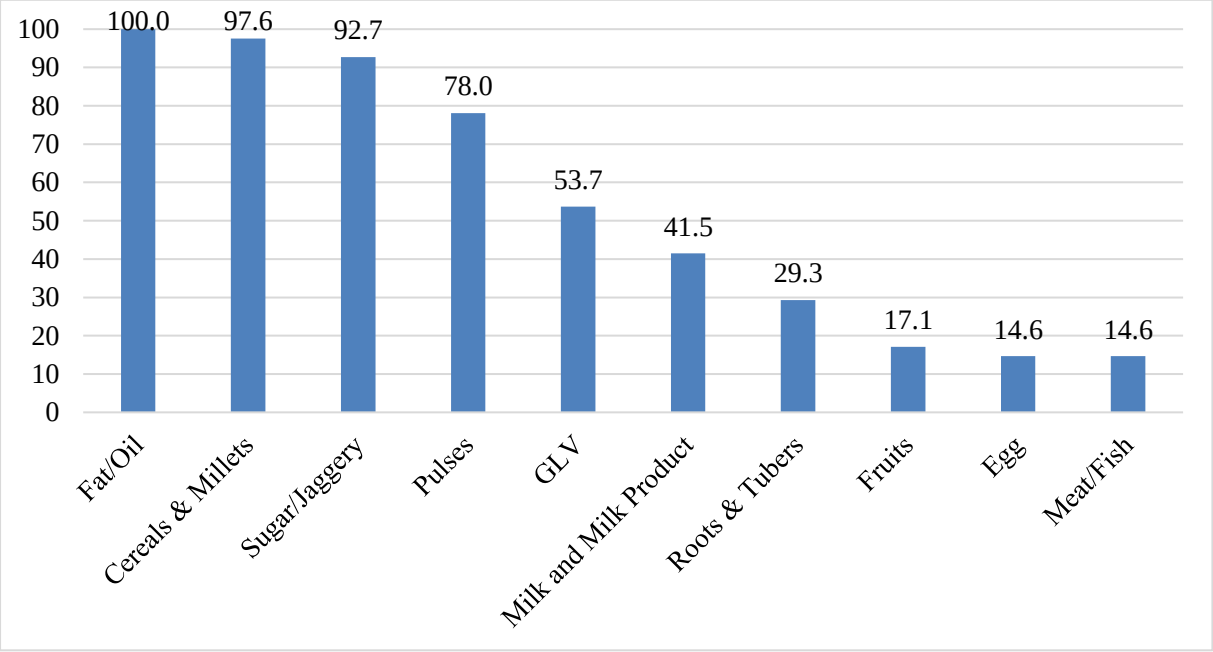
Most of the pregnant women (85%) covered for the study received the Tetanus Toxoid (TT) immunization during the current pregnancy, and 58% received two doses of TT. Among those pregnant women who did not receive TT immunization (6 pregnant women) cited reasons such as ‘not offered’ (3 women) and ‘not aware’ (3 women). Ten women had pregnancy complications such as anaemia (8 women) and sickle cell anaemia (1 woman), and diabetes mellitus (1 woman).

The information on IFA consumption by pregnant women is summarised in **Table 52.** IFA tablets were given to 97.5% of the 40 pregnant women who registered for ANC. Most of them (40%) received IFA from government hospitals, followed by AWW/ANM/ASHA (37.5%) and private doctors (20%). Among the women who received IFA, 72% received <100 IFA tablets, and the remaining 28% received at least 100 IFA tablets. Regarding IFA consumption, 69% of women consumed <100 IFA, while 31% consumed more than 100. Participation of pregnant women in the ICDS supplementary nutrition programme is presented in **Table 52**. A majority **(**83%) of pregnant women received supplementary nutrition through the ICDS, and 88.2% shared it with other family members. The AWW provided nutrition counselling/ advice to every pregnant woman receiving supplementary nutrition.

7.2.4 Food intakes during pregnancy

Table 54 lists the food groups pregnant women consume in the tribal hamlets of *Attappadi*. Some pregnant women avoided certain foods such as papaya (5 women) and pineapple (5 women). Other foods avoided by pregnant women were garlic (3 women), ginger (1 woman), and roots/tubers (1 woman). Pregnant women most typically consume cereals, pulses, green leafy vegetables, and other vegetables, according to self-reported diet data. Milk & milk products, roots, and tubers were also regularly consumed by pregnant women. Meat, eggs, and fruit were rarely consumed.

Figure 23: Self-reporting of daily consumption of various food items by the currently pregnant women in *Attappadi* (N=41)



7.3. Antenatal care by mothers of children (0-35 months)

Details of the utilization of ANC services by the mothers of children (0-35 months) are presented in **Tables 55** and **56**. Nearly all mothers (97.8%) of children under 35 months old used ANC services during their last pregnancy, and 92% of those mothers had five or more ANCs. About 88% of women registered for ANC before 12 weeks of gestation. The majority (88.5%) of women underwent ANC at government health facilities. Similarly, a majority (84.5%) of the ANCs were being conducted by Medical Officers (MO)-PHC, followed by

Private Doctors (10.4%) and ANM (4.1%). Almost every woman underwent the investigations including weight recording, physical examination, blood pressure readings, haemoglobin estimation, ultrasound scan, and urine examination. All the women stated that they had received advice during ANC regarding the importance of regularly attending ANCs, eating green leafy vegetables, and taking iron and folic acid (IFA) supplements.

Tetanus Toxoid (TT) vaccination was given to all mothers included in the study during pregnancy, with 97.8% receiving two doses. IFA tablets were given to all the women, and the majority (93.3%) received them from a government facility. The majority of women who received IFA tablets (94.4%) had a sufficient receipt (100+ tablets), and 91% of them consumed at least 100 IFA. Almost all the women (98.5) received ICDS supplementary nutrition during their last pregnancy, and the supply of ICDS supplementary food was regular (98.1%). Many of these women reported sharing the THR with their family members.

7.4. Details of delivery and breastfeeding

Information on delivery and breastfeeding is shown in **Table 57**. We found that two-thirds (65.8%) of deliveries were normal, and one-third (34.2%) were caesarean/assisted deliveries. Most deliveries (97.9%) occurred in health facilities, 82% in government facilities, and 16.4% in private hospitals. Most births were attended by government doctors (80.0%) and the remaining 16.4% by private doctors. Of all women, 72.5% received cash benefits under JSY and special assistance from ITDP. However, 26% of the women reported that they did not receive any financial support for their last pregnancy. About half of the mothers benefited from referral transport services to reach health facilities and back home after delivery.

Most (96%) of the mothers reported that the birth weights of their new-borns were recorded. Of them, 99% of mothers reported that the birth weight was recorded on the day of delivery. The proportion of new-borns with low birth weight (LBW) was 41.4%. Information on birth weight was collected from Mother and Child Protection (MCP) cards (55.7%), parents' recall (40.1%), and anganwadi records (4.2%). The mean birth weight of the children was 2.53 Kg. Childhood immunization (administered all the essential vaccines as per the primary immunisation schedule) is almost universal in the community (98.9%). Of the children (275), 85.4% were fed yellow milk (colostrum), an essential source of nutrition and immune

protection for the newborn. Close to 6% of the children (16 children) were fed pre-lacteals, mostly due to insufficient milk (11 children). Very few mothers think that pre-lacteals are good for children, so they feed them. (**See Table 57**). Information regarding post-natal care is presented in **Table 58.**

CHAPTER 8

CONCLUSION OF THE FINDINGS

8.1. Socio-economic characteristics: This study covered 523 children (0-59 months), 150 adolescent girls (10-19 years), 40 pregnant women, and 110 lactating mothers from 480 tribal households in *Attappadi* Taluk, Kerala. The selected households comprised 77.5% *Irula*, 13.3% *Kurumba*, and 9% *Muduga* tribes. The overall literacy rate of the population (age more than six years) was 77.6% (males 78.9% and females 76.7%). Among tribal households in *Attappadi*, *Pucca* dwellings accounted for 49.2% of all households; the remaining were *Semi-pucca* or *Kutcha* houses. Tap water (44.6%) and water from streams (34.4%) were primary drinking water sources. Most households (68.8%) used firewood as cooking fuel. Electricity was present in 83.7% of households. Seventy-four per cent of the households had sanitation facilities and were in use. The primary income source for most households (71.4%) was daily wage work. Mahatma Gandhi National Rural Employment Guarantee Programme (MGNREGP) was one of the principal sources of income for households. The cultivation and gathering of forest products are no longer a source of subsistence for tribal households in *Attappadi* Taluk. Almost all (95.8%) households were protected from food insecurity by being covered under the Public Distribution System (PDS). The community kitchen is in operation in almost all the tribal villages, however, in this study, we have not conducted any evaluation of the programme. The use of alcohol (21.8%) and tobacco (42.3%) was found to be rampant among the population. The prevalence of alcohol use (daily or at least once a week) was 46.8% for men and 1.9% for women. Tobacco use was 48.8% for men and 42.3% for women.

8.2. Food and nutrient intakes: The mean daily intakes (g/day) of all the food groups except for 'roots & tubers' were considerably below the recommended daily intakes (RDIs) for tribal children (1-3 years). The only food groups adequately consumed by boys and girls (4-12 years) in *Attappadi* were 'roots & tubers' and 'pulses & legumes.' Consumption of all other food groups such as 'milk& milk products', 'green leafy vegetables', 'other vegetables', and 'fat & oil' etc. was unacceptably low among children (1-12 years). Among adult men and women with sedentary and moderate physical activity, the consumption of the majority of foods including leafy vegetables, milk & milk products, and fats & oils were lower than the suggested

levels (RDI). In terms of the daily macro and micronutrient consumption for children (1-6 years), protein intake was within the RDA. Intake of all other nutrients was severely deficient among children. Children (4-6 years) received enough folate through their diet. Vitamin C intake for pregnant women was at or above the RDA. Pregnant women and children (1-6 years) have severe deficiencies in fat, energy, iron, riboflavin, calcium, and vitamin A.

8.3. Nutritional anthropometry: For children (0-59 months), the prevalence of underweight, stunting, and wasting was 48.3%, 40.9%, and 27.4% respectively. Of the total children included in the survey, 61.4% had anthropometric failures of any form. Among the children (5-9 years), more than one-third (35.5%) were thin (low BMI for age), and one in every 25 was overweight/obese. The prevalence of thinness (low BMI) among adolescent girls (10-19 years) was 20.9% with a higher rate (25.6%) among young adolescent girls (10-14 years). Overall, this indicates that in every ten adolescent girls in *Attappadi*, two have a low BMI for age, and one experiences overweight/obesity.

The number of pregnant women 'at risk' in terms of low height (<145 cm) was 9 and low weight (<39 kg) was seven. Of the total 40 pregnant women, 14 were of low height or low weight, and two had both the conditions of low height and low weight. The prevalence of chronic energy deficiency (BMI < 18.5 kg/m2) among lactating mothers was 40%, and overweight/obesity (BMI ≥ 25 kg/m2) was 15%. Among the overall adult population (≥18 years), 30.6% were suffering from chronic energy deficiency with a prevalence of 22.9% among males and 33.2% among females. The prevalence of overweight/obesity among adult tribal males and females was 12.2%, and 13.4% respectively.

8.4. Anaemia and micronutrient deficiencies: Anaemia is a widespread public health problem across all age groups among the tribal population in *Attappadi*. The overall prevalence of anaemia in children (aged 12-59 months) was 91.2%. The prevalence of anaemia was highest (97.7%) in the youngest children (12-23 months). Most adolescent girls have mild (53.4%) and moderate (42.1%) anaemia. The overall prevalence of anaemia among pregnant women was 86.8%. Of them, the proportion of pregnant women with severe anaemia was 2.6%. The overall prevalence of anaemia in lactating women was 80%. Close to 50% of the tribal children (12-59 months) in *Attappadi* had iron deficiency. A large number of children (12-59 months) were deficient in Vitamin B12(34.6%), and Vitamin D (20%). Folate deficiency and Vitamin A deficiency (VAD) were 15.7% and 11.8% respectively among pre-school children.

