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Comprehensive National Nutrition Survey: 2016–2018

Ministry of Health and Family Welfare

Government of India

UNICEF

Population Council

NATIONAL HEALTH MISSION
राष्ट्रीय स्वास्थ्य मिशन

सत्यमेव जयते
Ministry of Health and Family Welfare
Government of India

POSHAN Abhiyaan
PM's Overarching Scheme for Holistic Nourishment
सही पोषण - देश रोशन

Comprehensive National Nutrition Survey

2016 – 2018

CNNS
Birth to Adolescence

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Contents

List of Tables

List of figures

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Dr. Ajay Khera,
Commissioner (MCH), MoHFW

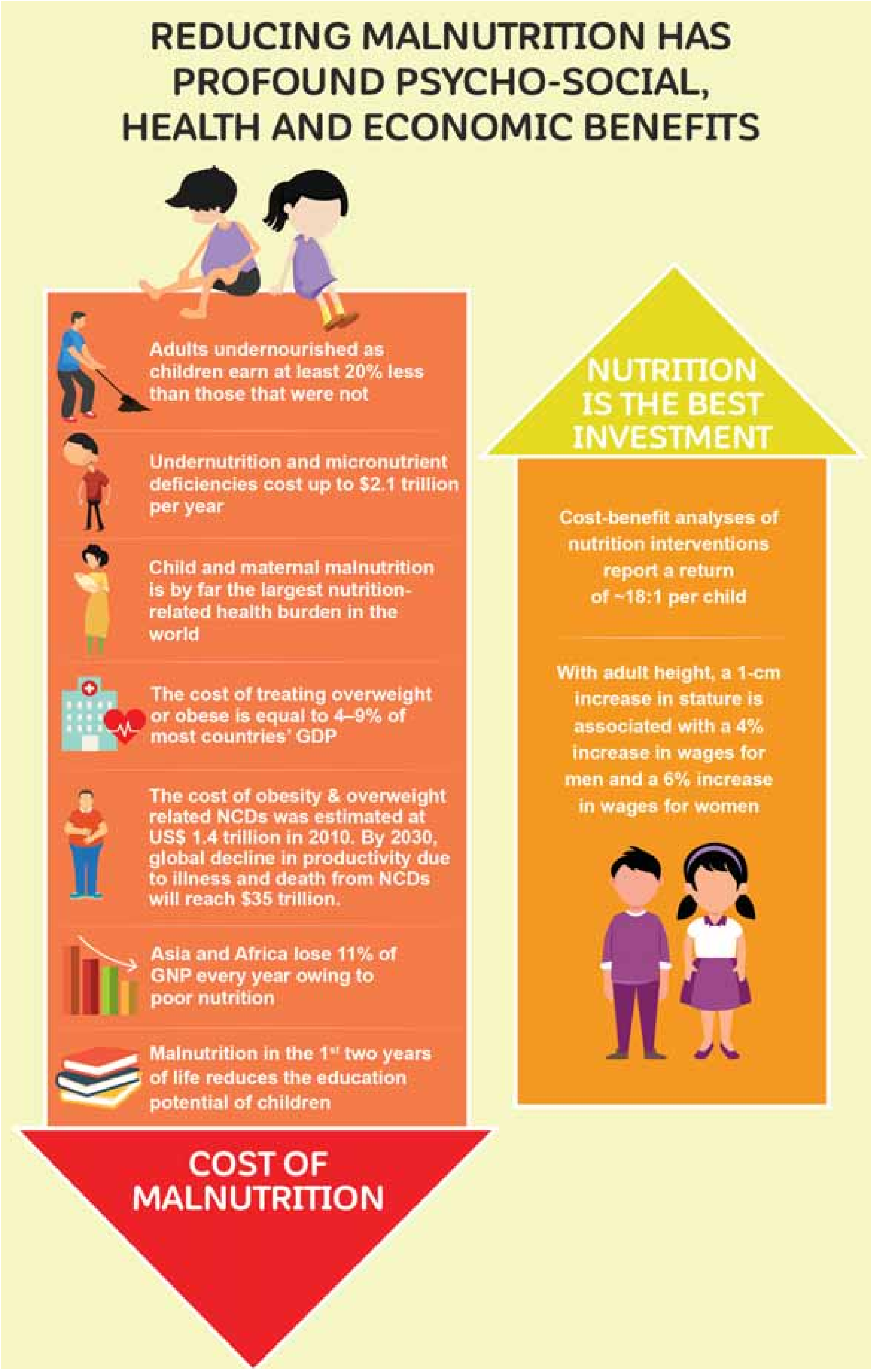
Abbreviations

AHS	Annual Health Survey
AIIMS	All India Institute of Medical Sciences
BCP	Bromocresol Purple
BMI	Body Mass Index
BOND	Biomarkers of Nutrition for Development
BP	Blood Pressure
CAFE	Computer Assisted Field Editing
CAPI	Computer Assisted Personal Interview
CDC	Centre for Disease Control
CDSA	Clinical Development Services Agency
CEB	Census Enumeration Blocks
CES	Coverage Evaluation Survey
CKD	Chronic Kidney Disease
CNNS	Comprehensive National Nutrition Survey
CRP	C-reactive Protein
DALYs	Disability Adjusted Life Years
DLHS	District Level Health Survey
DMLT	Diploma in Medical Laboratory
DNA	Deoxyribonucleic acid
DQA	Data Quality Assurance
EAG	Empowered Action Group (States including Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttarakhand and Uttar Pradesh)
EQAS	External Quality Assurance Scheme
EED	Environmental Enteropathy Disorder
EIBF	Early Initiation of Breastfeeding
EURECCA	European Registration of Cancer Care
G/dl	Grams per decilitre
GBD	Global Burden of Diseases
GDP	Gross Domestic Product
GFR	Glomerular Filtration Rate
GHO	Global Health Observatory
GOI	Government of India
GNP	Gross National Product
HAZ	Height for Age Z score
Hb	Haemoglobin
HbA1C	Glycosylated Haemoglobin
Hcg	Human Chronic Gonadotropin
HDL	High Density Lipoprotein
HPLC	High-performance Liquid Chromatography
IDD	Iodine Deficiency Disorders
IDF	International Diabetes Federation
IIHMR	Indian Institute of Health Management Research
IIPS	International Institute for Population Sciences
IOM	Institute of Medicine

IRB	Institutional Review Board
IYCF	Infant and Young Child Feeding practices
JME	Joint Malnutrition Estimates
Kcal/kg	Calories per kilogram
Kg/m^2	Kilogram per square meter
KSCH	Kalawati Saran Children's Hospital
LDL	Low Density Lipoprotein
LMS	Lambda, Mu and Sigma method
Mg/dl	Milligrams per decilitre
mmHg	Millimetres of Mercury
MOHFW	Ministry of Health Family Welfare
MUAC	Mid-Upper Arm Circumference
MUIC	Median Urinary Iodine Concentrations
MWCD	Ministry of Women and Child Development
NCD	Non-Communicable Diseases
NFHS	National Family Health Survey
Ng/ml	Nanogram Per Millimetre
NHANES	National Health and Nutrition Examination Survey
NIH	National Institutes of Health
NIMS	National Institute of Medical Statistics
NIN	National Institute of Nutrition
Nmol/l	Nanomoles Per Litre
NNMB	National Nutrition Monitoring Bureau
OBC	Other Backward Classes
PCA	Primary Census Abstract
Pg/ml	Picogram Per Millimetre
PGIMER	Post Graduate Institute of Medical Education and Research
PPS	Probability Proportional to Size
PSU	Primary Sampling Unit
RR	Response Rate
RSOC	Rapid Survey on Children
SC	Scheduled Caste
SD	Standard Deviation
SDG	Sustainable Development Goal
SE	Standard Error
SOP	Standard Operating Procedure
SRL	SRL Diagnostics
SSFT	Subscapular Skinfold Thickness
ST	Scheduled Tribe
TAC	Technical Advisory Committee
TAG	Technical Advisory Group
TEM	Technical Error of Measurement
TOT	Training of Trainers
TSFT	Triceps Skinfold Thickness
Ug/dl	Micrograms per decilitre
UNICEF	United Nations Children's Fund
VAD	Vitamin A Deficiency
WAZ	Weight for Age Z score
WC	Waist Circumference
WHO	World Health Organisation
WHZ	Weight for Height Z score

CHAPTER 1

Introduction and objectives



Source: Global Nutrition Report 2014, McGovern 2017 FAO, 2014

India's impressive economic growth has led to considerable progress in improving livelihoods for the most vulnerable. This dynamic progress lifted 271 million people out of poverty in one decade, but strong income inequality persists (OPHI, 2019).

Malnutrition has been identified as one of the principal causes limiting India's global economic potential (Copenhagen consensus, 2012). The remaining socio-economic inequalities have stifled more equitable growth and subsequent economic expansion. While fertility and malnutrition declined in the past two decades (IIPS, 2017), non-communicable diseases (NCD) have arisen as major causes of death (Dandona, 2017).

In recognition of the remaining challenges in nutrition, health and hygiene/sanitation, the Government of India has launched the POSHAN Abhiyaan (National Nutrition Mission), National Health Mission and Swachh Bharat Abhiyaan (water, sanitation and hygiene) Mission. The government has matched the commitment by creating ambitious targets and supporting efforts with substantial budgets.

To provide robust data on the shifting conditions of both undernutrition and overweight and obesity, the Ministry of Health conducted the Comprehensive National Nutrition Survey (CNNS) to collect a comprehensive set of data on nutritional status of Indian children from 0–19 years of age. This survey was the largest micronutrient survey ever implemented globally. Also, the survey used gold standard methods to assess anaemia, micronutrient deficiencies and biomarkers of NCDs for the first time in India.

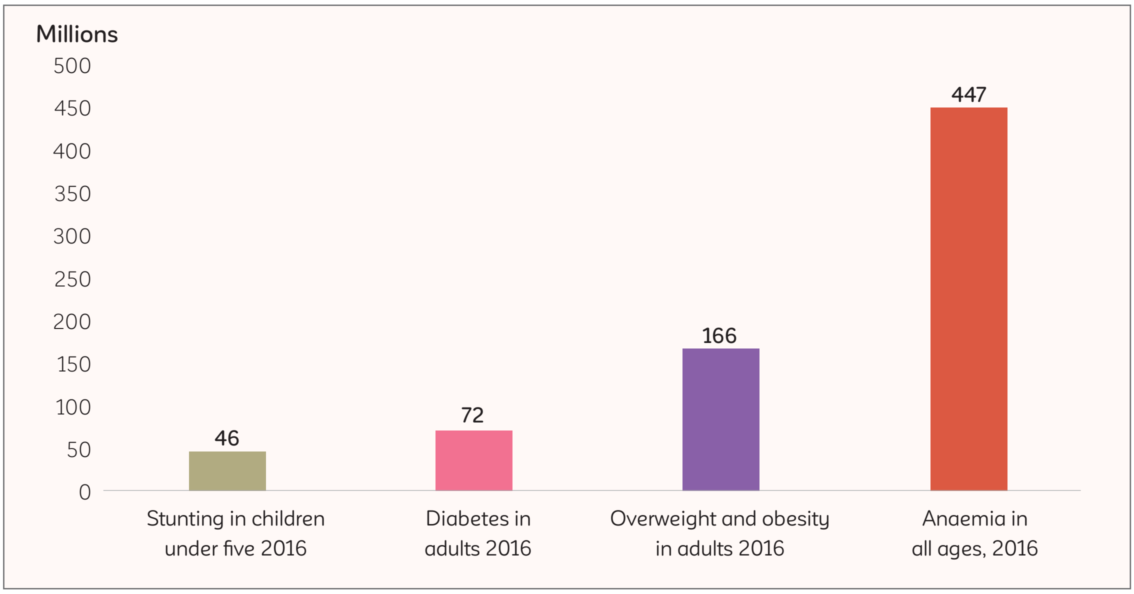
Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. The condition encompasses both undernutrition and overweight and obesity. Food and feeding behaviours in children are closely linked to and shaped by their family's preferences, practices and backgrounds. Many families cannot afford or access sufficient nutritious foods like fresh fruits and vegetables, legumes, nuts, meat and milk. Parents also may lack knowledge on appropriate foods and feeding practices for the child's age and have inadequate awareness and or means for proper caring and health-seeking behaviours.

The global burden of malnutrition is unacceptably high, with nearly half of all deaths in children under five years linked to poor nutrition (Black, 2013). Stunting in early life can have long-term effects on health, physical and cognitive development, learning and earning potential, thereby placing an immense human and economic toll at the individual, household, community and national level. A global review on child stunting and economic outcomes revealed a 1 cm increase in height was associated with a 4% increase in wages for men and a 6% increase in wages for women (McGovern, 2017). Investing in the reduction of child malnutrition is paramount for human and economic development.

Despite substantial economic growth in India over most recent decades, chronic malnutrition (stunting) in children under five years of age reduced by only one-third between 1992 and 2016 and remains alarmingly high, with 38.4% of children stunted in the country (NFHS, 1992; IIPS, 2017).

Anaemia in India is a severe public health problem among women, adolescent girls and young children. In addition to increased morbidity and negative effects on physical well-being (weakness and/or fatigue), anaemia is associated with delayed mental and psychomotor development and an increased risk of maternal mortality (WHO, 2017). Poor nutrition, leading to iron deficiency, is the principal underlying factor in more than 60% of all anaemia cases (Kasselbaum, 2016). More than half of all women of reproductive age and children under five years were anaemic (IIPS, 2017). As shown in Figure 1.1., the estimated 447 million persons with anaemia, causes India to contribute almost one quarter to the global burden as calculated by the Global Burden of Disease in 2016 (Kasselbaum, 2016).

Figure 1.1: The burden of malnutrition among children and adults in India (presented in millions)



Sources: Stunting - Joint Child Malnutrition Estimates, 2019; Diabetes - IDF DIABETES ATLAS, Eighth edition, 2017; Overweight and obesity - Global Health Observatory (GHO) data, 2018; Anaemia -. The Global Burden of Anaemia, 2016 and Global Burden of Disease Study, 2013.

In addition to undernutrition, shifts in diet and lifestyle patterns have led to increased risks for non-communicable diseases (NCDs). Globally, and in India, NCDs are increasingly prevalent across all socio-economic strata and contribute a larger proportion to premature mortality (GBD, 2017). As market exposure increases, foods and drinks high in fat, sugar and salt are cheaper and more readily available, leading to a rapid rise in the number of children and adults who are overweight and at risk for diet-related NCDs such as heart disease and diabetes. Furthermore, the dual burdens of undernutrition and overnutrition are becoming more apparent within the same community, household, and among individuals who can be concurrently overweight, stunted and/or micronutrient deficient.

India is home to almost one-fifth of the world's population and has undergone a nutrition transition from an underweight to an overweight population during recent decades (Agrawal, 2002; Dandona, 2017). This has come at significant cost to population health and well-being and to already overburdened health systems. In 2016, the five leading causes of disability-adjusted life years (DALYs) in India were ischaemic heart disease, chronic obstructive pulmonary disease, diarrhoeal diseases, lower respiratory infections, and cerebrovascular disease and the top five risk factors for DALYs were child and maternal malnutrition, air pollution, dietary factors, high blood pressure, and high blood glucose (Dandona, 2017).

The nutrition transition has accompanied a rise in the prevalence of overweight and obesity in India (IIPS, 2017; Luhar, 2017), with an estimated 166 million adults overweight or obese in 2016 (WHO, 2018) (Figure 1.1). In addition, the prevalence of diabetes is on the rise and is increasingly being diagnosed in children, adolescents and younger adults due to rising levels of obesity, physical inactivity and poor diet. Given its emergence across socio-economic groups, diabetes is no longer considered to be a disease associated with affluence. In India, it is estimated that 73 million adults are affected by diabetes (Figure 1.1), the second largest number worldwide (IDF, 2017).

The government of India has strongly committed to achieving the 2030 Sustainable Development Goals (SDGs). If undernutrition is not effectively reduced, the country will not meet its SDG targets for maternal and child mortality reduction. In addition, if overweight and obesity are not aggressively addressed, the burden of non-communicable disease will exact a terrible cost on the development of India and reduce its contribution to global health and economic progress. The current nutrition situation in India justifies its high level national commitment with strong policy initiatives based on evidence-informed interventions towards combating all forms of malnutrition in the country. Ambitious targets have been set for POSHAN Abhiyaan to reduce stunting (2%), underweight (2%), anemia (3%) among young children, women and adolescent girls and reduce low birth weight (2%) per annum. Also the National Health Mission (NHM) includes programmatic components such as health system strengthening, Reproductive-Maternal- Neonatal-Child and Adolescent Health (RMNCH+A), and prevention and treatment of communicable and non-communicable diseases. The NHM envisages achievement of universal access to equitable, affordable & quality health care services that are accountable and responsive to people's health and wellbeing.

1.1 Purpose and objectives of the CNNS

In the review of evidence prior to planning and designing the 2016–18 India Comprehensive National Nutrition Survey (CNNS), a number of gaps were identified in the existing nationally representative data. These consisted of:

1. micronutrient deficiencies in pre-school, school-age children and adolescents
2. causes of anaemia in children and adolescents including assessment of haemoglobinopathies
3. biomarkers of non-communicable diseases in school-age children and adolescents
4. representative data on health and nutrition for school-age children 5–9 years and young adolescents 10–14 years of age
5. characterization of anthropometry related to undernutrition or overweight / obesity

Previous national surveys had not collected nationally representative data on children between the age of 5 and 14 years. These populations received less attention than those who are considered to be more vulnerable (pre-school children and adolescents). School-age children are beneficiaries of the world's largest school feeding programme (Mid-Day Meal Scheme, 2014). Obtaining representative data on undernutrition and associated factors for this important, but neglected, age group, was therefore a key objective of the CNNS.

Anaemia continues to be a major public health problem in the country. While iron deficiency is an important cause of anaemia and of concern at certain points in the life cycle (pregnancy, infancy and adolescence), several other factors also contribute to anaemia including deficiencies of vitamin A, folate, vitamin B12 and zinc, illnesses, helminths and parasitic infections. Genetic conditions such as sickle cell anaemia and other haemoglobinopathies are also significant contributors to anaemia in South Asia. As there were no nationally representative data on the causes of anaemia in children and adolescents, the CNNS was designed to collect these data.

Micronutrient deficiencies are an important cause of morbidity and mortality, especially in infants and pre-school children. Even mild to moderate micronutrient deficiencies can lead to impaired cognitive development, poor physical growth, increased morbidity and decreased work productivity in adulthood (Murray, 2012; Black, 2013). Micronutrients of public health importance in childhood and adolescence generally include iron, vitamin A, iodine and zinc. More recently, folate, vitamin B12 and vitamin D have received greater attention. Published and unpublished data from some regions and individual studies suggest a high prevalence of these micronutrient deficiencies in India (Eilander, 2010; Kapil, 2011; Menon, 2011; Agarawal, 2013; Kapil, 2013a; Kapil, 2014; Kumar, 2014; Gonmei, 2017). However, these data sources were limited for projecting the national burden of these conditions and for providing robust inputs for programme and policy making due to the following methodological constraints:

- surveys provided crude estimates of deficiency based on recalled dietary intakes
- surveys used surrogate measures for a condition (anaemia for iron deficiency, stunting for zinc deficiency, night blindness and Bitot's spots for vitamin A deficiency)
- small studies in high risk or deprived settings can be biased towards certain geographies and specific populations
- biomarkers for micronutrient deficiencies (serum retinol and serum transferrin) have often not been adjusted for subclinical inflammation
- comparisons between survey data results are difficult to interpret because of heterogeneous estimation techniques

Prior national and sub-national surveys (NFHS, DLHS, AHS and NNMB) provided some, but not adequate information on risk factors for non-communicable diseases (Figures 1.2, 1.3 &1.4). The identified information gaps included:

1. limited or no data on micronutrients deficiencies across age groups
2. limited data for 5–14 age groups in most of nutrition indicators
3. no data on NCDs for under 5 and 10–14 year age groups
4. lack of data on lipid profiles to assess the risk of heart disease in school-age children and adolescents
5. measures of chronic kidney disease (CKD) in school-age children and adolescents
6. correlates of NCDs including truncal adiposity (waist circumference), other measures of adiposity (skinfold thicknesses), muscular strength, and physical fitness

Based on identified information gaps, the CNNS was designed to provide nationally representative data on anthropometry, micronutrient deficiencies and risk factors for non-communicable diseases to help inform programmes and policies tackling the most critical nutritional challenges in the country.

Figure 1.2: Nutrition data availability and gaps in pre-school children aged 0–4 years

0–4 years

	NFHS-4 (2014–15)	AHS (2012–13)	DLHS (2012–13)	RSOC (2013)/ CES (2009)	NNMB (2012)
Anthropometry	• Height • Weight	• Height • Weight	• Height • Weight	• Height • Weight	• Height • Weight
IYCF Practices	• Breastfeeding • Complementary Feeding	• Breastfeeding • Complementary Feeding	• Breastfeeding • Complementary Feeding	• Breastfeeding • Complementary Feeding	• Food consumption • Nutrient intake
Anaemia	• Haemoglobin	• Haemoglobin	• Haemoglobin	**No data**	• Clinical symptoms
Micronutrient Status* Iron, Vitamin A, B-vitamin, Zinc, Iodine, Vitamin D; **Worm Infestation**	**No data**	**No data**	**No data**	**No data**	• Micronutrient intake • Goitre

Figure 1.3: Nutrition data availability and gaps in school age children/early adolescents aged 5–14 years

5–14 years

	NFHS-4 (2014–15)	AHS (2012–13)	DLHS (2012–13)	CES (2009)	NNMB (2012)
Anthropometry	No data	No data	No data	No data	• Height • Weight
Body composition	No data	No data	No data	No data	No data
Anaemia	No data	No data	• Haemoglobin	No data	• Clinical symptoms
Micronutrient Status* Iron, Vitamin A, B-vitamin, Zinc, Iodine; Worm Infestation	No data	No data	No data	No data	• Micronutrient intake • Goitre
Physical fitness; Non-communicable diseases: Blood pressure, Blood glucose, Blood lipid	No data				

Figure 1.4: Nutrition data availability and gaps in adolescents aged 15–19 years

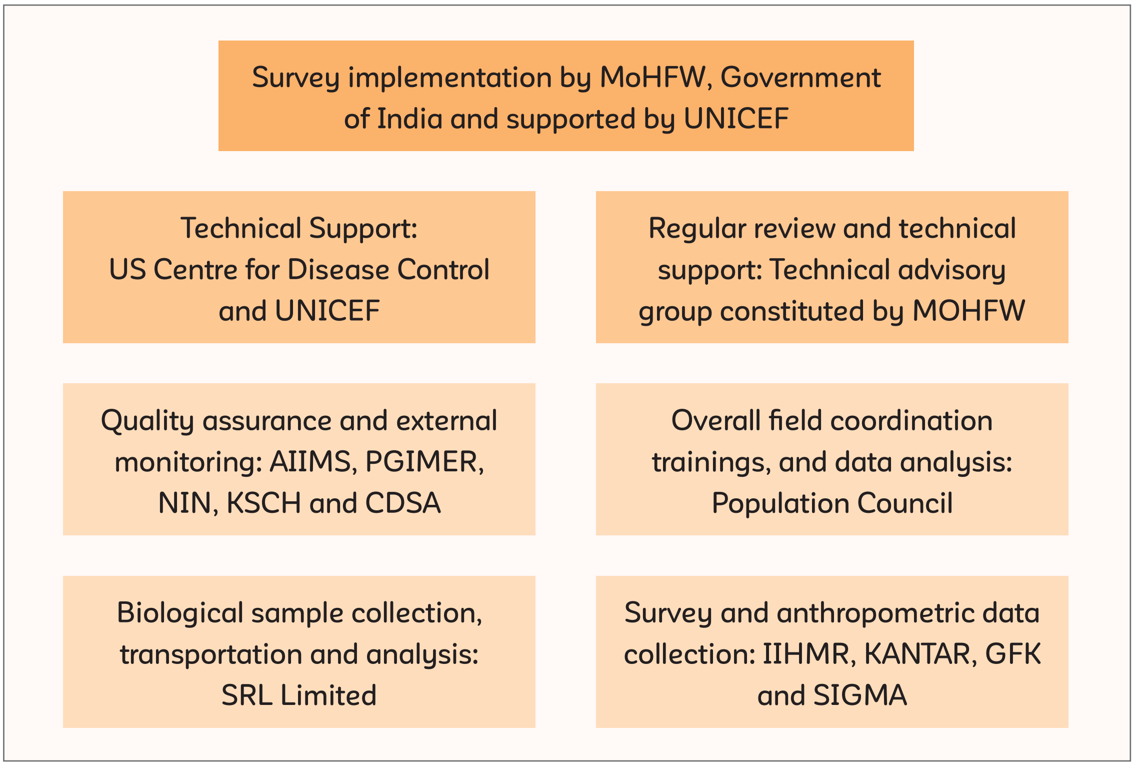
15–19 years

	NFHS-4 (2014–15)	AHS (2012–13)	DLHS (2012–13)	CES (2009)	NNMB (2012)
Anthropometry	• Height • Weight • Body mass index	• Height • Weight • Body mass index	• Height • Weight • Body mass index	No data	• Height • Weight • Body mass index
Body composition	No data	No data	No data	No data	No data
Anaemia	• Haemoglobin	• Haemoglobin	• Haemoglobin	No data	No data
Micronutrient Status* Iron Vitamin A B-vitamin Zinc Iodine Worm Infestation	No data	No data	No data	No data	• Micronutrient intake • Goitre
Physical fitness Non-communicable diseases Blood pressure Blood glucose Blood lipid	No data				

The main objective of the CNNS was to collect nationally representative data on the nutritional status of pre-schoolers (0–4 years), school-age children (5–9 years) and adolescents (10–19 years) through interviews, comprehensive set of anthropometric measures and biochemical indicators. The aim was to estimate the prevalence of malnutrition among children and adolescents and to identify key factors associated with the nutrition transition in India by using robust tools and gold standard methods to reorient national programme and policy. The specific objectives of the CNNS were:

- to assess the extent and severity of micronutrient deficiencies among children and adolescents
- to assess risk factors for non-communicable diseases among school-age children and adolescents
- to estimate the prevalence of dual burden of malnutrition in children and adolescents using a comprehensive set of established anthropometric measures

Figure 1.5: Partnership for CNNS implementation



In the beginning of 2016, the National Statistical Commission, Ministry of Statistics and Programme Implementation (MoSPI), Government of India approved the survey design and protocol for the Comprehensive National Nutrition Survey. The survey methodology is described in detail in Chapter 2. The ethical approval was received at the national level from the PGIMER. The CNNS was conducted under the leadership of the MoHFW, Government of India and Technical Advisory Committee designated by the MoHFW, in collaboration with the United Nations Children's Fund (UNICEF) (Figure 1.5).

The Population Council served as the lead implementation agency for the survey. Data collection was managed by four survey agencies (KANTAR Public, Gfk Mode Pvt. Ltd, SIGMA Research and Consulting Pvt. Ltd and the Indian Institute of Health Management Research, Jaipur). Biological samples were collected and analysed by SRL Ltd.

The Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh and Kalawati Saran Children's Hospital, New Delhi, provided concurrent monitoring support for the household survey and anthropometric measurements. The US Centers for Disease Control and Prevention (CDC) in Atlanta, USA; the All India Institute of Medical Sciences (AIIMS), Delhi; the National Institute of Nutrition (NIN), Hyderabad; and Clinical Development Services Agency (CDSA), Delhi provided quality assurance support for data collection and laboratory analysis of biosamples.

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CHAPTER 2

Methods

LARGEST MICRONUTRIENT SURVEY EVER CONDUCTED: CNNS 2016-18

Key findings

The Comprehensive National Nutrition Survey (CNNS) India 2016–18 is the largest micronutrient survey ever conducted and included the following:

- 112,316 children and adolescents interviewed with anthropometric measures collected
- Blood, urine and stool samples drawn from 51,029 children and adolescents
- 2,500 survey personnel in 30 states
  - 200 trainers and coordinators
  - 900 interviewers
  - 360 anthropometric measurers
  - 360 survey supervisors and quality observers
  - 100 data quality assurance (DQA) team members
  - 360 phlebotomists
  - 200 laboratory workers
  - 30 microscopists

The CNNS was conducted in all 30 states of India using a multi-stage survey design covering rural and urban households. The survey collected data from three target population groups: pre-schoolers (0–4 years), school-age children (5–9 years) and adolescents (10–19 years).

2.1 Sample size

The CNNS sample was designed to estimate prevalence of anthropometric and biochemical indicators in the three age groups across the following domains:

i) national level

ii) state level

iii) urban / rural area within a state

iv) male / female within a state

v) slum / non-slum areas in four metropolitan cities (Delhi, Mumbai, Chennai and Kolkata)

As prior estimates for a large majority of CNNS indicators were not known, the sample size was based on evidence available from small scale studies. Accounting for design effects and maximizing the sample power with the available resources, a minimum sample size of 1000 for anthropometric and 500 for biochemical indicators was fixed for each age group in each state and adjusted for rural and urban area and slum and non-slum settings. At the national level, the planned sample was calculated to be 122,100 children and adolescents from 2035 primary sampling units (PSUs) across the country (Table 2.4). The planned sample size was 40,700 individuals in each of the three age groups for the household survey and anthropometric measurements (Table 2.5) and 20,350 individuals for biological samples for each of the three age groups (Table 2.6).

2.2 Sample design

The CNNS used a multi-stage sampling design to select a representative sample of households and individuals aged 0–19 years across the 30 states. In each state, the rural sample was selected in two stages. The first stage was the selection of PSUs using probability proportional to size (PPS) sampling and the second stage was a systematic random selection of households within each PSU. In large PSUs, the sampling design involved three stages, with the addition of a segmentation procedure to reduce enumeration areas to manageable sizes.

In rural areas, the 2011 census list of villages (village was PSU in rural areas) served as the sampling frame for the first stage. The 2011 Primary Census Abstract (PCA) provided data on the number of households, population size and sex, persons belonging to scheduled castes (SC) or scheduled tribes (ST), and information on literacy for each village of India. All villages with fewer than 10 households were removed from the CNNS sampling frame. To ensure a sufficient number of households in selected PSUs, villages with less than 150 households in the sampling frame were linked to neighbouring villages to create 'linked PSUs' with a minimum of 150 households. This exercise was completed before the stratification of the sampling frame.

To ensure representation of different socioeconomic groups in the sample, a stratified sampling procedure was adopted at the first sampling stage in rural areas, following methods employed in the NFHS-3 survey (IIPS and Macro International, 2007). The rural sampling frame consisting of villages was stratified by a number of variables including geographical region, village size, percentage of males working in the non-agricultural sector, percentage of the population belonging to a scheduled caste or scheduled tribe, and female literacy. Two types of stratification were performed – explicit stratification and implicit stratification. At the first level of stratification, districts were grouped into contiguous regions in each state. At the second level of stratification, within each region, villages were further grouped by levels of two or more indicators from the above list (explicit stratification) following the stratification scheme used in the NFHS-3. Typically, within each region of a state, 6–9 explicit strata were formed. In the last level of stratification, villages within each explicit stratum were arranged alternatively by increasing and decreasing level of female literacy (implicit stratification). That is, within the first stratum, villages were arranged according to increasing level of female literacy, in the second stratum according to decreasing level of female literacy, in the third stratum based on increasing level of female literacy and so on. This scheme was used in all but five states (Orissa, Jharkhand, Chhattisgarh, Mizoram, and Kerala) where female literacy was used as an explicit stratification variable and percentage of the population belonging to a scheduled caste or scheduled tribe was used as an implicit stratification variable. PSUs were selected from the stratified lists using PPS random sampling.

For the second stage (household) of sampling, a household listing was completed immediately prior to data collection. The listing was conducted in each PSU, or segment of PSU, to create an up to date frame for the selection of households. This sample frame included:

- layout maps identifying residential structures
- household location / address
- numbering each household
- listing the name of the head of the household
- availability of eligible respondent for interview

Large PSUs with more than 300 households were divided into approximately equal size segments (usually about 150 households) and two segments were randomly selected to represent the PSU. The household listing was only conducted in the selected segments.

In urban areas, the sampling frame for the first stage was a list of all the wards in the state obtained from the 2011 PCA stratified by geographical region. Urban wards were selected from this stratified list using PPS random sampling. Every ward consists of several census enumeration blocks (CEBs), each comprising approximately 100–150 households. For the second stage of sampling, a list of all the CEBs in each of the selected wards was used to randomly select one CEB from each selected ward. To ensure a sufficient number of households in the selected sampling unit, smaller CEBs were linked to neighbouring CEBs to create a sampling unit with a minimum of 150 households. Subsequently, in each selected CEB, a household listing was carried out similar to the listing conducted for rural PSUs. In the third stage of sampling, households were randomly selected from these lists.