8.5. Infant and young child feeding (IYCF) practices: Exclusive breastfeeding was 71.4% for children (0-5 months). Close to 70% of the mothers (of children 0-35 months) reported that they put their children to breasts within one hour of delivery. Of the children (0-35 months), 85.4% were fed yellow milk (colostrums). Nearly 6% of the children were fed pre-lacteals, mostly due to insufficient milk. For children (12-35 months), the most commonly given food items were: homemade semi-solid food (38.6%), ICDS supplements (35%), homemade solid food (33.5%), processed food such as biscuits, etc. (30.9%), and cow/goat/buffalo milk (17.8%). The diet of the tribal children (6-11 months) in *Attappadi* was primarily cereal-based (98%). Among the tribal children (6-23 months), 70.2% were able to meet the Minimum Diet Diversity defined by the WHO. Among the tribal children (6-23 months) in *Attappadi*, half of them (50.3%) were able to have Minimum Acceptable Diet.

8.6. Access to health and nutrition services: More than 90% of the children (6-59 months) received the benefit of the supplementary nutrition programme from the ICDS. The majority (95.8%) of the mothers of children (6-35 months) reported that they get the take-home ration (THR) for their children regularly (once every month). The THR consumption among children was found to be almost universal (98.7%). Growth monitoring was found to be regular (once in a month) for 72.5% of children (6-35 months) and 65.3% of children (36-59 months). It was found that only half of the children (36-59 months) received de-worming tablets in the last year.

Only 50% of the children (6-35 months) and 44.6% (36-59 months) received IFA syrup. However, the consumption of IFA is even low. Among the children 9-35 months, 92.2% received at least one massive vitamin A supplementation the previous year. The proportion of children who received VAS was 86% for children (36-59 months). Almost 70% of the tribal adolescent girls received IFA tablets in the last 12 months before the survey. The coverage of de-worming tablets was 52.3% among adolescent girls in the 12 months preceding the survey.

8.7. Short-term morbidities among children: One in every ten children (0-59 months) had any illness during the preceding two weeks of the survey. The common morbidities reported by the mothers for their children during the previous fortnight were fevers (27.6%), ARI (8.5%), diarrhoea (5%), dysentery (1.6%), and measles (1.4%). Most mothers (63%) reported that they approach a

government physician for healthcare if their children fall sick. Another 34.2% of mothers usually approach a private physician for health seeking for their children.

8.8. Utilisation of ANC services: Almost all (97.6%) of the currently pregnant women registered their pregnancy and started availing of ANC services. The proportion of pregnant women registered for ANC before 12 weeks of gestation was 85%. Most pregnant women underwent ANC at a government hospital (75%), followed by a private hospital (25%). IFA tablets were given to 97.5% of the 40 pregnant women who registered for ANC.

The proportion of new-borns with low birth weight (LBW) was 41.4%. The mean birth weight of the tribal children was 2.53 Kg.

8.9. Observations from the field

Attappadi, although a bleak tribal hinterland, is an avenue of income and livelihood for many settlers from various parts of Kerala and Tamil Nadu. Settlers are engaged in large-scale farming, animal husbandry, trade, etc. *Attappadi* is also an emerging non-conventional energy hub of Kerala with rooftop solar power and wind energy. There are also large tea plantations in this area. The production of cardamom, pepper, areca nut, etc., is also substantial in this area.

Cultivation and income from forest resources are no longer a source of livelihood among the tribal population in *Attappadi*. MGNREGA has become the primary livelihood and income source for most tribal households. Even young girls and boys enter the workforce after just finishing their 12 standards of schooling. Many adolescent boys and girls prefer MGNREGS jobs over higher education, which can be counterproductive to the community's future. Several mothers were found to be bringing their young children with them to the workplaces. This often affect the infants' proper care and feeding. Many *Tribal promoters* reported that 'mothers carry their children to the workplaces (MGNREGA worksite), often in the remote forest areas. During work time, children do not get adequate care or feeding. This happens mostly among families with no additional members to take care of the children in the mother's absence.

Upon being asked about the severe malnutrition problems in the community, a village head (*Moopan*) stated that 'earlier we used to cultivate varieties of millets and the diet was mainly

millets. We used to get a variety of green leafy vegetables and roots and tubers from the forest.' He said: 'cultivation has declined due to wild animal conflicts and reduced soil fertility.' Another person stated that 'farming has become impossible without depending on chemical fertilizers and pesticides.' Another old tribal woman stated, 'considering the high input cost and the low crop production, cultivation has become costly.' She also stated that 'people are getting ration (referring PDS) and job (MGNREGA), and our diet largely depends on the market.' Another woman said, 'we used to buy only salt and oil from the market, and everything else was produced by us or collecting from the forest. Now we go for MGNREGA and buy everything (rice, vegetables, and oil) from shops.'

Many of the tribal households were found rearing chickens and goats. But, only a few reported consuming eggs, milk, meat, etc. Several traditional green leafy vegetables (Muringa, Amaranth, etc.) were found in the tribal hamlets. Despite having many fruit varieties in the area, fruit consumption was observed less among the tribal population.

To address the issues of poverty, food insecurity, and malnutrition, the government of Kerala has been implementing community kitchens in all the tribal hamlets in *Attappadi*. This scheme is an additional scheme along with PDS, ICDS, MDM, and MGNREGA. Under this scheme, the tribal people were given two cooked meals daily.

The research team observed a dedicated government system under the leadership of ITDP to coordinate the interdepartmental convergence for better implementation of government schemes and programs for tribal development in the area. However, many of tribal people of *Attappadi* reported that that many schemes and programs were designed and implemented without seeking the opinion of the tribal population. It is important to recognize and consider the community's views in designing new schemes. Consultation with stakeholders (people's representatives, women (pre-consumption/pregnant/lactating), men (husbands, fathers of adolescents and children), adolescents, elderly, etc. of the tribal communities) before designing and implementing schemes and programmes will increase community engagement and acceptance.

Health department officials were found to be very cooperative and concerned about the issues of the tribal population. However, they said that the idle attitude and carelessness of the tribal population regarding health seeking is a challenge. According to them, the community needs

to realize the importance of proper health-seeking for themselves and their children. They also said that the young children not getting proper care.
The research team have noticed that the frontline health workers working hard in the community, especially the Anganwadi workers (AWW) and Accredited Social Health Activists (ASHA). Many of these AWWs and ASHA could recall information such as date of birth, birthweight, Hb levels, height, and weight of the children registered in their area.

The team made an effort to explore why there is a growing reliance on private hospitals for ANC. Women who were asked why they chose a private facility over a government one for ANC stated that they were concerned about being referred at the last minute to tertiary care facilities in Trissur, Coimbatore, etc.

The survey team observed that many known cases of sickle-cell anaemia in men, women, and children in the community. A few cases of goitre (16 cases of Grade-1 and 3 cases of Grade 2) were also found among the population.

The local health system enforces compliance. The community complied with the health system's requirements, primarily from fear of the negative consequences of non-compliance. They feel that the health system could not appreciate the context of their daily lives.

It appears that mothers personally do not like to provide IFA syrup to their children. They considered IFA syrup as medicine, and unless there is an illness, they do not give medicine. However, some mothers are giving IFA syrup as the doctor prescribed as a medicine for some diseases. In some cases, mothers do not follow the dosage of IFA syrup. They said that children take the syrup in two-three days. Overall, the mothers of *Attappadi* do not have appropriate knowledge of the complications and consequences of Anemia and the benefits of consuming IFA syrup.

Consumption of IFA tables/syrup was less across the target groups, such as children, adolescent girls, pregnant women, and lactating mothers.

Despite the high SAM prevalence, admissions in the three nutrition rehabilitation centres (NRC) in *Attappadi* were very few. *The tribal promoters* reported that parents do not want to

admit their SAM children to NRCs, afraid of wage loss (workdays). Further, the follow-up with the discharged children is also poor.

8.10. Case histories of neonatal/infant deaths in *Attappadi*

The research team visited 12 households where neonatal deaths occurred and collected information on the death of these children. The current age of mothers who experience child loss ranges between 22 to 47 years. Among the deceased children, six were males, and six were females. All of these children died within two weeks of birth (eight died in the first week, and four died in the second week). Two children who died were born without medical attention at home. Seven of the children who passed away were born prematurely (three children before 24 weeks, one child between 28-32 weeks, and three children between 32-36 weeks). The mean birthweight was 651.6 gms for children born before 24 weeks, 840 gms for children between 28-32 weeks, and 1973.3 grams for children born after 32 weeks.

As per the hospital records, the causes of death included respiratory distress (3 cases), preeclampsia (2 cases), hypoglycemia (2 cases), congenital heart diseases (2 cases), sudden infant death syndrome, myocardial dysfunction, congenital anomaly, birth asphyxia, premature-RDS, hypoplastic heart syndrome, and neonatal shock. Respiratory distress is one of the most common disorders that usually manifest within the first 48-72 hours of life and occurs when the baby's lungs have not produced enough surfactant. A high mortality rate was documented among neonates born to women with preeclampsia. Hypoglycemia (low blood glucose level than the standard range) can be caused by poor nutrition for the mother during pregnancy. These are all symptoms of intrauterine growth restriction (IUGR), which is brought on by the women's low nutritional status both before and during pregnancy.

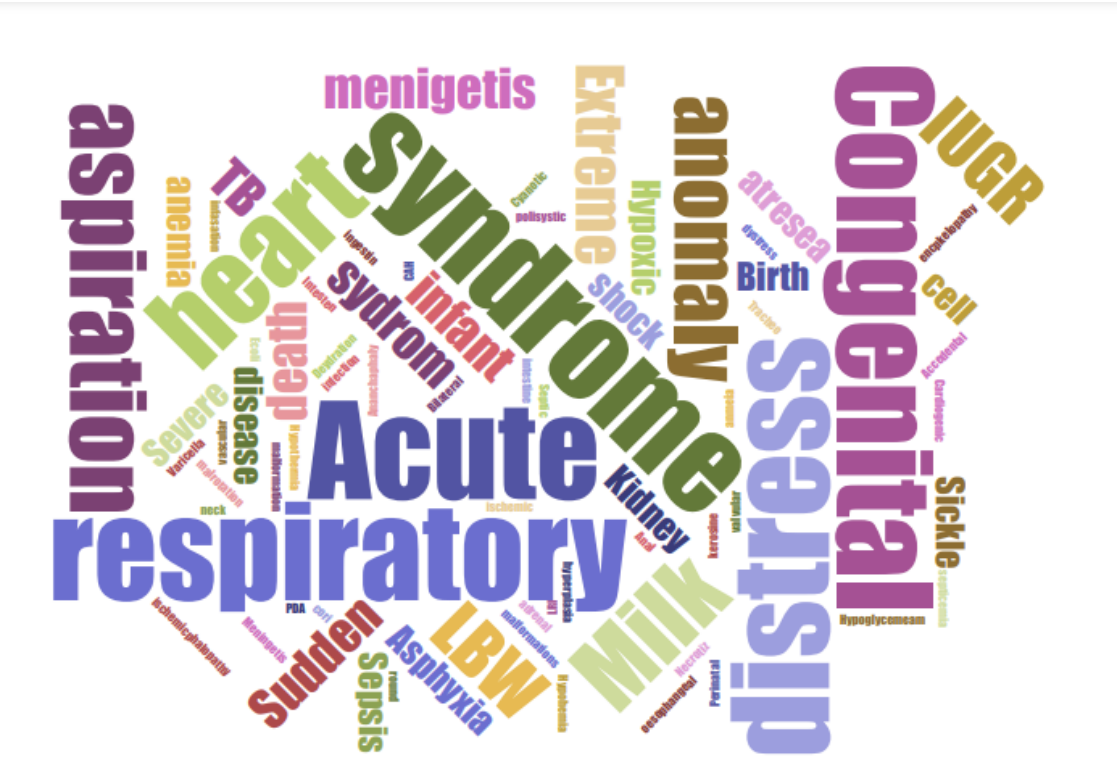
8.11. Analysis of neonatal/infant death statistics (2012-2021)

We examined the statistic on child fatalities maintained by the health department in *Attappadi*. Between 2012 and 2021, 136 fatalities were recorded among the tribal population in *Attappadi*. Among the dead children, 63 were female and 68 were male. The mean age (in days) at death was 49 [CI: 35-63]. A large majority of the children died (66.2%) before reaching the 28th day of birth, 14.7% of children died between 29 and 90 days of birth, and the remaining died after that. All these children died before reaching their first birthday. The mean birthweight was

1830 gms [CI: 1720-1940]. The proportion of children born with a birth weight of less than 1000 gms was 12.5%, and 1000 gms to 1449 gms was 16.2%. Of these children, 84% were born in a health facility (16% at home). At the time of death, 73% of children were in the medical facility, while 27% were at home without any medical attention.