2.3 Survey implementation

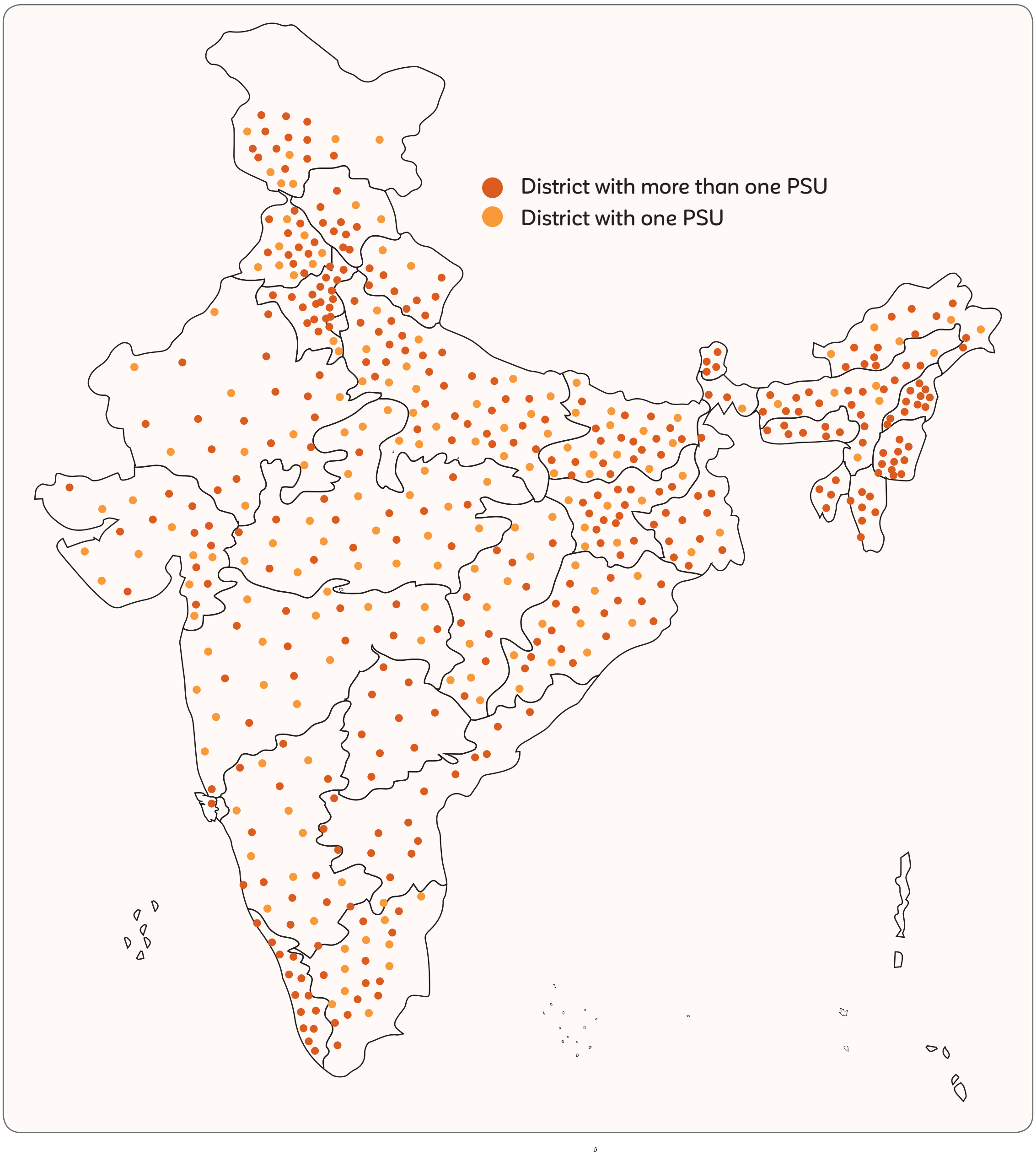
The survey was implemented under the guidance of the MoHFW, UNICEF, a Technical Advisory Group (TAG) and the US CDC. Survey data collection was implemented by four survey agencies, one field-based quality assurance team, one field and lab-based quality assurance team (CDSA), one main laboratory, two quality control laboratories (AIIMS and National Institute of Nutrition) and the lead management agency Population Council.

A technical advisory committee led by the MoHFW was constituted to guide and approve the survey design, tools and protocols for the CNNS. The CNNS TAG was chaired by Joint Secretary, (RMNCH+A) of the MoHFW and co-chaired by Deputy Commissioner, Child

Health and Immunization MoHFW and Ex-Director, National Institute of Medical Statistics (NIMS). The members included technical experts in nutrition, physiology, biochemistry, parasitology and sampling and survey methodology (Annexure 1). The TAG met at regular intervals throughout the duration of the project to approve survey protocols, monitor progress and review survey findings.

The lead agency (Population Council) worked closely with the four survey agencies and laboratories under close supervision of UNICEF. Monthly coordination and review meetings were held with personnel from the lead agency, survey agencies, the main laboratory and quality control laboratories throughout the data collection period to review field activities, training schedules, supplies and logistics and data collection and quality issues.

Figure 2.1: Selected districts and PSUs, India, CNNS 2016–18



For survey implementation, the country was divided into four zones with each zone covering 7–8 states. Data collection occurred in two states simultaneously in each of the four zones during each phase of the survey. Therefore, data were collected in a maximum of eight states at one time. The survey was carried out in all four zones concurrently from 24 February 2016 to 26 October 2018. A zone and state survey operational plan were developed for data collection activities and included the target sample size and number of PSUs to be completed by the 5 to 6 field teams working in each state and zone. Efforts were made to ensure that the survey was implemented in each state at least six weeks after the biannual vitamin A supplementation round.

2.4 Household survey interview

Household surveys involved an interview with the head of the household and an eligible respondent. For children below age 10 years, this was the parent or caregiver and for adolescents aged 10–19 years, the respondent was the adolescent.

2.4.1 Survey questionnaires

The CNNS used a household and an individual questionnaire for all participants. All questionnaires were administered in the principal languages of the state and/or English.

Household questionnaire

In the household questionnaire, the interviewer listed all the usual residents in the household and all visitors who stayed at the house the night before the interview. For each person listed, information was collected on age, sex, marital status, relationship to the head of the household, education and employment status. Religion and SC/ST status were collected for the head of the household. Data were also collected on water and sanitation facilities, source of lighting, type of cooking fuel, and ownership of house, land, livestock and durable assets such as radio, television and vehicles. Information was also collected on use of private/public health facilities and access to social entitlements such as take-home rations and/or health insurance cards.

Individual questionnaire

Individual questionnaires were completed for all eligible children and adolescents aged 0–19 years who were usual residents of the sampled household. Separate questionnaires were developed for the different age groups; children aged 0–4 years, children aged 5–9 years, adolescents aged 10–14 years and adolescents aged 15–19 years. The questionnaires included the following information:

- **background characteristics:** child/adolescent's date of birth, sex, birth order, parents' education, employment status and exposure to mass media
- **infant and young child feeding (IYCF) practices and dietary diversity:** information on IYCF practices was collected from mothers or other caregivers of children aged

0–23 months using the World Health Organization (WHO) recommended definitions, methods and questionnaire (WHO, 2008); for older children, daily and seven day food frequency questions on consumption of key food items were used to assess dietary diversity

- **health status:** immunization doses received (under five); receipt of high-dose vitamin A and iron supplementation (under five); morbidity (0–19 years)

Table 2.1: Information collected in the CNNS by age group, India, CNNS 2016–18

	Pre-school children (0–4 years)	School-age children (5–9 years)	Adolescents (10–19 years)
Household characteristics	■ Household members roster ■ Socio-economic status		
Environmental condition	■ Access to and use of safe drinking water ■ Access to and use of sanitation facilities ■ Hygiene practices		
Health status	■ Morbidity ■ Immunization ■ Vitamin A, iron supplementation	■ Morbidity	■ Morbidity
Dietary intake	■ Breastfeeding ■ Complementary feeding ■ Dietary diversity	■ Dietary diversity	■ Dietary diversity

2.4.2 Translation and pretesting of survey questionnaires

All questionnaires were translated into 20 state-specific languages in which the interviews took place. Translation was conducted by qualified professionals with strong linguistic skills who were familiar with the terminology used in health and nutrition surveys (Table 2.2).

Table 2.2: Languages of CNNS questionnaires by state, India, CNNS 2016–18

State(s)	Languages
Andhra Pradesh, Telangana	Telugu
Arunachal Pradesh, Bihar, Chhattisgarh, Delhi, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Uttarakhand, Uttar Pradesh	Hindi
Assam	Assamese
Gujarat	Gujarati
Jammu and Kashmir	Urdu, Hindi
Karnataka and Goa	Kannada
Kerala	Malayalam
Maharashtra and Goa	Marathi
Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura	Manipuri, Khasi, Garo, Mizo, Nagamese, Nepali, Bengali
Odisha	Odia
Punjab	Punjabi
Tamil Nadu	Tamil
West Bengal	Bengali

The questionnaires were pretested in the field for cultural and social acceptability, length, complexity, order and structure among 100 respondents in four different settings (rural, urban and slum areas) in Delhi, Maharastra, Uttar Pradesh and West Bengal and were finalized based on the feedback received from the pretesting.

2.4.3 Recruitment, training and standardization of field data collectors

About 900 interviewers were hired to conduct the household interviews. In addition, close to 400 supervisors and quality control staff were also engaged. In each PSU, four survey interviewers, two health investigators and two laboratory technicians worked as a team to complete the interviews and assessment of about 60 children over the course of five working days. In every state, an average of five teams worked together to complete all interviews in 3 to 4 months.

The interviewers were university graduates with previous experience in survey data collection who were able to spend several months working in the field. Male and female interviewers were assigned respondents of the same sex to ensure that respondents felt comfortable to speak about topics that they may find sensitive. The recruitment took into account the number of staff needed with language capacities in the states where data collection was on-going. Before data collection, all interviewers completed a four-week training on conducting the survey.

The training included:

I. general aspects of the survey including objectives, design and protocol

II. explanation, demonstration and role play of the interview procedures and anthropometric measurements

III. field practice of survey procedures, interview and anthropometric measurements

A strict adherence to the standard interview procedure was emphasized throughout the training. At the end of the training period, written and oral tests were conducted, and the final selection of data collectors was based on their performance during the training period, in the field practice and in the written and oral tests. Approximately 20% more than the required number of interviewers were recruited at the training to allow for normal levels of attrition and replacement in the event of poor performance.

Three two-week training sessions for master trainers (ToT) were conducted in Delhi, Jaipur and Darjeeling by the Population Council and experts from Kalawati Saran Children's Hospital, PGIMER and UNICEF. The master trainers conducted cascade trainings in all states in a phased manner to ensure rigorous and standardized training and survey implementation.

2.4.4 Data collection and data entry

2.4.4.1 Household listing and selection

In each state, household listing was conducted in selected PSUs prior to the initiation of survey data collection. A household listing form was used to identify and select eligible households. A two-member team of one mapper and one lister visited each PSU, marked its physical boundaries, drew a map and prepared a list of households. The team labelled each house with a unique number using a chalk or marker and noted the location of the house on the map. Following the listing, the survey team selected eligible households in the field using systematic random sampling in a pre-programmed excel spreadsheet. In order to ensure that the household listing was current and to minimize non-response, a maximum period of two weeks was allowed between household listing and the start of data collection.

During household listing, the head of household was asked to give the names of all household members aged between 0–19 years. Households with members between 0–19 years were classified into three categories (0–4 years, 5–9 years and 10–19 years) for selection from each group. In each household, only one participant was selected from each age group. For households with eligible participants from more than one age group, a maximum of three (one from each group) participants was interviewed.

2.4.4.2 Selection of survey participants

From each age group, 22 households containing eligible children were selected for the survey using systematic random sampling. During the interview with the household head, if more than one eligible child/adolescent was present in a given age group, one child/adolescent was randomly selected using a KISH table .

The inclusion and exclusion criteria for the survey participants were as follows:

Inclusion criteria

Individuals in selected households were eligible to participate in the survey if they:

i) were between 0–19 years of age

ii) were usual residents of the selected household

iii) consented/assented to participate in the survey

Exclusion criteria

Individuals in selected households were not eligible to participate in the survey if they:

i) did not fulfil the above-mentioned inclusion criteria

ii) had a major physical deformity (e.g. paralysis, cerebral palsy) or cognitive disabilities

iii) had an acute febrile or infectious illness

iv) had a known chronic systemic illness including tuberculosis, cancer, liver disease and renal disease

v) were on medications for chronic illnesses

vi) had an acute injury

vii) were pregnant

Currently married adolescents aged 10–19 years not visibly pregnant were asked whether they had a menstrual period in the past 30 days. If not, an hCG urine test was performed to detect pregnancy. The survey (interview, anthropometry measurements or biological sample collection) was not conducted for pregnant adolescents.

2.4.4.3 Computer assisted personal interview

The survey employed the Computer Assisted Personal Interviewing (CAPI) method for collecting survey data. This involved the interviewer using a mini laptop computer to administer the survey and record responses directly into the system. A data entry package was developed using the CSPro software. CAPI surveys have shown to improve data quality through less missing data and fewer errors due to functions built into the data entry programme which prevent entry of illogical data. Field data were uploaded directly into the database and shared with the central office on a weekly basis, allowing for timely quality control.

2.4.5 Quality assurance of household interviews

2.4.5.1 Internal monitoring and supervision

The performance of the interviewers was supervised at different levels. In each PSU, one supervisor and a data quality control observer were deployed to supervise the team. Team supervisors had a postgraduate degree and extensive experience in field survey management. The team supervisor was responsible for overall planning, coordination and execution of the fieldwork, rapport building with the community, supervision of fieldwork and reporting on PSU completion. Supervisors were responsible to ensure that all sampled households were visited, and all eligible respondents were contacted. The supervisors also compared the list of household members from the household listing to the original sample listing for quality assurance.

2.4.5.2 Three-tiers of monitoring for data quality assurance

The CNNS involved a rigorous three-tier system for data quality assurance as described below.

First tier survey data quality assurance

At the first level, monitoring was conducted by quality control observers who observed survey interviews and interviewer-respondent interactions and provided feedback to the interviewers on their performance. If re-interviews were required, data quality observers compared data from the two interviews. At least 30% of the interviews in a PSU were monitored and feedback was provided to the data collectors on a daily basis.

Another layer of monitoring and supervision in the first tier was conducted by the zonal field managers and state field managers of the survey agency. Each zone had one zonal field manager and one state field manager responsible for the training and supervision of field data collectors. Their responsibilities included managing the field operations and reviewing and providing feedback on data quality. These managers observed at least 2–3 interviews (including anthropometric measurements) in each PSU they visited and provided feedback and support for survey implementation.

Second tier survey data quality assurance

At the second level, monitoring and supervision was provided by a three-member data quality assurance team in each state that monitored 80% of the selected PSUs. In the PSU, the data quality assurance team visited 10% of households to validate the household listing process. If more than 10% inconsistency was found, the listing was redone. The team observed three interviews in each PSU they visited and conducted a minimum of three re-interviews for quality assurance.

CAFE software: The CNNS survey also employed computer-assisted field editing (CAFE) tool using the CSPro software to collect re-interviews of a number of questions conducted by independent data quality assurance teams. Data were reviewed, and feedback was provided immediately to teams to maintain data quality.

Third tier survey data quality assurance

A third level of quality assurance for survey data was provided by experts from PGIMER, UNICEF and Population Council. These supervision teams observed interviews and provided feedback to the field teams, as well as provided input on corrective actions at all levels of implementation.

In addition to these three levels of field monitoring, based on weekly data received at the Population Council, field-check tables (a set of data quality tables) were generated every fortnight and sent to the agencies responsible for data collection. The information was shared with field supervisors and discussed with field teams on a regular basis.

2.5 Anthropometric measurements

All children and adolescents for whom the interview was completed were measured for a variety of anthropometric indicators. For children aged 0–4, mothers were also measured for height and weight. Table 2.3 presents the measurements conducted for each age group.

Table 2.3: Anthropometric measurements taken in CNNS by age group, India, CNNS 2016–18

<table>
<tr><th></th><th>Pre-school children
(0–4 years)</th><th>School-age children
(5–9 years)</th><th>Adolescents
(10–19 years)</th></tr>
<tr><td rowspan="2">Anthropometric measurements</td><td colspan="3">■ Height/Length
■ Weight
■ Mid-upper arm circumference
■ Triceps skinfold thickness
■ Subscapular skinfold thickness (1–19 years)</td></tr>
<tr><td></td><td colspan="2">■ Waist circumference</td></tr>
</table>

2.5.1 Anthropometric equipment

The CNNS used the highest quality equipment to ensure the safety and accuracy of anthropometric measurements for children and adolescents. Digital SECA scales from Germany and three-piece wooden height/length boards were procured from UNICEF and set up on a portable wooden square to ensure a level measurement surface. When used to measure standing height, the height board was set straight with a spirit level before measurement. Standard UNICEF mid-upper arm circumference (MUAC) tapes and fiberglass tapes were used for arm and waist circumference measures. Holtain Skinfold Calipers, United Kingdom were used for skinfold measures. All anthropometric equipment was checked for functionality and calibrated daily before starting data collection.

Equipment used in CNNS anthropometric measurements

Anthropometric measurement	Equipment
Height/length	Three-piece wooden board
Weight	Digital SECA scale
Mid-upper arm circumference (MUAC)	MUAC tape
Triceps skinfold thickness (TSFT), Subscapular skinfold thickness (SSFT)	Holtain Skinfold Calipers
Waist circumference (WC)	Fiberglass tape

All anthropometric measurements were taken twice, with the exception of weight which was only measured once and hand grip strength which was measured three times. Measurements were recorded on a form specific for anthropometry.

2.5.2 Recruitment and training of survey anthropometrists

About 360 individuals were recruited to perform the anthropometric measurements. From a field of applicants with previous training in public health, a group of qualified trainees was selected, along with a number of extra personnel to serve as replacements during the survey period. Before the fieldwork, a four-week training on conducting the measurements was conducted

The training included:

i) general aspects of the survey including objectives, design and protocol

ii) explanation of survey procedures and demonstration of using all equipment and conducting measurements

iii) field practice for performing anthropometric measurements

The anthropometry training also covered how to unpack and repack anthropometric equipment, equipment care and maintenance, setting up a comfortable measurement space, rapport building with child/mother doe measurement, identification and recording of physical deformities, and data quality control and emergency procedures. A strict adherence to the standard interview/measurement procedures was emphasized throughout the training.

All trainees completed anthropometric standardization exercises in which their measurement skills were assessed for thoroughness, accuracy and precision. During the standardization exercise, each performed all anthropometric measurements (except weight) for 10 children 2 to 10 years of age. Measurements were conducted twice with an hour between measurements.

To assess the accuracy and precision of each trainee, their measures were compared to those of the master trainers. To identify bias, a + or – sign was assigned to each measurement depending on whether the trainee's measurement was larger (+) or smaller (-) compared to the trainer's. A balanced count of +/- signs demonstrated the absence of systematic error. Intra-observer technical error of measurement (TEM) and reliability were calculated using the difference between the two measures of the trainee. Inter-observer TEM and reliability were calculated by comparing the trainee's two measures to the trainer's measure (Ulijaszek, 1999). Trainees with excess bias or unacceptable TEM scores were either dismissed or retrained until they were able to make accurate measurements.

Only those trainees who passed the standardization test with acceptable levels of technical proficiency were hired for the survey.

2.5.3 Anthropometry data collection and data entry

Anthropometric measurements were taken after the interview with the child's caregiver or adolescent was completed and consent was given by the caregiver/adolescent for measurement. The anthropometrists noted on the questionnaire if the child or adolescent had any physical deformities. A comprehensive list of questions included in the questionnaire helped to document the type of physical deformity.

Height, weight, triceps skinfold thickness (TSFT), subscapular skinfold thickness (SSFT), and mid- upper arm circumference (MUAC) were measured for all children and adolescents. Waist circumference and hand grip strength were measured only for children 5–9 years old and adolescents 10–19 years of age.

In each household, anthropometrists identified a well-lit space with a smooth floor to set up the anthropometric equipment. A flat wooden square was placed on the floor and tested with a spirit level to ensure a level surface for weight and height measures. Two trained anthropometrists working together as a team conducted all anthropometric measurements. TSFT, SSFT, MUAC and waist circumference were measured twice, weight was measured once, and hand grip strength was measured three times.

Weights were measured with electronic digital scales. Under-five year old children were measured in light pants or lightly clothed. Older children and adolescents were measured lightly clothed. Children who were not able to stand unassisted on the scale were measured with the mother/child function, where the child was weighed in the arms of the caregiver standing on the scale.

Heights (or lengths) were measured using three-piece wooden height boards. Children younger than age 24 months were measured lying down (recumbent length) and older children, adolescents and mothers were measured standing (standing height). All persons measured were aligned straight on the height board with legs fully extended and head set level according to the Frankfort plane.

Mid- upper arm circumference (MUAC) was measured on the right arm using UNICEF child sized 25 cm length MUAC measuring strips. Older children and adolescents were measured with fibreglass tapes. The midpoint of the middle upper arm was identified, clearly marked and measured with standard pressure. Waist circumference was measured with a fibreglass 150 cm measuring tape. The measure was made after allowing the subject to let out their breath to prevent muscle contraction. All measures were taken to the nearest 1 mm. All tapes or strips were exchanged or discarded for new tapes/strips when no longer in adequate condition to make accurate measures.

The readings for each anthropometric measure, except weight, were performed by the anthropometrists and recorded manually on the data collection form. Data were then entered electronically using the data entry application on the field laptop.

If anthropometric assessment was not possible after repeated visits to the household, the anthropometrists recorded the data as incomplete and the reason for not completing data collection.

2.5.4 Quality assurance of anthropometric measurements

2.5.4.1 Internal monitoring and supervision

The performance of the anthropometrists was supervised at different levels. As discussed below (section 2.4.5.1), in each PSU, one supervisor and a data quality control observer were deployed to supervise the team performance.

2.5.4.2 Three-tiers of data quality assurance

As discussed before (See section 2.4.5.2) a three-tier system of data quality assurance mechanism was implemented in CNNS.

First tier data quality assurance of anthropometry data

The first level of monitoring for anthropometry was conducted by quality control observer in the field team who oversaw calibration of anthropometric equipment and anthropometric measurements in field. The quality control observers took detailed notes of the performance of the anthropometrists in the field based on observations provided feedback. If required, anthropometrists were sent back to households to re-do measurements. At least 30% of the measurements in a PSU were monitored and feedback was provided to the anthropometrists on daily basis.

Another layer of monitoring and supervision in the first tier was conducted by the zonal field managers and state field managers of survey agency. Each zone had one zonal field manager and one state field manager responsible for the training and supervision of field data collectors. Their responsibilities included managing the field operations, reviewing and providing feedback on data quality. They visited field to observe at least 2–3 interviews and measurement in each PSU they visited and to review the interviewer and anthropometric measurer's survey implementation and provide feedback and support.

Second tier data quality assurance of anthropometry data

The second tier of monitoring and supervision consisted of a three-member data quality assurance team in each state, who monitored data collection activities throughout the survey. The data quality assurance team monitored 80% of the selected PSUs. The data quality assurance team observed a minimum of three anthropometry measurements and validated by re-measures for another three respondents in each PSU visited.

Third tier data quality assurance of anthropometry data

A third level of quality assurance for survey data was provided by the experts from the PGIMER, UNICEF and Population Council. The supervision teams visited the PSUs and observed interviews and provided feedback to the field team and provided responses for corrective actions to all levels (survey agencies, UNICEF and the Population Council).

The CNNS survey also employed computer-assisted field editing (CAFE) to collect re-measurement data of anthropometry conducted by independent data quality assurance teams. These data were reviewed, and feedback was provided immediately to the team to maintain data quality.

2.6 Biological sample collection

On the morning following the anthropometry, fasting blood, urine and stool samples were collected from selected children aged 1–19 years. For biological sample collection, two out of three children among 5–9 years and 10–19 years were selected using systematic random sampling. All children aged 1–4 years were selected for biological sample collection based on the response rate observed in pilot testing. Biological samples were taken only after verbal (child) and written (caregiver/adolescent) consent was obtained and the household interview was completed. Blood, urine and faecal samples were collected to estimate the prevalence of micronutrient deficiencies, subclinical inflammation and parasitic infections. Blood pressure was measured for adolescents aged 10–19 years.

SRL Limited was responsible for the collection, transportation and testing of biological samples in all 30 states.

2.6.1 Recruitment and training of phlebotomists

SRL Limited hired approximately 360 trained phlebotomists for collecting blood samples and conducting blood pressure measurements. These personnel were qualified with a Diploma in Medical Laboratory Technology (DMLT) and had demonstrated experience in sample collection. All phlebotomists were trained and tested by experienced trainers from SRL and assessed by the CDSA team to ensure standardized procedures prior to the start of the survey.

2.6.2 Sample collection, packing and transportation

On the day anthropometric measurements were taken, in the evening, phlebotomists visited households selected for biological sample collection and obtained the consent of the parent/caregiver of the child/adolescent for sample collection. Following consent, the process of sample collection was explained and an information leaflet in the local language was provided. In addition, containers (labelled with name and ID) for collecting stool and urine sample were provided to the adult. Parents/caregivers were given a time of visit for the following morning and requested to ensure the child/adolescent would be fasting prior to sample collection.

In the morning, blood, urine and stool samples were collected from the selected children and adolescents by the phlebotomists. Eight millilitres (ml) of blood was collected from children 1–4 years and 10 ml from children 5–19 years. Once collected, the vacutainer tubes with blood samples were placed in cool boxes without direct contact with the icepacks and transported to the nearest pre-identified collection centre at appropriate temperatures. The blood samples for serum retinol were covered with aluminium foil soon after collection to protect against light exposure. At the collection centre, the blood samples were spun for 20 minutes and aliquoted into appropriate sized tubes for laboratory testing. Whole blood was stored in the refrigerator at 5–7°C. Serum samples were frozen, following procedures to minimize freeze-thaw cycles, prior to the laboratory analysis.

Urine (15 ml) was collected in a sterile wide mouthed container. To prevent contamination by normal vaginal, perineal and anterior urethral flora, the subjects were instructed to collect a clean-catch midstream urine specimen.

Stool was collected with a small provided scoop and placed in a sterile container with a tight-fitting leak proof lid.

All blood, urine and stool samples were labelled appropriately with the subject's unique ID and barcodes. Urine and stool samples were packed separately from the blood specimens. The laboratory worked closely with couriers and air carriers to make sure that specimens arrived at the laboratory within 24 hours following proper specimen handling procedures.

2.6.3 Quality assurance of biological samples

Given the challenges in ensuring proper handling and transport of biological specimens from field conditions to the laboratory, rigorous quality control and monitoring systems were included in the CNNS standard operating procedures (SOPs) to ensure quality of biomarker data. All laboratory testing equipment was validated daily or weekly against internal standards. Three levels of quality assurance were implemented. First, an internal quality control sample was used for each batch of 20 survey samples. Second, for external quality assurance, a subset of samples was sent to other participating laboratories monthly for comparison testing. SRL laboratories participated in the BIORAD and US CDC- external quality assurance scheme (EQAS). Third, on a weekly basis, a percentage of samples were split and reanalysed as a third quality control measure. Microscopy was conducted by accredited trained specialists in three laboratories. Sub-samples for microscopy were sent to All India Institute for Medical Sciences (AIIMS) laboratories for validation testing. SRL reference labs were reviewed by the College of American Pathology and given accreditation as a quality laboratory. Lastly, in addition to these internal quality control mechanisms in place at the SRL laboratories, 5% of the survey samples were randomly selected and sent to the National Institute of Nutrition (NIN) and AIIMS laboratories for additional quality control testing.

The quality assurance assays for vitamin A and zinc were conducted at the NIN, Hyderabad, and for all other parameters at AIIMS, New Delhi.

External validation of laboratory test results was conducted though participation in the US CDC VITAL-EQA programme designed to provide labs measuring nutritional markers in serum with an independent assessment of their analytical performance. The programme assists labs in monitoring the degree of variability and bias in their assays for quality improvement. For the CNNS, serum samples were sent by CDC to SRL twice a year to assess relevant laboratory methods.

2.6.3.1 Laboratory monitoring

Laboratory visits were made by US CDC personnel during pilot testing and three times during the different phases of survey implementation. In addition, TAG members and quality control partners made regular visits. The US CDC provided technical support related to biological sample collection, management, analysis and reporting, as well as pilot testing and quality control testing.

The Clinical Development Services Agency (CDSA) team conducted in-depth supervision of the collection of biological samples. This involved observation of sample collection, transportation, centrifugation, sample processing in the collection centres and laboratory analyses. CDSA personnel conducted time and temperature monitoring of biological samples transported from PSUs to the laboratory using data loggers and provided ongoing feedback to the SRL field and lab teams. Time and temperature were also monitored with data loggers placed above the sample tubes in the cool boxes during transport. An SMS-based reporting system was used to report the daily dispatch of biological samples from the PSU, receipt at the collection centre and at the reference laboratories.

In addition, with the CDSA team, the data quality assurance team conducted spot checks of biological sample collection. PGIMER, UNICEF and Population Council personnel also observed sample collection, transport and processing to ensure all protocols were followed.

2.6.4 Biochemical analysis

Table 2.7 outlines the nutritional biochemical indicators and inflammatory markers assessed for the three age groups. The selection of specific biomarkers corresponding to individual micronutrients was based on their utility to predict functional status. Special attention was given to the recent international initiatives including Biomarkers of Nutrition for Development (BOND) (Raiten, 2011), European Registration of Cancer Care (EURECCA) (Eurecca, 2014) and NHANES, especially for the estimation methods.

In the CNNS, standard internationally-recognized methods were used for the biochemical analyses (Table 2.8). The results of all laboratory tests were sent directly to the lead agency for merging with the survey interview and anthropometry data.

2.7 Pilot testing

A comprehensive two-week pilot test was conducted in four PSUs (not selected in the final list) in Bihar prior to the launch of the survey. Two field staff from each of the four survey agencies were trained for the pilot testing. The pilot test simulated the entire survey process, including the selection of households and respondents, administration of household and individual questionnaires, anthropometry measures, and collection of biological samples. A total of 240 respondents were interviewed using the CAPI method in four PSUs. This included 60 participants from each PSU, with 20 from each of the three age groups (0–4 years, 5–9 years and 10–19 years). Biological samples were collected from half of the respondents. The pilot test was monitored and supervised by TAG members, UNICEF and the lead agency Population Council. All survey procedures and data collection instruments were tested and finalised based on the findings and learning from the pilot test.

2.8 Data management and analysis

Survey data were entered directly into purposed built forms using CAPI and archived on the hard drive to standard databases. CAPI survey data and laboratory specimens were tracked with unique numeric identification codes specific to households and individual respondents, generated from the sample listing of households and individuals. Only authorized survey personnel had access to survey forms and electronic data. The dataset was examined for consistency using measures of central tendency, ranges, and distributions of continuous variables. Frequency tables were created for categorical variables to identify outliers and data inconsistencies. Any identified errors that could not be corrected through validation or other information in the database were set to missing.

In the CNNS, samples were allocated to different sampling domains (states, urban and rural areas within states) in a non-proportional manner. Therefore, sampling weights were required to ensure representativeness of the estimates at the national/ state level and at the local level, such as rural, urban and urban slum areas in metropolitan cities. The sampling weights were based on sampling probabilities calculated for each sampling stage (cluster and household level). Sample weights were calculated for the three survey age groups and for the survey sample and biological sample at both the state and national level.

To calculate the sampling weights, first, the overall probability of selection for each individual in the sample was calculated. This was obtained by multiplying the probability of selecting a PSU (or its segment) by the probability of selecting a household with a survey-eligible child. If more than one child in one of the three age categories was present in the household, the probability of selecting one eligible child per age category was calculated and multiplied by the individual selection probability described above. Sample design weights were then calculated by inversing the probability and adjusting for estimated non-response rates at the household and individual level. When calculating sample weights for the subset of the population eligible for biological sample collection, one more step was added which involved adjusting the probability of a child being selected for both interview and biological sample collection for the estimated non-response rate for biological sample collection. The final sampling weights were normalized by multiplying the weights by the estimated total sampling fraction obtained from the survey for each age category for the survey and biological sample populations separately. This was done both at the state level and at the national level to ensure equal numbers of weighted and unweighted cases at both levels.

Once the final merged dataset was created, sample weights were calculated and added to the database. First, descriptive statistics were used to examine variable distributions. Following this initial analysis, categorical variables were created, including wealth and other indices. Percentages of missing data were calculated for all variables.

Prior to analysis, all measures outside the physical limits of the survey instruments were set to missing and the mean of two valid anthropometric measures taken for analysis.

Age and sex standardized z-scores were calculated for height-for-age, weight-for-height, and weight-for-age. BMI-for-age, MUAC-for-age, TSFT-for-age and SSFT-for-age were calculated using the WHO Child Growth Standards (https://www.who.int/childgrowth/en/) and the WHO international growth reference data for children and adolescents 5–19 years of age (https://www.who.int/growthref/en/). Age and sex standardized z-scores were calculated for children and adolescents aged 5–19 years for TSFT, SSFT, MUAC and waist circumference from growth references based on the NHANES survey data (Addo, 2010; Addo, 2017; Sharma, 2015). Data analyses were conducted by staff at Population Council with support from UNICEF. All analyses were performed using STATA 15 (StataCorp; College Station, TX, USA).

2.9 Response rates

Table 2.9 shows CNNS response rates for individual interviews as well as biological sample collection for India and states. Overall, the response rates for individual interviews were 95% or more in the three age groups. In states, a similar picture was seen, except in few states in which response rates for adolescents were between 90% and 95%. Response rates for biological sample collection was somewhat low – 63–64% in the three age groups. It was highest in Odisha (78–88%) and lowest in Jammu and Kashmir (42–47%).

2.10 Sampling errors and limitations on use of data

Sampling errors for CNNS are calculated for selected variables considered to be of primary interest for the government. The results are presented in the appendix. They present the value of the variable (R), its standard error (SE), the number of unweighted (N) and weighted (WN) cases, the design effect (is the ratio of standard error of the present sampling design and the standard error that would result if a simple random sample had been used), the relative standard error (SE/R) and the 95 percent confidence limits (R±Rla) .

Following are the limitations on use of CNNS data

- CNNS is a cross sectional survey. The data cannot be used to conduct analyses of causality. It provides information on the associations between indicators and outcomes.
- CNNS sampling and sample size was designed to present results at state level. Analysis below the state level will not be statistically representative.
- Disaggregated analysis, for example by socio-economic status of CNNS biochemical indicators at state level cannot be done due to limitations in sample size.
- The timing of CNNS data collection varies by states. Indicators affected by seasonality should be compared and interpreted with caution.

2.11 Ethical considerations

International ethical approval was obtained from the Population Council's Institutional Review Board (IRB) in New York. National approval was obtained from the ethics committee of PGIMER in Chandigarh. Ethical approvals were obtained prior to initiating survey activities.

Informed consent and assent procedures

As the CNNS targeted children and adolescents 0–19 years of age, consent/assent was requested before conducting the interviews. For the CNNS, consent/assent was obtained as follows:

I. only informed consent from parents/caregivers for children aged 0–10 years

II. both informed consent from parents/caregivers for adolescents aged 11–17 years and assent from adolescents aged 11–17 years

III. only informed consent from adolescents aged 18–19 years

The participant information sheet and consent/assent form described the purpose of the study, the survey procedures including interview, anthropometry and biological sample collection, the potential risks and benefits of participation, the right to refuse participation or answer any question, measures to ensure confidentiality, and included the contact details for the study coordinators. The forms included consent/assent for the collection of survey interview data, anthropometric measurements, and blood, urine and stool samples.

The consent/assent forms were translated into state languages. A copy of the consent/assent form was given to the mother/caregiver/ adolescent to read or was read out if the participant was illiterate. Only after all questions were answered, the mother/caregiver/adolescent signed the consent/assent form. For illiterate participants, a thumb impression (right hand) was taken in the presence of a witness.

Risks and benefits

There were no significant risks from participating in the survey or from the collection of anthropometric data. Interviewer training focused on providing assurance to participants about their confidentiality and alleviating possible discomfort when answering potentially sensitive questions (e.g., past illness, socio-economic status, household sanitation facilities). Interviewers were trained to elicit information in a non-judgemental way. Efforts were also made to minimize discomfort during the anthropometric measurements and anthropometrists were trained in performing measurements on young children.

The risk of adverse events during the collection of biological samples was related to phlebotomy. The phlebotomists explained the procedure in detail prior to starting and comforted the child during the procedure. Younger children were suggested to sit in their parent's lap during the blood draw. A juice drink and biscuits were provided to all survey participants immediately after the blood collection and participants were monitored for a few minutes after the blood draw to ensure there was no bleeding, serious bruising, or fainting.

Parents/caregivers of children /adolescents identified with critical conditions from the analysis of the biological samples were given an immediate alert. The methods to identify critical conditions (Critical Call-Out) were developed by the survey laboratories. Such conditions included diabetes, high blood pressure, chronic kidney disease, severe anaemia and other conditions.

All survey data were transmitted in formats that could not identify the study participant or household. No names, addresses or GIS information were recorded or stored in the CAPI database.

Compensation/incentives

No compensation was provided for participating in the survey. However, participants were notified about their laboratory results and anthropometric measurements were shared immediately with parents/adolescents after data collection. The results from blood, urine and stool tests were provided in a sealed envelope, along with a general information sheet guiding parents/caregivers on whom to consult for further care and management, if necessary, in cases of micronutrient deficiencies and or risk factors for non-communicable diseases. Results for each participant were couriered individually to their home address. Parents and adolescents were directed to contact the doctor/medical personnel in their nearby health centre to interpret the laboratory results.

Table 2.4: Number of primary sampling units (PSUs) and target sample size by state, India, CNNS 2016–18

State	Number of PSUs	Target sample size for household survey and anthropometric measurement	Target sample size for biological sample collection
Andhra Pradesh	60	3,600	1,800
Arunachal Pradesh	65	3,900	1,950
Assam	70	4,200	2,100
Bihar	70	4,200	2,100
Chhattisgarh	65	3,900	1,950
Delhi*	100	6,000	3,000
Goa	55	3,300	1,650
Gujarat	55	3,300	1,650
Haryana	60	3,600	1,800
Himachal Pradesh	70	4,200	2,100
Jammu & Kashmir	60	3,600	1,800
Jharkhand	65	3,900	1,950
Karnataka	55	3,300	1,650
Kerala	50	3,000	1,500
Madhya Pradesh	60	3,600	1,800
Maharashtra*	100	6,000	3,000
Manipur	60	3,600	1,800
Meghalaya	65	3,900	1,950
Mizoram	50	3,000	1,500
Nagaland	60	3,600	1,800
Odisha	65	3,900	1,950
Punjab	55	3,300	1,650
Rajasthan	65	3,900	1,950
Sikkim	60	3,600	1,800
Tamil Nadu*	100	6,000	3,000
Telangana	60	3,600	1,800
Tripura	60	3,600	1,800
Uttar Pradesh	105	6,300	3,150
Uttarakhand	60	3,600	1,800
West Bengal*	110	6,600	3,300
India	**2,035**	**122,100**	**61,050**

*Inflated to provide slum and non-slum estimates in four metro cities (New Delhi, Mumbai, Chennai and Kolkata)

Table 2.5: Target sample size for household survey and anthropometric measurements by age group, India, CNNS 2016–18

State	0–4 years			5–9 years			10–19 years			All age groups
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Andhra Pradesh	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Arunachal Pradesh	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Assam	500	900	1,400	500	900	1,400	500	900	1,400	4,200
Bihar	500	900	1,400	500	900	1,400	500	900	1,400	4,200
Chhattisgarh	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Delhi*	1,500	500	2,000	1,500	500	2,000	1,500	500	2,000	6,000
Goa	600	500	1,100	600	500	1,100	600	500	1,100	3,300
Gujarat	500	600	1,100	500	600	1,100	500	600	1,100	3,300
Haryana	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Himachal Pradesh	500	900	1,400	500	900	1,400	500	900	1,400	4,200
Jammu & Kashmir	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Jharkhand	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Karnataka	500	600	1,100	500	600	1,100	500	600	1,100	3,300
Kerala	500	500	1,000	500	500	1,000	500	500	1,000	3,000
Madhya Pradesh	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Maharashtra*	1,500	500	2,000	1,500	500	2,000	1,500	500	2,000	6,000
Manipur	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Meghalaya	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Mizoram	500	500	1,000	500	500	1,000	500	500	1,000	3,000
Nagaland	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Odisha	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Punjab	500	600	1,100	500	600	1,100	500	600	1,100	3,300
Rajasthan	500	800	1,300	500	800	1,300	500	800	1,300	3,900
Sikkim	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Tamil Nadu*	1,500	500	2,000	1,500	500	2,000	1,500	500	2,000	6,000
Telangana	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Tripura	500	700	1,200	500	700	1,200	500	700	1,200	3,600
Uttar Pradesh	500	1,600	2,100	500	1,600	2,100	500	1,600	2,100	6,300
Uttarakhand	500	700	1,200	500	700	1,200	500	700	1,200	3,600
West Bengal*	1,500	700	2,200	1,500	700	2,200	1,500	700	2,200	6,600
India	**19,100**	**21,600**	**40,700**	**19,100**	**21,600**	**40,700**	**19,100**	**21,600**	**40,700**	**122,100**

*Inflated to provide slum and non-slum estimates in four metro cities (New Delhi, Mumbai, Chennai and Kolkata)

Table 2.6: Target sample size for biological sample collection by age group, India, CNNS 2016–18

State	0–4 years			5–9 years			10–19 years			All age groups
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Andhra Pradesh	250	350	600	250	350	600	250	350	600	1,800
Arunachal Pradesh	250	400	650	250	400	650	250	400	650	1,950
Assam	250	450	700	250	450	700	250	450	700	2,100
Bihar	250	450	700	250	450	700	250	450	700	2,100
Chhattisgarh	250	400	650	250	400	650	250	400	650	1,950
Delhi*	750	250	1,000	750	250	1,000	750	250	1,000	3,000
Goa	300	250	550	300	250	550	300	250	550	1,650
Gujarat	250	300	550	250	300	550	250	300	550	1,650
Haryana	250	350	600	250	350	600	250	350	600	1,800
Himachal Pradesh	250	450	700	250	450	700	250	450	700	2,100
Jammu & Kashmir	250	350	600	250	350	600	250	350	600	1,800
Jharkhand	250	400	650	250	400	650	250	400	650	1,950
Karnataka	250	300	550	250	300	550	250	300	550	1,650
Kerala	250	250	500	250	250	500	250	250	500	1,500
Madhya Pradesh	250	350	600	250	350	600	250	350	600	1,800
Maharashtra*	750	250	1,000	750	250	1,000	750	250	1,000	3,000
Manipur	250	350	600	250	350	600	250	350	600	1,800
Meghalaya	250	400	650	250	400	650	250	400	650	1,950
Mizoram	250	250	500	250	250	500	250	250	500	1,500
Nagaland	250	350	600	250	350	600	250	350	600	1,800
Odisha	250	400	650	250	400	650	250	400	650	1,950
Punjab	250	300	550	250	300	550	250	300	550	1,650
Rajasthan	250	400	650	250	400	650	250	400	650	1,950
Sikkim	250	350	600	250	350	600	250	350	600	1,800
Tamil Nadu*	750	250	1,000	750	250	1,000	750	250	1,000	3,000
Telangana	250	350	600	250	350	600	250	350	600	1,800
Tripura	250	350	600	250	350	600	250	350	600	1,800
Uttar Pradesh	250	800	1,050	250	800	1050	250	800	1,050	3,150
Uttarakhand	250	350	600	250	350	600	250	350	600	1,800
West Bengal*	750	350	1,100	750	350	1,100	750	350	1,100	3,300
India	**9,550**	**10,800**	**20,350**	**9,550**	**10,800**	**20,350**	**9,550**	**10,800**	**20,350**	**61,050**

*Inflated to provide slum and non-slum estimates in four metro cities (New Delhi, Mumbai, Chennai and Kolkata)

Table 2.7: Specific nutritional biochemical indicators and inflammatory markers evaluated in the three age groups, India, CNNS 2016–18

<table>
<tr><th>Indicator Group</th><th>Pre-school children (1–4 years)</th><th>School-age children (5–9 years)</th><th>Adolescents (10–19 years)</th></tr>
<tr><td>Anaemia and haemoglobinopathies</td><td colspan="3">■ Haemoglobin
■ Variant haemoglobins</td></tr>
<tr><td>Inflammatory biomarkers</td><td colspan="3">■ C-reactive protein</td></tr>
<tr><td>Protein</td><td colspan="3">■ Serum protein and albumin</td></tr>
<tr><td>Micronutrients</td><td colspan="3">■ Iron: Serum ferritin, serum transferrin receptor
■ Vitamin A: Serum retinol
■ Zinc: Serum zinc
■ B-vitamins: Erythrocyte folate, serum B12
■ Vitamin D: Serum 25 (OH)D
■ Urinary iodine</td></tr>
<tr><td>Non-communicable diseases</td><td></td><td colspan="2">■ Blood pressure
■ Blood glucose, HbA1c
■ Lipid profile: Serum cholesterol, LDL, HDL, and triglycerides
■ Renal function: Serum creatinine, urinary protein creatinine ratio</td></tr>
</table>

Table 2.8: Biochemical indicators and analysis methodology, India, CNNS 2016–18

Indicator Group	Indicators	Method
Anaemia and haemoglobinopathies	Haemoglobin	5 parts automated cell counter (Beckman coulter)/ Photometric estimation (cyanmethaemoglobin method)
	Variant haemoglobin	Ion Exchange HPLC
Inflammatory biomarkers	C-reactive protein	Nephelometry, Particle-enhanced immunonephelometry
Protein	Serum protein	Spectrophotometry (Siemens, Dade Dimension) Biuret reaction
	Serum albumin	Spectrophotometry, Bromocresol purple (BCP) dye binding
Micronutrients	Serum ferritin	2 site sandwich immunoassay
	Serum transferrin receptor	Nephelometry, Particle -enhanced immunonephelometry
	Serum retinol	HPLC Reverse phase chromatography
	Serum zinc	Flame Atomic Absorption spectrometry with D2 correction
	Erythrocyte folate	Competitive immunoassay using direct chemiluminescence (Siemens Centaur)
	Serum B12	Competitive immunoassay using direct chemiluminescence (Siemens Centaur)
	Serum 25(OH)D	Antibody competitive immunoassay using direct chemiluminescence (Siemens Centaur)
	Urinary iodine	Microplate method based on Sandell Kolthoff reaction
Non-communicable diseases (NCDs)	Blood pressure	Digital equipment
	Blood glucose	Spectrophotometry, Hexokinase
	HbA1c	HPLC
	Serum cholesterol	Spectrophotometry, cholesterol oxidase esterase peroxidase
	HDL	Spectrophotometry, direct measure-PEG/ CHOD
	LDL	Spectrophotometry, direct measure/ CHOD
	Triglycerides	Spectrophotometry, enzymatic endpoint
	Serum creatinine	Spectrophotometry, alkaline picrate - kinetic IFCC IDMS standardized
	Urinary protein	Spectrophotometry, Pyrogallol red
	Urinary creatinine	Spectrophotometry, alkaline picrate - kinetic IFCC IDMS standardized

Table 2.9: Data collection period, sample size achieved in individual interview and biological sample collection by age group and response rate by state, India, CNNS 2016–18

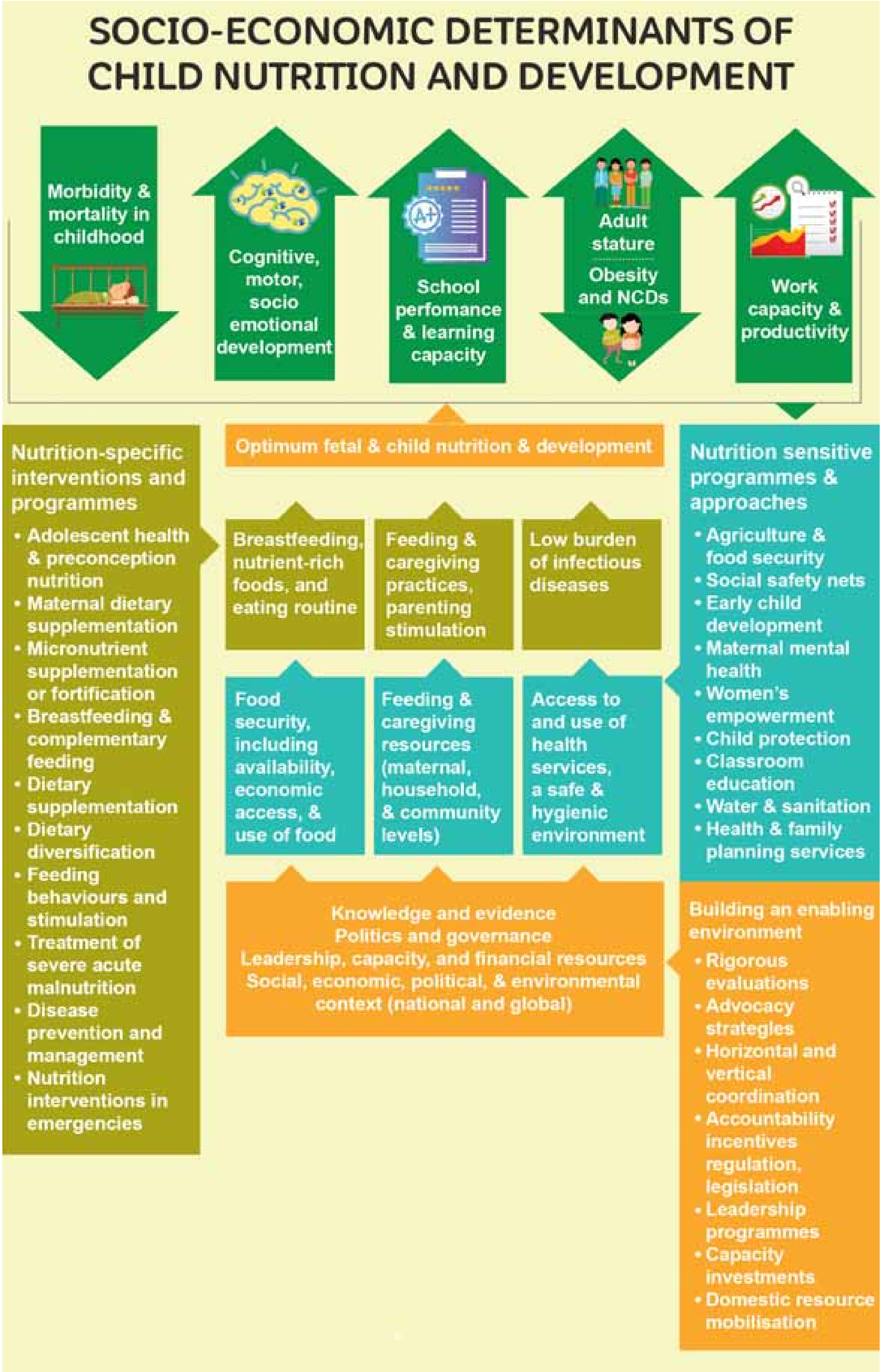
States	Month and year of fieldwork		Individual interview						Biological sample collection*					
			0–4 years		5–9 years		10–19 years		0–4 years		5–9 years		10–19 years	
	From	To	N	RR	N	RR	N	RR	N	RR	N	RR	N	RR
Andhra Pradesh	Aug-16	Dec-16	1,173	98.2	1,218	99.4	1,126	98.3	443	88.3	636	95.8	561	99.6
Arunachal Pradesh	Apr-18	Oct-18	1,268	99.0	1,181	97.4	1,072	94.6	840	84.4	665	84.5	582	81.5
Assam	Jul-16	Nov-16	1,452	98.4	1,455	97.8	1,386	95.4	419	69.3	536	73.7	495	71.4
Bihar	Aug-16	Dec-16	1,407	95.5	1,422	96.4	1,379	96.1	623	82.3	758	80.0	713	77.6
Chhattisgarh	Sep-17	Apr-18	1,200	95.5	1,203	96.9	1,085	90.3	703	70.4	627	78.3	533	73.8
Goa	Jul-16	Sep-16	1,036	95.9	1,063	97.1	1,021	94.7	339	78.3	398	74.9	393	77.0
Gujarat	Nov-17	Mar-18	1,066	94.9	1,094	98.3	1,024	94.8	699	79.3	577	79.2	533	78.2
Haryana	Mar-17	Jun-17	1,090	96.7	1,092	97.8	1,069	94.9	527	60.4	537	73.8	543	76.3
Himachal Pradesh	Jul-16	Oct-16	1,192	95.7	1,204	97.1	1,147	95.0	355	72.4	491	81.6	456	79.5
India	**Feb-16**	**Oct-18**	**38,060**	**96.8**	**38,405**	**97.8**	**35,856**	**94.7**	**17,230**	**68.9**	**17,601**	**75.3**	**16,181**	**74.1**
Jammu and Kashmir	May-18	Aug-18	1,156	96.6	1,172	98.2	1,144	96.8	387	45.7	413	52.9	359	47.1
Jharkhand	Mar-17	Jul-17	1,226	93.2	1,230	94.5	1,093	91.1	681	66.9	590	72.0	518	71.2
Karnataka	Jun-18	Sep-18	949	94.2	993	97.1	912	94.1	517	65.4	467	70.6	418	68.8
Kerala	Oct-17	Apr-18	898	100.0	907	99.9	842	100.0	523	69.3	431	71.4	381	67.9
Madhya Pradesh	Oct-16	Feb-17	1,152	94.7	1,199	96.8	1,137	94.5	455	72.6	622	77.8	592	78.2
Maharashtra	Nov-16	May-17	1,921	97.3	1,957	98.9	1,910	97.4	873	55.8	959	73.6	895	70.4
Manipur	Oct-17	Feb-18	1,206	98.1	1,207	98.7	1,153	94.4	844	83.3	698	86.8	696	90.6
Meghalaya	Jun-18	Oct-18	1,114	99.3	1,087	99.4	989	96.8	484	54.1	441	60.9	393	59.7

States	Month and year of fieldwork		Individual interview						Biological sample collection*					
			0–4 years		5–9 years		10–19 years		0–4 years		5–9 years		10–19 years	
	From	To	N	RR	N	RR	N	RR	N	RR	N	RR	N	RR
Mizoram	Mar-16	Jun-16	1,009	97.4	1,026	98.8	966	92.4	307	73.0	440	85.8	379	78.5
Nagaland	Nov-16	May-17	1,199	99.8	1,189	99.8	1,100	98.3	231	47.9	258	43.4	232	42.2
NCT of Delhi	Mar-16	Sep-16	1,735	96.0	1,745	96.3	1,572	94.0	602	83.8	729	83.6	670	85.2
Odisha	Nov-17	Feb-18	1,313	100.0	1,343	99.0	1,271	97.0	927	85.0	790	88.3	764	90.3
Punjab	Sep-17	Mar-18	1,004	96.4	1,048	99.0	996	96.3	571	69.0	538	77.1	534	80.5
Rajasthan	Oct-16	Jan-17	1,221	96.9	1,277	99.2	1,217	96.1	445	91.1	674	94.8	639	95.3
Sikkim	Jul-18	Oct-18	1,121	98.5	1,107	97.6	996	93.5	805	87.1	660	89.5	629	94.8
Tamil Nadu	May-18	Aug-18	1,906	98.9	1,899	99.6	1,861	98.0	507	33.5	556	44.0	577	46.6
Telangana	Feb-16	Jul-16	1,037	94.4	1,006	95.2	979	92.7	435	98.9	476	94.6	447	91.3
Tripura	Oct-17	May-18	1,133	97.6	1,123	98.7	1,062	94.7	505	56.6	420	56.2	395	55.8
Uttar Pradesh	Apr-16	Sep-16	1,965	94.9	1,996	96.2	1,798	91.2	557	70.1	698	69.9	579	64.4
Uttarakhand	Sep-17	Feb-18	1,134	94.5	1,154	96.5	1,077	88.9	579	62.9	587	76.4	519	72.4
West Bengal	Jun-18	Oct-18	1,777	96.3	1,808	98.0	1,472	89.5	1,047	71.8	929	77.2	756	77.1

Note - N: Unweighted number, RR: Response rate
#Denominator for response rate: Children/adolescents who were eligible in the households at the time of survey
* Denominator for response rate: Two thirds of children/adolescents aged 1–19 years whose individual interview was successfully completed were selected using systematic random sampling. About the 5% sample were either homolysed or quantity not sufficient (QNS) for analysis but counted as non-response

CHAPTER 3

Characteristics of the study sample



Source: The Lancet Maternal and Child Nutrition Series, as built on the UNICEF Nutrition Conceptual Framework

Key findings

- The Comprehensive National Nutrition Survey (CNNS) collected data for three population groups from 30 states in India:
  - 38,060 pre-schoolers aged 0–4 years
  - 38,355 school-age children aged 5–9 years
  - 35,830 adolescents aged 10–19 years
- Thirty-one percent of mothers of children aged 0–4 years, 42% of mothers of children aged 5–9 years, and 53% of mothers of adolescents aged 10–19 years never attended school
- Less than half of mothers of children and adolescents were exposed to any mass media in 5/9 Empowered Action Group (EAG) states (Assam, Bihar, Jharkhand, Rajasthan, Uttar Pradesh) and Meghalaya
- The majority (~ 80%) of respondents were Hindus, followed by Muslims (16%), Christians (3%) and Sikhs (1%)
- More than 50% of adolescents in Bihar, Jharkhand and Madhya Pradesh were from poorest wealth quintile households

3.1 Importance of background characteristics

To understand different forms of malnutrition, it is critical to know the background conditions of the population who present the differing forms of malnutrition. In terms of malnutrition, school children are not facing the exact same risk factors of newborns, just as adolescent girls are not facing the same issues as adolescent boys. The systematic collection of background characteristics is important not only for the demonstration of an effective implementation of the survey sample, but also to provide the data on who is found with which conditions, where, and at what point within the life cycle.

The Lancet conceptual framework for actions to achieve optimum fetal and child nutrition and development (Black, 2013) based on the UNICEF conceptual framework for nutrition (UNICEF, 2015) presents an overview of the multi-factorial causes of nutrition.

The determinants of optimum growth and development (in the infographic above) are defined in the horizontal layers of causality, from the most distant socioeconomic and political determinants (in yellow) through the basic cause (in blue) to the most immediate conditions (in green) defining how food, disease, and care have a critical impact on nutrition. The socioeconomic inequalities in malnutrition in countries like India show the great importance of basic systemic determinants of malnutrition. In particular, maternal education is associated with improved child-care practices related to health and nutrition and improved access and compliance to interventions leading to less risk of undernutrition and overweight/obesity.

Almost all stunting takes place in the first 1000 days after conception. Evidence shows that appropriate complementary feeding practices reduces the incidence of stunting. On the other hand, severe infectious diseases in childhood (measles, diarrhoea, pneumonia, meningitis, and malaria) provoke wasting and possibly stunting. Environmental enteropathic disorder (EED) is a condition identified by reduced intestinal absorptive capacity, altered barrier integrity in the intestine and mucosal inflammation. It is found in young children living in unhygienic conditions. Children with EED also have high rates of symptomatic and asymptomatic infections, which can significantly hamper growth.

Maintaining a clean and hygienic environment along with active care seeking behaviour for common childhood diseases helps to ensure rapid healthy growth in early childhood. Optimum growth in the first 1000 days of life is also a preventive factor for overweight in adolescence and adulthood. Overweight and obesity often represent an excess of consumption of certain dietary items and can be accompanied with poor diets also insufficient in micronutrients.

Adolescent nutrition is important for boys and girls, but for those who are to be mothers, it is critical for the health and wellbeing of the mother-child pair. After early infancy, adolescence is the second period of rapid growth and maturation from childhood to adulthood. Some evidence shows that there is potential for catch-up growth in height during adolescence. Addressing malnutrition before women become pregnant is the only effective exit to malnutrition within the life cycle. As pregnancy in adolescence can stunt a girl's growth and increase the risk of complications and mortality during childbirth, it is critical to have effective services that keep girls in school, provide a quality education and to delay pregnancy until after the woman has reached adulthood.

3.2 Sample age distribution of children and adolescents

This chapter describes the demographic and socioeconomic characteristics of the survey population including age, sex, place of residence, mother's schooling, caste, religion, household wealth status, and dietary practices. This information is useful for understanding factors affecting the health and nutrition of children and adolescents across the country's diverse geographies and populations.

The Comprehensive National Nutrition Survey (CNNS) was implemented in all 30 states of India during 2016–2018. The CNNS included three population groups – pre-schoolers 0–4 years, school-age children 5–9 years and adolescents 10–19 years – in rural and urban areas and included a total sample of 38,060 and 38,355 children aged 0–4 years and 5–9 years, respectively, and 35,830 adolescents aged 10–19 years.

Girls and boys were equally represented in the three age groups, with a slightly larger percentage of boys (51.9%), compared to girls (48.1%), among children 0–4 years of age (Tables 3.1, 3.2 & 3.3).

Among children aged 0–4 years, 62% were ≥ 24 months (Table 3.1). This is expected in a population with a declining fertility rate. The distribution of age in months and age in years of the under five year old sample is available in the data quality annex. The age of the mother is an important determining characteristic for young children as younger mothers often have less knowledge of and/or access to services. For children under five years of age, 57% of mothers were between 25–34 years of age (Table 3.1).

In the school-age children 61% of the sample were of 5 to 7 years of age and the remaining 39% were of 8 to 9 years of age (Table 3.2). Among the sample of adolescents 10–19 years, 52% were early adolescents (10–14 years) and 48% were late adolescents (15–19 years) (Table 3.3).

3.3 Socio-demographic and behaviour characteristics

Across all three age groups, ~75% of participants were from rural areas. The majority (~ 80%) of survey respondents were Hindus, followed by Muslims (~16%), Christians (~2%), and ~1% each from Sikh and other religions (Tables 3.1, 3.2 & 3.3).

More than half (~55%) of children and adolescents consumed a vegetarian (without egg) diet. (Tables 3.1, 3.2 & 3.3). From 36 to 40% of children and adolescents reported to consume a non-vegetarian diet. The remaining reported diets were vegetarian plus consumption of egg (Tables 3.1, 3.2 & 3.3).

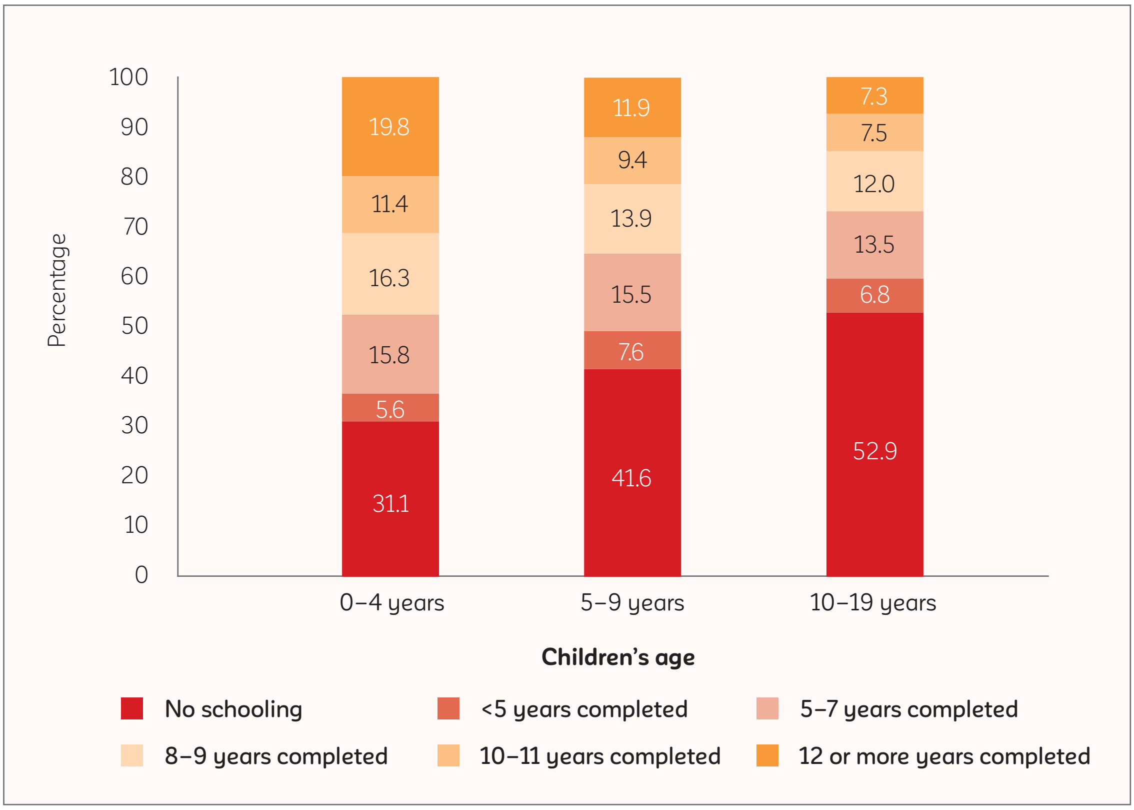
Mother's schooling was reported for children for all age groups. These results are presented in Figure 3.1 below. Child's schooling was reported for school aged children and adolescents. Among children aged 5–9 years, 91% were currently attending school (Table 3.2). For adolescents aged 10–19 years, 52% were 10–14 and 48% were 15–19 years of age (Table 3.3). Three-quarters (75%) of adolescents (aged 10–19 years) were currently attending school.

Approximately 40% of children and adolescents belonged to 'other backward classes' (OBC) and 23% and 11–13% belonged to scheduled castes (SC) and scheduled tribes (ST), respectively. One-quarter of the sampled children and adolescents did not belong to an OBC, SC, or ST. (Tables 3.1, 3.2 & 3.3).

The wealth index is a measure of socio-economic status based on possession of a number of common household items. The wealth index is a quintile so it is equally distributed across the sample population at the national level. The variation of wealth and inequity of distribution of resources is visible at the state level and is presented in Figure 3.4 below.

The percentage of mothers with no formal education was high across the three age groups, with 31%, 42%, and 53% of mothers of children aged 0–4, 5–9, and 10–19 years not having attended school (Figure 3.1). Only 20% of mothers of pre-schoolers, 12% of mothers of school-age children, and 7% of mothers of adolescents had completed 12 or more years of schooling.

Figure 3.1: Mother's level of schooling by child age group, India, CNNS 2016–18



The percentage of mothers having completed 12 or more years of schooling varied by state. For mothers of children aged 0–4 years, the highest rates were in Kerala (60%) and Tamil Nadu (51%), while < 20% of mothers of pre-schoolers completed ≥ 12 years of schooling in 16 states (Figure 3.2).

In 5 out of 9 Empowered Action Group (EAG) states (Assam, Bihar, Jharkhand, Rajasthan, Uttar Pradesh) and in Meghalaya, mothers/caregivers of < 50% of children aged 0–4 years were exposed to any type of mass media (read a newspaper or magazine, listen to the radio or watch television at least weekly) (Figure 3.3). A much larger proportion of mothers/caregivers (≥ 80%) were exposed to at least one form of mass media in all five south Indian states (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Telangana), in addition to Haryana, Maharashtra, Mizoram, Punjab, and Sikkim.

More than 50% of adolescents in Bihar, Jharkhand Madhya Pradesh, were from households in the poorest wealth quintile, while a substantial proportion of adolescents in Goa, Haryana, Kerala, Punjab, and Tamil Nadu resided in households in the richest wealth quintile (Figure 3.4).