8.12 Causes of neonatal/infant deaths in *Attappadi*

The major causes of the 136 child fatalities between 2012 and 2021 in *Attappadi* are summarised in **Table 59.** Acute respiratory distress syndrome (ARDS) was the most common cause of death, followed by extreme preterm birth, congenital heart disease, extremely low birth weight, milk aspiration, intrauterine growth restriction, congenital anomalies, etc. Major causes of neonatal and infant deaths in *Attappadi* are presented in the word cloud below:



CHAPTER 9
DISCUSSION AND THE WAY FORWARD

9.1 Discussion

This study has found the decline of traditional cultivation and the tribal people's reduced access to the wild food environment. The traditional cultivation of the tribal communities in *Attappadi* included millets, pulses, and oilseeds such as maize, ragi, little millet, red gram, groundnut, etc. [45]. During the survey, people complained that many stopped cultivating crops due to less yield/crop failure and animal attacks. They said that people from outside started commercial farming using chemical fertilizers and pesticides, which made the traditional cultivation methods impossible. The food of the tribal communities in *Attappadi* is mainly dependent on PDS and the open market. We found that the traditional cultivation of millets, pulses, oil seeds, and collection of forest resources has fallen to the level that they no more provide any income and nutrition security to the tribal population in *Attappadi*. Although different varieties of indigenous leafy vegetables and fruits were observed in the area, consumption was meagre.

Wage employment under MGNREGA has replaced traditional livelihood resource bases such as the cultivation and gathering of forest resources. The government has also ensured food security through PDS, and community kitchens. Nutrition and health programs and services are also made available to the tribal population. The ITDP *Attappadi* has cash transfer programs providing financial assistance to pregnant and lactating mothers to protect them from financial stress and its subsequent health and nutrition consequences on children and mothers.

Despite providing foods, shelter, other services free, the tribal population in *Attappadi* experiences poor nutrition and health outcomes. Exploring the reasons why the indigenous community in *Attappadi* continues to experience poor access to healthcare, research [46] highlighted the marginalisation of indigenous culture and healing traditions, lack of community engagement, forced compliance, stigma and discrimination, and the failure of government in addressing the broader determinants of health such as restoration of access to land and forest resources.

This comprehensive study on malnutrition in the tribal population in *Attappadi* of Kerala state yet again demonstrates the high prevalence of all forms of malnutrition across the population, including children (0-9 years), adolescent girls (10-19 years), and adults, currently pregnant women and lactating mothers. We know from empirical evidence that indigenous populations often have less access to health and nutrition services than their non-indigenous counterparts [3] [47-49], and this inequality exists even in high-income countries [47, 50]. The indigenous population faces the additional barrier of poor access to healthcare, worsening the situation further due to multiple other reasons [51]. Despite successes in health and social development, the State of Kerala is not immune to the social exclusion and marginalisation of indigenous communities living in the state. Several studies point to the disadvantages of tribal communities in terms of poor access to healthcare, morbidity, and mortality in Kerala [9].

Food and nutrient intakes across age groups were found less. Except for roots & tubers, the daily intake of all food groups was insufficient to meet the RDI among children (1-12 years). Adult men and women consumed sufficient amounts of pulses & legumes and roots & tubers, but consumption of all other food groups was well below the RDI. For pregnant women and lactating mothers, most foods such as cereal and millet, non-leafy vegetables, milk & milk products were lower than the recommended levels. Food and nutrient deprivation during critical life stages such as pregnancy, childhood, adolescence, etc. will have huge adverse nutrition, health, and developmental consequences for the community.

Malnutrition is widespread across age groups among the tribal population in *Attappadi*. The underweight, stunting, and wasting prevalence among children (0-59 months) was 48.3%, 40.9%, and 27.4%, respectively. Six in every 10 children of this age group had anthropometric failures of any form. Among children (5-9 years), 35.4% were thin, and 4.2% were overweight/obese. The prevalence of thinness and overweight/obesity among adolescent girls (10-19 years) were 20.9% and 10.5%, respectively. Of the total 40 pregnant women, 14 were of low height (<145 cm) or low weight (<39 kg), and two had both conditions. The mean height, weight, and MUAC of lactating mothers were 149.8 cm, 45.5 kg, and 23.5 cm, respectively. Chronic energy deficiency (BMI < 18.5 kg/m2) was 40% among lactating mothers, and 15% of them were overweight/obese (BMI > 25 kg/m2). Almost one-third (30.6%) of the adult population (age 18+) in the tribal hamlets of *Attappadi* suffered chronic energy deficiency. CED prevalence was higher among women (33.2%) than men (22.9%). The prevalence of overweight/obesity among adult tribal males and females was 12.2% and 13.1%,

respectively. The malnutrition burden among the tribal population in *Attappadi* is higher than that of the overall burden of Kerala.

Anaemia is a severe public health problem affecting almost all segments of the tribal population in *Attappadi*. The prevalence of anaemia was unacceptably high among children, adolescent girls (96.6%) pregnant women (86.8%), and lactating mothers (80%). A substantial number of children (12-59 months) were deficient in essential micronutrients such as iron (50%), Vitamin B12 (34.6%), Vitamin D (20%), folate (16%), and Vitamin A (12%).

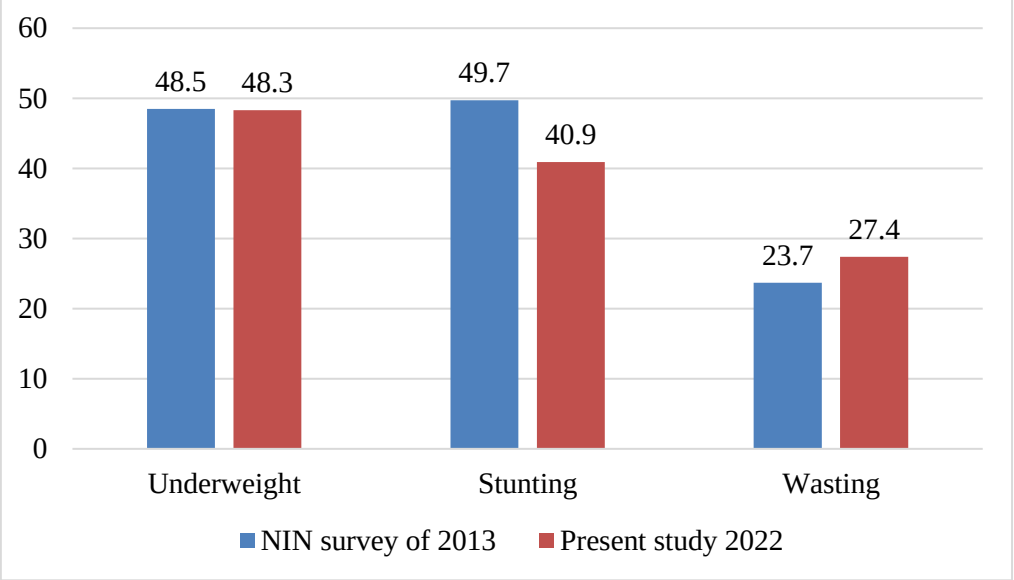
We found relatively better performance in feeding practices and utilisation of nutrition services such as initiation of breastfeeding within one hour (70%), feeding of colostrum (85%), exclusive breastfeeding (71.4%), utilisation of ICDS supplementary nutrition services (90%), vitamin A supplementation (92.2%), and proper growth monitoring (72.5%) in the community. Health seeking for children was also found to be good (97%). However, short-term morbidities (like fever, ARI, diarrhoea, Dysentery, and measles) among children (0-59 months) were found to be relatively high (41%), indicating the susceptibility of children to recurring infections. Timely registration of pregnancy and availing of ANC was almost universal. Most deliveries (97.9%) were institutional. The proportion of new-borns with low birth weight (LBW) was very high in the community (41.4%), with a mean birth weight of 2.53 Kg.

To improve the nutrition and health outcomes of the tribal population in *Attappadi*, we need to engage with the community in designing culturally appropriate programmes. We also need to identify the traditional solutions and engage the people in the community to revive their traditional ways of food and healing practices. While designing the programme, stakeholders' views will be considered.

Overall, we can conclude that in comparison to all children in Kerala and the Palakkad district, the malnutrition rate among tribal children (0-59 months) in *Attappadi* is much higher. Tribal children had a 1.7 times higher risk of being stunted. There was only a modest decrease in the prevalence of malnutrition between 2013 and 2022. The prevalence of underweight has remained stagnant. A decrease of 8.8% has been observed in stunting. Surprisingly, the prevalence of wasting has increased among tribal children. Tribal women in *Attappadi* have 3.3 times more chance of being chronic energy deficiency than that of other women in Kerala. On the other side, the burden of overweight/obesity is also on the rise among tribal women.

Tribal children in *Attappadi* have a 2.3 times higher likelihood of having anaemia than other children living in Kerala. Likewise, tribal women are 2.8 times more likely to be anaemic during pregnancy than an average woman in Kerala. (See **Table 60 and Figure 24**). However, as we have not conducted analysis of the effect of sickle cell disease on the high prevalence of anaemia among the tribal population in *Attappadi*.

Figure 24: Progress in combating the malnutrition among tribal children (0-59 months) in *Attappadi* between 2013 and 2022



9.2 The way forward

We propose the following strategies that may help in addressing malnutrition among children, adolescents, women, and men in *Attappadi*. These strategies will supplement the existing government actions/programmes and can be implemented in cooperation and collaboration with local self-governments, *Kudumbashree*, etc.

1. Identification and promotion of culturally appropriate and acceptable local food-based solutions to combat malnutrition

Tribal population in *Attappadi* are among the most vulnerable to marginalisation, malnutrition, and chronic disease. They will be more resilient and sustainable if their traditional food system is strengthened. Hence, it is crucial to map the traditional food-related good practices, traditional food crops, and identification of geographically appropriate new varieties of

vegetables and fruits with high nutritive values. Reviving traditional cultivation methods and food practices, and introducing new varieties can be promoted through group farming activities of men and women under the MGNREGS and NRLM. This will improve local production and increase the diversity of the food basket of the tribal population in *Attappadi*.

2. Informal and participatory system for mainstreaming health and nutrition information

Although a government (the health and tribal development departments) led system exists for the promotion of health and nutrition information in the community, there is a huge cultural disconnect between the tribal population and healthcare service providers. This often results in insensitive, dismissive, and discriminatory behavior on the part of healthcare personnel. The healthcare service providers' give more emphasis on achieving targets than making qualitative results. Therefore, an alternative/informal platform to promote health and nutrition information led by the women's self-help group (SHG) can be more appropriate. Techniques like participatory rural appraisal (PRA) and participatory learning and action (PLA) can be used to mainstream solutions for health and nutrition issues.

3. Community-led pre-conception nutrition movement

All newly married women and men should be enrolled in a 'health self-help group (HSHG). The health department will help screen all women for nutrition deficiencies, risks, etc. They should receive the necessary information from the HSHG regarding family planning, a healthy diet, etc. Women who are pregnant and lactating need to receive extra care and month-by-month guidance. This system must be completely informal and run by peers from the same neighbourhood/community.

4. Locally managed augmented mid-day meal and ICDS supplements for children

To address malnutrition among children and adolescents, the quality of MDM and ICDS supplement must be increased with the participation and monitoring of the PRIs, and other agencies. The MDM should be able to provide all the essential macro and micro-nutrients to the children. LSG may create nutri-gardens for each school/ICDS Anganwadi with the help of MGNREGP workers.