Figure 3.2: Percentage of mothers/caregivers of children aged 0–4 years exposed to any mass media, India, CNNS 2016–18

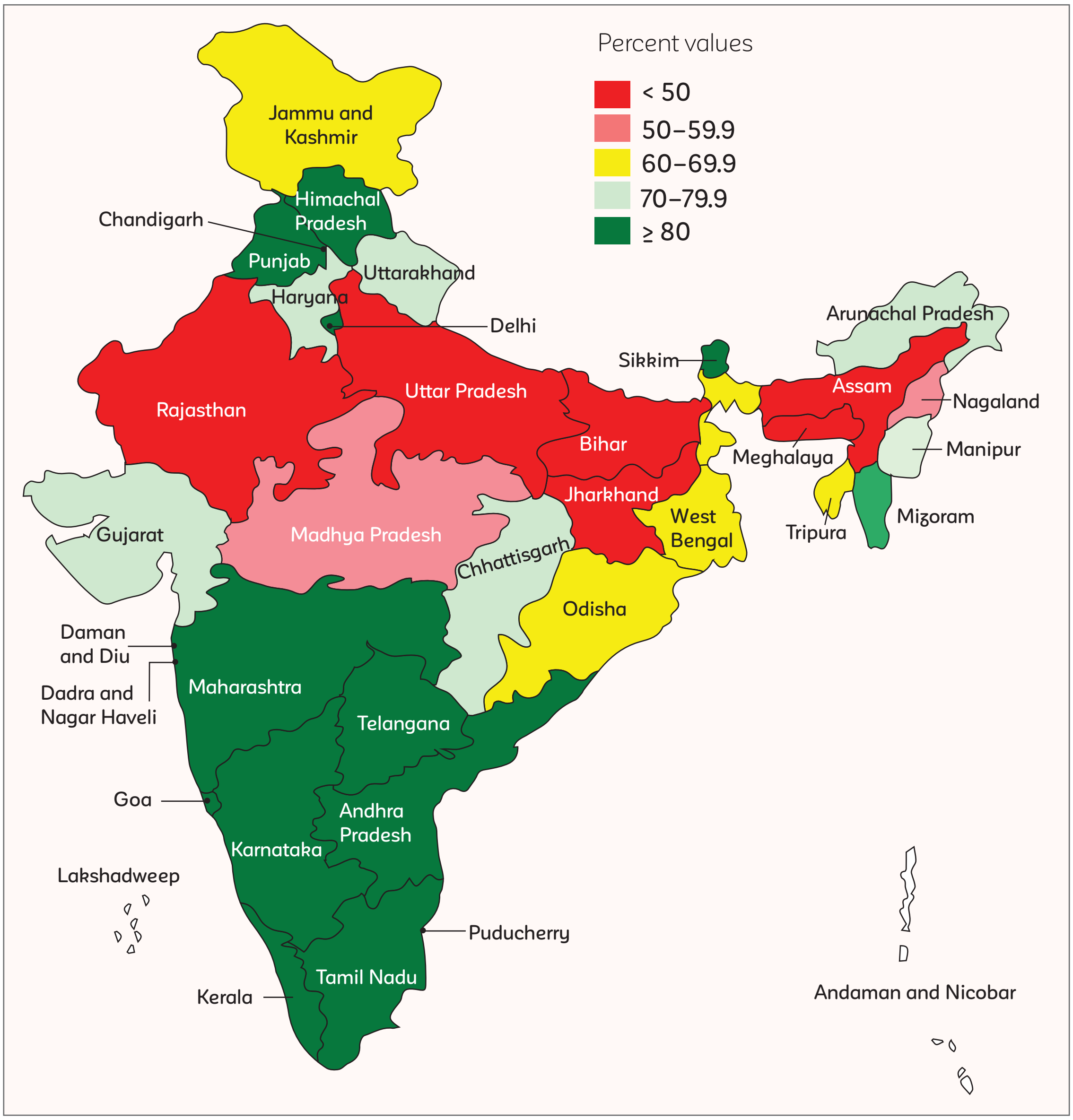
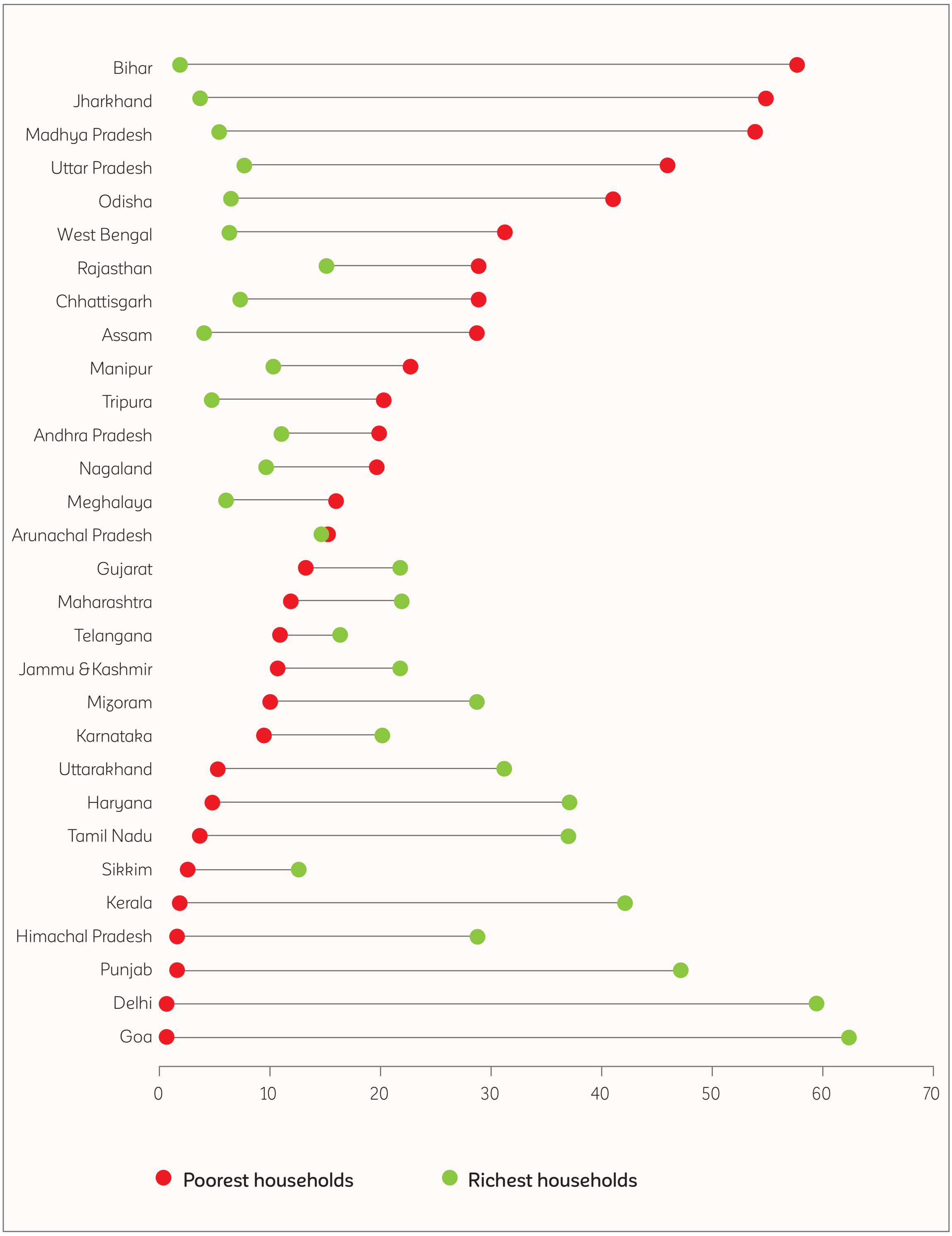
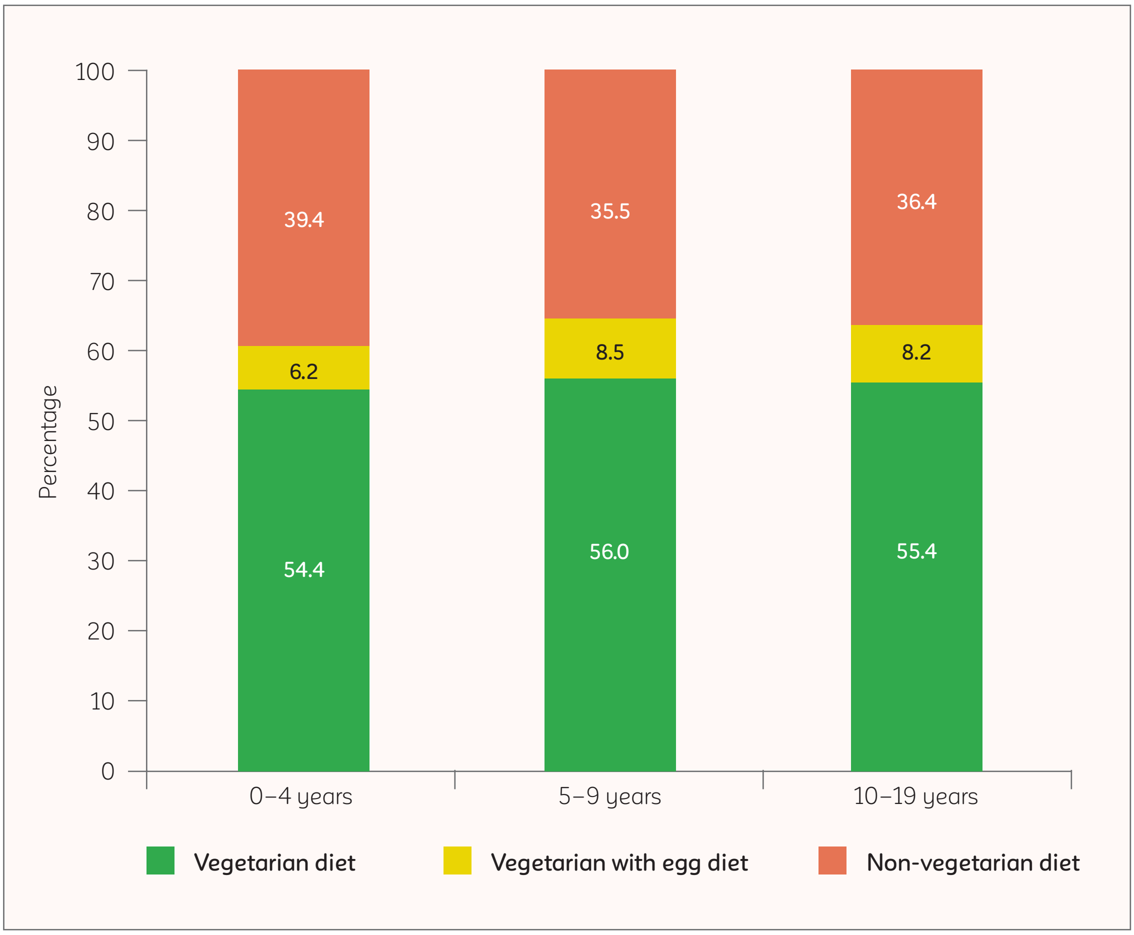


Figure 3.3. Percentage of adolescents aged 10–19 years in the poorest and richest wealth quintile households by state, India, CNNS 2016–18



Based on an assessment of self-reported weekly food consumption from the respondent or mother/caregiver of the respondent, the majority (54% – 56%) of participants in the three age groups were vegetarian, more than one-third (36% – 39%) were non-vegetarian, and a small proportion (6% – 9%) consumed eggs along with a vegetarian diet.

Figure 3.4: Type of diet consumed by age group, India, CNNS 2016–18



Overall, less than half (44%) of mother/caregivers of children aged 0–4 years reported having a vegetarian diet. However, dietary practices varied widely across states. More than 75% of mothers/caregivers of children aged 0–4 years reported consuming a purely vegetarian diet during the previous one week in Haryana, Himachal Pradesh, Punjab, Rajasthan, and Uttar Pradesh. This contrasts with the less than 10% of mother/caregivers of children aged 0–4 years in Andhra Pradesh, Goa, Kerala, Tamil Nadu, and Tripura who reported consuming a vegetarian diet during the previous week (Figure 3.6).

Figure 3.5: Percentage of mothers/caregivers of children aged 0–4 years consuming a vegetarian diet during the previous week by state, India, CNNS 2016–18

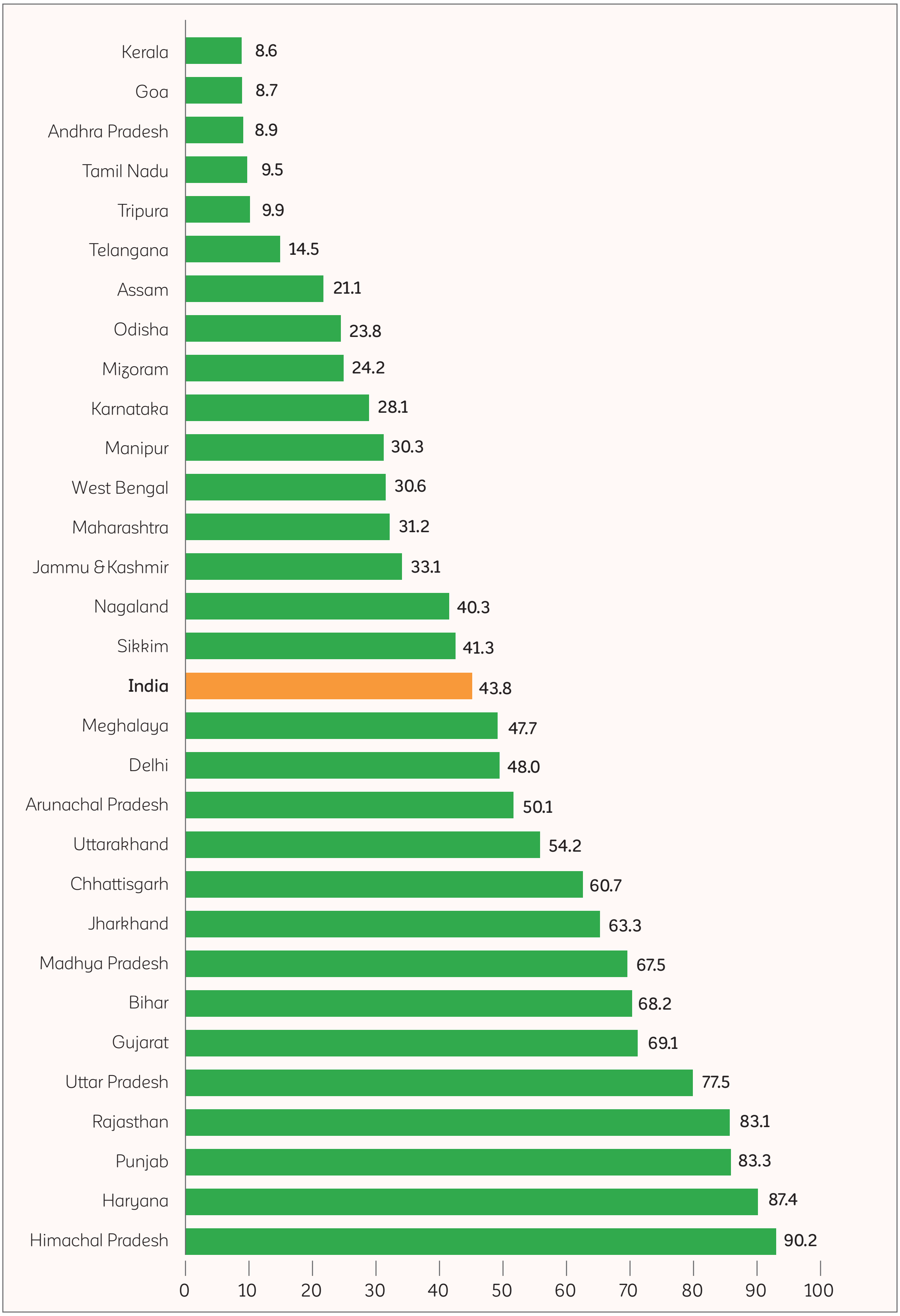
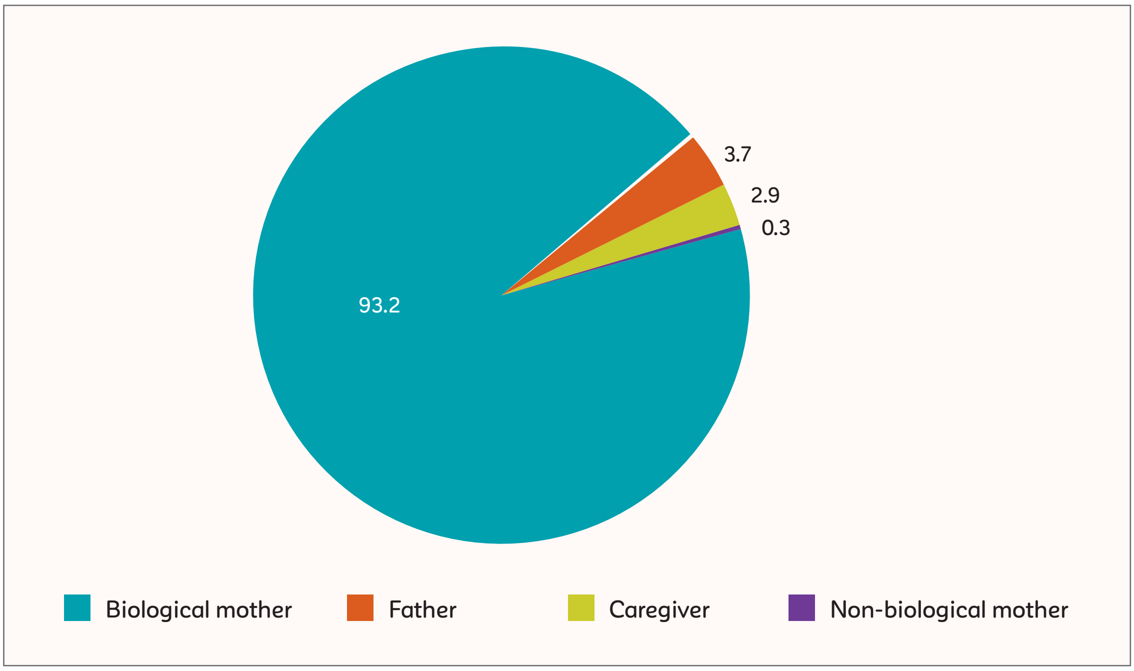


Figure 3.6: Percentage of respondents of children aged 0–4 years by relationship to child, India, CNNS 2016–18



For interviews of children under five years of age, mothers or caregivers were interviewed. For the children 5 to 9 years of age, the children were interviewed with support from parent caregiver. For children from 10 to 19 years of age, the interviews were conducted directly with the adolescent. For the children under five years of age, the biological mother was the respondent in 93% of all interviews. The father was the next most common respondent providing information in 4% of interviews, followed by a caregiver in 3% of interviews and the non-biological mothers in 0.3% of the interviews.

Table 3.1: Percent distribution of sampled children aged 0–4 years by selected characteristics, India, CNNS 2016–18

		Number	
	Weighted percent	Weighted	Unweighted
Sex of child			
Male	51.9	19,740	19,948
Female	48.1	18,320	18,112
Child age (in months)			
<6	9.5	3,615	3,208
6–8	5.0	1,899	1,841
9–11	5.0	1,904	1,953
12–17	9.4	3,593	3,710
18–23	9.4	3,593	3,691
24–35	20.2	7,698	7,660
36–47	20.6	7,847	8,185
48–59	20.8	7,913	7,812
Type of diet			
Vegetarian	54.4	20,700	16,059
Vegetarian with egg	6.2	2,347	2,754
Non-vegetarian	39.4	15,013	19,247
Mother's age (in years)			
< 20	2.7	1,037	1,050
20–24	31.0	11,795	9,506
25–29	38.2	14,555	13,975
30–34	19.1	7,262	8,715
≥ 35	8.1	3,073	4,539
Don't know/died	0.9	338	275
Mother's schooling			
No schooling	31.1	11,826	7,214
< 5 years completed	5.6	2,120	2,153
5–7 years completed	15.8	6,013	5,394
8–9 years completed	16.3	6,212	6,933
10–11 years completed	11.4	4,322	5,377
≥ 12 years completed	19.8	7,545	10,958
Don't know	0.1	22	31
Religion			
Hindu	79.3	30,164	26,124
Muslim	16.1	6,136	5,113
Christian	2.6	977	4,788
Sikh	1.0	374	679
Other	1.1	409	1,356
Caste/Tribe			
Schedule caste	22.7	8,652	6,981
Schedule tribe	13.0	4,948	7,673
Other backward class	39.3	14,961	11,677
Other	25.0	9,499	11,729
Residence			
Urban	23.7	9,017	17,421
Rural	76.3	29,043	20,639
Wealth index			
Poorest	20.0	7,613	3,064
Poor	20.0	7,622	4,575
Middle	20.0	7,602	7,289
Rich	20.0	7,612	9,812
Richest	20.0	7,612	13,320
Total	100.0	38,060	38,060

Table 3.2: Percent distribution of sampled children aged 5–9 years by selected characteristics, India, CNNS 2016–18

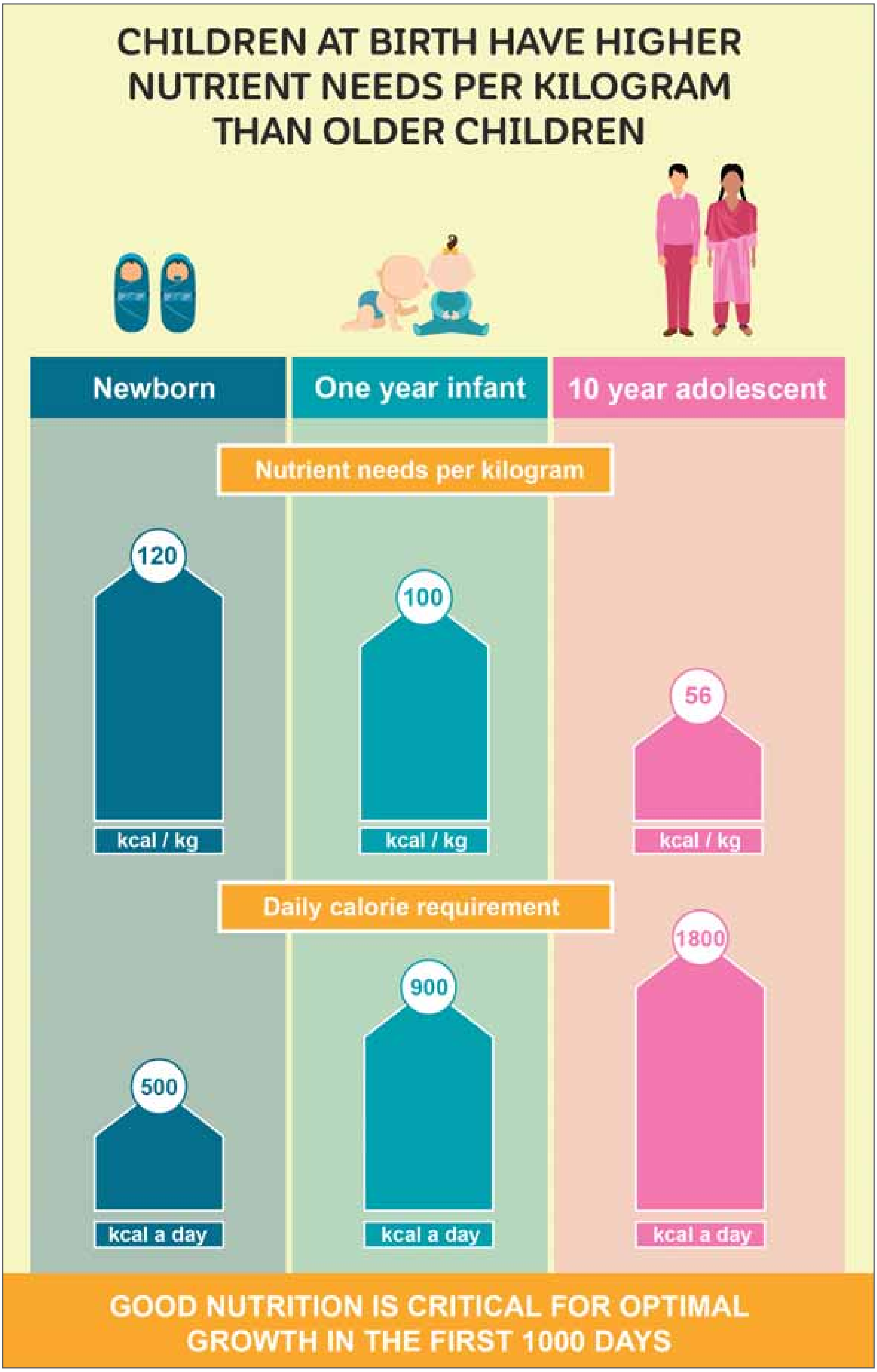
		Number	
	Weighted percent	Weighted	Unweighted
Sex of child			
Male	50.4	19,320	20,059
Female	49.6	19,035	18,296
Child age (in years)			
5–7	60.9	23,338	23,298
8–9	39.2	15,017	15,057
Type of diet			
Vegetarian	56.0	21,460	16,901
Vegetarian with egg	8.5	3,248	3,858
Non-vegetarian	35.5	13,647	17,596
Child's schooling status			
Currently in school	90.7	34,786	35,761
Not in school	9.3	3,568	2,594
Mother's schooling			
No schooling	41.6	15,957	9,760
< 5 years completed	7.6	2,918	3,147
5–7 years completed	15.5	5,950	6,005
8–9 years completed	13.9	5,314	6,532
10–11 years completed	9.4	3,613	4,986
≥ 12 years completed	11.9	4,553	7,850
Religion			
Hindu	78.9	30,253	26,412
Muslim	16.3	6,238	5,100
Christian	2.6	1,000	4,771
Sikh	1.1	404	720
Other	1.2	460	1,352
Caste/Tribe			
Schedule caste	22.8	8,745	7,098
Schedule tribe	12.9	4,963	7,616
Other backward class	39.6	15,201	12,001
Other	24.6	9,446	11,640
Residence			
Urban	24.2	9,290	17,499
Rural	75.8	29,065	20,856
Wealth index			
Poorest	20.0	7,673	2,890
Poor	20.0	7,671	4,430
Middle	20.0	7,672	7,069
Rich	20.0	7,672	10,158
Richest	20.0	7,668	13,808
Total	100	38,355	38,355

Table 3.3: Percent distribution of adolescents aged 10–19 years by selected characteristics, India, CNNS 2016–18

		Number	
	Weighted percent	**Weighted**	**Unweighted**
Sex of child			
Male	49.9	17,865	18,425
Female	50.1	17,965	17,405
Age (in years)			
10–14	51.9	18,591	18,435
15–19	48.1	17,239	17,395
Type of diet			
Vegetarian	55.4	19,853	15,664
Vegetarian with egg	8.2	2,950	3,271
Non-vegetarian	36.4	13,027	16,895
Child's schooling status			
Currently in school	74.8	26,814	29,221
Not in school	25.2	9,016	6,609
Mother's schooling			
No schooling	52.9	18,939	13,321
< 5 years completed	6.8	2,444	2,856
5–7 years completed	13.5	4,836	5,422
8–9 years completed	12.0	4,291	5,464
10–11 years completed	7.5	2,696	4,048
≥ 12 years completed	7.3	2,624	4,719
Religion			
Hindu	80.2	28,751	24,916
Muslim	15.2	5,453	4,629
Christian	2.3	816	4,413
Sikh	1.2	426	710
Other	1.1	384	1,162
Caste/Tribe			
Scheduled caste	22.5	8,072	6,630
Scheduled tribe	10.9	3,892	6,980
Other backward class	41.7	14,943	11,419
Other	24.9	8,922	10,801
Residence			
Urban	24.7	8,863	16,224
Rural	75.3	26,967	19,606
Wealth index			
Poorest	20.0	7,170	3,053
Poor	20.0	7,162	4,688
Middle	20.0	7,168	6,747
Rich	20.0	7,163	9,053
Richest	20.0	7,167	12,289
Total	100.0	35,830	35,830

CHAPTER 4

Infant and young child feeding and diets


CHILDREN AT BIRTH HAVE HIGHER NUTRIENT NEEDS PER KILOGRAM THAN OLDER CHILDREN
Newborn
One year infant
10 year adolescent
Nutrient needs per kilogram
120
kcal / kg
100
kcal / kg
56
kcal / kg
Daily calorie requirement
500
kcal a day
900
kcal a day
1800
kcal a day
GOOD NUTRITION IS CRITICAL FOR OPTIMAL GROWTH IN THE FIRST 1000 DAYS

Key findings

Initiation of breastfeeding

- Fifty-seven percent of children aged 0–24 months were breastfed within one hour of birth

Exclusive breastfeeding

- Fifty-eight percent of infants under age six months were exclusively breastfed

Continued breastfeeding at age one year

- Eighty-three percent of children aged 12 to 15 months continued breastfeeding at one year of age

Complementary feeding

- Timely complementary feeding was initiated for 53% of infants aged 6 to 8 months

Minimum dietary diversity, meal frequency and acceptable diet

- While 42% of children aged 6 to 23 months were fed the minimum number of times per day for their age, 21% were fed an adequately diverse diet and 6% received a minimum acceptable diet

Food consumption among school-age children and adolescents

- More than 85% consumed dark green leafy vegetables and pulses or beans at least once per week
- One-third consumed eggs, fish or chicken or meat at least once per week
- 60% consumed milk or curd at least once per week

Infant and young child feeding (IYCF) practices shape the nutritional status of children under two years of age and impact child survival and health and development outcomes in the long term. For older children and adolescents, dietary diversity reflects access to a variety of foods and nutrient adequacy of the diet. The focus of this chapter is on the feeding practices of infants and children under two years of age and the diversity of foods consumed by children and adolescents aged 5–9 and 10–19 years, as reported in the CNNS.

4.1 Infant and young child feeding (IYCF) practices

Optimal feeding practices during infancy and early childhood, comprising of early initiation of breastfeeding, exclusive breastfeeding in the first six months of life, continued breastfeeding through age one year, timely introduction of complementary foods, diversity of diet and frequency are critical for child survival, healthy growth and development of children under two years of age.

4.1.1 Early initiation of breastfeeding

Breastmilk is considered the best source of nutrition for the healthy growth and development of an infant. The World Health Organization (WHO) recommends early initiation of breastfeeding (EIBF) as it stimulates breastmilk production, fosters bonding between the mother and newborn, reduces neonatal mortality, and increases the duration of breastfeeding (WHO, 1998; UNICEF, 2002). Further, maternal colostrum produced during the first few days after delivery is rich in nutrients and antibodies that protect the newborn from infection and illness (Edmond, 2016; Victora, 2016)

Early initiation of breastfeeding
Definition: Proportion of children born in the last 24 months who were put to the breast within one hour of birth

Source: World Health Organization (WHO). Indicators for assessing infant and young child feeding practices. Part II: measurement. Geneva: WHO; 2010

Overall, 57% of children born in the two years prior to the survey initiated breastfeeding within one hour of birth (Figure 4.1). There were no differences in EIBF practices between male and female children (Table 4.1). Among the different castes, the scheduled tribes (67%) had the highest prevalence of EIBF, followed by the scheduled castes (58%) (Table 4.1).

4.1.2 Exclusive breastfeeding and continued breastfeeding at age one year

Breastmilk contains all the nutrients an infant needs in the first six months of life and exclusive breastfeeding during this period is sufficient and beneficial for health, growth and development (Edmond, 2006; Lopez-Alarcon, 1997; Perera, 1999; Zaman, 1997). Exclusive breastfeeding is considered a key intervention for the reduction of early infant morbidity and mortality and the WHO recommends exclusive breastfeeding for the first six months of life. As breastmilk is significant source of energy and key nutrients, the WHO recommends continued breastfeeding beyond the six-month period, along with provision of nutritionally-adequate and safe complementary foods (WHO, 2003).

Exclusive breastfeeding
Definition: Proportion of infants 0–5 months of age who received only breastmilk during the previous day

Source: World Health Organization (WHO). Indicators for assessing infant and young child feeding practices. Part II: measurement. Geneva: WHO; 2010

Fifty-eight percent of infants under the age of six months were exclusively breastfed (Figure 4.1). No differences were observed between male vs. female infants (Table 4.1). A higher proportion of infants belonging to the schedule tribes (70%) were exclusively breastfed, compared to their counterparts (Table 4.1).

Continued breastfeeding at 1 year of age
Definition: Proportion of children 12–15 months of age who received breastmilk during the previous day

Source: World Health Organization (WHO). Indicators for assessing infant and young child feeding practices. Part II: measurement. Geneva: WHO; 2010

The majority (83%) of children aged 12–15 months continued to be breastfed at age one year (Figure 4.1). Similar to exclusive breastfeeding, a higher proportion of children aged 12–15 months who belonged to scheduled tribes (91%) continued to be breastfed at age one year, compared to their counterparts (Table 4.1). A higher proportion of children residing in rural areas (85%) were breastfed at age one year, compared to children in urban areas (76%). An inverse relationship was observed between continued breastfeeding at one year of age and household wealth, as the prevalence was 92% and 69% among children in the poorest and richest households, respectively (Table 4.1).

4.1.3 Complementary feeding

To meet the growing nutritional needs of the baby, it is recommended to initiate complementary feeding from 6 months of age while continuing breastfeeding. (WHO, 2004). After 6 months of age, breastmilk alone is not enough to meet the nutritional demands of the growing infant. Therefore, timely and nutrient-dense complementary foods from 6 months of age are critical for optimum growth and development of the infant and young child.

Introduction of complementary foods
Definition: Proportion of infants 6–8 months of age who received solid, semi-solid or soft foods during the previous day

Source: World Health Organization (WHO). Indicators for assessing infant and young child feeding practices. Part II: measurement. Geneva: WHO; 2010

Over half of all children started to breastfeed in the first hour after birth (57%). Almost three fifths of children in India were exclusively breastfed (58%) in the six months of life. Over half (53%) of the infants aged 6 to 8 months received timely initiation of complementary feeding. (Figure 4.1).

A higher proportion (59%) of children residing in urban areas were given complementary foods from six months of age, compared to their rural counterparts (51%). The proportion of infants receiving timely complementary feeding increased with household wealth, from 42% in the lowest wealth quintile to 68% in the highest wealth quintile (Table 4.1).

Figure 4.1: Infant feeding practices, India, CNNS 2016–18

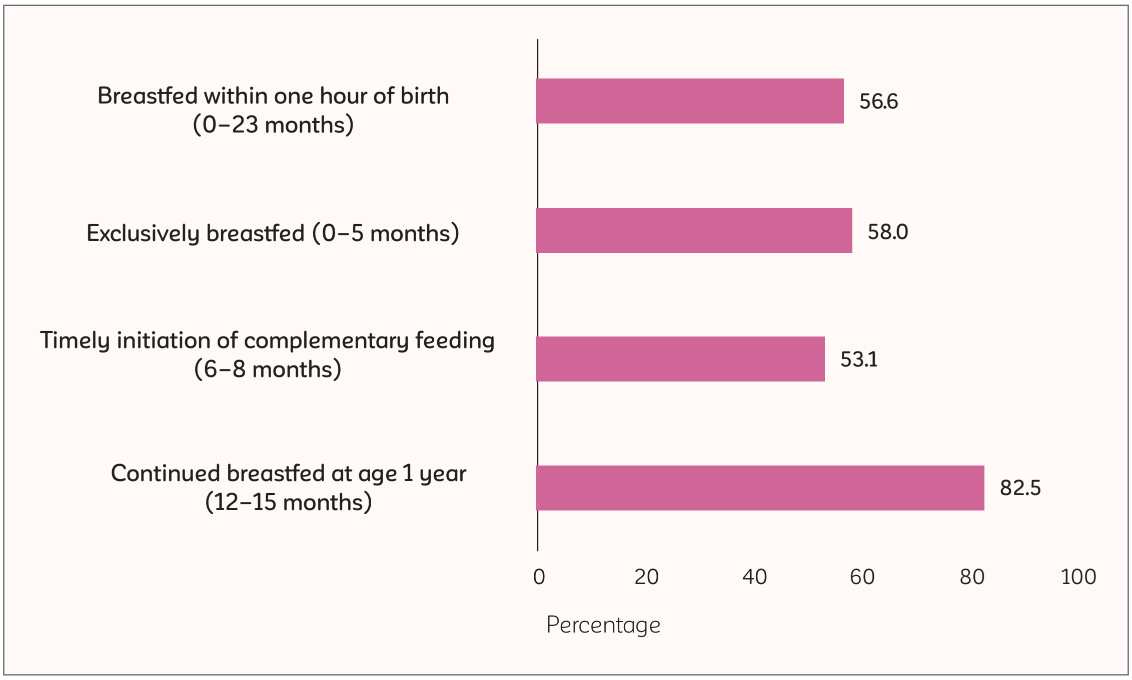
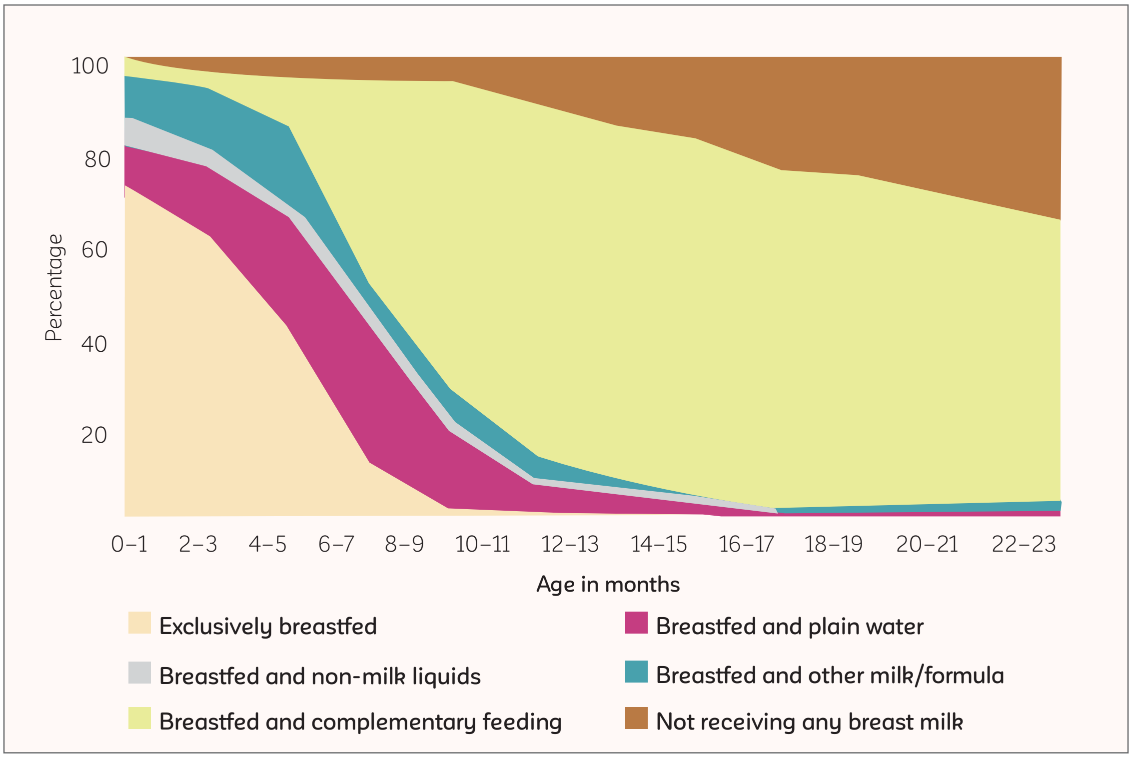


Figure 4.2 presents the trend in infant and young child feeding practices according to child age. As expected, the percentage of children exclusively breastfed decreased after 6 months of age with the introduction of complementary feeding. However, a substantial proportion of infants aged 0 to 5 months received water and or other milks/formula in addition to breastmilk, with increasing prevalence after 4 months of age (Figure 4.2).