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Table 5: Sample coverage details

Parameters	Participants			
	Children (0-59 months)	Adolescent Girls (10-19 years)	Currently Pregnant Women	Lactating Mothers
Households	480			
Socio-economic profile	523	150	40	110
Anthropometry	516	67	40	100
Hb estimation*	404	88	38	75
Micronutrient profile*	404	NA	NA	NA

* Only children 12-59 months were included for Hb testing and micronutrient profiling

Table 6: Distribution (%) of socio-economic characteristics of the selected households in *Attappadi*

Socio-economic characteristics	N=480	Per cent
Type of Tribe		
Irula	372	77.5
Kurumba	64	13.3
Muduga	43	9.0
Others	1	0.2
Religion		
Hindu	475	98.9
Christian	5	1.1
Type of Family		
Nuclear	356	74.2
Extended Nuclear	90	18.8
Joint	34	7.0
Family Size		
2-3 members	101	21.0
4-6 members	345	71.9
7+ members	34	7.1
Mean family size [95% CI]	4.5 [4.4 - 4.6]	
Education of the head of the household		
Non-literate/ can read and write	120	25.4
1-4 Class	57	12.0
5 – 8 Class	97	20.5
9 – 12 Class	177	37.4
Collage & above	22	4.7
Occupation of the head of the household		
Daily wage labourer	342	71.3
Unemployed/unable to work	59	12.3
Service/Professional	47	9.8
Cultivator	14	2.9
Driver/Others/Business	14	2.9
Housewife	3	0.8
Household landholding (Acres)		
No Land	159	33.1
Marginal landholding <2.5	234	48.8
Small landholding 2.5 – 5.0	51	10.6
Large landholding ≥ 5.0	36	7.5

Table 7: Distribution (%) of the physical facilities of the selected households in *Attappadi*

Physical facilities	**Households n (%)**	
N	**480**	**Per cent**
Type of house		
Kutcha	98	20.4
Semi-Pucca	146	30.4
Pucca	236	49.2
Source of drinking water		
Open well	41	8.5
Tube well	20	4.2
Tap	214	44.6
Pond or tank	40	8.3
Stream/river/canal	165	34.4
Type of cooking fuel		
Firewood	330	68.8
Liquefied Petroleum Gas	147	30.6
Kerosene	2	0.4
Bio-gas	1	0.2
Households having electricity	403	83.7
Households with Sanitary Latrines		
Present, and using	357	74.4
Present, but not using	48	10.0
No facility	75	15.6
Households having a separate kitchen	418	87.1

Table 8: Distribution (%) of households having access to social safety programmes in *Attappadi*

Access to social safety programs	**N**	**Per cent**
MGNREGS	425	88.5
PDS/TPDS	460	95.8
Mid-day-meal	276	57.6
ICDS	435	90.6

Table 9: Alcohol and tobacco use among the study population (≥15 years) in *Attappadi*

Details	**Male n (%)**	**Female n (%)**	**Total n (%)**
N	**498**	**622**	**1120**
Alcohol	233 (46.8)	12 (1.9)	245 (21.8)
Tobacco	243 (48.8)	231 (37.1)	474 (42.3)

Table 10: Mean Height, Weight, and MUAC of children 0-59 months in *Attappadi*

BOYS		Age group (Months)	GIRLS	
N	**Mean [95% CI]**		**N**	**Mean [95% CI]**
Height (cm)				
43	67.1 [65.4 – 68.7]	0-11	34	62.2 [60.2–64.3]
55	76.0 [75.0– 77.1]	12-23	38	75.5 [74.2– 76.7]
60	84.2 [83.1– 85.4]	24-35	58	84.6 [83.4– 85.8]
55	93.1 [92.1– 94.1]	36-47	44	93.1 [90.0–92.6]
60	98.9 [97.1– 100.6]	48-59	68	98.9 [97.6– 100.1]
Weight (Kg)				
43	7 [6.6 – 7.4]	0-11	34	5.8 [5.3– 6.4]
55	8.8 [8.5 – 9.0]	12-23	38	8.5 [8.0 – 8.9]
60	10.2 [9.9 – 10.5]	24-35	58	10.2 [9.7 – 10.6]
55	12.3 [11.8 – 12.7]	36-47	44	11.6 [11.2 – 12.1]
60	13.3 [12.9 – 13.8]	48-59	68	13.3 [12.7 – 13.9]
MUAC (cm)				
43	13.7 [13.3 – 14.0]	0-11	34	12.9 [12.4 – 13.4]
55	14.0 [13.7 – 14.3]	12-23	38	13.5 [13.1 – 13.9]
60	14.1 [13.8 – 14.3]	24-35	58	14.3 [14.0 – 14.5]
55	14.5 [14.2 – 14.7]	36-47	44	14.5 [14.1 – 14.8]
60	14.7 [14.4 – 15.0]	48-59	68	14.8 [14.5 – 15.2]

Table 11: The Prevalence of Underweight, Stunting, and Wasting among children (0 - 59 months) in *Attappadi*

Weight-for-age					
Age group (months)	**N**	**Severe underweight** [WAZ <-3SD]	**Moderate underweight** [WAZ -3SD to -2SD]	**Total underweight** [WAZ <-2SD]	**Normal** [WAZ ≥-2SD]
<12	77	11.7	26.0	37.7	62.3
12-35	209	16.3	32.5	48.8	51.2
36-59	230	16.2	35.4	51.6	48.4
0-59	**516**	**15.5**	**32.8**	**48.3**	**51.7**
Height-for-age					
Age Group (months)	**n**	**Severe stunting** [HAZ <-3SD]	**Moderate stunting** [HAZ-3SD to -2SD]	**Total stunting** [HAZ <- 2SD]	**Normal** [HAZ ≥-2SD]
<12	77	7.8	15.6	23.4	76.6
12-35	209	20.6	32.5	53.1	46.9
36-59	230	7.8	27.8	35.6	64.4
0-59	**516**	**13.0**	**27.9**	**40.9**	**59.1**
Weight-for-height					
Age Group (months)	**N**	**Severe wasting** [WHZ <-3SD]	**Moderate wasting** [WHZ -3SD to -2SD]	**Total wasting** [WHZ < - 2SD]	**Normal** [WHZ ≥ -2SD]
<12	77	9.1	13.0	22.1	77.9
12-35	209	5.7	19.6	25.3	74.7
36-59	230	8.7	22.3	31.0	69.0
0-59	**516**	**7.6**	**19.8**	**27.4**	**72.6**

*WHO New Child Growth Standards (2007) SD: Standard Deviation

Table 12: Nutrition status of children (0-59 months) by Sex in *Attappadi*

Nutrition Status	**Underweight**			**Stunting**			**Wasting**		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
N	**273**	**242**	**515**	**273**	**242**	**515**	**273**	**242**	**515**
Severe	14.7	16.5	15.5	16.2	9.5	13.0	9.2	5.8	7.6
Moderate	34.4	31.0	32.8	26.0	30.2	27.9	20.2	19.4	19.8
Total	**49.1**	**47.5**	**48.3**	**42.1**	**39.7**	**41.0**	**29.3**	**25.2**	**27.4**
Normal growth	50.9	52.5	51.7	57.9	60.3	59.0	70.7	74.8	72.6

Table 13: Distribution (%) of nutritional status of children (0-59 months) by their socio-demographic characteristics

Socio-demographic characteristics	N=516	Weight for age		Height for age		Weight for height	
		Underweight	Normal	Stunting	Normal	Wasting	Normal
Type of family							
Nuclear	371	48.9	51.1	41.0	59.0	28.7	71.3
Extended	105	51.4	48.6	43.8	56.2	25.7	75.0
Joint	40	35.0	65.0	32.5	67.5	20.0	80.0
χ^2, p-value		*3.3, 0.192*		*1.5, 0.464*		*1.5, 0.463*	
Household size							
2-3	85	50.6	49.4	38.8	61.2	32.9	67.1
4-6	390	48.8	51.2	42.6	57.4	26.7	73.3
≥ 7	41	39.0	61.0	29.3	70.7	22.0	78.0
χ^2, p-value		*1.6, 0.441*		*2.8, 0.235*		*2.0, 0.366*	
Landholding status							
No land	167	49.7	50.3	41.9	58.1	31.1	68.9
< 2.5 acres	247	50.6	49.4	41.3	58.7	26.7	73.3
2.5 – 5 acres	62	41.0	59.0	38.7	61.3	18.0	88.0
> 5 acres	40	40.0	60.0	37.5	62.5	30.0	70.0
χ^2, p-value		*3.0, 0.381*		*0.4, 0.940*		*4.0, 0.255*	
Source of drinking water							
Open well/Tube well	61	47.5	52.5	37.7	62.3	24.6	75.4
Tape water	234	46.8	53.2	40.2	59.8	27.0	73.0
Pond/Tank/Stream/ River	221	50.2	49.8	42.5	57.5	28.5	71.5
χ^2, p-value		*0.5, 0.757*		*0.5, 0.758*		*0.3, 0.821*	
Type of cooking fuel used in the household							
Firewood/Kerosine	358	50.3	49.7	40.8	59.2	28.2	71.8
LPG/Biogas	158	44.0	56.0	41.1	58.9	25.5	74.5
χ^2, p-value		*1.7, 0.186*		*0.05, 0.939*		*0.4, 0.522*	
Presence of electricity							
Present	424	48.9	51.1	41.3	58.7	29.6	70.4
Absent	92	45.7	54.3	39.1	60.9	17.4	82.6
χ^2, p-value		*0.3, 0.568*		*0.1, 0.705*		*5.6, 0.018*	
Presence/use of sanitary latrine							
Present and using	385	49.0	51.0	42.3	57.7	27.1	72.9
Present but not using/ Absent	131	46.6	53.4	36.4	63.6	28.2	71.8
χ^2, p-value		*0.2, 0.636*		*1.3, 0.252*		*0.06, 0.797*	
Separate kitchen							
Present	446	49.7	50.3	41.0	59.0	29.0	71.0
Absent	70	46.6	60.0	40.0	60.0	17.1	82.9
χ^2, p-value		*2.2, 0.133*		*0.02, 0.870*		*4.2, 0.039*	
Type of house							
Kutcha	101	48.5	51.5	38.6	61.4	27.7	72.3
Semi-pucca	173	49.4	50.6	43.4	56.6	24.4	75.6
Pucca	242	47.5	52.5	40.1	59.9	29.3	70.7
χ^2, p-value		0.14, 0.929		0.71, 0.699		1.23, 0.540	

Table 14: Distribution (%) of children (5-9 years) and adolescent girls according to their nutritional status in *Attappadi*

Age	N	Severe thinness (BAZ <-3SD)	Moderate thinness (BAZ <-2SD)	Normal (BAZ -2 SD to +1SD)	Overweight/ obesity (BAZ > +1SD)
5-9	48	10.4	25.1	60.4	4.2
10-14	43	4.7	20.9	65.1	9.3
15-19	24	4.2	8.3	75.0	12.5
10-19	67	4.5	16.4	68.7	10.5

Table 15: Mean Height, Weight, and MUAC of pregnant women and lactating mothers in *Attappadi*

Details	N	Mean Height (cm) [95% CI]	Mean Weight (Kg) [95% CI]	Mean MUAC (cm) [95% CI]
Pregnant women	40	150.0 [148.1- 151.9]	48.2 [45.2-51.2]	23.0 [22.0-24.0]
Lactating mothers	100	149.8 [148.6-151.0]	45.5 [43.6-47.4]	23.5 [22.9-24.2]

Table 16: Body Mass Index (BMI) of lactating mothers in *Attappadi*

BMI categories	n (Per cent)
N	**100**
WHO cut-off	
<18.5 Kg/m^2[Underweight]	40 (40.0)
18.5 to 24.9 Kg/m^2[Normal]	45 (45.0)
≥ 25 Kg/m^2[Overweight/obese]	15 (15.0)
Asian cut-off	
<18.5 Kg/m^2[Underweight]	40 (40.0)
18.5 to 22.9 Kg/m^2[Normal]	38 (38.0)
≥ 23 Kg/m^2[Overweight/obese]	22 (22.0)

Table 17: Body Mass Index (BMI) of the adult population (age ≥18 years) in *Attappadi*