Figure 4.2: Infant and young child feeding practices by child age, India, CNNS 2016–18



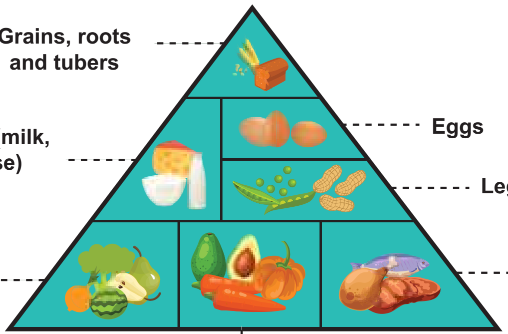
4.1.4 Minimum dietary diversity, meal frequency, and acceptable diet

A nutritionally-adequate diet during the first two years of life is necessary for optimal growth, health and development of children. Dietary diversity is a proxy for nutrient adequacy of the diet. Insufficient dietary diversity and meal frequency play a key role in nutritional deficiencies among infants and young children, leading to increased risks of childhood morbidity and mortality (Arimond, 2004; Black, 2008; Oddy, 2003). The three core indicators of minimum dietary diversity, minimum meal frequency, and minimum acceptable diet are recommended by the WHO to assess the quality of complementary feeding practices for children aged 6 to 23 months (Figure 4.3).

Figure 4.3: Complementary feeding indicators for children aged 6–23 months

MINIMUM DIETARY DIVERSITY

Proportion of children 6-23 months of age who received foods from 4 or more food groups during the previous day



MINIMUM MEAL FREQUENCY

Proportion of breastfed and non-breastfed children 6-23 months of age who receive solids, semi-solids, or soft foods (including milk feeds for non-breastfed children) the minimum number of times or more during the previous day

6-8 months

9-23 months

6-23 months

"meals" include both meals and snacks

MINIMUM ACCEPTABLE DIET

Proportion of children aged 6-23 months who receive a minimum acceptable diet.

This is a composite indicator of the following two groups:

Breastfed children aged 6-23 months	Non-breastfed children aged 6-23 months
Breastfed children aged 6-23 month who had at least the minimum dietary diversity and the minimum meal frequency during the previous day	Non-breastfed children aged 6-23 months who received at least two milk feeding, and had at least the minimum dietary diversity, and the minumum meal frequency during the previous day

Proportion of children aged 6-23 months who received iron-fortified food designed for infants and young children, or that is fortified in the home during the previous day

Consumption of iron-rich foods during the previous day

Source: World Health Organization (WHO). Indicators for assessing infant and young child feeding practices. Part II: measurement. Geneva: WHO; 2010

While 42% of children aged 6 to 23 months were fed the minimum number of times per day for their age, only 21% of children aged 6 to 23 months were fed an adequately diverse diet containing four or more food groups (Table 4.2). Dietary diversity differed between breastfed and non-breastfed children, with a higher proportion of non-breastfed children aged 6 to 23 months receiving an adequately diverse diet (36%), compared to breastfed children (18%) (Table 4.2). A reverse pattern was observed for minimum meal frequency, with a higher proportion of breastfed children being fed the minimum number of times for their age) compared to children who were not breastfed (50% vs 42%) (Table 4.2). There were clear trends of increasing dietary diversity and increasing meal frequency with age among non-breastfed children (Figure 4.4), however, among breastfed children, dietary diversity increased with age, while meal frequency declined (Figure 4.5).

Figure 4.4: Feeding practices among breastfed and non-breastfed children aged 6–23 months, India, CNNS 2016–18

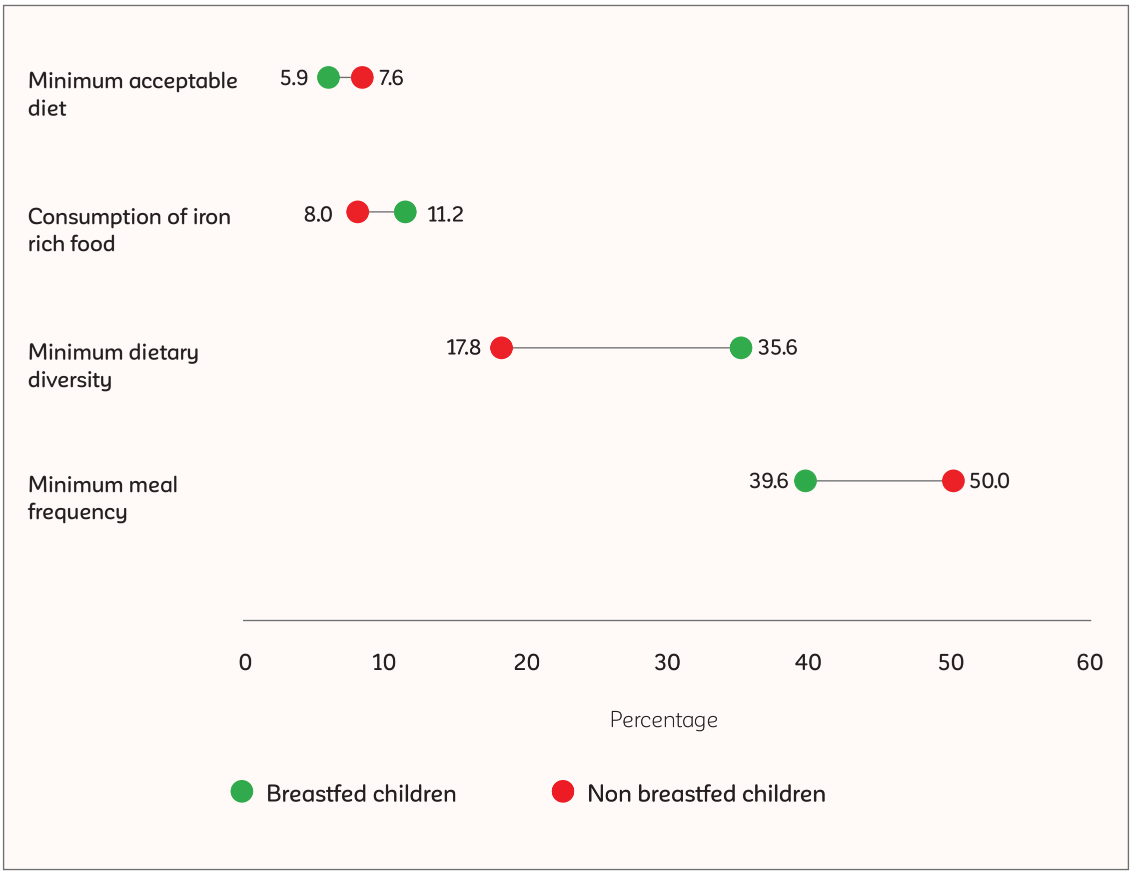
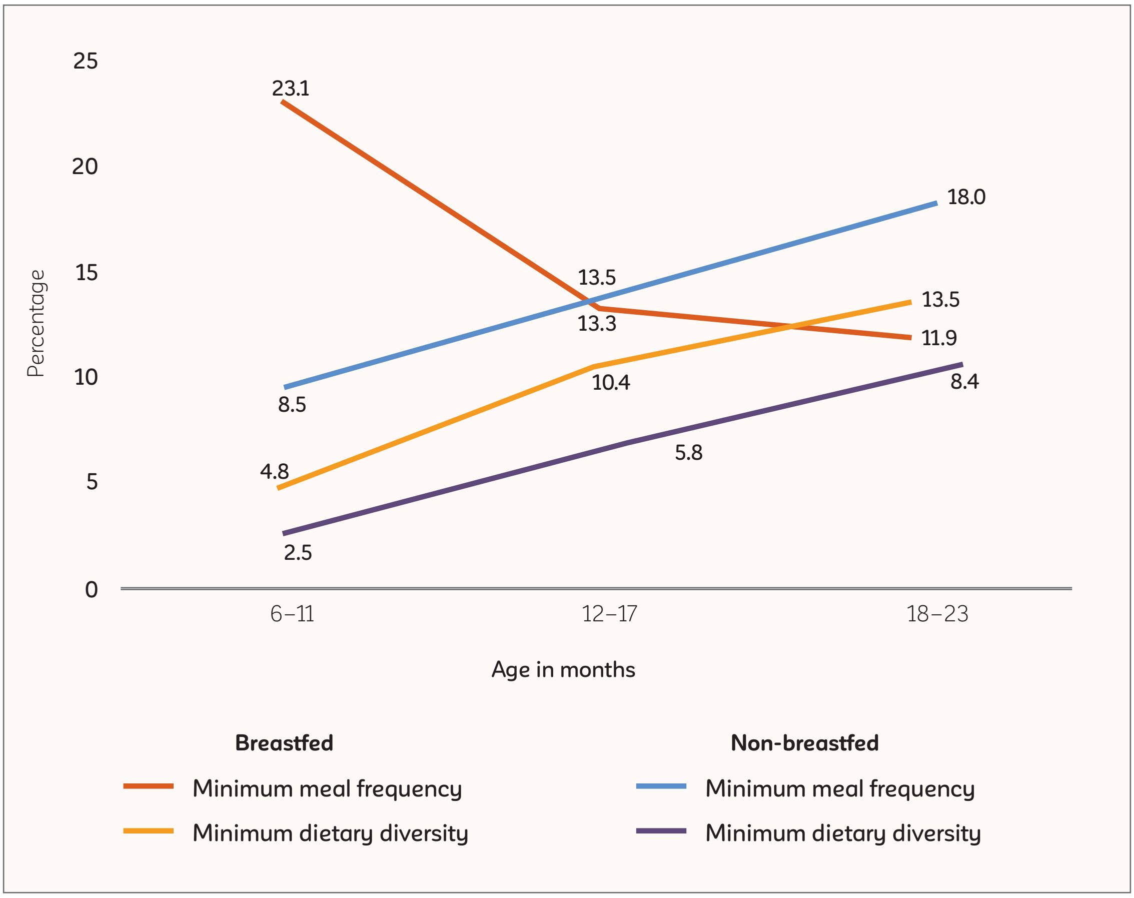


Figure 4.5: Minimum meal frequency and minimum dietary diversity by child age among breastfed and non-breastfed children, India, CNNS 2016–18



As expected, the mother's dietary preference influenced the child's diet. Dietary diversity was lower among children of mothers who were vegetarians, compared to children of mothers who consumed non-vegetarian foods (Table 4.2). Among both breastfed and non-breastfed children, a higher proportion of children residing in urban areas (26.9%) were fed an adequately diverse diet compared to children in rural areas (19%). This was in contrast to minimum meal frequency, with 44% and 37% of rural and urban children receiving the required number of meals, respectively. The prevalence of minimum dietary diversity increased with the level of the mother's schooling, with the reverse observed for minimum meal frequency (Table 4.2). A similar pattern was observed for household wealth, with a steady increase in the percentage of children receiving an adequately diverse diet in higher wealth households and a decreasing trend for meal frequency. While a larger proportion of Sikh children (39%) and Christian children (35%) were fed a minimum diverse diet, compared to children of other religions, larger proportions of Hindu (43%) and Muslim (42%) children were fed the minimum number of times for their age, compared to other religious groups (Table 4.2).

There were state level differences in dietary diversity and meal frequency. The proportion of children aged 6 to 23 months who received a minimum diverse diet or more was highest in Meghalaya (62%) and lowest in Jharkhand (12%) and Rajasthan (12%) (Table 4.3). The percentage of children receiving minimum meal frequency ranged from 22% in Andhra Pradesh to 67% in Sikkim (Table 4.3).

Overall, only 9% of children aged 6 to 23 months received iron-rich foods (Table 4.2). The mother's diet influenced the consumption of iron-rich foods by their children, as 4% of children of mothers who were vegetarians consumed these foods. Consumption of iron-rich foods was substantially higher among Christian children (30%), followed by Muslim children (16%). There was also high state variability, with the lowest consumption of iron-rich foods in Haryana (1%) and the highest consumption in Meghalaya (54%) (Table 4.3). In 7 out of 30 states, less than 5% of children aged 6 to 23 months consumed iron-rich foods (Table 4.3).

Only six percent of all children aged 6 to 23 months were fed a minimum acceptable diet (Table 4.2). The percentage increased slightly with higher levels of maternal schooling and household wealth. Only 4% of children of mothers who had no schooling received a minimum acceptable diet, as compared to 10% of children of mothers with 12 or more years of schooling (Table 4.2). Similarly, only 3% of children from households in the lowest wealth quintile received a minimum acceptable diet, as compared to 9% of children in the highest wealth quintile households (Table 4.2). The prevalence of minimum acceptable diet varied widely across states, ranging from 1% in Andhra Pradesh to 36% in Sikkim (Table 4.3). In 10 out of 30 states, < 5% of children aged 6 to 23 months received a minimum acceptable diet (Table 4.3 & Figure 4.6).

Figure 4.6: Percentage of children aged 6–23 months receiving a minimum acceptable diet by state, India, CNNS 2016–18

4.2 Food consumption among children aged 2–9 years and adolescents aged 10–19 years

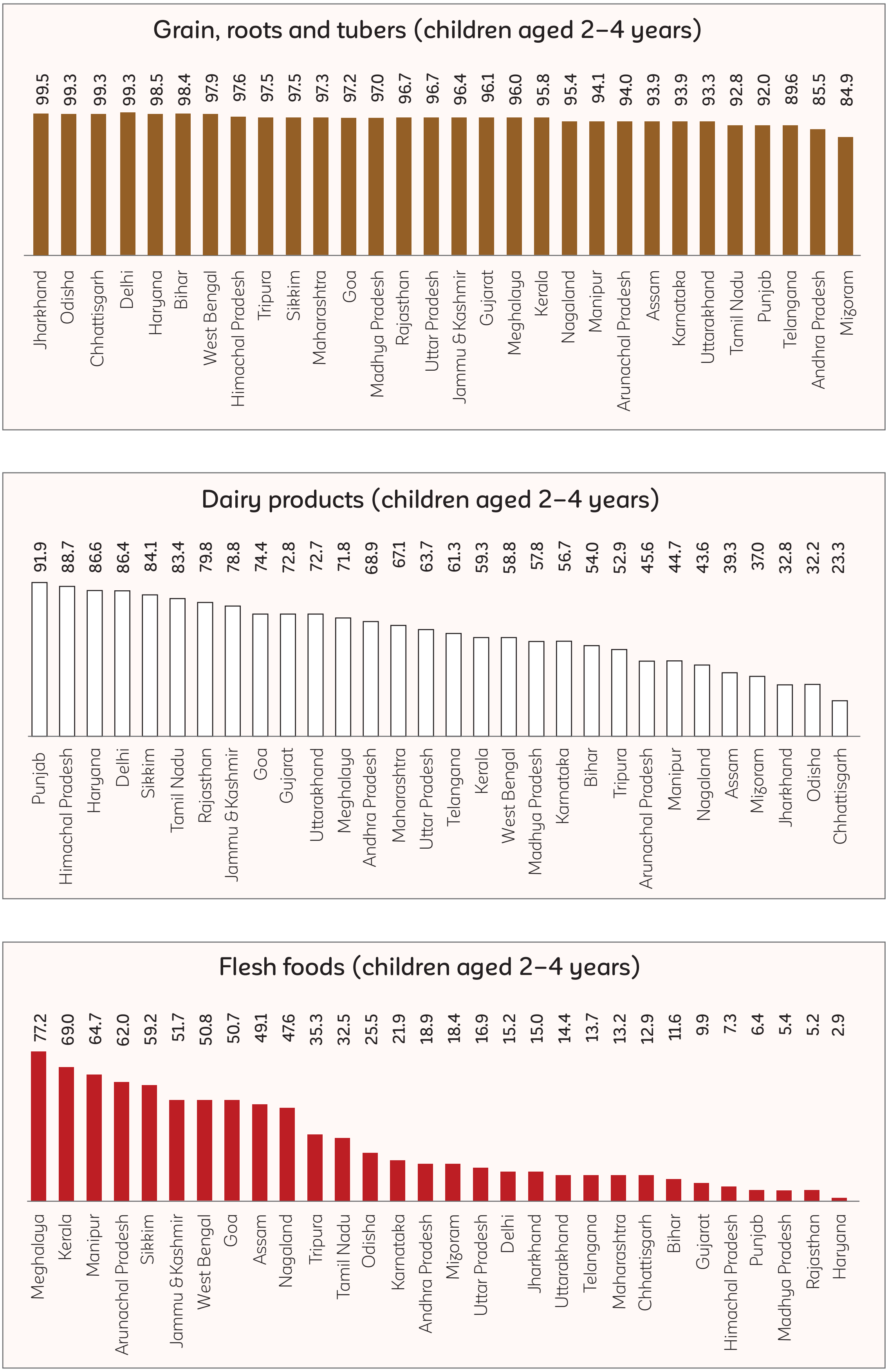
A balanced diet is essential for healthy growth and development of children and adolescents. To assess dietary diversity for children aged 2 to 4 years, the consumption of seven food groups during the previous day was assessed; grains, roots and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables.

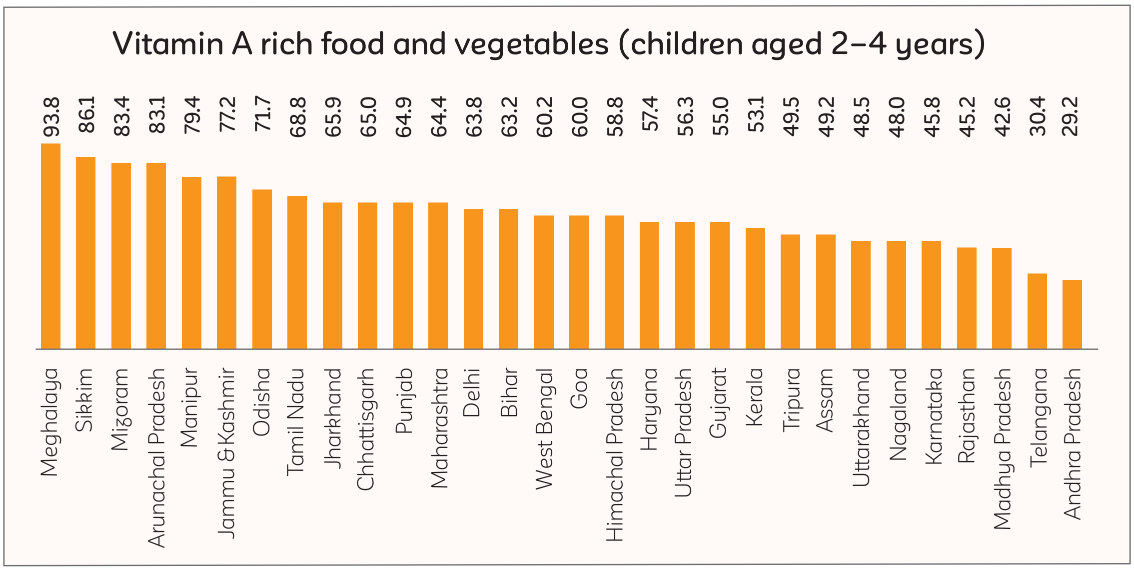
Among children aged 2 to 4 years, 96% consumed grains, roots and tubers, 62% consumed dairy products, and 5% consumed vitamin A-rich fruits and vegetables the previous day (Table 4.4). Eggs (16%) and flesh foods (1%) were the least commonly consumed food groups among children aged 2 to 4 years. Child food consumption patterns varied by the mother's schooling status and household wealth. The proportion of children aged 2 to 4 years consuming dairy products, eggs, and other fruits and vegetables the previous day increased with the mother's education level and household wealth status.

Among Sikh children, the proportions of children consuming legumes and nuts (40%), dairy products (92%), vitamin A-rich fruits and vegetables (68%) and other fruits and vegetables (66%) was highest. Consumption of flesh foods (46%) and eggs (33%) was highest among Christian children (Table 4.4). A higher proportion of children residing in urban compared to rural areas consumed dairy products (74% vs. 58%), eggs (22% vs. 14%), and other fruits and vegetables (50% vs. 38%) (Table 4.4).

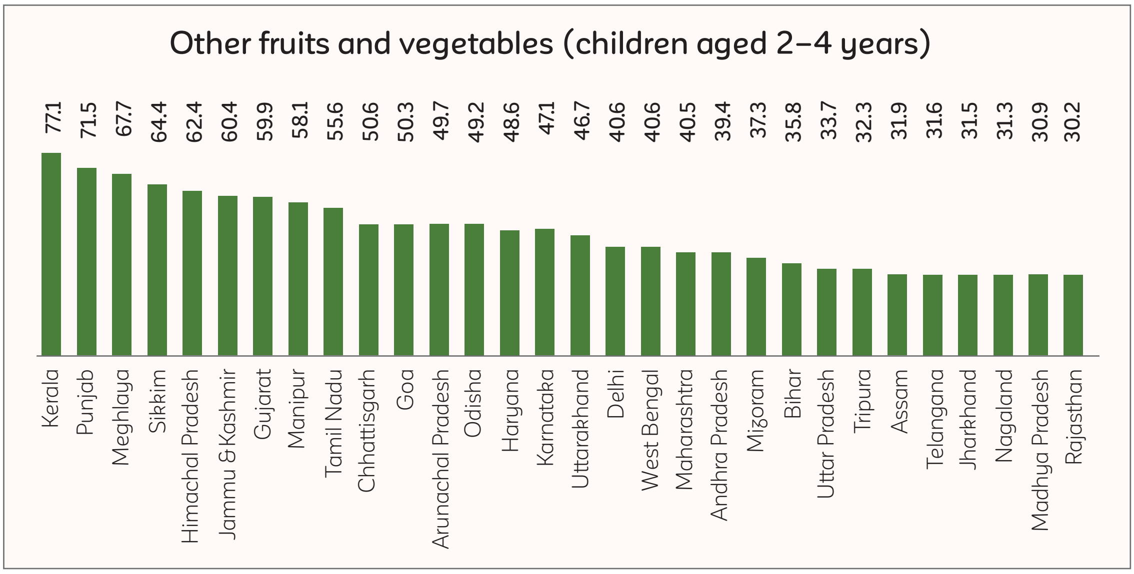
Among children aged 2 to 4 years, the consumption of dairy products, flesh foods, eggs, and vitamin A-rich fruits and vegetables varied widely across states (Table 4.5 & Figure 4.7). The proportion of children consuming dairy products the previous day was lowest in Chhattisgarh (23%) and highest in Punjab (92%). The consumption of flesh foods was lowest in Haryana and highest in Meghalaya. The consumption of eggs was also lowest in Haryana (3%) and highest in Meghalaya (71%). The consumption of vitamin A-rich fruits and vegetables ranged from 29% in Andhra Pradesh to 94% in Meghalaya and consumption of other fruits and vegetables was lowest in Rajasthan (30%) and highest in Kerala (77%) (Table 4.5).

Figure 4.7: Food groups consumed during the previous 24 hours among children aged 2–4 years by state, India, CNNS 2016–18

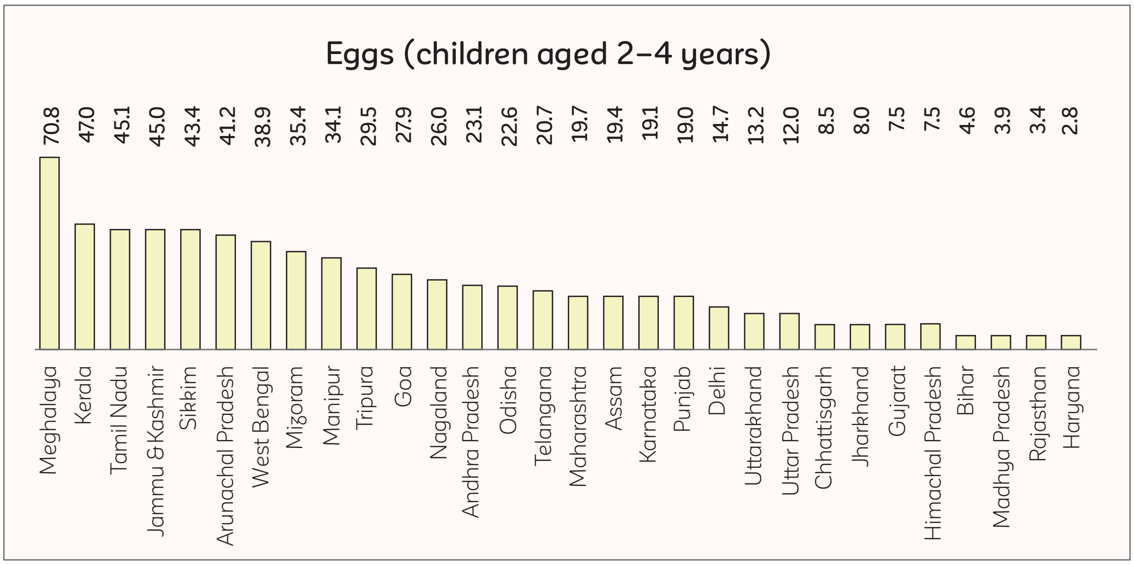




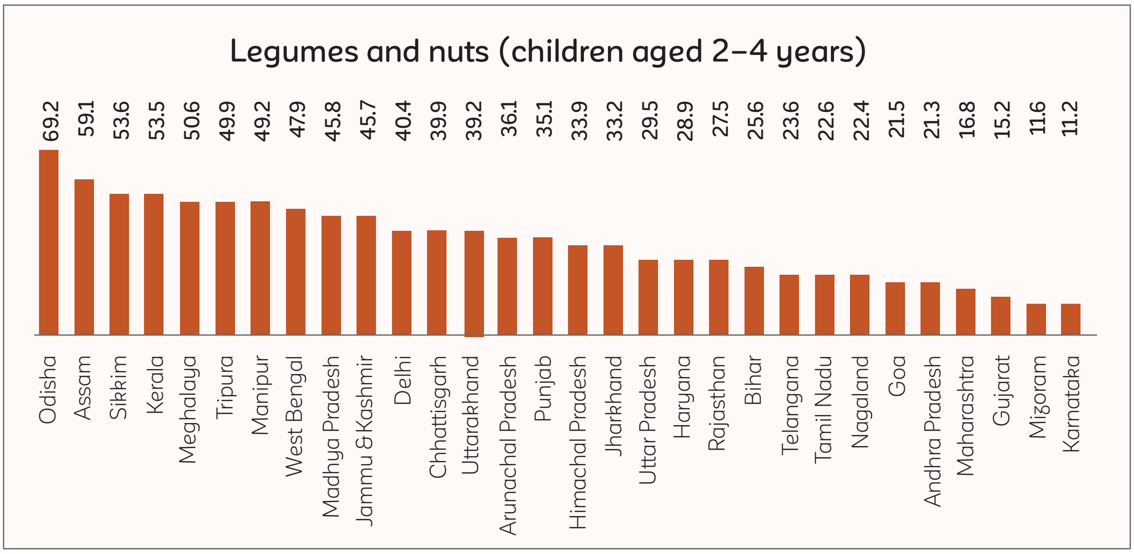
Vitamin A rich food and vegetables (children aged 2–4 years)



Other fruits and vegetables (children aged 2–4 years)



Eggs (children aged 2–4 years)



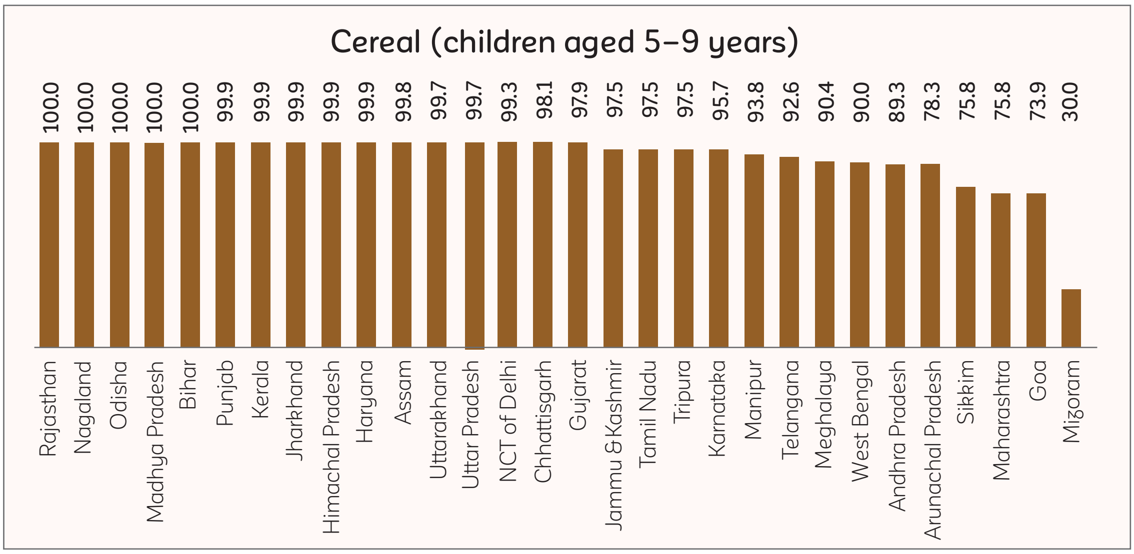
To assess dietary diversity for children aged 5 to 9 years and adolescents aged 10–19 years, the consumption of a variety of food groups at least once day and once per week was assessed. Among school-age children and adolescents, the majority consumed dark green leafy vegetables (~90%) and pulses or beans (85%) at least once per week (Tables 4.6 &4.8). The consumption of dairy products was less frequent, with two-thirds of school-age children and adolescents consuming milk or curd at least once per week. Fruits, eggs, and fish or chicken or meat were consumed least frequently. Among school-age children, 40% consumed fruits, 35% consumed eggs, and 36% consumed fish or chicken or meat (Table 4.6). Similarly, among adolescents, only 41% consumed fruits, 35% consumed eggs, and 36% consumed fish or chicken or meat (Table 4.8).

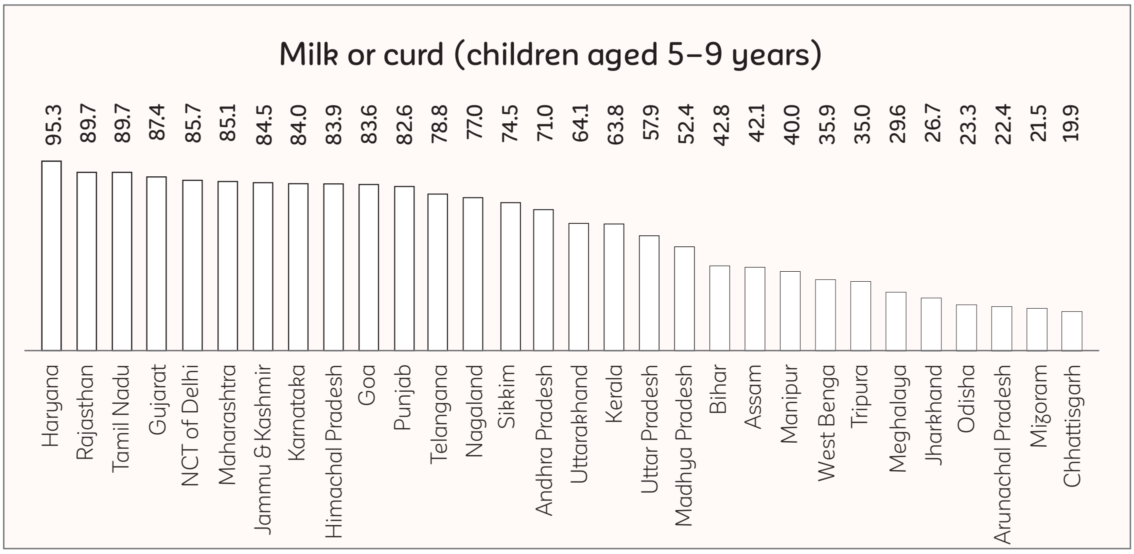
Overall, food consumption patterns were similar between male and female school-age children and adolescents, except for milk or curd and eggs. Among adolescents, a higher proportion of males consumed milk or curd and eggs, compared to females, with only a slight difference among school-age children. Food consumption patterns varied by the mother's schooling status and household wealth among both school-age children and adolescents. The consumption of milk or curd, fruits, eggs, and fish or chicken or meat increased with higher levels of maternal schooling and household wealth (Tables 4.6 &4.8).