BMI categories	Male (%)	Female (%)	Total (%)
N	**131**	**388**	**519**
WHO cut-off			
<18.5 Kg/m^2[Underweight]	22.9	33.2	30.6
18.5 to 24.9 Kg/m^2[Normal]	64.9	53.4	56.3
≥ 25 Kg/m^2[Overweight/obese]	12.2	13.4	13.1
Asian cut-off			
<18.5 Kg/m^2[Underweight]	22.9	33.2	30.6
18.5 to 22.9 Kg/m^2[Normal]	51.1	41.5	43.9
≥ 23 Kg/m^2[Overweight/obese]	26.0	25.2	25.5

Table 18: Average household consumption of food stuffs (g/cu/day) and percent of RDI

Particulars		Cereals & Millets	Pulses & Legumes	Green Leafy Veg.	Other Veg.	Roots & Tubers	Nuts & Oil Seeds	Condi. & Spices	Fruits	Fish	Other Flesh Foods	Milk & Milk Product	Fats & Oils	Sugar & Jaggery
No. of Households (n=79)	Mean	356.1	70.8	21.8	50.8	110.4	*9.8*	*17.5*	*49.9*	*9.8*	*3.4*	51.6	1.2	26.3
	SD	112.3	37.7	33.2	64.3	70.5	*16.2*	*10.4*	*42.5*	*31.0*	*15.1*	92.1	3.5	14.3
	RDI	**460**	**40**	**40**	**60**	**50**	**-**	**-**	**-**	**-**	**-**	**150**	**20**	**30**

Table 19: Average household consumption of nutrients (cu/day) and percent of RDA

Particulars		Protein (g)	Total Fat (g)	Energy (Kcal)	Calcium (mg)	Iron (mg)	Vit-A (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vit-C (mg)	Dietary folate (µg)
(n = 79 HHs)	Mean	57.6	27.9	2010.3	358.9	11.6	403.0	1.2	0.7	12.2	54.2	382.7
	Median	55.4	25.7	1976.9	314.9	10.9	240.2	1.2	0.2	11.7	46.5	564.2
	SD	12.1	15.1	465.3	188.8	4.7	493.9	0.3	0.7	3.1	37.5	258.4
	RDA	**60**	**-**	**2320**	**600**	**17**	**600**	**1.2**	**1.4**	**16**	**40**	**200**
% of RDA	<50	0	-	1	35	15	47	1	36	8	10	1
	50-70	7	-	15	18	33	7	6	32	27	11	4
	≥70	72	-	63	26	31	25	72	11	44	58	74

SD: Standard Deviation, RDA: Recommended Dietary Allowance, CU: Consumption Unit/co-efficient unit

Table 20: Average intake of various food groups (g/day) among children

Food groups		1-3 years			4-6 years			7-9 years	10-12 years- Boys			10-12 years-Girls		
		(n=55)	RDI	Deficiency	(n=37)	RDI	Deficiency	(n=29)	(n=8)	RDI	Deficiency	(n=7)	RDI	Deficiency
Cereals & Millets	*Mean*	127.7	175	27	165.4	270	38.7	219.8	244.3	420	41.8	239.6	380	36.9
	SD	67.2			81.9			75.7	100.6			115		
Pluses & Legumes	*Mean*	31	35	11.4	35.7	35	-	51.3	61.6	45	-	71.8	45	-
	SD	27.3			29.3			33.6	32.9			31.2		
Green Leafy Vegetables	*Mean*	5.8	40	85.5	15.7	50	68.6	20	11.3	50	77.4	21	50	58.0
	SD	13.5			26.6			31.7	14.2			40.9		
Other Vegetables	*Mean*	11.5	20	42.5	27.2	30	9.3	39.7	28.8	50	42.4	23.3	50	53.4
	SD	15			30.3			51.1	30.2			29.9		
Roots & Tubers	*Mean*	35	10	-	62.5	20	-	76.2	50.3	30	-	106.3	30	-
	SD	34.9			43.3			44.4	47.1			68.3		
Nuts & Oils seeds	*Mean*	2.6			5.6			7.3	2.6			2.1		
	SD	4.8			9.8			12.9	3.4			3.4		
Condiments & Spices	*Mean*	5.4			9.4			12.2	10.1			17.1		
	SD	4.5			6.9			7.1	8.4			10.7		
Fruits	*Mean*	23.2			29.9			36.6	40.4			38.3		
	SD	35.7			39			26.1	60.5			37.1		
Other Flesh Foods	*Mean*	9.2			10.2			9.6	7			13.1		
	SD	19.6			17.7			19.3	19.8			34.7		
Milk & Milk Products	*Mean*	25.8	300	91.4	41.1	250	83.4	24.4	0.1	250	99.6	32.5	250	87.0
	SD	52.7			88.3			53.2	0.2			23.7		
Fats & Oils	*Mean*	5.9	25	76.4	8.5	25	66.0	10.7	6.6	22	70.0	12.4	22	43.6
	SD	5.6			8.6			7.3	4.8			9.4		
Sugar & Jaggery	*Mean*	9.9	30	67	15.4	40	61.5	17	19.4	45	-	23.4	45	48.0
	SD	13.3			12.4			13.3	14.7			11.9		

Table 21: Average intake of various food groups (g/day) among adult males

Food groups		Sedentary Male			Moderate Male		
		(n=20)	RDI	Deficiency	(n=66)	RDI	Deficiency
Cereals & Millets	*Mean*	348.1	460	24.3	440	520	15.4
	SD	127.8			126.5		
Pluses & Legumes	*Mean*	78.6	40	-	73.1	50	-
	SD	45.7			39.2		
Green Leafy Vegetables	*Mean*	13.1	40	67.2	24.6	40	38.5
	SD	21.6			36		
Other Vegetables	*Mean*	64.4	60	-	53	70	24.3
	SD	106.4			70.9		
Roots & Tubers	*Mean*	108.4	50	-	120.8	60	-
	SD	87.9			83.9		
Nuts & Oils seeds	*Mean*	13.3			10.3	45	77.1
	SD	19.8			18.1		
Condiments & Spices	*Mean*	17.1			19.5		
	SD	10.5			11.8		
Fruits	*Mean*	40.5			51.2		
	SD	39.5			53.3		
Other Flesh Foods	*Mean*	13.9			11.7		
	SD	25.6			25.1		
Milk & Milk Products	*Mean*	96.9	150	35.4	44.9	200	77.5
	SD	103.5			89.2		
Fats & Oils	*Mean*	14.6	20	27.0	13.2	20	34.2
	SD	10.7			9.4		
Sugar & Jaggery	*Mean*	25.0	30	16.6	25.4	35	27.4
	SD	14.7			13.6		

Table 22: Average intake of various food groups (g/day) among adult females

Food groups		NPNL Sedentary			NPNL Moderate			Pregnant women	Lactating mothers
		(n=31)	RDI	Deficit	(n=34)	RDI	Deficit	(n=5)	(n=23)
Cereals & Millets	*Mean*	323	410	21.2	357.4	440	18.7	370.8	366.2
	SD	121.6			112.2			147.3	142
Pluses &Legumes	*Mean*	61.6	40	-	66.5	45	-	94	77
	SD	40.2			35.8			38.1	38.5
Green Leafy Vegetables	*Mean*	20.8	100	79.2	22.9	100	77.1	53.4	21.3
	SD	33.4			31.5			40.2	29.7
Other Vegetables	*Mean*	56.4	40	-	47.5	40	-	34.1	71.2
	SD	85.7			57			55.9	70.1
Roots & Tubers	*Mean*	98.2	50	-	116.3	50	-	86.5	113.6
	SD	73			88.3			39.2	59
Nuts & Oils seeds	*Mean*	8.6			9.7	25	61.2	7	11.8
	SD	15.3			15.3			6.3	23.4
Condiments & Spices	*Mean*	16.5			17.5			21.7	18.1
	SD	11.7			11.9			7.1	9.7
Fruits	*Mean*	41			47.5			50	37.2
	SD	43.2			43.1			34.7	37.1
Other Flesh Foods	*Mean*	18.7			7.1			23.8	16.7
	SD	29.1			20.9			53.2	30
Milk & Milk Products	*Mean*	70	100	30.0	30.8	150	79.4	40.1	44.6
	SD	109.2			54.5			54.7	78.2
Fats & Oils	*Mean*	13.2	20	34.0	11.1	20	44.5	20.7	10.8
	SD	8.8			6.4			13.7	5.5
Sugar & Jaggery	*Mean*	27	35	22.8	28.5	20	-	33.7	22.4
	SD	11.5			15.6			23.4	10.8

Table 23: Average daily intake of various nutrients by children (1-3 years)

Nutrients	Median (n=55)	Std. Deviation	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	20.8	9.9	10	12.5	-	-
Fat (g)	10.1	9.4	37	37	72.7	72.7
Energy (Kcal)	711.0	337.0	1110	1110	35.9	35.9
Calcium (mg)	129.5	127.0	400	500	67.6	74.1
Iron (mg)	4.4	2.6	6	8	26.7	45.0
Vitamin-A (µg)	90.0	194.0	180	390	50.0	76.9
Thiamin (mg)	0.5	0.2	0.6	0.7	16.7	28.6
Riboflavin (mg)	0.3	0.1	0.8	1.1	62.5	72.7
Niacin (mg)	3.9	2.2	6	7	35.0	44.3
Vitamin-C (mg)	14.3	19.6	24	30	40.4	52.3
Total Folate (µg)	113.1	145.9	97	120	-	5.8
Zinc(mg)	2.9	1.4	2.8	3.3	-	12.1

Table 24: Average daily intake of various nutrients by children (4-6 years)

Nutrients	Median (n=37)	Std. Deviation	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	30.4	13.1	13	16	-	-
Fat (g)	15.3	13.0	53	54	71.1	71.7
Energy (Kcal)	983.9	424.4	1360	1360	27.7	27.7
Calcium (mg)	172.7	137.6	450	550	61.6	68.6
Iron (mg)	5.5	4.2	8	11	31.3	50.0
Vitamin-A (µg)	104.2	272.5	240	510	56.6	79.6
Thiamin (mg)	0.6	0.3	0.8	0.9	25.0	33.3
Riboflavin (mg)	0.4	0.2	1.1	1.3	63.6	69.2
Niacin (mg)	5.3	2.8	8.0	9	33.8	41.1
Vitamin-C (mg)	26.7	37.1	27.0	35	1.1	23.7
Total Folate (µg)	147.5	572.0	111	135	-	-
Zinc (mg)	3.8	1.6	3.7	4.5	2.7	15.6

Table 25: Average daily intake of various nutrients by children (7-9 years)

Nutrients	Median (n=29)	Std. Deviation	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	38.4	11.1	19	23	-	-
Fat (g)	20.8	10.5	47	48	55.7	56.7
Energy (Kcal)	1353.4	377.8	1700	1700	20.4	20.4
Calcium (mg)	172.9	156.8	500	650	65.4	73.4
Iron (mg)	7.6	4.3	10	15	24.0	49.3
Vitamin-A (µg)	159.9	599.6	290	630	44.9	74.6
Thiamin (mg)	0.7	0.3	1.0	1.1	30.0	36.4
Riboflavin (mg)	0.5	0.2	1.3	1.6	61.5	68.8
Niacin (mg)	7.4	2.6	10	11	26.0	32.7
Vitamin-C (mg)	37.4	36.9	36	45	-	16.9
Total Folate (µg)	213.3	520.5	142	170	-	-
Zinc (mg)	4.9	1.6	4.9	5.9	-	16.9

Table 26: Average daily intake of various nutrients by boys (10-12 years)

Nutrients	Median (n=8)	Std. Deviation	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	38.3	14.4	27	32	-	-
Fat (g)	12.3	7.2	62	62	80.2	80.2
Energy (Kcal)	1292.6	505.3	2220	2220	41.8	41.8
Calcium (mg)	153.7	145.1	650	850	76.4	81.9
Iron (mg)	6.4	3.4	12	16	46.7	60.0
Vitamin-A (µg)	257.7	175.1	360	770	28.4	66.5
Thiamin (mg)	1.0	0.4	1.3	1.5	23.1	33.3
Riboflavin (mg)	0.6	0.2	1.7	2.1	-64.7	71.4
Niacin (mg)	7.7	3.5	12	15	35.8	48.7
Vitamin-C (mg)	20.9	17.7	45	55	53.6	62.0
Total Folate (µg)	203.2	85.4	180	220	-	7.6
Zinc (mg)	5.1	2.1	7	8.5	27.1	40.0