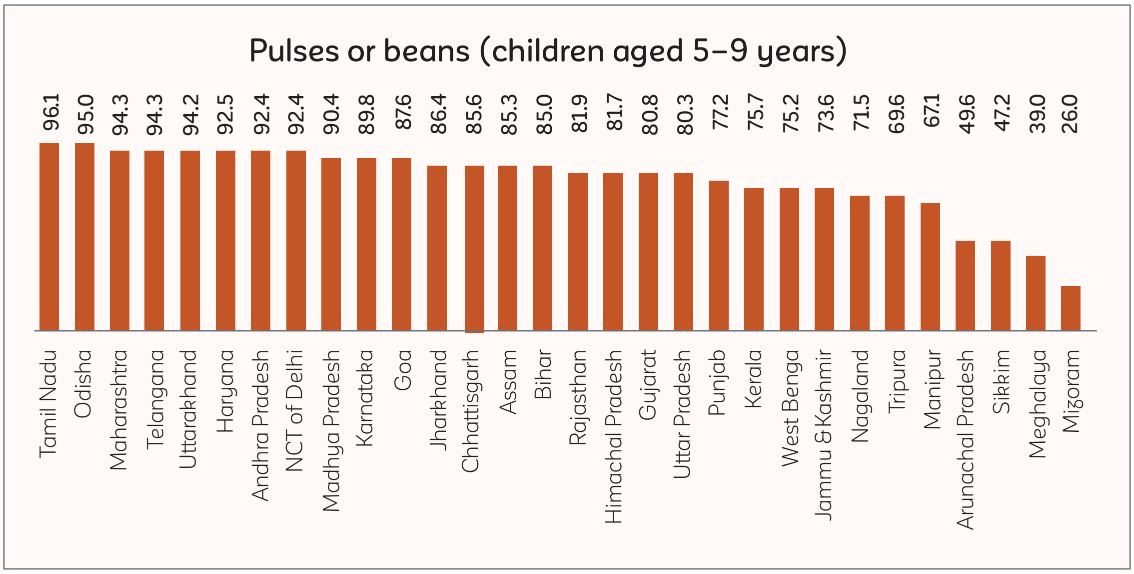
Large inter-state variability was observed in the dietary practices of children aged 5–9 years and adolescents aged 10–19 years. Among children aged 5–9 years, the consumption of milk or curd was lowest in the central, east, and north-eastern states of Chhattisgarh (20%), Odisha (23%), Mizoram (22%), and Arunachal Pradesh (22%) (Table 4.7). Higher consumption of milk products was observed in the northern and western states, with the highest consumption in Haryana (95%) (Table 4.7). A similar pattern was observed among adolescents, with lower consumption of milk products in the east and north-eastern states and higher consumption in the northern and western states (Table 4.9). Consumption of pulses or beans at least once per week was > 80% in 20/30 states for both school-age children and adolescents. Consumption of dark green leafy vegetables was > 80% in 12/30 states among school-age children and in 25/30 states among adolescents. The consumption of other types of foods at least once per week also varied widely across states. Among school-age children, fruit consumption ranged from 18% in Bihar to 79% in Goa, egg consumption ranged from 4% in Haryana to 85% in Tamil Nadu, and consumption of fish or chicken or meat ranged from 3% in Himachal Pradesh to 86% in Kerala (Table 4.7).

Figures 4.7 and 4.8 present the daily food consumption patterns for school-age children and adolescents by state. In most states, cereals (>85%) were the most commonly consumed food group, while eggs and fish or chicken or meat were least commonly consumed (< 5%) among both school-age children and adolescents. Consumption of milk or curd daily was highest in the northern states (≥ 40%) and lowest in the north-eastern states (≤ 15%).

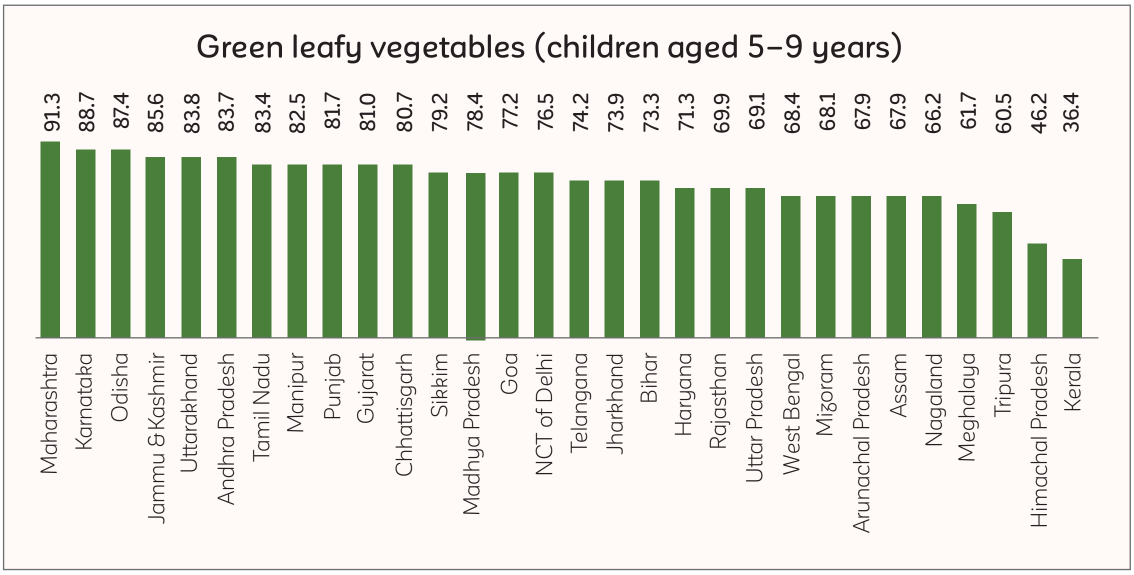
Figure 4.8: Daily consumption of various food groups among children aged 5–9 years by state, India, CNNS 2016–18



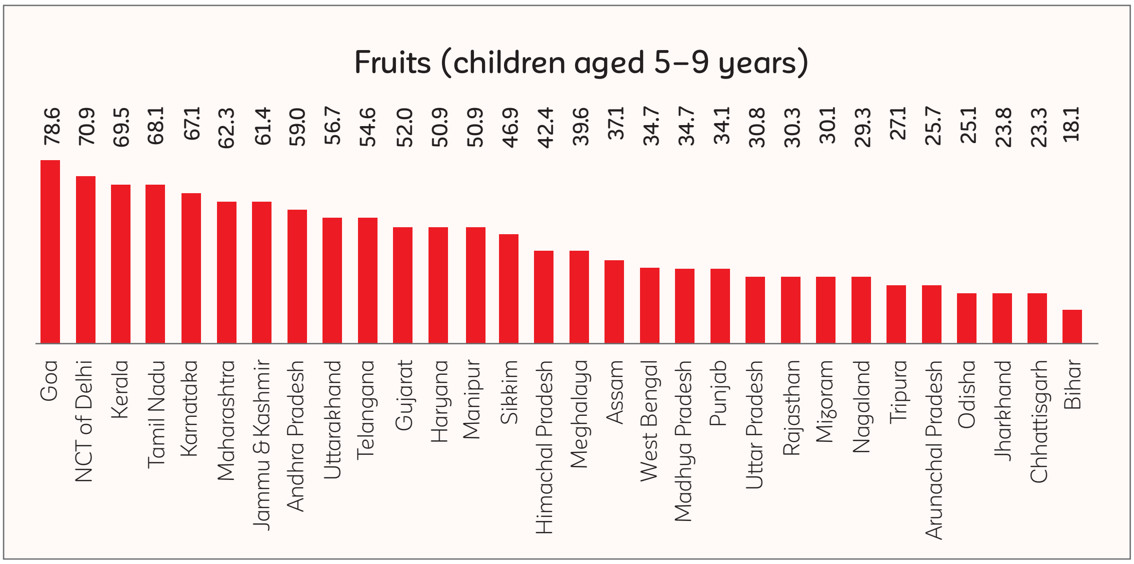




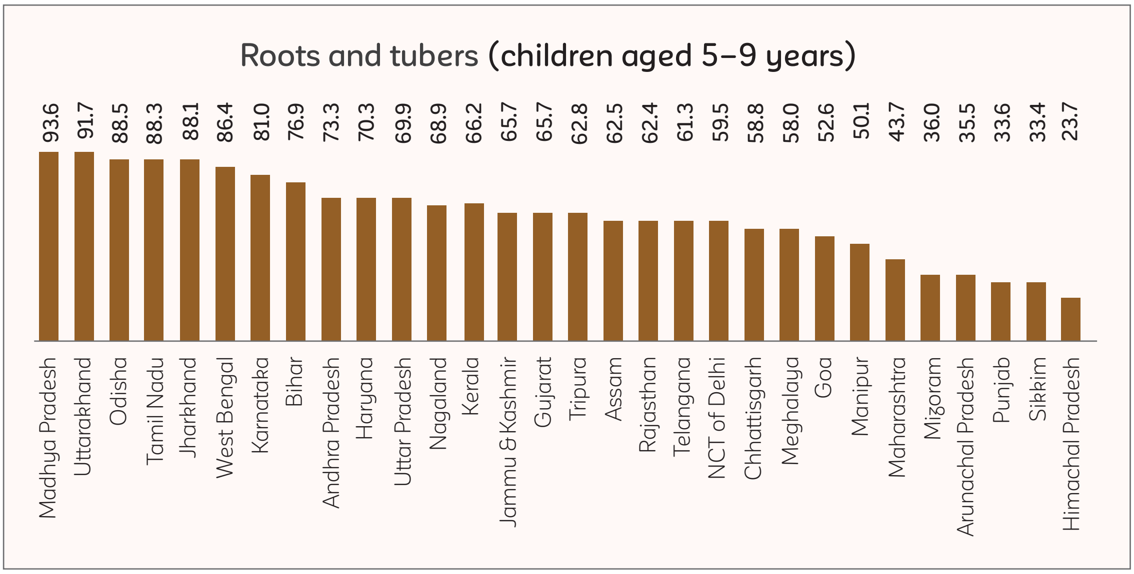
Pulses or beans (children aged 5–9 years)
96.1
95.0
94.3
94.3
94.2
92.5
92.4
92.4
90.4
89.8
87.6
86.4
85.6
85.3
85.0
81.9
81.7
80.8
80.3
77.2
75.7
75.2
73.6
71.5
69.6
67.1
49.6
47.2
39.0
26.0
Tamil Nadu
Odisha
Maharashtra
Telangana
Uttarakhand
Haryana
Andhra Pradesh
NCT of Delhi
Madhya Pradesh
Karnataka
Goa
Jharkhand
Chhattisgarh
Assam
Bihar
Rajasthan
Himachal Pradesh
Gujarat
Uttar Pradesh
Punjab
Kerala
West Benga
Jammu & Kashmir
Nagaland
Tripura
Manipur
Arunachal Pradesh
Sikkim
Meghalaya
Mizoram

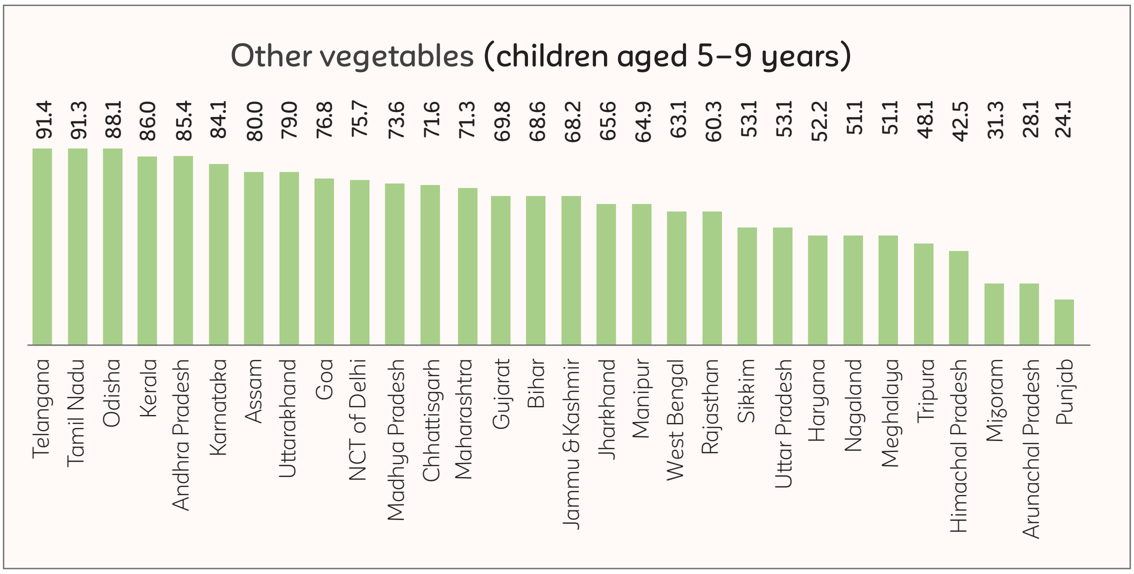


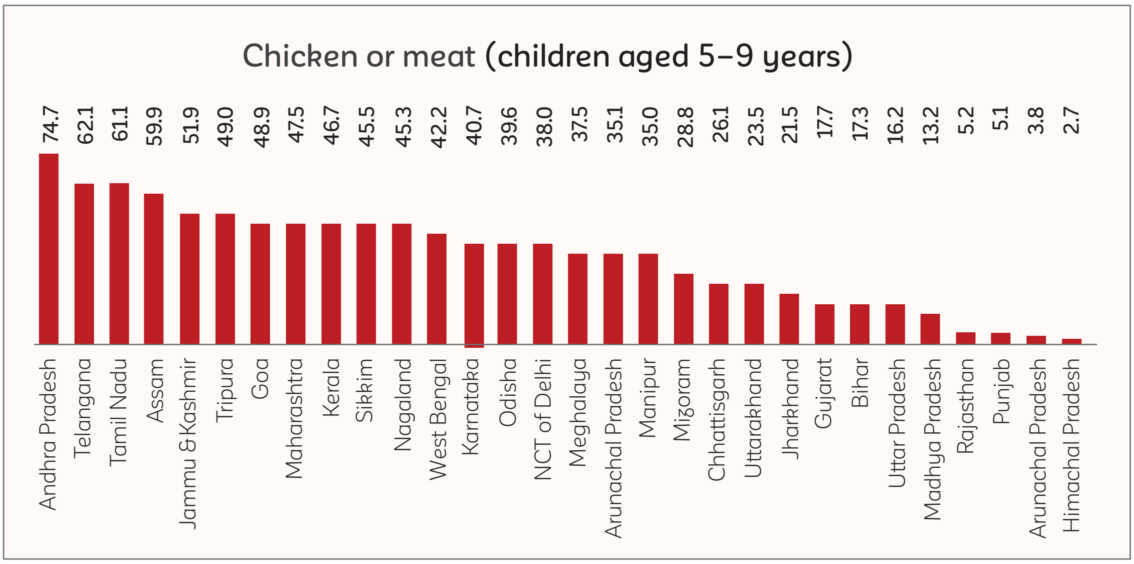
Green leafy vegetables (children aged 5–9 years)
91.3
88.7
87.4
85.6
83.8
83.7
83.4
82.5
81.7
81.0
80.7
79.2
78.4
77.2
76.5
74.2
73.9
73.3
71.3
69.9
69.1
68.4
68.1
67.9
67.9
66.2
61.7
60.5
46.2
36.4
Maharashtra
Karnataka
Odisha
Jammu & Kashmir
Uttarakhand
Andhra Pradesh
Tamil Nadu
Manipur
Punjab
Gujarat
Chhattisgarh
Sikkim
Madhya Pradesh
Goa
NCT of Delhi
Telangana
Jharkhand
Bihar
Haryana
Rajasthan
Uttar Pradesh
West Bengal
Mizoram
Arunachal Pradesh
Assam
Nagaland
Meghalaya
Tripura
Himachal Pradesh
Kerala

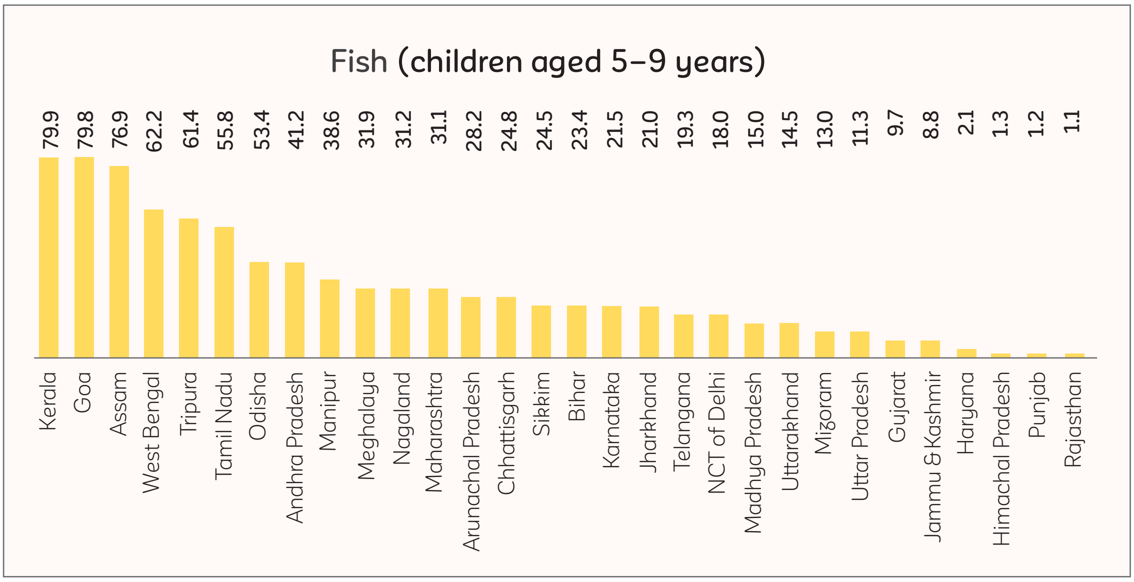


Fruits (children aged 5–9 years)
78.6
70.9
69.5
68.1
67.1
62.3
61.4
59.0
56.7
54.6
52.0
50.9
50.9
46.9
42.4
39.6
37.1
34.7
34.7
34.1
30.8
30.3
30.1
29.3
27.1
25.7
25.1
23.8
23.3
18.1
Goa
NCT of Delhi
Kerala
Tamil Nadu
Karnataka
Maharashtra
Jammu & Kashmir
Andhra Pradesh
Uttarakhand
Telangana
Gujarat
Haryana
Manipur
Sikkim
Himachal Pradesh
Meghalaya
Assam
West Bengal
Madhya Pradesh
Punjab
Uttar Pradesh
Rajasthan
Mizoram
Nagaland
Tripura
Arunachal Pradesh
Odisha
Jharkhand
Chhattisgarh
Bihar


Roots and tubers (children aged 5–9 years)
93.6
91.7
88.5
88.3
88.1
86.4
81.0
76.9
73.3
70.3
69.9
68.9
66.2
65.7
65.7
62.8
62.5
62.4
61.3
59.5
58.8
58.0
52.6
50.1
43.7
36.0
35.5
33.6
33.4
23.7
Madhya Pradesh
Uttarakhand
Odisha
Tamil Nadu
Jharkhand
West Bengal
Karnataka
Bihar
Andhra Pradesh
Haryana
Uttar Pradesh
Nagaland
Kerala
Jammu & Kashmir
Gujarat
Tripura
Assam
Rajasthan
Telangana
NCT of Delhi
Chhattisgarh
Meghalaya
Goa
Manipur
Maharashtra
Mizoram
Arunachal Pradesh
Punjab
Sikkim
Himachal Pradesh


Other vegetables (children aged 5–9 years)
91.4
91.3
88.1
86.0
85.4
84.1
80.0
79.0
76.8
75.7
73.6
71.6
71.3
69.8
68.6
68.2
65.6
64.9
63.1
60.3
53.1
53.1
52.2
51.1
51.1
48.1
42.5
31.3
28.1
24.1
Telangana
Tamil Nadu
Odisha
Kerala
Andhra Pradesh
Karnataka
Assam
Uttarakhand
Goa
NCT of Delhi
Madhya Pradesh
Chhattisgarh
Maharashtra
Gujarat
Bihar
Jammu & Kashmir
Jharkhand
Manipur
West Bengal
Rajasthan
Sikkim
Uttar Pradesh
Haryana
Nagaland
Meghalaya
Tripura
Himachal Pradesh
Mizoram
Arunachal Pradesh
Punjab


Chicken or meat (children aged 5–9 years)
74.7
62.1
61.1
59.9
51.9
49.0
48.9
47.5
46.7
45.5
45.3
42.2
40.7
39.6
38.0
37.5
35.1
35.0
28.8
26.1
23.5
21.5
17.7
17.3
16.2
13.2
5.2
5.1
3.8
2.7
Andhra Pradesh
Telangana
Tamil Nadu
Assam
Jammu & Kashmir
Tripura
Goa
Maharashtra
Kerala
Sikkim
Nagaland
West Bengal
Karnataka
Odisha
NCT of Delhi
Meghalaya
Arunachal Pradesh
Manipur
Mizoram
Chhattisgarh
Uttarakhand
Jharkhand
Gujarat
Bihar
Uttar Pradesh
Madhya Pradesh
Rajasthan
Punjab
Arunachal Pradesh
Himachal Pradesh


Fish (children aged 5–9 years)
79.9
79.8
76.9
62.2
61.4
55.8
53.4
41.2
38.6
31.9
31.2
31.1
28.2
24.8
24.5
23.4
21.5
21.0
19.3
18.0
15.0
14.5
13.0
11.3
9.7
8.8
2.1
1.3
1.2
1.1
Kerala
Goa
Assam
West Bengal
Tripura
Tamil Nadu
Odisha
Andhra Pradesh
Manipur
Meghalaya
Nagaland
Maharashtra
Arunachal Pradesh
Chhattisgarh
Sikkim
Bihar
Karnataka
Jharkhand
Telangana
NCT of Delhi
Madhya Pradesh
Uttarakhand
Mizoram
Uttar Pradesh
Gujarat
Jammu & Kashmir
Haryana
Himachal Pradesh
Punjab
Rajasthan

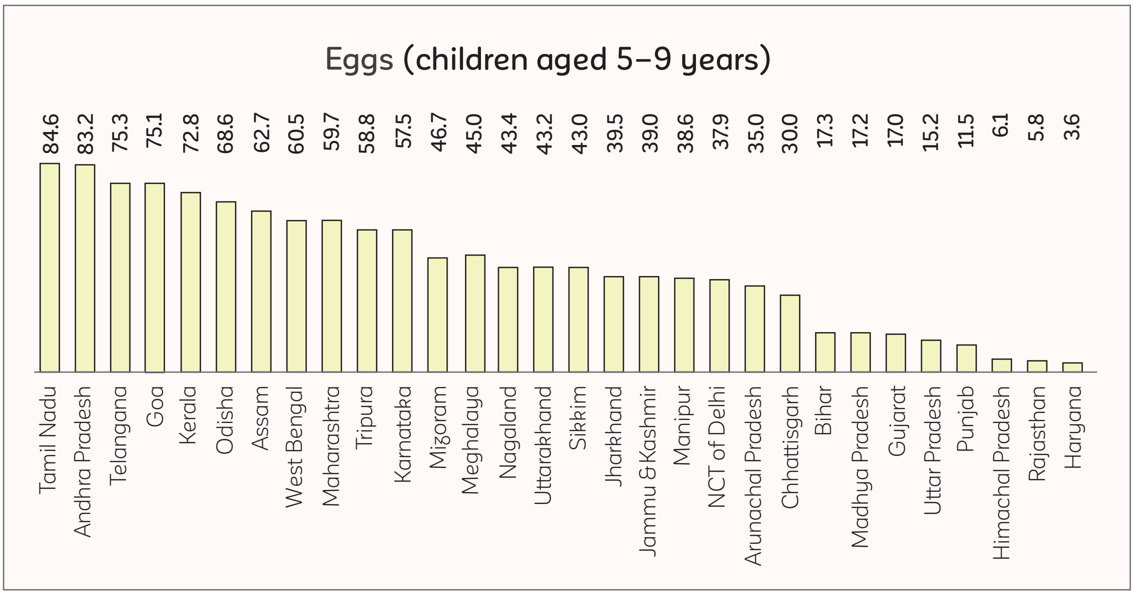
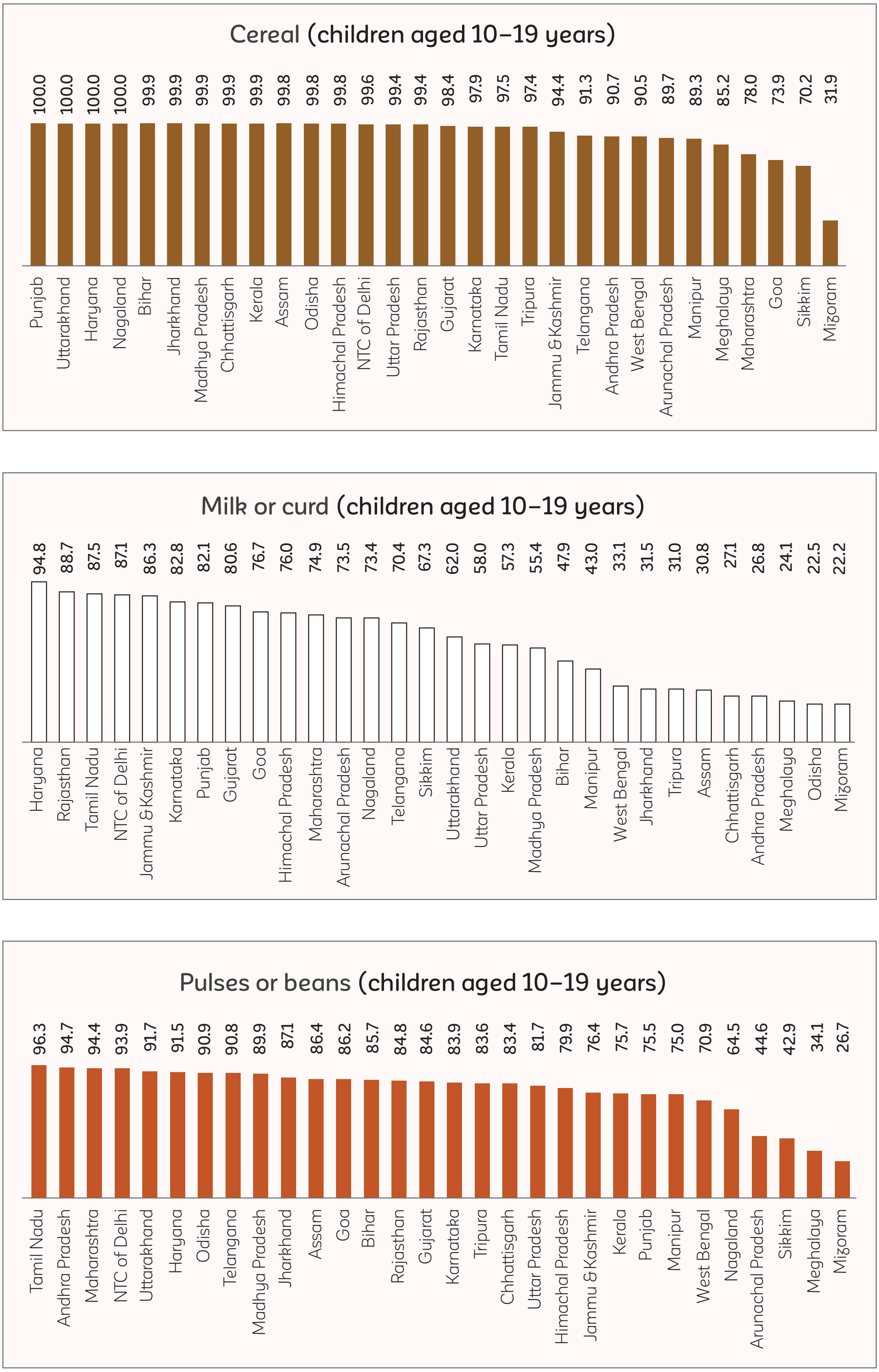
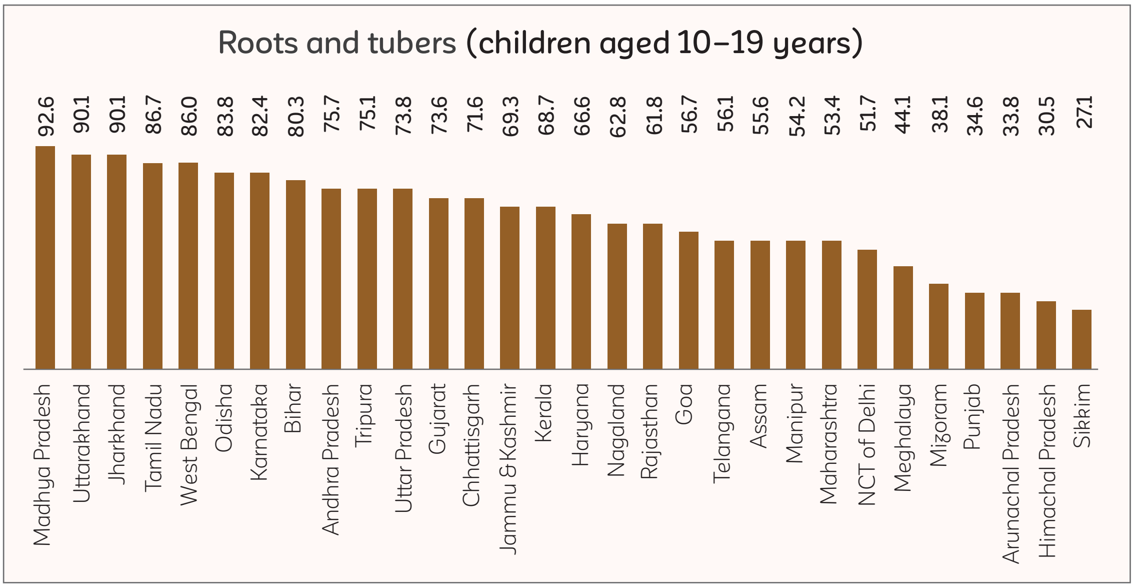

Eggs (children aged 5–9 years)
84.6
83.2
75.3
75.1
72.8
68.6
62.7
60.5
59.7
58.8
57.5
46.7
45.0
43.4
43.2
43.0
39.5
39.0
38.6
37.9
35.0
30.0
17.3
17.2
17.0
15.2
11.5
6.1
5.8
3.6
Tamil Nadu
Andhra Pradesh
Telangana
Goa
Kerala
Odisha
Assam
West Bengal
Maharashtra
Tripura
Karnataka
Mizoram
Meghalaya
Nagaland
Uttarakhand
Sikkim
Jharkhand
Jammu & Kashmir
Manipur
NCT of Delhi
Arunachal Pradesh
Chhattisgarh
Bihar
Madhya Pradesh
Gujarat
Uttar Pradesh
Punjab
Himachal Pradesh
Rajasthan
Haryana

Figure 4.9: Daily consumption of various food groups among adolescents aged 10–19 years by state, India, CNNS 2016–18




Roots and tubers (children aged 10–19 years)
92.6
90.1
90.1
86.7
86.0
83.8
82.4
80.3
75.7
75.1
73.8
73.6
71.6
69.3
68.7
66.6
62.8
61.8
56.7
56.1
55.6
54.2
53.4
51.7
44.1
38.1
34.6
33.8
30.5
27.1
Madhya Pradesh
Uttarakhand
Jharkhand
Tamil Nadu
West Bengal
Odisha
Karnataka
Bihar
Andhra Pradesh
Tripura
Uttar Pradesh
Gujarat
Chhattisgarh
Jammu & Kashmir
Kerala
Haryana
Nagaland
Rajasthan
Goa
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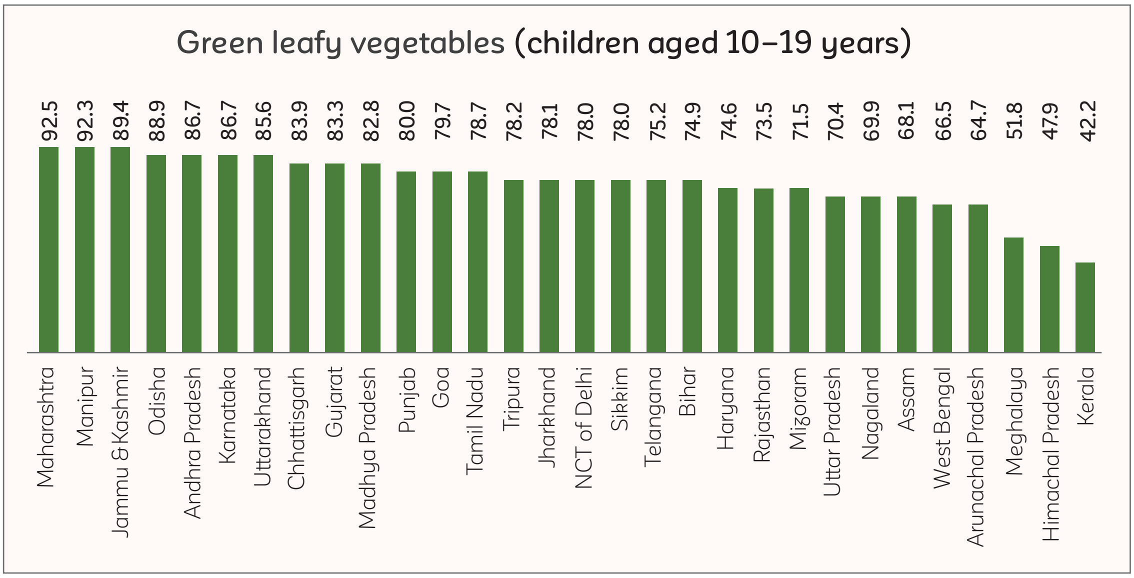
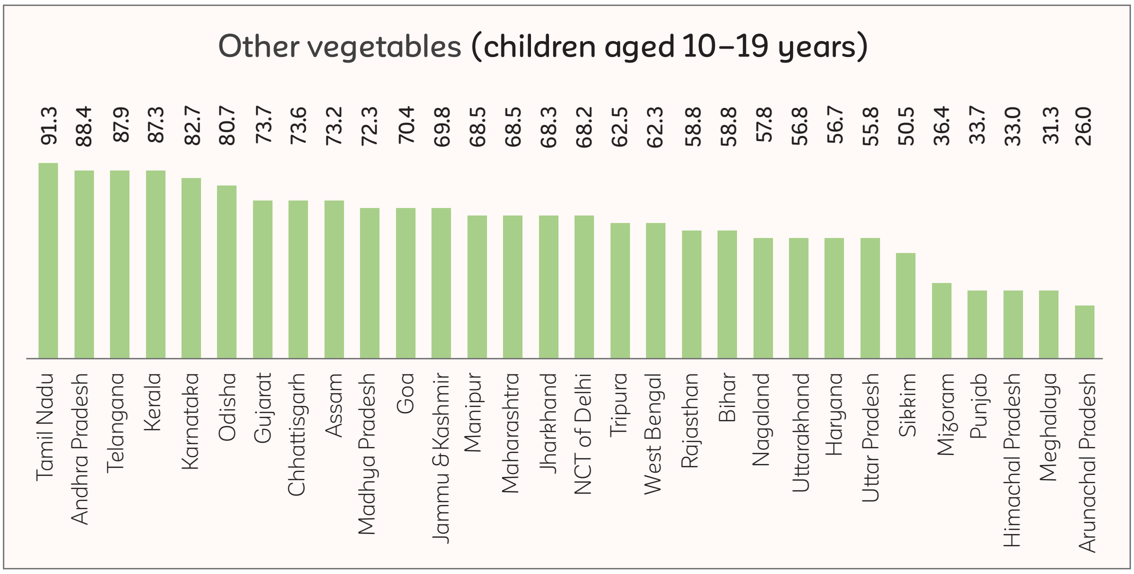
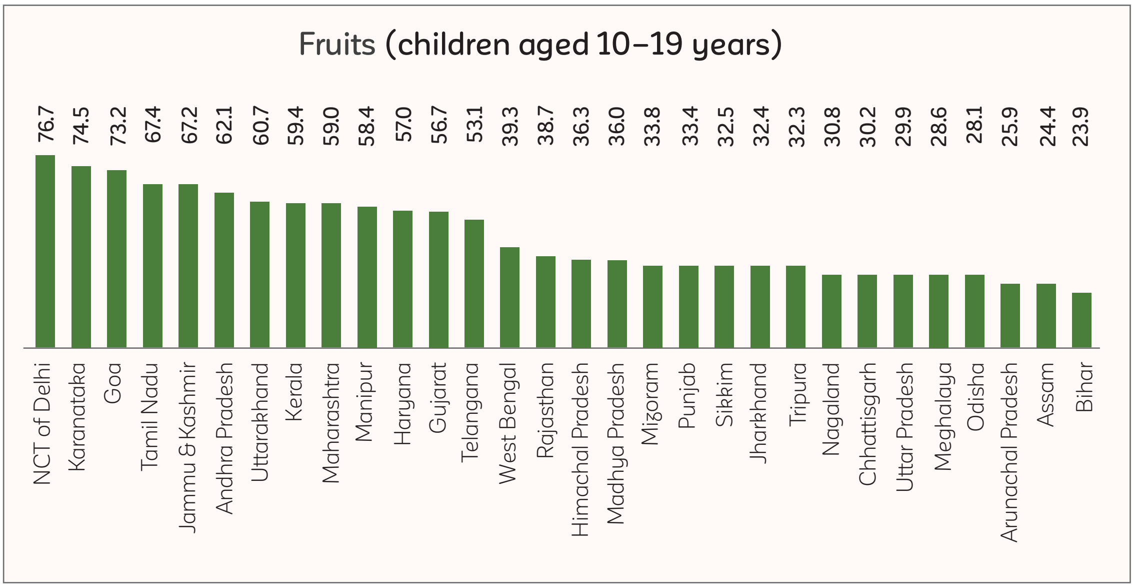
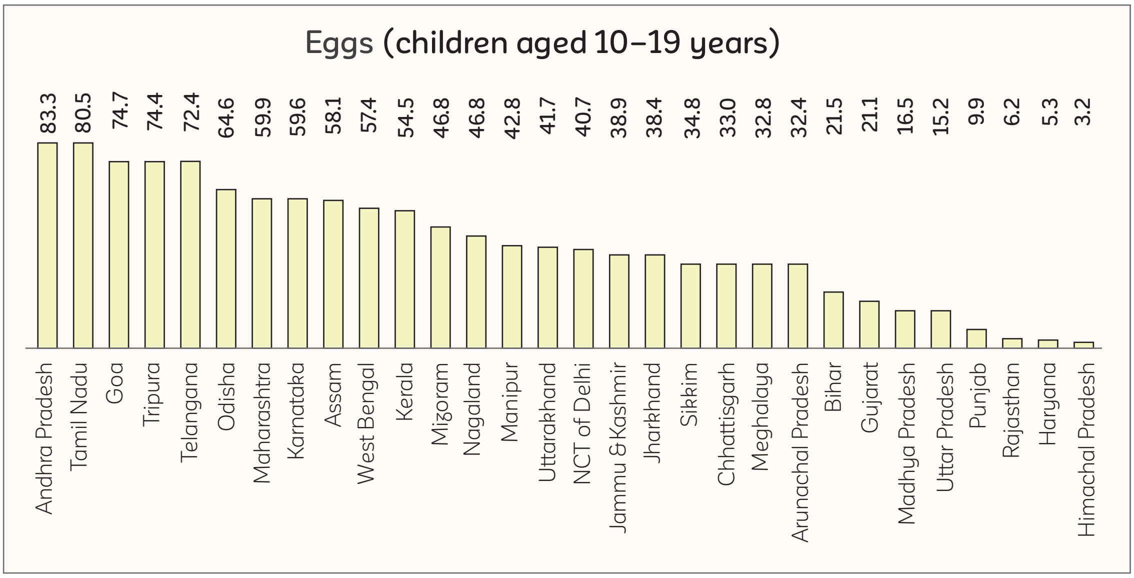
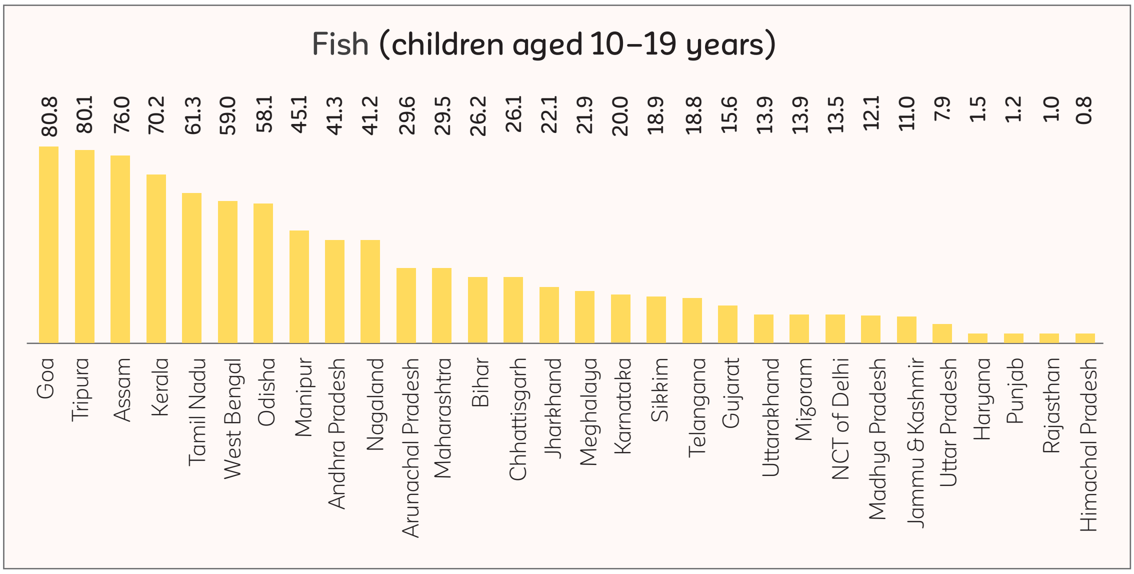
Punjab
Arunachal Pradesh
Himachal Pradesh
Sikkim


Green leafy vegetables (children aged 10–19 years)
92.5
92.3
89.4
88.9
86.7
86.7
85.6
83.9
83.3
82.8
80.0
79.7
78.7
78.2
78.1
78.0
78.0
75.2
74.9
74.6
73.5
71.5
70.4
69.9
68.1
66.5
64.7
51.8
47.9
42.2
Maharashtra
Manipur
Jammu & Kashmir
Odisha
Andhra Pradesh
Karnataka
Uttarakhand
Chhattisgarh
Gujarat
Madhya Pradesh
Punjab
Goa
Tamil Nadu
Tripura
Jharkhand
NCT of Delhi
Sikkim
Telangana
Bihar
Haryana
Rajasthan
Mizoram
Uttar Pradesh
Nagaland
Assam
West Bengal
Arunachal Pradesh
Meghalaya
Himachal Pradesh
Kerala


Other vegetables (children aged 10–19 years)
91.3
88.4
87.9
87.3
82.7
80.7
73.7
73.6
73.2
72.3
70.4
69.8
68.5
68.5
68.3
68.2
62.5
62.3
58.8
58.8
57.8
56.8
56.7
55.8
50.5
36.4
33.7
33.0
31.3
26.0
Tamil Nadu
Andhra Pradesh
Telangana
Kerala
Karnataka
Odisha
Gujarat
Chhattisgarh
Assam
Madhya Pradesh
Goa
Jammu & Kashmir
Manipur
Maharashtra
Jharkhand
NCT of Delhi
Tripura
West Bengal
Rajasthan
Bihar
Nagaland
Uttarakhand
Haryana
Uttar Pradesh
Sikkim
Mizoram
Punjab
Himachal Pradesh
Meghalaya
Arunachal Pradesh


Fruits (children aged 10–19 years)
NCT of Delhi 76.7
Karanataka 74.5
Goa 73.2
Tamil Nadu 67.4
Jammu & Kashmir 67.2
Andhra Pradesh 62.1
Uttarakhand 60.7
Kerala 59.4
Maharashtra 59.0
Manipur 58.4
Haryana 57.0
Gujarat 56.7
Telangana 53.1
West Bengal 39.3
Rajasthan 38.7
Himachal Pradesh 36.3
Madhya Pradesh 36.0
Mizoram 33.8
Punjab 33.4
Sikkim 32.5
Jharkhand 32.4
Tripura 32.3
Nagaland 30.8
Chhattisgarh 30.2
Uttar Pradesh 29.9
Meghalaya 28.6
Odisha 28.1
Arunachal Pradesh 25.9
Assam 24.4
Bihar 23.9


Eggs (children aged 10–19 years)
Andhra Pradesh 83.3
Tamil Nadu 80.5
Goa 74.7
Tripura 74.4
Telangana 72.4
Odisha 64.6
Maharashtra 59.9
Karnataka 59.6
Assam 58.1
West Bengal 57.4
Kerala 54.5
Mizoram 46.8
Nagaland 46.8
Manipur 42.8
Uttarakhand 41.7
NCT of Delhi 40.7
Jammu & Kashmir 38.9
Jharkhand 38.4
Sikkim 34.8
Chhattisgarh 33.0
Meghalaya 32.8
Arunachal Pradesh 32.4
Bihar 21.5
Gujarat 21.1
Madhya Pradesh 16.5
Uttar Pradesh 15.2
Punjab 9.9
Rajasthan 6.2
Haryana 5.3
Himachal Pradesh 3.2


Fish (children aged 10–19 years)
Goa 80.8
Tripura 80.1
Assam 76.0
Kerala 70.2
Tamil Nadu 61.3
West Bengal 59.0
Odisha 58.1
Manipur 45.1
Andhra Pradesh 41.3
Nagaland 41.2
Arunachal Pradesh 29.6
Maharashtra 29.5
Bihar 26.2
Chhattisgarh 26.1
Jharkhand 22.1
Meghalaya 21.9
Karnataka 20.0
Sikkim 18.9
Telangana 18.8
Gujarat 15.6
Uttarakhand 13.9
Mizoram 13.9
NCT of Delhi 13.5
Madhya Pradesh 12.1
Jammu & Kashmir 11.0
Uttar Pradesh 7.9
Haryana 1.5
Punjab 1.2
Rajasthan 1.0
Himachal Pradesh 0.8

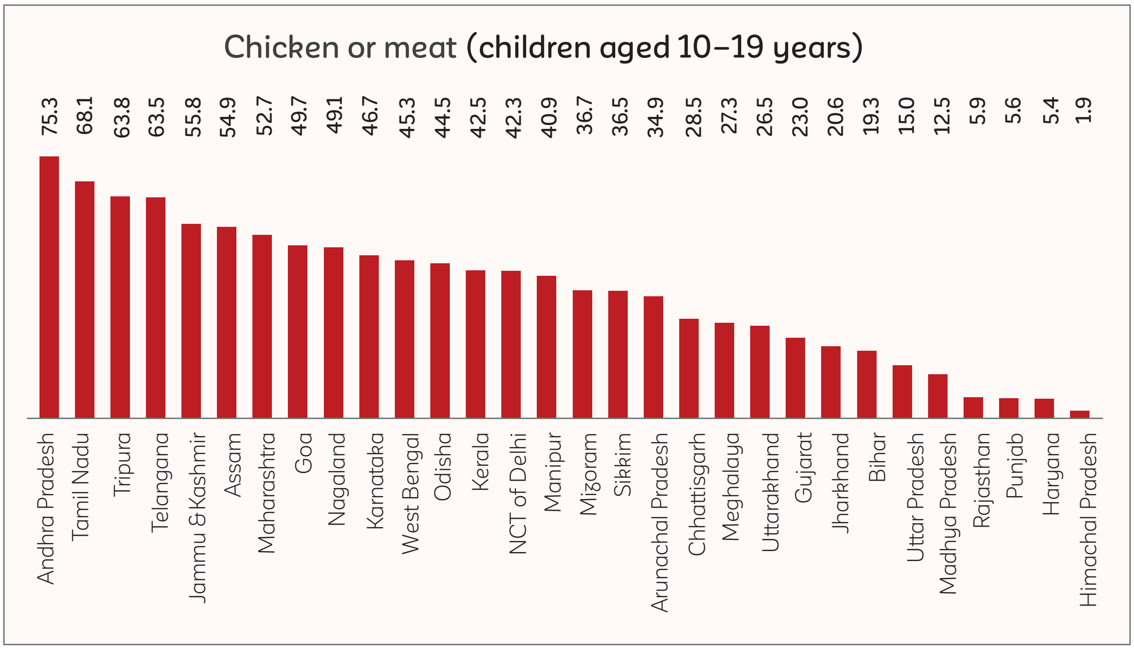

Chicken or meat (children aged 10–19 years)
75.3
68.1
63.8
63.5
55.8
54.9
52.7
49.7
49.1
46.7
45.3
44.5
42.5
42.3
40.9
36.7
36.5
34.9
28.5
27.3
26.5
23.0
20.6
19.3
15.0
12.5
5.9
5.6
5.4
1.9
Andhra Pradesh
Tamil Nadu
Tripura
Telangana
Jammu & Kashmir
Assam
Maharashtra
Goa
Nagaland
Karnataka
West Bengal
Odisha
Kerala
NCT of Delhi
Manipur
Mizoram
Sikkim
Arunachal Pradesh
Chhattisgarh
Meghalaya
Uttarakhand
Gujarat
Jharkhand
Bihar
Uttar Pradesh
Madhya Pradesh
Rajasthan
Punjab
Haryana
Himachal Pradesh

Table 4.1: Percent distribution of IYCF practices among children 0–23 months by selected background characteristics, India, CNNS 2016–18

Characteristic	Children 0–23 months		Children 0–5 months		Children 12–15 months		Children 6–8 months	
	Percentage breastfed within one hour of birth[1]	Weighted number	Percentage exclusively breastfed	Weighted number	Percentage continued breastfed at age 1 year	Weighted number	Percentage with timely initiation of complementary feeding	Weighted number
Sex of child								
Male	57.1	7,619	57.7	1,979	82.8	1,302	53.0	958
Female	56.1	6,986	58.4	1,636	82.1	1,190	53.2	941
Child age (in months)								
<6	58.7	3,615	58.0	3,615	–	–	–	–
6–8	58.5	1,899	–	–	–	–	53.1	1,899
9–11	57.3	1,904	–	–	–	–	–	–
12–17	56.0	3,593	–	–	82.5	2,492	–	–
18–23	53.7	3,593	–	–	–	–	–	–
Mother's age (in years)								
< 20	60.6	833	63.5	331	82.3	77	60.8	145
20–24	56.4	5,732	59.9	1,443	84.1	938	48.1	785
25–29	56.3	5,054	57.3	1,107	80.5	989	57.4	643
30–34	57.2	2,091	56.4	530	82.4	342	54.8	207
≥ 35	56.5	791	46.7	190	87.3	131	53.6	100
Mother's schooling								
No schooling	55.0	4,134	55.2	1,016	88.1	711	36.9	531
< 5 years completed	59.8	696	55.6	189	83.7	144	63.3	78
5–7 years completed	55.0	2,242	69.7	527	84.1	401	46.9	332
8–9 years completed	56.1	2,418	63.9	659	83.5	418	57.4	302
10–11 years completed	63.6	1,711	51.7	416	74.8	285	65.7	203
≥ 12 years completed	55.7	3,401	53.0	808	76.6	533	66.6	450

Characteristic	Children 0–23 months		Children 0–5 months		Children 12–15 months		Children 6–8 months	
	Percentage breastfed within one hour of birth[1]	Weighted number	Percentage exclusively breastfed	Weighted number	Percentage continued breastfed at age 1 year	Weighted number	Percentage with timely initiation of complementary feeding	Weighted number
Religion								
Hindu	56.8	11,597	59.3	2,887	83.4	1,987	52.8	1,513
Muslim	51.9	2,359	48.4	558	79.9	412	52.8	296
Christian	73.9	358	67.1	102	87.6	48	58.7	40
Sikh	52.4	125	59.5	27	62.4	24	74.5	17
Other	75.2	166	72.8	41	56.1	22	51.6	33
Caste/Tribe								
Scheduled Caste	58.4	3,452	59.0	847	86.2	617	54.5	478
Scheduled Tribe	66.8	1,753	70.3	521	91.1	302	45.2	219
Other Backward Class	52.7	5,691	57.4	1,390	77.9	979	51.5	703
Other	56.0	3,709	50.7	856	81.8	594	57.6	498
Residence								
Urban	54.7	3,522	59.8	785	75.6	613	58.9	487
Rural	57.2	11,084	57.5	2,830	84.7	1,879	51.1	1,412
Wealth index								
Poorest	55.8	2,828	60.1	713	92.2	557	41.8	341
Poor	55.3	3,012	59.1	904	83.9	400	43.6	401
Middle	59.6	2,846	61.2	644	82.9	509	48.3	430
Rich	57.7	2,943	54.4	716	83.9	516	64.8	354
Richest	54.7	2,976	55.2	638	68.8	510	68.0	373
Total	56.6	14,605	58.0	3,615	82.5	2,492	53.1	1,899

Note: Data are based on births in the past two years where the children were living at the time of the interview.
[1]Includes children who started breastfeeding immediately after birth.

Table 4.2: Percentage of children aged 6–23 months receiving minimum dietary diversity, minimum meal frequency, minimum acceptable diet, and iron-rich foods by breastfeeding status and selected background characteristics, India, CNNS 2016–18

Characteristic	Among breastfed children 6–23 months, percentage with:					Among non-breastfed children 6–23 months, percentage with:					Among all children 6–23 months, percentage with:				
	minimum dietary diversity[1]	minimum meal frequency[2]	minimum acceptable diet[3]	consumption of iron-rich food[4]	Weighted number	minimum dietary diversity[1]	minimum meal frequency[5]	minimum acceptable diet[6]	consumption of iron-rich food[4]	Weighted number	minimum dietary diversity[1]	minimum meal frequency[7]	minimum acceptable diet[8]	consumption of iron-rich food[4]	Weighted number
Sex of child															
Male	17.2	50.9	7.6	7.0	4,676	37.2	34.4	2.1	11.3	839	20.6	43.2	6.4	7.8	5,640
Female	18.4	49.1	7.7	9.1	4,281	34.1	44.2	9.3	11.1	943	21.4	40.5	6.5	9.4	5,350
Child age (in months)															
6–8	5.4	76.5	3.1	1.2	1,806	8.7	25.0	0.0	0.1	74	5.6	73.4	2.9	1.2	1,899
9–11	12.4	41.9	5.3	3.5	1,736	22.6	17.4	0.2	3.1	156	13.4	39.5	4.9	3.5	1,904
12–17	21.3	41.8	9.3	8.6	2,925	36.8	38.0	5.0	8.1	583	24.1	34.7	7.5	8.7	3,593
18–23	26.3	46.3	10.7	15.4	2,491	39.0	55.5	11.2	15.1	969	30.0	33.7	8.1	15.0	3,593
Type of diet of mother															
Vegetarian	13.9	53.1	6.8	4.2	4,991	30.5	41.8	15.0	5.3	933	16.6	44.9	5.8	4.3	6,060
Vegetarian with egg	20.8	44.2	6.8	6.7	526	50.6	49.5	25.7	11.3	150	27.8	34.5	5.4	7.8	694
Non-vegetarian	22.9	46.5	8.9	13.7	3,440	39.1	33.9	12.2	19.0	698	26.0	38.8	7.3	14.7	4,236
Mother's age (in years)															
< 20	17.3	44.0	3.6	6.7	425	22.1	30.5	0.0	11.3	71	18.0	38.6	2.9	7.3	502
20–24	16.5	48.3	7.4	7.5	3,494	34.5	33.9	7.5	11.3	697	19.6	40.6	6.3	8.0	4,290
25–29	19.1	50.1	7.5	8.3	3,219	35.8	52.7	6.7	11.7	660	22.3	41.9	6.5	9.1	3,946
30–34	18.2	53.5	9.8	8.2	1,236	41.8	25.1	1.8	10.9	274	22.6	43.1	7.6	8.5	1,561
≥ 35	18.8	54.3	8.1	11.5	514	28.6	46.4	4.0	6.7	67	20.1	47.7	7.0	10.8	601
Mother's schooling															
No schooling	9.2	58.6	4.3	6.9	2,628	25.0	25.1	0.5	10.3	422	11.4	50.4	3.9	7.2	3,118
< 5 years completed	14.7	54.0	7.3	8.7	418	15.9	27.6	4.8	2.9	80	14.8	45.3	6.0	8.3	507
5–7 years completed	17.4	48.7	6.0	6.9	1,480	35.3	52.4	25.2	8.1	210	20.0	43.2	6.1	7.3	1,716
8–9 years completed	18.8	44.8	6.4	9.1	1,458	33.6	51.4	4.2	9.6	280	21.6	38.5	5.4	9.3	1,759
10–11 years completed	22.5	42.7	10.4	8.6	1,018	36.3	34.5	6.0	11.7	237	25.2	34.3	8.2	9.1	1,295
≥ 12 years completed	27.1	46.4	13.0	9.1	1,952	47.3	46.3	1.6	14.9	552	31.8	36.2	9.6	10.3	2,592

Characteristic	Among breastfed children 6–23 months, percentage with:					Among non-breastfed children 6–23 months, percentage with:					Among all children 6–23 months, percentage with:				
	minimum dietary diversity[1]	minimum meal frequency[2]	minimum acceptable diet[3]	consumption of iron-rich food[4]	Weighted number	minimum dietary diversity[1]	minimum meal frequency[5]	minimum acceptable diet[6]	consumption of iron-rich food[4]	Weighted number	minimum dietary diversity[1]	minimum meal frequency[7]	minimum acceptable diet[8]	consumption of iron-rich food[4]	Weighted number
Religion															
Hindu	16.9	50.3	7.6	6.2	7,154	34.3	38.8	6.4	7.9	1,364	19.9	42.5	6.5	6.4	8,710
Muslim	20.3	50.9	7.7	15.2	1,444	35.7	45.3	4.4	20.5	308	23.4	41.8	6.2	16.4	1,801
Christian	27.9	39.4	10.3	23.6	201	60.3	33.0	0.0	51.2	51	35.1	32.0	8.0	29.8	256
Sikh	32.7	29.0	10.7	1.0	67	55.2	39.6	0.0	5.2	27	38.5	20.8	7.1	2.1	98
Other	11.6	51.4	4.3	6.4	92	34.7	31.5	0.0	1.1	31	17.3	38.0	3.2	5.1	125
Caste/ Tribe															
Scheduled caste	15.6	52.3	7.6	6.1=`	2,213	41.8	9.0	1.0	13.6	346	19.3	45.4	6.4	7.1	2,605
Scheduled tribe	15.2	53.0	5.7	9.7	1,087	19.9	32.6	3.4	9.5	131	15.8	47.7	5.1	9.8	1,231
Other backward class	16.1	50.4	7.7	6.7	3,397	35.4	52.7	9.8	11.7	782	19.9	41.2	6.6	7.6	4,301
Other	23.6	45.9	8.6	10.9	2,259	35.6	48.3	3.9	9.3	523	26.2	37.3	6.8	10.8	2,852
Residence															
Urban	22.6	46.9	10.1	9.3	2,076	40.8	38.4	3.1	13.9	586	26.9	36.7	7.6	10.2	2,736
Rural	16.3	51.0	6.9	7.6	6,881	33.0	39.9	6.7	9.9	1,196	19.0	43.6	6.1	8.0	8,254
Wealth index															
Poorest	7.6	58.6	2.7	7.2	1,805	21.1	17.0	1.1	6.3	266	9.3	51.0	2.5	7.0	2,116
Poor	13.8	56.0	6.4	7.5	1,828	33.9	45.2	12.9	5.5	243	16.1	50.0	6.4	7.3	2,107
Middle	18.5	47.8	7.2	7.5	1,852	31.7	38.7	0.7	13.6	304	20.5	41.4	6.1	8.6	2,202
Rich	20.8	44.3	9.7	8.7	1,807	29.1	34.3	14.3	12.7	371	22.6	36.7	8.0	9.3	2,227
Richest	28.9	43.0	12.6	9.0	1,666	48.6	56.5	1.5	13.4	598	34.7	31.9	8.9	10.2	2,338
Total	17.8	50.1	7.6	8.0	8,957	35.6	39.6	14.6	11.2	1,782	20.9	41.9	6.4	8.5	10,990

Note: Data are based on births in the past two years where the children were living at the time of the interview.

[1] Children received foods from four or more of the following food groups: a. infant formula, milk other than breastmilk, cheese or yogurt or other milk products; b. foods made from grains or roots, including porridge or gruel, fortified baby food; c. vitamin A-rich fruits and vegetables; d. other fruits and vegetables; e. eggs; f. meat, poultry, fish, shellfish, or organ meats; g. beans, peas, lentils, or nuts; h. foods made with oil, fat, ghee, or butter.

[2] For breastfed children, minimum meal frequency is receiving solid or semi-solid food at least twice a day for infants 6–8 months and at least three times a day for children 9–23 months.

[3] Breastfed children aged 6–23 months are considered to be fed a minimum acceptable diet if they are fed the minimum dietary diversity as defined in footnote 1 and the minimum meal frequency as defined in footnote 2.

[4] Children aged 6–23 months who received any liver, kidney, heart or other organ meat; any chicken, duck, or other poultry; any fresh or dried fish or shellfish; or any other meat during the previous day.

[5] For non-breastfed children aged 6–23 months, minimum meal frequency is receiving solid or semi-solid food or milk feeds at least four times a day.

[6] Non-breastfed children aged 6–23 months are considered to be fed a minimum acceptable diet if they receive other milk or milk products at least twice a day, receive the minimum meal frequency as defined in footnote 5, and receive solid or semi-solid foods from at least four food groups not including the milk or milk products (dairy) food group.

[7] Children are fed the minimum recommended number of times per day according to their age and breastfeeding status as described in footnotes 2 and 4.

[8] Children aged 6–23 months are considered to be fed a minimum acceptable diet if they receive breastmilk, other milk or milk products, are fed the minimum dietary diversity as described in footnote 1, and are fed the minimum meal frequency as described in footnotes 2 and 4.

Table 4.3: Percentage of children aged 6–23 months with minimum dietary diversity, minimum meal frequency, minimum acceptable diet, and consumption of iron-rich foods by state, India, CNNS 2016–18

State	Percentage with minimum dietary diversity[2]	Percentage with minimum meal frequency[3]	Percentage with minimum acceptable diet[4]	Percentage with consumption of iron-rich food[5]	Weighted number
India	**21.0**	**41.9**	**6.4**	**8.6**	**10,990**
North					
Delhi	29.7	24.9	6.4	7.0	569
Haryana	30.8	30.7	6.5	0.9	334
Himachal Pradesh	41.1	40.9	13.6	6.9	363
Jammu & Kashmir	39.2	31.1	7.1	23.4	340
Punjab	41.2	22.6	7.4	3.0	285
Rajasthan	11.6	43.6	3.5	1.4	310
Uttarakhand	34.1	38.1	12.2	7.9	321
Central					
Chhattisgarh	17.6	57.1	10.8	9.1	336
Madhya Pradesh	16.4	54.2	5.9	3.0	297
Uttar Pradesh	16.7	45.1	4.8	6.3	612
East					
Bihar	13.2	53.7	6.1	3.5	410
Jharkhand	11.6	60.6	6.7	7.1	388
Odisha	31.0	54.3	17.0	11.2	367
West Bengal	42.9	36.7	12.9	28.5	522
Northeast					
Arunachal Pradesh	37.5	55.8	20.6	34.7	428
Assam	24.7	38.9	6.5	21.7	375
Manipur	37.9	30.1	8.3	39.4	330

State	Percentage with minimum dietary diversity[2]	Percentage with minimum meal frequency[3]	Percentage with minimum acceptable diet[4]	Percentage with consumption of iron-rich food[5]	Weighted number
Meghalaya	62.3	28.0	7.7	54.3	363
Mizoram	19.8	32.8	2.8	10.8	285
Nagaland	20.3	46.9	5.6	24.4	337
Sikkim	58.8	67.4	35.9	38.1	334
Tripura	24.3	62.5	16.9	14.8	333
West					
Goa	31.6	23.0	3.1	23.7	300
Gujarat	16.5	30.2	3.6	3.0	314
Maharashtra	16.5	26.9	2.2	8.3	480
South					
Andhra Pradesh	11.9	22.0	1.3	4.9	327
Karnataka	18.3	31.6	3.6	8.7	289
Kerala	52.8	65.9	32.6	37.4	296
Tamil Nadu	36.5	24.1	4.2	13.2	571
Telangana	13.2	31.8	3.6	6.0	313

Note: Data are based on births in the past two years where the children were living at the time of the interview.
[1] Includes children who started breastfeeding immediately after birth.
[2] Children received foods from four or more of the following food groups: a. infant formula, milk other than breastmilk, cheese or yogurt or other milk products; b. foods made from grains or roots, including porridge or gruel, fortified baby food; c. vitamin A-rich fruits and vegetables; d. other fruits and vegetables; e. eggs; f. meat, poultry, fish, shellfish, or organ meats; g. beans, peas, lentils, or nuts; h. foods made with oil, fat, ghee, or butter.
[3] Children aged 6–23 months who received solid, semi-solid or soft foods the minimum number of times or more during the previous day.
[4] Breastfed children aged 6–23 months who had at least the minimum dietary diversity and the minimum meal frequency during the previous day and non-breastfed children aged 6–23 months who received at least 2 milk feedings and had at least the minimum dietary diversity (not including milk feeds) and the minimum meal frequency during the previous day.
[5] Children aged 6–23 months who received any liver, kidney, heart or other organ meat; any chicken, duck, or other poultry; any fresh or dried fish or shellfish; or any other meat during the previous day.