Table 27: Average daily intake of various nutrients by girls (10-12 years)

Nutrients	Median (n=7)	Std. Deviation	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	51.4	13.0	27	33	-	-
Fat (g)	19.5	14.0	57	57	65.8	65.8
Energy (Kcal)	1452.5	500.3	2060	2060	29.5	29.5
Calcium (mg)	333.5	215.5	650	850	48.7	60.8
Iron (mg)	10.6	4.8	16	28	33.8	62.1
Vitamin-A (µg)	69.5	1026.9	370	790	81.2	91.2
Thiamin (mg)	0.8	0.4	1.2	1.4	33.3	42.9
Riboflavin (mg)	0.5	0.2	1.6	1.9	68.8	73.7
Niacin (mg)	7.6	3.9	12	14	36.7	45.7
Vitamin-C (mg)	50.3	54.5	44	50	-	-
Total Folate (µg)	285.2	708.0	186	225	-	-
Zinc (mg)	5.6	1.8	7.1	8.5	21.1	34.1

Table 28: Average daily intake of various nutrients by adult male

Nutrients	ADULT MALE-SEDENTARY=20					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	62.4	15.5	43	54	-	-
Total Fat (g)	28.5	21.2	35	35	18.6	18.6
Energy (Kcal)	2055.6	592.7	2110	2110	2.6	2.6
Calcium (mg)	327.2	284.6	800	1000	59.1	67.3
Iron (mg)	10.0	4.2	11	19	9.1	47.4
Vitamin A (µg)	218.8	411.7	460	1000	52.4	78.1
Thiamin (mg)	1.3	0.4	1.2	1.4	-	7.1
Riboflavin (mg)	0.8	0.3	1.6	2	50.0	60.0
Niacin (mg)	12.1	3.7	12	14	-	13.6
Vitamin -C (mg)	30.1	37.3	65	80	53.7	62.4
Total Folate (µg)	247.4	413.3	250	300	1.0	17.5
Zinc (mg)	8.3	2.5	14.1	17	41.1	51.2

Table 29: Average daily intake of various nutrients by adult male

Nutrients	ADULT MALE-MODERATE=66					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	62.3	12.4	43.00	54.00	-	-
Total Fat (g)	25.4	13.	45	45	43.6	43.6
Energy (Kcal)	2199.3	496	2710	2710	18.8	18.8
Calcium (mg)	294.7	228	800	1000	63.2	70.5
Iron (mg)	11.2	5.4	11	19	-	41.1
Vitamin A (µg)	226.1	532	460	1000	50.8	77.4
Thiamin (mg)	1.3	0.3	1.5	1.8	13.3	27.8
Riboflavin (mg)	0.7	0.2	2.1	2.5	66.7	72.0
Niacin (mg)	14.0	3.4	15	18	6.7	22.2
Vitamin-C (mg)	47.3	41.	65	80	27.2	40.9
Total Folate (µg)	246.7	688	250	300	1.3	17.8
Zinc (mg)	8.3	1.9	14.1	17	41.1	51.2

Table 30: Average daily intake of various nutrients by adult female

Nutrients	NPNL-SEDENTARY=31					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	53.5	12.3	36.00	46.00	-	-
Total Fat (g)	21.9	17.2	28	28	21.8	21.8
Energy (Kcal)	1873.5	505.2	1660	1660	12.9	-
Calcium (mg)	287.8	282.9	800	1000	64.0	71.2
Iron (mg)	8.7	6.6	15	29	42.0	70.0
Vitamin A (µg)	185.5	355.8	390	840	52.4	77.9
Thiamin (mg)	1.0	0.3	1.1	1.4	9.1	28.6
Riboflavin (mg)	0.7	0.2	1.6	1.9	56.3	63.2
Niacin (mg)	11.4	3.2	9	11	-	-
Vitamin-C (mg)	40.8	33.1	55	65	25.8	37.2
Total Folate (µg)	230.2	547.7	180	220	-	-
Zinc (mg)	7.1	1.9	11	13.2	35.5	46.2

Table 31: Average daily intake of various nutrients by adult female

Nutrients	NPNL-MODERATE=34					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	52.2	13.7	36.00	46.00	-	-
Total Fat (g)	21.4	10.1	28	28	23.6	23.6
Energy (Kcal)	1906.9	443.1	2130	2130	10.5	10.5
Calcium (mg)	275.3	150.9	800	1000	65.6	72.5
Iron (mg)	9.7	3.2	15	29	35.3	66.6
Vitamin A (µg)	280.2	570.5	390	840	28.2	66.6
Thiamin (mg)	1.1	0.3	1.4	1.7	21.4	35.3
Riboflavin (mg)	0.7	0.2	2	2.4	65.0	70.8
Niacin (mg)	11.5	3.2	12	14	4.2	17.9
Vitamin-C (mg)	37.9	38.3	55	65	31.1	41.7
Total Folate (µg)	233.4	936.7	180	220	-	-
Zinc (mg)	7.0	1.9	11	13.2	36.4	47.0

Table 32: Average daily intake of nutrients by pregnant women

Nutrients	Pregnant women=5					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	63.6	3.4	53.60	68.00	-	6.5
Total Fat (g)	39.4	15.3	45	46	12.4	14.3
Energy (Kcal)	1949.9	564.	2010	2010	3.0	3.0
Calcium (mg)	426.4	190.	800	1000	46.7	57.4
Iron (mg)	14.8	7.7	21	27	29.5	45.2
Vitamin A (µg)	60.5	446.	406	900	85.1	93.3
Thiamin (mg)	1.6	0.2	1.6	2	-	20.0
Riboflavin (mg)	0.7	0.1	2.3	2.7	69.6	74.1
Niacin (mg)	12.7	3.0	11	13.5	-	5.9
Vitamin-C (mg)	83.9	45.5	65	70	-	-
Total Folate (µg)	279.2	61.4	480	570	41.8	51.0
Zinc (mg)	9.2	0.8	12	14.5	23.3	36.6

Table 33: Average daily intake of various nutrients by lactating mothers

Nutrients	Lactating mothers=23					
	Median	SD	EAR	RDA	Deficit to the EAR (%)	Deficit to the RDA (%)
Protein (g)	57.6	13.5	48.10	61.00	-	-
Total Fat (g)	21.9	13.4	49	49	55.3	55.3
Energy (Kcal)	1945.9	526.3	2220	2220	12.3	12.3
Calcium (mg)	279.9	136.2	1000	1200	72.0	76.7
Iron (mg)	11.3	3.4	16	23	29.4	50.9
Vitamin A (µg)	359.0	495.1	720	950	50.1	62.2
Thiamin (mg)	1.3	0.3	1.7	2.1	23.5	38.1
Riboflavin (mg)	0.7	0.2	2.4	2.9	70.8	75.9
Niacin (mg)	12.3	3.5	13	16	5.4	23.1
Vitamin-C (mg)	48.5	37.4	95	115	48.9	57.8
Total Folate (µg)	254.4	78.6	280	330	9.1	22.9
Zinc (mg)	7.9	2.3	11.8	14.1	33.1	44.0

Table 34: Prevalence (%) of anaemia among children (12-59 months) in *Attappadi*

Age Group (months)	**N**	**Severe** [Hb <7 g/dl]	**Moderate** [Hb 7 -9.9 g/dl]	**Mild** [Hb 10 – 10.9 g/dl]	**Total** [Hb <11 g/dl]	**No anemia** [Hb ≥11 g/dl]
12-23	84	16.7	66.7	14.3	97.7	2.3
24-35	115	2.6	67.0	26.1	95.7	4.3
36-47	95	2.1	50.5	33.7	86.3	13.7
48-59	125	2.4	48.8	35.2	86.4	13.6
12-59	**419**	**5.2**	**57.8**	**28.2**	**91.2**	**8.8**

Table 35: Prevalence (%) of anaemia among adolescent girls, pregnant women, and lactating mothers in *Attappadi*

Respondents	**Hemoglobin levels**	**Prevalence (%)**
Adolescent girls (N=88)	Normal (Hb ≥12 g/dl)	3.4
	Mild anemia (Hb10-11.9 g/dl)	53.4
	Moderate anemia (Hb7-9.9 g/dl)	42.1
	Severe anemia (Hb<7 g/dl)	1.1
Pregnant women (N=38)	Normal (Hb ≥ 11 g/dl)	13.2
	Mild anemia (Hb 10-10.9 g/dl)	31.6
	Moderate anemia (Hb 7-9.9 g/dl)	52.6
	Severe anemia (Hb <7 g/dl)	2.6
Lactating mothers (N=75)	Normal (Hb ≥ 12 g/dl)	20.0
	Mild anemia (Hb 10-11.9 g/dl)	38.7
	Moderate anemia (Hb 7-9.9 g/dl)	41.3
	Severe anemia (Hb <7 g/dl)	0 (0)

Table 36: Proportion of children (12-59 months) with micronutrient deficiencies in *Attappadi*

Micronutrients		12-23 months	24-35 months	36-47 months	47-59 months	Pooled (12-59 months)
Iron deficiency (Serum ferritin <12 ng/mL)	N	65	109	90	123	387
	n (%)	42 (64.6)	64 (58.7)	38 (42.2)	49 (39.8)	193 (49.9)
Folate deficiency (Serum erythrocyte folate < 151 ng/ml)	N	73	109	90	123	395
	n (%)	11 (15.1)	11 (10.1)	16 (17.8)	24 (19.5)	62 (15.7)
Vitamin-B12 deficiency (Serum Vit B12 < 203 pg/nl)	N	70	106	90	122	388
	n (%)	24 (34.3)	34 (32.1)	31 (34.4)	45 (36.9)	134 (34.6)
Vitamin-D deficiency (Serum 25 (OH) concentration < 12 ng/mL)	N	74	109	91	124	398
	n (%)	13 (17.6)	17 (15.6)	17 (18.7)	32 (25.8)	79 (19.9)
Vitamin-A deficiency (Serum retinol concentration < 20 mg/dL)	N	74	109	91	124	398
	n (%)	10 (13.5)	11 (10.1)	12 (13.2)	14 (11.3)	47 (11.8)

Table 36A: Mean and median values of micronutrient among children (12-59 months) in *Attappadi*

	N	Mean	Median	Minimum	Maximum
Serum Vitamin B12	388	304.1	262.0	85.0	1280.0
Serum Ferritin	387	18.3	12.2	1.0	214.5
Serum erythrocyte Folate	395	7.8	7.6	0.2	19.8
Vitamin D (Serum 25 (OH))	398	17.2	17.6	0.5	45.6
Vitamin A (Serum retinol)	398	36.8	34.0	8.3	99.0

Table 37: Demographics of the children (0-59 months)

Characteristics	Children (0-35 months) n (%)	Children (36-59 months) n (%)	Children (0-59 months) n (%)
N	**275**	**222**	**497**
Age (in months)			
0-11	77 (28.0)	NA	77 (28.0)
12-23	92 (33.4)	NA	92 (33.4)
24-35	106 (38.6)	NA	106 (38.6)
36-47	NA	98 (44.1)	98 (44.1)
48-59	NA	124 (55.9)	124 (55.9)
Sex of the child			
Male	155 (56.4)	113 (50.9)	268 (53.9)
Female	120 (43.6)	109 (49.1)	229 (46.1)

Table 38: Distribution (%) of children (0-35 months) according to their birth order and birth interval

	0-11 months n (%)	12-23 months n (%)	24-35 months n (%)
N	**77**	**92**	**106**
Birth order			
First	29 (37.7)	34 (37.0)	37 (34.9)
Second	27 (35.1)	29 (31.5)	41 (38.7)
Third	14 (18.1)	22 (23.9)	24 (22.6)
Fourth	55 (6.5)	6 (6.5)	4 (3.8)
Fifth and above	2 (2.6)	1 (1.1)	0
Birth Interval*			
12-23 months	11 (14.3)	9 (9.8)	12 (11.3)
24-35 months	13 (16.9)	15 (16.3)	16 (15.1)
≥36 months	22 (28.6)	32 (34.8)	40 (37.7)
First birth	29 (37.7)	34 (37.0)	37 (34.9)

* Spacing (in months) between previous two births

Birth interval data is missing for five children, and hence the total will not match with N

Table 39: Distribution (%) of children (0-35 months) according to current feeding practices in *Attappadi*

Particulars	Age group of children(months)		
	0-5 Months n (%)	6-11 Months n (%)	12-35 months n (%)
N	**28**	**49**	**195**
Only breast milk	20 (71.4)	0	0
Breastfed + complementary feeding	8 (28.6)	47 (95.9)	72 (36.9)
Normal adult food	0	2 (4.1)	123 (63.1)

Table 40: Distribution (%) of children (6-35 months) according to current feeding practices

Particulars	Children 6-11 months n (%)	Children 12-35 months n (%)
N	**49**	**198**
Type of complementary foods given to the child		
Cow/goat/buffalo milk	19 (38.8)	35 (17.8)
Formula milk	1 (2.0)	14 (7.1)
ICDS Supplement	32 (65.3)	69 (35.0)
Commercial baby foods	8 (16.3)	19 (9.6)
Processed Foods/Biscuits	24 (49.0)	61 (30.9)
Homemade semi-solids	45 (91.8)	76 (38.6)
Homemade solids	25 (51.0)	66 (33.5)
Food groups included in the child's diet		
Cereals & millets	48 (98.0)	83 (42.6)
Pulses	32 (65.3)	79 (40.1)
Green leafy vegetables	49 (100)	198 (100)
Other Vegetables	24 (49.0)	76 (38.6)
Roots and tubers	18 (36.7)	66 (33.5)
Fruits	25 (51.0)	74 (37.6)
Milk and milk products	17 (34.7)	67 (34.0)
Eggs	17 (34.7)	72 (36.5)
Meat (including organ meat)	11 (22.5)	57 (28.9)
The frequency of complementary feeds given		
1-2 feeds	15 (30.6)	20 (10.2)
≥ 3 feeds	34 (69.4)	177 (89.8)

Table 41. Distribution (%) of children (6-23 months) by Minimum Diet Diversity (MDD) and Minimum Acceptable Diet (MAD)

Particulars	Children (6-23 months) n (%)
N	**141**
Food items generally consumed	
Grains, roots, tubers	115 (81.6)
Legume and nuts	95 (67.6)
Dairy product	141 (100)
Flesh food (meat, organ meat, fish, etc.)	55 (39.0)
Egg	74 (52.5)
Vit-A rich fruits and vegetables	141 (100)
Other fruits and vegetables	89 (63.1)
Diet diversity Score (DDS)	
1	0 (0)
2	26 (18.4)
3	16 (11.4)
4	11 (7.8)
5	15 (10.6)
6	20 (14.2)
7	53 (37.6)
Minimum Diet diversity (MDD)	
Diet diversity score <4 (Not able to meet MDD)	42 (29.8)
Diet diversity score ≥4 (Able to meet MDD)	99 (70.2)
Minimum Acceptable Diet (MAD)	
Children with no adequate acceptable diet	70 (49.7)
Children with adequate acceptable diet	71 (50.3)

Table 42: Access and utilization of ICDS services by children (6-59 months) in *Attappadi*

Particulars	Children (6-35 months) n (%)	Children (36-59 months) n (%)
N	**247**	**222**
Receiving supplementary food from ICDS	237 (95.6)	205(92.3)
Frequency of receiving supplementary food (Monthly)	227 (91.9)	
Consumption of supplementary food	234 (94.7)	
Status of weight monitoring (In the last 3 months)	**N:247**	**N:217**
Not weighed	8 (3.2)	5(2.3)
Weighed once	24 (9.7)	28 (12.6)
Weighed twice	36 (14.6)	32 (14.4)
Weighed thrice	179 (72.5)	145(65.3)
Whether the AWW discussed about the weight of the child		
Discussed	218 (91.2)	188 (86.6)
Not discussed	21 (8.8)	29 (13.4)
Status of deworming tablet distribution (In the last 1 year)		
Received	NA	108 (48.7)
Not received	NA	114 (51.3)

Table 43: Access and utilization of Iron Folic Acid (IFA) supplementation by children (6-59 months) in *Attappadi*

Particulars	Children (6-35 months) n (%)	Children (36-59 months) n (%)
N	**247**	**222**
Received IFA syrup		
Received	124 (50.2)	99 (44.6)
Not received	120 (48.6)	123 (55.4)
Source of IFA syrup	**N=124**	**N=99**
ANM	88 (71.0)	80 (80.1)
AWW	31 (25.0)	19 (19.9)
Govt. Doctor	5 (4.0)	0
Reason for not receiving IFA syrup	**N=120**	**N=123**
Not aware	67 (55.8)	84 (68.3)
Not offered/provided	41 (34.2)	38 (30.9)
No need	12 (10.0)	1 (0.8)
Number of IFA syrup bottles received	**N=124**	**N=99**
1	93 (75.0)	57 (57.6)
2	29 (23.4)	37 (37.4)
Not aware	2 (1.6)	5 (5.0)
Number of IFA syrup bottles consumed	**N=124**	**N=99**
0	32 (25.8)	19 (19.2)
1	70 (56.5)	49 (49.5)
2	18 (14.5)	26 (26.3)
Not aware	4 (3.2)	5 (5.0)
Reason for partial consumption of IFA syrup	**N=102**	**N=68**
Not aware	23 (22.6)	19 (27.9)
Not offered	15 (14.7)	13 (19.1)
Side effects/harmful	25 (24.5)	2 (2.9)
Not responded	39 (38.2)	34 (50.0)

* Reference period for these services was last 12 months

Table 44: Vitamin-A Supplementation among children (9-59 months) in *Attappadi*

Particulars	Children 9-35 months n (%)	Children 36-59 months n (%)
N	**217**	**222**
Received doses of Vitamin A		
Received	200 (92.2)	191 (86.0)
Not received	7 (3.2)	10 (4.5)
Not aware	10 (4.6)	21 (9.5)
Number of doses received by children (9-15 months)	**40**	
1	27 (67.5)	NA
2	7 (17.5)	NA
Not aware	6 (15.0)	NA
Number of doses received by children (≥16 months)	**177**	**191**
1	28 (15.8)	6 (3.1)
2	138 (78.0)	185 (96.9)
Not aware	11 (6.2)	0
Person who administered the Vitamin A dose	**200**	
AWW	19 (9.5)	NA
ANM/LHV	167 (83.5)	NA
Govt Doctor	14 (7.0)	NA
Place of administration of Vitamin-A dose		
AWW/Sub-centre	183 (91.5)	NA
PHC/Hospital	17 (8.5)	NA
Reason for non/partial receipt	**7**	**10**
Unaware of the need	6 (85.7)	NA
Fear of side effects	1 (14.3)	NA

Table 45: Hygiene and childcare practices of mothers of children (0-59 months) in *Attappadi*

Particulars	Children 0-35 months n (%)	Children 36-59 months n (%)
N	**275**	**222**
Mothers' handwashing practice before feeding the child		
With soap	148 (53.8)	89 (40.1)
With soil/ash	2 (0.7)	1 (0.5)
Only with water	125 (45.5)	132 (59.4)
Mothers' handwashing practice after defecation		
With soap	197 (71.6)	143 (64.4)
With soil/ash	12 (4.4)	11 (5.0)
Only with water	66 (24.0)	68 (30.6)
Who takes care of the child when the mother goes to work*	**163**	**182**
Mother/father-in-law	66 (40.5)	36 (19.8)
Elder siblings	5 (3.1)	11 (6.0)
Carry to the work site	75 (46.0)	65 (35.7)
Leave at the AWW/Creche	17 (10.4)	54 (29.7)
Others	0	16 (8.8)

* Included only those mothers who go for work

Table 46: Short-term morbidities and health seeking among children (0-59 months) in *Attappadi*

Particulars	Children 0-35 months n (%)	Children 36-59 months n (%)	Children 0-59 months n (%)
N	**275**	**222**	**497**
Health seeking for children			
None/not responded	3 (1.1)	4 (1.8)	7 (1.4)
Govt. Doctor	165 (60.0)	148 (66.7)	313 (63.0)
Private Doctor	102 (37.1)	68 (30.6)	170 (34.2)
Others	5 (1.8)	2 (0.9)	7 (1.4)
Incidence of illnesses (in last 2 weeks)			
No illness	132 (48.0)	163 (73.4)	295 (59.4)
Fever	88 (32.0)	49 (22.1)	137 (27.6)
Diarrhea	17 (6.2)	8 (3.6)	25 (5.0)
Dysentery	4 (1.5)	4 (1.8)	8 (1.6)
Acute Respiratory Infection (ARI)	31 (11.3)	11 (5.0)	42 (8.5)
Measles	3 (1.1)	4 (1.8)	7 (1.4)

Table 47: Demographics of the adolescent girls (10-19 years) covered in the survey in *Attappadi*

Particulars	Adolescent girls (10-19 years) n (%)
N	**86**
Age	
10-14 years	47 (54.7)
15-19 years	39 (45.3)
Age at Menarche	
11 years	11 (12.8)
12 years	30 (34.9)
13 years	9 (10.5)
≥14 years	12 (14.0)
Not attained	24 (27.9)
Mean age at menarche	12.4 [12.10- 12.70]

Table 48: Adolescent girls' (10-19 years) hygiene practices and access to health services in *Attappadi*

Particulars	Adolescent girls (10-19 years) n (%)
N	**86**
Status of deworming tablets (in the last year)	
Received once	29 (33.7)
Received twice	16 (18.6)
Not received	41 (47.7)
Deworming tablets received from	
AWWs/ANM	22 (48.9)
School teacher	21 (46.7)
Doctor	2 (4.4)
Hand washing practice	
After the defection	
With soap	56 (65.1)
With soil/ash	5 (5.8)
Only with water	25 (29.1)
Before eating food	
Wash with water	38 (53.5)
Wash with soil/ash	2 (2.3)
Wash with soap	46 (44.2)

Table 49: Adolescent girl's access to Iron Folic Acid supplementation programmes in *Attappadi*

Particulars	**Adolescent girls (10-19 years) n (%)**
N	**86**
IFA tablets received (in the last 12 months)	
Received	60 (69.8)
Not received	26 (30.2)
Reason for not receiving IFA	**N=26**
Not aware	15 (57.7)
Not offered	11 (42.3)
IFA tablets received from	**N=60**
AWWs/ANM	10 (16.7)
School teacher	48 (80.0)
Medical officer (Doctor)	2 (3.3)
Number of IFA tablets received	
1-14	20 (33.3)
15-30	14 (23.3)
>30	16 (26.7)
Not aware	10 (16.7)
Number of IFA tablets consumed	
0	4 (8)
1-14	25 (50.0)
15-30	8 (16.0)
>30	13 (26.0)
Age when the first IFA tablet consumed	
<10	3 (5.0)
10	14 (23.3)
11	9 (15.0)
12	7 (11.7)
13	13 (21.7)
14	6 (10.0)
Not aware	8 (13.3)

Table 50: Demographics of the currently pregnant women covered in the Survey in *Attappadi*

Particulars	Currently pregnant women n (%)
N	**41**
Age in years	
≤20 years	4 (9.7)
21-25 year	16 (39.0)
≥26 years	21 (51.3)
Gestation age (weeks)	
Within 12 weeks	7 (17.1)
13 – 24 weeks	22 (53.7)
> 24 weeks	12 (29.3)
Age at marriage	
<18 years	9 (22.0)
18-22 years	23 (56.1)
23-26 years	9 (22.0)
Number of pregnancies	
1	15 (36.6)
2	7 (17.1)
3	12 (29.3)
≥4	7 (17.1)
No. of living children	
0	18 (43.9)
1	6 (14.6)
2	11 (26.8)
3+	6 (14.6)

Table 51: Antenatal Care (ANC) service details of the currently pregnant women in *Attappadi*

ANC details	**Currently pregnant women n (%)**
N	**41**
Registered for ANC	40 (97.6)
Gestational age at registration	**N=40**
1-4 weeks	9 (22.5)
5-8 weeks	15 (37.5)
9-12 weeks	10 (25.0)
>12 weeks	6 (15.0)
Place of ANC	
Sub-center	2 (5.0)
PHC/CHC	28 (70.0)
Private clinic	10 (25.0)
No. of ANC visits completed	
1	7 (17.1)
2	2 (4.5)
3	8 (19.5)
4	10 (24.4)
5	13 (31.7)
Components of ANC received	
Physical examination	40 (100.0)
Weight recording	38 (95.0)
Urine examination	37 (92.5)
HB examination	37 (92.5)
BP measurements	32 (80.0)
Advise received during ANC	
Received	40 (100.0)
Advise received on:	
Consume more GLV	39 (97.5)
Consume more vegetables and fruits	40 (100.0)
Take at least 100 IFA tablets	39 (97.5)
Status of TT vaccination	34 (85.0)
Number of TT vaccination received	
One	11 (27.5)
Two	23 (57.5)
Not done	6 (15.0)
Reason for not taking TT	
Not offered	4 (57.1)
Not aware	3 (43.9)

Table 52: Antenatal care (ANC) service details of the currently pregnant women in *Attappadi*

ANC details	Currently pregnant women n (%)
N	**40**
IFA tablet received	39 (97.5)
IFA received from	
AWW/ANM/LHV	15 (37.5)
Govt. Doctor	16 (40.0)
Private Doctor	8 (20.0)
No. of IFA tablets received	
Received 100 tablets	11 (28.2)
Received <100 tablet	28 (71.8)
Reason for not receiving IFA	
Not aware	1 (2.5)
Consumption of IFA	
Consumed at least 100 tablets	27 (69.3)
Consumed < 100 tablets	12 (30.7)
Access to ICDS services	**N=41**
Supplementary nutrition from AWC	34 (82.9)
Sharing of supplementary nutrition among family members	30 (88.2)
Reason for not receiving ICDS supplementary nutrition	
Not registered/offered	5 (71.4)
No Need	2 (28.6)
Received any nutrition advice from AWC	37 (90.2)

Table 53: Complications during pregnancy reported by the currently pregnant women in *Attappadi*

Particulars	Currently pregnant women n (%)
N	**40**
Presence of any pregnancy complications	10 (25.0)
Details of pregnancy complications	
Anaemia	8 (20.0)
Sickle cell	1 (0.3)
Diabetes mellitus	1 (0.3)

Table 54: Avoidance of food items by the currently pregnant women in *Attappadi*

Particulars	Currently pregnant women n (%)
N	**40**
Food items avoided in pregnancy	
Papaya	5 (12.5)
Pineapple	5 (12.5)
Garlic	3 (7.5)
Ginger	1 (2.5)
Roots	1 (2.5)

Table 55: Antenatal Care (ANC) details of the last pregnancy by mothers of children (0-35 months) in *Attappadi*

ANC details	Mothers of children (0-35 months) n (%)
N	**275**
ANC status	
ANC service availed	269 (97.8)
ANC service not availed	6 (2.2)
Gestational age (in weeks) at first ANC	**N=269**
1-4 weeks	21 (7.8)
5-8 weeks	94 (34.9)
9-12 weeks	122 (45.4)
≥ 13 weeks	32 (11.9)
Place of ANC service received	
AWC/Sub-centers	12 (4.5)
PHC/CHC/Tribal hospital	226 (84.0)
Private Clinic/Hospital	28 (10.4)
Home	3 (1.1)
ANC service provider	
ANM	11 (4.1)
MO-PHC/Govt. Doctor	230 (85.5)
Pvt. Doctor	28 (10.4)
Total number of ANC visits	
2	2 (0.7)
3	9 (3.4)
4	11 (4.1)
5+	247 (91.8)
Essential components of ANC received	
Conducted physical examination	267 (99.3)
Measurement of weight	269 (100)
Urine test	268 (99.6)
Screening of anemia (Hb test)	268 (99.6)
Measurement of blood pressure	269 (100)
Ultrasound scan	269 (100)
Advice received from the ANC provider	
Received	266 (98.8)
Not received	3 (1.2)
Details of advice received	
Attend regular ANC checkups	261 (98.1)
Consume extra food	263 (98.9)
Eat more green leafy vegetables and fruits	263 (98.9)
Consume IFA tablets at least for 100 days	263 (98.9)

Table 56: Antenatal Care (ANC) details of the last pregnancy by mothers of children (0-35 months) in *Attappadi*

ANC details	Mothers of children (0-35 months) n (%)
N	**269**
Tetanus Toxoid (TT) injection received	269 (100)
No. of TT injections received	
1	6 (2.2)
2	263 (97.8)
Iron Folic Acid (IFA) tablets received	269 (100)
Source of IFA tablets	
AWW/ANM	45 (16.7)
Govt. Doctor	206 (76.6)
Private Doctor	18 (6.7)
Number of IFA tablets received	
<100	12 (4.5)
100-150	169 (62.8)
>150	85 (31.6)
Not aware	3 (1.1)
Reason for receiving <100 IFA tablets	**N=12**
Not aware	7 (58.3)
Not offered	1 (8.3)
No need	4 (33.3)
Number of IFA tablets consumed	
<50	6 (2.3)
50-99	18 (6.8)
100+	242 (89.8)
Not aware	3 (1.1)
Mean IFA consumption [95% CI]	124.2 [119.5 -129.0]
Reason for partial consumption of IFA	**N=24**
Not supplied	3 (12.5)
Side effect	4 (16.7)
IFA is harmful	17 (70.8)
ICDS supplementary nutrition	**N=275**
Received	265 (98.5)
Receipt of ICDS supplementary nutrition	**N=265**
Monthly	260 (98.1)
Weekly/fortnightly	5 (1.9)
Sharing of the ICDS supplementary nutrition with other members of the household	223 (84.1)

Table 57: Delivery and breastfeeding details of the mothers of children (0-35 months) in *Attappadi*

Particulars	**Mothers of children (0-35 months) n (%)**
N	**275**
Type of delivery	
Normal	181 (65.8)
Caesarean	88 (32.0)
Assisted	6 (2.2)
Place of delivery	
Home	6 (2.1)
PHC/Government hospital	224 (81.5)
Private hospital	45 (16.4)
Who conducted delivery	
Elders/TBA	6 (2.1)
ANM/LHV	4 (1.5)
Govt Doctor	220 (80.0)
Private Doctor	45 (16.4)
The monetary benefit received for institutional delivery (including JSY)	
Received	195 (72.5)
Not received	70 (26.0)
Not aware	4 (1.5)
The benefit received in Rs Mean amount received (95% CI)	17127 [15176-19079]
Availed referral transport	134 (49.8)
Birthweight recorded	264 (96.0)
When did birthweight record	
Same day	262 (99.2)
Next day	2 (0.8)
Birthweight (in Kg)	
Mean Birthweight [95% CI]	2.53 [2.47- 2.60]
Birthweight < 1500g	8 (3.1)
Birthweight 1500g – 2499g	100 (38.3)
Birthweight ≥ 2500g	153 (58.6)
Source of birthweight information	
MCP card	147 (55.7)
Anganwadi records	11 (4.2)
Parents' recall	106 (40.1)
Initiation of breastfeeding	
Within 1 hour	191 (69.5)
The same day, but after 1 hour	51 (18.5)
After 24 hours	33 (12.0)
Given pre-lacteals	16 (5.8)
Feeding of colostrum	235 (85.4)
Childhood vaccination (Children 12-23 months)	**N=92**
Fully immunized	91 (98.9)
Partially immunized	1 (1.1)
Not immunized	0 (0)

Table 58: Post-natal Care (PNC) by mothers of children (6-11 months) in *Attappadi*

Particulars	Mothers of children (6-11 months) n (%)
N	**49**
Status of IFA after delivery	
Received	40 (81.6)
Source of IFA	
AWW/ANM	9 (22.5)
Govt. Doctor	28 (70.0)
Private Doctor	3 (7.5)
The mean number of IFA tablets received	
Mean [95% CI]	67 [54-80]
ICDS supplementary nutrition after delivery	
Received	44 (89.8)
Reason for not receiving ICDS supplementary nutrition	
Not offered	4 (80.0)
No need	1 (20.0)
Status of ICDS supplementary nutrition supply	
Monthly	42 (95.5)
Weekly	2 (4.5)
Sharing of ICDS supplement among family members	
Sharing with other members	35 (79.6)

Table 59: Causes of neonatal/infant deaths in *Attappadi*

Cause of death	No. of cases	Per cent
Acute respiratory distress syndrome	35	18.0
Extreme preterm	31	15.9
Congenital heart disease	22	11.3
Extreme low birth weight	13	6.7
Milk aspiration	12	6.2
Intrauterine growth restriction	9	4.6
Congenital anomalies	7	3.6
Sudden infant death syndrome (SIDS)	6	3.1
Birth asphyxia	5	2.6
Sepsis	5	2.6
Hypoglycaemia	4	2.1
Tuberculous meningitis	3	1.5
Bronchopulmonary dysplasia (BPD)	2	1.0
Sickle cell anaemia	2	1.0
hypoxic ischemic encephalopathy	2	1.0
Accidental kerosene ingestion	1	0.5
Anencephaly	1	0.5
Anorectal malformations	1	0.5
Cardiogenic shock	1	0.5
Cardiomyopathy	1	0.5
Causes	1	0.5
Congenital malformation on intestine	1	0.5
Cyanotic heart diseases	1	0.5
Dehydration	1	0.5
Diaphragmatic Hernia	1	0.5
Down Syndrome	1	0.5
E Coli Sepsis	1	0.5
Epilepticus	1	0.5
Esophageal atresia	1	0.5
Hydrocephalus	1	0.5
Hyperplasia	1	0.5
Hypohemia	1	0.5
Hypothermia	1	0.5
Hypovolemic shock	1	0.5
Intestinal malrotation	1	0.5
Kidney failure	1	0.5
Kidney malformation	1	0.5
Lower respiratory infections	1	0.5
Meconium aspiration	1	0.5
Meningitis	1	0.5
Myocardial dysfunction	1	0.5
Necrotizing fasciitis	1	0.5
Neonatal seizures	1	0.5
Oesophageal atresia	1	0.5

Pericardial bleeding	1	0.5
Pneumonia	1	0.5
Polycystic kidney disease (PKD)	1	0.5
Pulmonary aspiration	1	0.5
Pulmonary hypertension	1	0.5
Renal failure	1	0.5
Severe anameia	1	0.5
varicella	1	0.5
Total	**195**	**100**

Note: The table contains the causes of 136 deaths between 2012 and 2021 where some of them were caused by multiple causes

Table 60: The prevalence of malnutrition among tribal children (0-59 months) in *Attappadi* and all children in Kerala and Palakkad district

	Present study 2022	**NIN survey in Attappadi, 2013**	**NNMB Tribal survey, Kerala, 2009**	**NFHS-5 Kerala, 2019-21**	**NFHS-5 Palakkad district, 2019-21**
Children (0-59 months)					
Underweight	48.3	48.5	40.0	19.7	27.7
Stunting	40.9	49.7	53.0	23.4	29.7
Wasting	27.4	23.7	15.5	15.8	21.7
Anaemia[1]	91.2	-	-	39.4	51.9
Women (15-49 years)					
CED (BMI <18.5 Kg/m^2)	33.2	48.4	44.2	10.1	12.9
Overweight/obesity	25.2	9.3	12.3	38.1	32.9
Pregnant women					
Anaemia (Hb<12 g/dL)	86.8	-	-	31.4	40.5

1 In NFHS, anaemia estimation is done for children 6-59 months. In our survey, the estimation is done only for children 12-59 months

2. The present study, NIN survey in 2013, and NNMB used BMI ≥ 23 Kg/m^2 as cut off for overweight/obesity (WHO Asian cut off). Whereas the NFHS used BMI ≥ 25 Kg/m^2 as cut off for overweight/obesity.