Table 4.4: Percentage of children aged 2–4 years consuming specific foods during the previous 24 hours by selected background characteristics, India, CNNS 2016–18

Characteristic	Grains, roots and tubers	Legumes and nuts	Dairy products	Flesh foods	Eggs	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Weighted number
Sex of child								
Male	96.3	32.3	63.6	18.6	15.6	55.9	41.0	12,124
Female	96.2	30.9	60.3	18.8	15.6	55.4	39.6	11,337
Child age (in months)								
24–35	95.9	30.8	64.2	17.5	15.6	53.9	38.1	7,669
36–47	96.2	31.7	62.0	18.7	14.7	56.3	40.9	7,848
48–59	96.6	32.4	59.8	19.8	16.4	56.7	42.0	7,914
Type of diet of mother								
Vegetarian	96.9	30.6	62.2	8.8	7.1	55.2	36.8	12,494
Vegetarian with egg	95.0	26.7	61.2	15.3	28.5	54.5	39.8	1,454
Non-vegetarian	95.6	33.7	61.9	32.2	24.8	56.4	45.0	9,513
Mother's age (in years)								
< 20	93.4	26.1	55.0	25.8	29.0	49.5	39.5	204
20–24	96.3	31.6	63.4	19.4	15.6	55.5	38.5	6,064
25–29	96.2	31.5	62.7	17.3	15.3	55.3	41.7	9,504
30–34	96.5	33.3	60.7	19.6	15.9	56.3	41.4	5,173
≥ 35	96.9	30.0	59.5	20.3	15.0	56.8	38.0	2,283
Mother's education								
No schooling	96.5	28.1	49.8	15.2	9.6	52.4	29.6	7,694
< 5 years completed	97.4	34.3	55.0	25.7	13.8	58.2	38.0	1,424
5–7 years completed	95.6	31.5	59.2	18.3	15.8	51.4	40.5	3,772
8–9 years completed	96.4	35.9	65.4	19.4	16.8	56.6	41.0	3,795
10–11 years completed	95.7	33.2	71.0	22.4	20.2	59.1	46.5	2,612
≥ 12 years completed	96.0	32.6	80.5	20.1	23.0	61.8	56.5	4,146

Characteristic	Grains, roots and tubers	Legumes and nuts	Dairy products	Flesh foods	Eggs	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Weighted number
Religion								
Hindu	96.6	31.6	62.8	14.2	13.4	55.6	39.9	18,572
Muslim	95.5	31.4	57.8	37.4	23.3	54.0	39.2	3,778
Christian	91.1	32.8	57.4	45.7	33.2	57.3	51.3	619
Sikh	92.3	40.0	92.1	4.9	14.9	68.3	66.0	249
Other	96.0	29.3	46.9	18.0	17.5	66.3	36.3	243
Caste/Tribe								
Schedule caste	96.9	32.6	59.4	18.6	16.1	56.9	39.4	5,202
Schedule tribe	95.2	33.7	44.8	17.7	14.2	55.1	36.2	3,196
Other backward class	96.0	29.8	65.1	16.7	14.7	54.3	41.4	9,272
Other	96.6	32.6	68.8	22.6	17.3	57.1	41.8	5,792
Residence								
Urban	95.8	32.7	74.2	22.4	21.7	58.2	49.5	5,497
Rural	96.4	31.3	58.2	17.5	13.7	54.9	37.5	17,964
Wealth index								
Poorest	96.6	28.1	41.3	14.8	8.2	54.0	25.4	4,786
Poor	96.7	33.2	52.1	17.5	12.7	53.3	35.0	4,611
Middle	95.5	32.5	61.5	19.8	16.1	53.4	38.4	4,757
Rich	95.9	30.6	72.9	20.9	20.5	56.7	46.6	4,670
Richest	96.5	34.0	82.7	20.6	20.7	61.0	56.7	4,638
Total	96.2	31.6	62.0	18.7	15.6	55.7	40.3	23,461

Table 4.5: Percentage of children aged 2–4 years consuming specific foods during the previous 24 hours by state, India, CNNS 2016–18

State	Grains, roots and tubers	Legumes and nuts	Dairy products	Flesh foods	Eggs	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Weighted number
India	**96.2**	**31.6**	**62.0**	**18.7**	**15.6**	**55.7**	**40.3**	**23,461**
North								
Delhi	99.3	40.4	86.4	15.2	14.7	63.8	40.6	1,047
Haryana	98.5	28.9	86.6	2.9	2.8	57.4	48.6	652
Himachal Pradesh	97.6	33.9	88.7	7.3	7.5	58.8	62.4	709
Jammu & Kashmir	96.4	45.7	78.8	51.7	45.0	77.2	60.4	684
Punjab	92.0	35.1	91.9	6.4	19.0	64.9	71.5	627
Rajasthan	96.7	27.5	79.8	5.2	3.4	45.2	30.2	750
Uttarakhand	93.3	39.2	72.7	14.4	13.2	48.5	46.7	705
Central								
Chhattisgarh	99.3	39.9	23.3	12.9	8.5	65.0	50.6	757
Madhya Pradesh	97.0	45.8	57.8	5.4	3.9	42.6	30.9	731
Uttar Pradesh	96.7	29.5	63.7	16.9	12.0	56.3	33.7	1,157
East								
Bihar	98.4	25.6	54.0	11.6	4.6	63.2	35.8	853
Jharkhand	99.5	33.2	32.8	15.0	8.0	65.9	31.5	747
Odisha	99.3	69.2	32.2	25.5	22.6	71.7	49.2	820
West Bengal	97.9	47.9	58.8	50.8	38.9	60.2	40.6	1,116

State	Grains, roots and tubers	Legumes and nuts	Dairy products	Flesh foods	Eggs	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Weighted number
Northeast								
Arunachal Pradesh	94.0	36.1	45.6	62.0	41.2	83.1	49.7	745
Assam	93.9	59.1	39.3	49.1	19.4	49.2	31.9	937
Manipur	94.1	49.2	44.7	64.7	34.1	79.4	58.1	790
Meghalaya	96.0	50.6	71.8	77.2	70.8	93.8	67.7	650
Mizoram	84.9	11.6	37.0	18.4	35.4	83.4	37.3	637
Nagaland	95.4	22.4	43.6	47.6	26.0	48.0	31.3	739
Sikkim	97.5	53.6	84.1	59.2	43.4	86.1	64.4	703
Tripura	97.5	49.9	52.9	35.3	29.5	49.5	32.3	664
West								
Goa	97.2	21.5	74.4	50.7	27.9	60.0	50.3	655
Gujarat	96.1	15.2	72.8	9.9	7.5	55.0	59.9	645
Maharashtra	97.3	16.8	67.1	13.2	19.7	64.4	40.5	1,261
South								
Andhra Pradesh	85.5	21.3	68.9	18.9	23.1	29.2	39.4	772
Karnataka	93.9	11.2	56.7	21.9	19.1	45.8	47.1	596
Kerala	95.8	53.5	59.3	69.0	47.0	53.1	77.1	535
Tamil Nadu	92.8	22.6	83.4	32.5	45.1	68.8	55.6	1,160
Telangana	89.6	23.6	61.3	13.7	20.7	30.4	31.6	640

Table 4.6: Percentage of children aged 5–9 years consuming specific foods at least once per week by selected background characteristics, India, CNNS 2016–18

Characteristics	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
Sex of child												
Male	62.8	85.3	88.4	71.6	40.3	36.1	24.1	28.5	34.9	31.4	7.6	19,323
Female	59.7	85.5	88.7	72.3	38.6	34.5	26.3	28.2	36.1	29.7	6.7	19,038
Age in years												
5–7	61.8	85.2	88.5	71.9	40.1	35.4	25.6	28.7	36.1	30.3	7.0	23,342
8–9	60.5	85.6	88.7	71.9	38.5	35.1	24.5	27.8	34.6	30.9	7.4	15,019
Mother's age (in years)												
< 20	48.9	73.3	74.8	67.0	44.3	46.2	61.7	61.6	68.4	26.7	4.7	61
20–24	57.9	83.7	86.3	76.3	41.1	42.5	31.9	36.4	44.7	30.4	8.3	2,152
25–29	62.7	86.2	88.7	71.3	41.4	38.6	26.4	31.1	38.0	31.2	7.5	12,115
30–34	63.4	86.6	88.9	72.6	41.1	34.6	23.8	27.6	33.9	31.6	7.5	12,936
≥ 35	62.2	85.0	89.7	71.9	37.0	33.9	25.8	27.1	35.8	29.1	6.6	6,802
Mother's schooling												
No schooling	50.4	81.4	87.6	71.6	27.0	25.4	19.4	22.2	28.7	24.5	4.5	15,960
<5 years completed	54.2	83.5	86.7	72.1	34.4	37.1	28.0	31.2	39.3	28.4	6.5	2,918
5–7 years completed	63.2	86.5	88.8	72.6	40.4	39.4	26.7	31.9	38.8	32.3	8.4	5,951
8–9 years completed	66.3	88.5	89.6	70.9	44.9	41.8	30.1	30.8	39.4	35.6	8.6	5,315
10–11 years completed	77.0	90.7	89.5	71.4	54.4	48.9	31.9	37.8	45.4	37.5	11.1	3,614
≥12 years completed	83.1	91.3	91.1	73.9	67.4	45.3	30.4	33.5	40.2	39.7	10.5	4,554

Characteristics	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
Religion												
Hindu	62.6	86.4	89.2	72.4	39.0	31.7	22.3	23.8	30.8	31.1	6.6	30,257
Muslim	54.0	81.9	85.4	71.7	40.0	47.7	35.3	47.0	54.6	30.1	10.1	6,240
Christian	57.0	77.1	87.7	71.5	46.1	63.5	50.4	53.7	65.0	28.0	6.6	1,001
Sikh	90.0	80.9	89.0	38.8	37.5	10.5	0.8	4.0	4.0	11.0	2.6	404
Other	55.7	84.4	90.5	69.9	49.7	63.7	39.8	45.5	52.9	23.0	6.3	460
Caste/Tribe												
Scheduled caste	56.7	84.1	89.1	72.0	33.7	35.0	25.5	28.5	35.4	27.9	6.3	8,745
Scheduled tribe	47.8	85.9	90.1	71.4	35.0	38.3	27.3	31.2	40.2	23.9	4.7	4,964
Other backward class	66.1	87.0	90.2	74.4	40.4	34.2	22.8	26.8	33.3	32.9	7.8	15,204
Other	64.9	83.7	84.7	68.1	45.7	35.7	27.5	29.4	36.7	32.7	8.3	9,448
Residence												
Urban	78.2	89.2	91.9	72.6	59.9	49.2	31.7	42.6	48.0	41.4	13.2	9,291
Rural	55.9	84.1	87.5	71.7	33.0	30.9	23.1	23.8	31.5	27.1	5.2	29,070
Wealth Index												
Poorest	37.3	76.3	83.5	72.2	19.4	21.4	19.8	15.9	24.8	18.8	1.7	7,674
Poor	47.3	82.9	87.9	72.9	23.3	28.2	21.9	21.4	29.0	24.0	2.9	7,672
Middle	59.2	86.9	89.1	71.8	35.2	36.4	25.9	30.3	37.8	31.7	7.6	7,673
Rich	75.9	89.4	90.3	71.0	50.4	44.9	29.6	37.2	43.4	36.2	10.0	7,673
Richest	86.7	91.3	91.9	71.6	69.1	45.6	28.6	37.1	42.6	42.2	13.6	7,668
Total	61.3	85.4	88.6	71.9	39.5	35.3	25.2	28.4	35.5	30.6	7.2	38,361

Table 4.7: Percentage of children aged 5–9 years consuming specific foods at least once per week by state, India, CNNS 2016–18

State	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
India	**61.3**	**85.4**	**88.6**	**71.9**	**39.5**	**35.3**	**25.2**	**28.4**	**35.5**	**30.6**	**7.2**	**38,361**
North												
Delhi	85.7	92.4	76.5	59.5	70.9	37.9	18.0	38.0	39.5	44.1	31.0	1,742
Haryana	95.3	92.5	71.3	70.3	50.9	3.6	2.1	5.1	5.1	18.1	9.5	1,092
Himachal Pradesh	83.9	81.6	46.2	23.7	42.4	6.1	1.3	2.7	3.1	9.0	3.3	1,204
Jammu & Kashmir	84.5	73.6	85.6	65.7	61.4	39.0	8.8	51.9	52.9	25.4	26.5	1,170
Punjab	82.6	77.2	81.7	33.6	34.1	11.5	1.2	3.8	3.9	10.6	1.7	1,047
Rajasthan	89.7	81.9	69.9	62.4	30.3	5.8	1.1	5.2	5.2	18.3	2.9	1,277
Uttarakhand	64.1	94.2	83.8	91.7	56.7	43.2	14.5	23.5	26.5	39.6	8.8	1,154
Central												
Chhattisgarh	19.9	85.6	80.7	58.8	23.3	30.0	24.8	26.1	29.3	22.2	2.8	1,203
Madhya Pradesh	52.4	90.4	78.4	93.6	34.6	17.2	15.0	13.0	20.3	40.0	1.7	1,199
Uttar Pradesh	57.9	80.3	69.1	69.9	30.8	15.2	11.3	16.1	18.2	32.7	8.9	1,996
East												
Bihar	42.8	85.0	73.3	76.9	18.1	17.3	23.4	17.3	26.6	25.3	1.4	1,422
Jharkhand	26.7	86.4	73.9	88.1	23.8	39.5	21.0	21.5	28.0	20.6	3.2	1,230
Odisha	23.3	95.0	87.4	88.5	25.1	68.6	53.4	39.6	64.1	44.7	1.4	1,343
West Bengal	35.9	75.2	68.4	86.4	34.7	60.5	62.2	42.2	66.6	26.0	8.2	1,806

State	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
Northeast												
Arunachal Pradesh	22.3	49.6	67.9	35.5	25.7	35.0	28.2	35.1	40.4	16.7	11.3	1,181
Assam	42.1	85.3	67.9	62.5	37.1	62.7	76.9	59.9	79.3	19.2	1.0	1,455
Manipur	40.0	67.1	82.5	50.1	50.9	38.6	38.6	35.0	49.2	30.4	4.8	1,206
Meghalaya	29.6	39.0	61.7	58.0	39.6	45.0	31.8	37.5	42.3	31.9	7.4	1,087
Mizoram	21.5	26.0	68.1	36.0	30.1	46.7	13.0	28.8	33.3	7.7	2.8	1,026
Nagaland	77.0	71.5	66.2	68.8	29.3	43.4	31.2	45.3	51.1	9.5	3.7	1,189
Sikkim	74.5	47.2	79.2	33.4	46.9	43.0	24.5	45.5	48.1	29.5	20.3	1,102
Tripura	35.0	69.6	60.5	62.8	27.1	58.8	61.4	49.0	63.8	15.0	4.7	1,086
West												
Goa	83.6	87.6	77.1	52.6	78.6	75.1	79.8	48.9	83.9	49.1	13.5	1,063
Gujarat	87.4	80.8	81.0	65.7	52.0	17.0	9.7	17.7	19.5	26.2	5.7	1,094
Maharashtra	85.1	94.3	91.3	43.7	62.3	59.7	31.1	47.5	52.3	37.6	9.0	1,957
South												
Andhra Pradesh	71.0	92.4	83.7	73.3	59.0	83.2	41.2	74.7	77.4	28.7	10.5	1,218
Karnataka	84.0	89.8	88.7	81.0	67.1	57.5	21.5	40.7	44.6	45.2	10.3	991
Kerala	63.8	75.7	36.4	66.2	69.5	72.8	79.9	46.7	85.6	38.7	3.7	907
Tamil Nadu	89.7	96.1	83.4	88.3	68.1	84.6	55.8	61.1	70.1	46.1	21.7	1,898
Telangana	78.8	94.2	74.2	61.3	54.6	75.3	19.3	62.1	64.6	24.2	23.0	1,006

Table 4.8: Percentage of children aged 10–19 years consuming specific foods at least once a week by selected background characteristics, India, CNNS 2016–18

Characteristics	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
Sex of child												
Male	63.5	86.2	87.4	74.1	42.6	38.0	25.5	30.7	37.9	38.5	13.8	17,868
Female	57.6	84.1	88.9	73.8	40.2	31.8	23.2	28.5	34.6	33.5	7.1	17,971
Age in years												
10–14	60.0	84.5	87.5	73.6	41.2	35.3	23.8	28.7	35.8	35.1	9.2	18,582
15–19	61.2	85.9	88.9	74.2	41.6	34.4	24.9	30.5	36.7	37.0	11.8	17,258
Mother's age (in years)												
< 20	50.3	86.9	96.2	72.5	43.5	50.1	28.5	29.4	42.5	25.5	8.2	68
20–24	71.0	87.5	96.2	79.3	44.1	44.8	34.6	39.7	47.4	27.9	23.4	62
25–29	53.5	84.5	87.9	74.0	43.8	46.9	31.4	37.2	46.5	41.3	11.2	1,496
30–34	59.9	85.7	89.4	75.0	44.8	39.6	27.2	33.0	40.0	36.7	10.3	6,628
≥ 35	65.1	87.0	89.6	74.4	45.8	38.3	25.2	31.4	38.8	37.5	11.5	10,628
Mother's schooling												
No schooling	54.6	82.9	86.9	74.4	32.0	27.5	19.2	24.8	30.2	30.6	8.1	18,944
<5 years completed	56.9	84.3	87.8	70.5	39.9	45.3	34.2	38.1	48.7	36.9	10.4	2,444
5–7 years completed	64.4	86.8	89.1	71.4	46.4	39.3	26.9	33.6	40.9	38.4	11.7	4,838
8–9 years completed	64.9	87.3	89.3	74.2	49.8	41.9	31.7	34.8	43.1	43.9	13.0	4,292
10–11 years completed	74.1	90.5	91.4	74.2	61.7	48.5	30.6	37.0	44.3	44.1	15.0	2,697
≥12 years completed	78.5	90.0	90.9	77.6	66.7	44.4	28.7	32.1	40.0	48.3	16.2	2,624

Characteristics	Type of food											Weighted number
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	
Religion												
Hindu	61.2	85.8	88.5	74.4	41.1	31.7	21.8	24.5	31.0	37.0	10.1	28,759
Muslim	55.3	82.9	86.7	75.2	42.7	48.1	34.4	52.7	59.9	33.4	11.8	5,454
Christian	58.0	78.8	87.1	71.6	46.2	62.3	54.1	56.7	70.0	32.1	13.1	816
Sikh	88.9	79.9	86.6	39.5	35.9	10.3	2.2	4.8	5.0	16.7	6.7	426
Other	58.9	86.4	87.6	64.0	44.0	53.6	35.0	46.6	53.5	30.9	12.0	384
Caste/Tribe												
Scheduled caste	57.6	82.2	86.1	72.4	37.9	35.9	24.3	28.4	35.6	35.2	10.5	8,073
Scheduled tribe	42.2	83.2	88.9	75.3	32.9	34.4	28.2	32.2	40.5	31.4	6.6	3,893
Other backward class	64.7	87.3	90.7	75.7	41.8	34.2	22.4	28.3	34.1	37.1	10.0	14,948
Other	64.2	85.0	85.6	71.7	47.6	35.3	26.0	31.7	38.5	37.0	12.7	8,926
Residence												
Urban	73.8	89.3	91.6	73.6	59.1	47.7	30.1	43.9	49.2	46.4	17.8	8,866
Rural	56.2	83.7	87.0	74.0	35.6	30.7	22.5	24.9	32.0	32.6	8.0	26,974
Wealth Index												
Poorest	39.6	77.1	82.6	75.3	20.7	19.6	18.9	17.1	23.5	26.5	3.6	7,170
Poor	51.0	83.6	86.9	75.5	29.8	30.9	23.8	25.3	33.0	31.3	6.2	7,165
Middle	59.0	86.2	88.9	73.4	38.5	36.7	25.0	29.2	36.8	35.5	9.8	7,171
Rich	70.8	88.7	90.1	72.3	51.1	40.6	26.7	36.7	42.8	41.3	14.7	7,164
Richest	82.3	90.1	92.3	73.1	66.8	46.5	27.3	39.6	44.9	45.5	17.9	7,169
Total	60.5	85.1	88.2	73.9	41.4	34.9	24.3	29.6	36.2	36.0	10.4	35,839

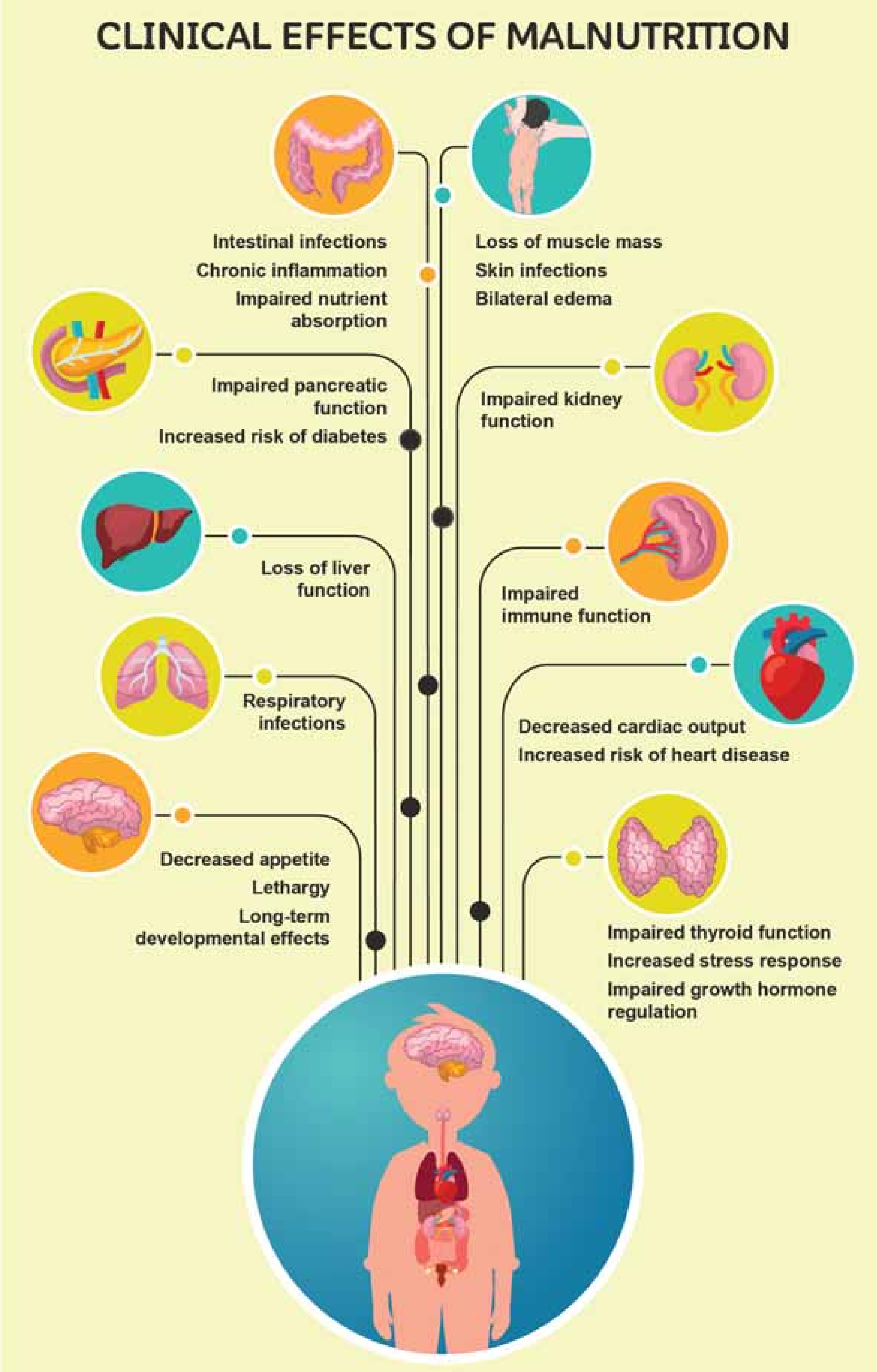
Table 4.9: Percentage of children aged 10–19 years consuming specific foods at least once per week by state, India, CNNS 2016–18

State	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
India	**60.5**	**85.1**	**88.2**	**73.9**	**41.4**	**34.9**	**24.3**	**29.6**	**36.2**	**36.0**	**10.4**	**35,839**
North												
Delhi	87.1	93.9	94.6	51.7	76.7	40.7	13.5	42.3	43.3	52.3	39.2	1,570
Haryana	94.8	91.5	90.7	66.6	57.0	5.3	1.5	5.4	5.6	26.9	23.9	1,069
Himachal Pradesh	76.0	79.9	64.1	30.5	36.3	3.2	0.8	1.9	1.9	13.4	3.4	1,147
Jammu & Kashmir	86.3	76.4	91.2	69.3	67.2	38.9	11.0	55.8	56.6	32.5	36.1	1,151
Punjab	82.1	75.5	83.0	34.6	33.4	9.9	1.2	5.6	5.8	15.6	3.4	993
Rajasthan	88.7	84.8	84.7	61.8	38.7	6.2	1.0	5.9	6.0	21.9	5.7	1,217
Uttarakhand	62.0	91.7	91.6	90.1	60.7	41.7	13.9	26.5	29.3	41.6	9.0	1,075
Central												
Chhattisgarh	27.1	83.4	88.1	71.6	30.2	33.0	26.1	28.5	32.4	32.1	2.5	1,084
Madhya Pradesh	55.4	89.9	92.7	92.6	36.0	16.5	12.1	12.5	17.5	47.2	2.6	1,136
Uttar Pradesh	58.0	81.7	83.1	73.8	29.9	15.2	7.8	15.0	16.3	34.6	9.3	1,799
East												
Bihar	47.8	85.7	90.1	80.3	23.9	21.5	26.2	19.3	29.4	30.9	3.4	1,380
Jharkhand	31.5	87.1	90.2	90.0	32.4	38.4	22.1	20.6	27.7	30.0	5.7	1,094
Odisha	22.5	90.9	94.3	83.8	28.1	64.6	58.1	44.4	68.9	51.8	5.6	1,276
West Bengal	33.1	70.9	74.3	86.0	39.3	57.4	59.0	45.3	66.0	32.2	10.3	1,470
Northeast												

State	Type of food											
	Milk or curd	Pulses or beans	Dark green, leafy vegetables	Roots and tubers	Fruits	Eggs	Fish	Chicken or meat	Fish or chicken or meat	Fried foods	Aerated drinks	Weighted number
Arunachal Pradesh	26.8	44.6	67.7	33.8	25.8	32.4	29.6	34.8	41.4	18.5	20.7	1,073
Assam	30.8	86.4	85.1	55.6	24.4	58.1	76.0	54.9	78.0	15.3	4.3	1,387
Manipur	43.0	75.0	93.6	54.2	58.4	42.8	45.1	40.9	57.6	39.0	5.6	1,153
Meghalaya	24.1	34.1	54.2	44.1	28.5	32.8	21.9	27.3	31.9	18.5	8.6	984
Mizoram	22.2	26.7	77.0	38.1	33.8	46.8	13.9	36.7	39.7	7.5	5.0	968
Nagaland	73.4	64.5	78.2	62.8	30.8	46.8	41.2	49.1	55.9	15.0	7.1	1,101
Sikkim	67.3	42.9	80.4	27.1	32.5	34.8	18.9	36.5	38.1	22.6	17.8	999
Tripura	31.0	83.6	81.6	75.1	32.3	74.4	80.1	63.8	82.6	25.9	8.7	1,061
West												
Goa	76.7	86.2	90.9	56.7	73.2	74.7	80.8	49.7	85.4	55.5	29.1	1,021
Gujarat	80.6	84.6	92.9	73.5	56.7	21.1	15.6	23.0	25.2	38.5	17.5	1,023
Maharashtra	74.9	94.3	95.7	53.4	59.0	59.9	29.5	52.7	56.4	46.4	14.4	1,912
South												
Andhra Pradesh	73.5	94.7	96.2	75.7	62.1	83.3	41.3	75.3	78.5	33.2	15.1	1,124
Karnataka	82.8	83.9	94.4	82.4	74.5	59.6	20.0	46.7	51.5	49.0	18.0	912
Kerala	57.3	75.7	90.2	68.7	59.4	54.5	70.2	42.5	77.3	41.6	8.6	841
Tamil Nadu	87.5	96.2	95.4	86.7	67.4	80.5	61.3	68.1	76.3	51.3	24.2	1,861
Telangana	70.4	90.8	94.1	56.1	53.1	72.4	18.8	63.5	64.6	28.4	27.9	979

CHAPTER 5

Anthropometric status of children and adolescents


CLINICAL EFFECTS OF MALNUTRITION
Intestinal infections
Chronic inflammation
Impaired nutrient absorption
Loss of muscle mass
Skin infections
Bilateral edema
Impaired pancreatic function
Increased risk of diabetes
Impaired kidney function
Loss of liver function
Impaired immune function
Respiratory infections
Decreased cardiac output
Increased risk of heart disease
Decreased appetite
Lethargy
Long-term developmental effects
Impaired thyroid function
Increased stress response
Impaired growth hormone regulation

Key findings

Malnutrition in pre-school children (0–59 months)

- 35% of children under five were stunted (HAZ <-2 SD)
- 17% of children under five were wasted (WHZ <-2 SD)
- 33% of children under five were underweight (WAZ <-2 SD)
- 11% of children 6–59 months were acutely malnourished as measured by MUAC (MUAC-for-age<-2 SD)
- 5% of children 6–59 months were acutely malnourished as measured by absolute MUAC (MUAC <125mm)
- 2% of children under five were overweight or obese (WHZ >+2 SD)
- 1% of children under five were overweight as measured by triceps skinfold thickness (TSFT) (TSFT-for-age >+2 SD)
- 2% of children 1 to 4 years were overweight as measured by subscapular skinfold thickness (SSFT) (SSFT-for-age >+2 SD)

Malnutrition in school-age children (5–9 years)

- 22% of school-age children were stunted (HAZ <-2 SD)
- 10% of school-age children were underweight (WAZ <-2 SD)
- 23% of school-age children were thin (BMI-for-age <-2 SD)
- 4% of school-age children were overweight or obese (BMI-for-age >+1 SD)
- 2% of school-age children were overweight as measured by TSFT (TSFT-for-age >+1 SD)
- 8% of school-age children were overweight as measured by SSFT (SSFT-for-age >+1 SD)
- 2% of school-age children had abdominal obesity (waist circumference-for-age >+1 SD)

Malnutrition in adolescents (10–19 years)

- 24% of adolescents were thin for their age (BMI-for-age <-2 SD)
- 5% of adolescents were overweight or obese (BMI-for-age >+1 SD)
- 4% of adolescents were overweight as measured by TSFT (TSFT-for-age >+1 SD)
- 6% of adolescents were overweight as measured by SSFT (SSFT-for-age >+1 SD)
- 2% of adolescents had abdominal obesity (waist circumference-for-age >+1 SD)

A comprehensive set of anthropometric measures were collected in the CNNS. These measures of the nutritional status of children and adolescents in India are used to diagnose undernutrition, overweight, and obesity. Malnourished children and adolescents are at higher risk for impaired growth, low immunity, poor mental development, and mortality (Black, 2013). As India is undergoing dramatic transitions in economy, demography and nutrition, conditions of overweight and obesity are on the rise, thereby posing greater risks for non-communicable diseases such as diabetes, cardiovascular disease and hypertension in the population (Kalra, 2012; WHO, 2016).

5.1 Anthropometric measurements

Survey anthropometrists were trained following best practices using the SMART Methodology (https://smartmethodology.org/) described in Chapter 2. All anthropometric measures were made by two trained anthropometrists working as a team. Two readings for each anthropometric measure, except weight (one measurement), were taken and recorded in the electronic data collection form. After removal of all values beyond the range of the anthropometric instrument, the mean of two readings was recorded as the final measure. If taking the anthropometric measures was not possible after repeated visits to the household, the anthropometrist recorded the form as incomplete, along with the reason. Children with significant physical deformities were not measured.

Height, weight, mid-upper arm circumference (MUAC), and triceps skinfold thickness (TSFT) were measured for all children and adolescents. Subscapular skinfold thickness (SSFT) was measured for children 1–9 years and adolescents 10–19 years of age. Waist circumference was measured only for children 5–9 years and adolescents 10–19 years of age (Table 5.1).

Table 5.1: Anthropometric measurements for children and adolescents by age, India, CNNS 2016–18

	Children 0–11 months	Children 12–59 months	Children aged 5–9 years	Adolescents aged 10–19 years
Height	YES	YES	YES	YES
Weight	YES	YES	YES	YES
Mid-upper arm circumference (MUAC)*	YES	YES	YES	YES
Triceps skinfold thickness (TSFT)	YES	YES	YES	YES
Subscapular skinfold thickness (SSFT)	NO	YES	YES	YES
Waist circumference	NO	NO	YES	YES

* 6–59 months

MUAC is a measure of muscle and fat mass on the normally non-dominant arm. It is commonly used to screen children for acute malnutrition. UNICEF and WHO recommended MUAC < 115 mm as one of the diagnostic criteria for severe acute malnutrition in children aged 6–60 months (WHO, 2009).

Body mass index (BMI), measured as kg/m^2, is a commonly used screening tool to assess thinness, overweight and obesity among children and adolescents aged 5–19 years. BMI is simple to measure and calculate and is, therefore, widely used to correlate weight with risk of poor health and nutrition at the population level. Research has demonstrated certain limitations, indicating that BMI measures excess weight but not always excess fat or location of body fat. Abdominal obesity among populations has been identified as an important indicator for increased risk of morbidity and mortality from NCDs (WHO, 2008). Abdominal obesity can occur even at normal BMI levels ($<20\ kg/m^2$) and can be diagnosed in childhood and adolescence (Sharma, 2015).

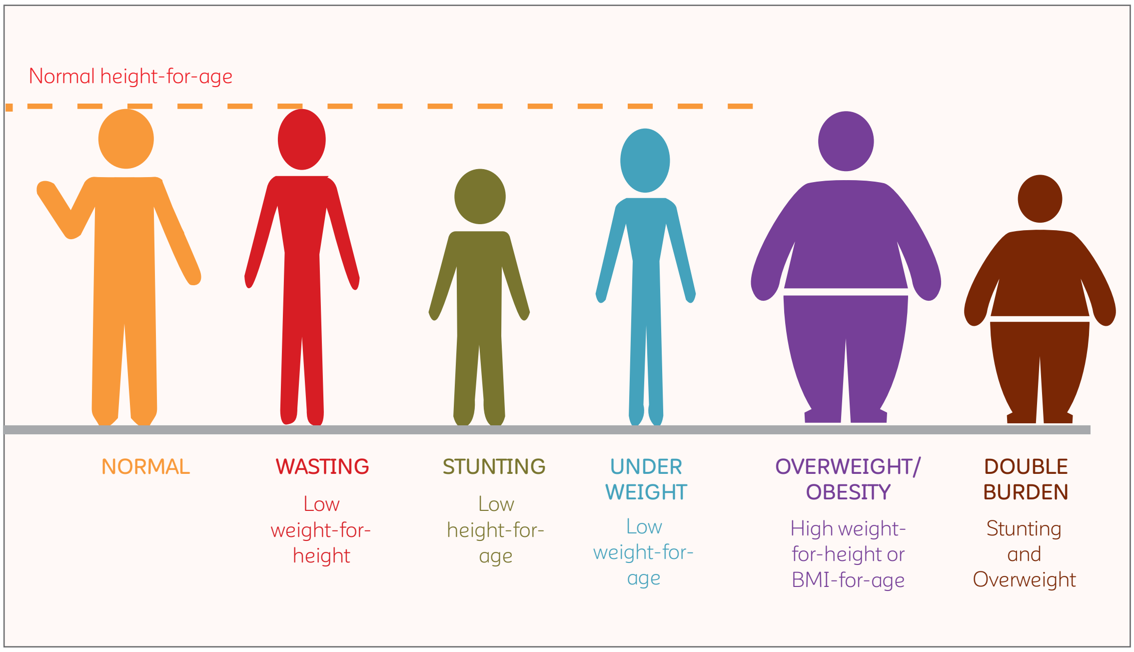
Waist circumference is used to measure abdominal obesity, which is an important indicator for increased risk of morbidity and mortality from NCDs (WHO, 2011). Abdominal obesity can occur even at normal BMI levels ($<20\ kg/m^2$) and can be diagnosed in childhood and adolescence (WHO, 2011). Other measures to predict the total amount of body fat in children and adolescents include triceps skinfold thickness (TSFT) and subscapular skinfold thickness (SSFT), based on the thickness of the skinfold as a measure of subcutaneous body fat (WHO, 2009; de Onis, 2007) and have been used in early childhood to identify distribution of body fat from infancy to early childhood (Yajnik, 2003). These measures have been demonstrated to be an easy and reliable method to estimate body fat (Boeke, 2013) and have been shown to be predictive of elevated levels of cardiovascular disease risk factors and metabolic syndrome (Laurson, 2011).

Global growth standards for skinfold thicknesses (TSFT and SSFT) are available for children under five years of age. The interpretation of skinfold thicknesses in school age children and adolescents (5–19 years) is complicated by the lack of references based on global data for interpretation. Age and sex specific growth references for TSFT, SSFT, MUAC and waist circumference have been developed for other populations (Addo, 2017; Sharma, 2015) but must be interpreted with care when applied to measures of Indian children.

5.2 Measures of undernutrition, overweight and obesity

Anthropometric indices of stunting, wasting, underweight, overweight and obesity provide specific information about growth and body composition for assessing nutritional status (Figure 5.1). The CNNS collected anthropometric measurements to assess these indicators among children 0–9 years and adolescents 10–19 years. Stunting, or low height-for-age, is a sign of chronic undernutrition that reflects failure to receive adequate nutrition over a long period and is also affected by recurrent and chronic illness. Children are defined as stunted if their height-for-age is more than two standard deviations below (< -2SD) the WHO Child Growth Standards median (WHO, 2009). Wasting, or low weight-for-height, is a measure of acute undernutrition and represents the failure to receive adequate nutrition leading to rapid weight loss or failure to gain weight normally. Children are defined as wasted if their weight-for-height is more than two standard deviations below (< -2SD) the WHO Child Growth Standards median (WHO, 2009). Wasting may result from inadequate food intake or from a recent episode of illness causing weight loss. Underweight, or low weight-for-age, is a composite index that takes into account both acute and chronic undernutrition. Children are defined as underweight if their weight-for-age is more than two standard deviations below (< -2SD) the WHO Child Growth Standards median (WHO, 2009). Overweight and obesity, or high weight-for-height, reflect body weight that is higher than what is considered a healthy weight for a given height. Children under five are defined as overweight if their weight-for-height is more than two standard deviations (> +2SD) above the WHO Child Growth Standards median (WHO, 2010). For children and adolescents 5–19 years, overweight and obesity are defined as BMI-for-age > +1SD and > +2SD above the WHO Child Growth Standards median (WHO, 2007). Reference ranges for all anthropometric indicators are presented in Table 5.2.

Figure 5.1: Types of malnutrition and reference measures, India, CNNS 2016–18



As the nutrition transition that accompanies globalization and economic growth has led to greater consumption of processed foods and more sedentary lifestyles, obesity has increased rapidly across the globe. The need for international growth references for older children and adolescents to track undernutrition, overweight and obesity was recognized. Growth references were constructed and validated by WHO to serve for school-aged child and adolescent health and nutrition programmes.

Table 5.2: Types of malnutrition and reference cut-offs, India, CNNS 2016–18

Measure	Severe	Moderate + severe	Overweight and obesity	Obesity
Children 0–4 years				
Stunting (HAZ)	<-3SD	<-2SD		
Wasting (WHZ)	<-3SD	<-2SD	>+2SD	>+3SD
Underweight (WAZ)	<-3SD	<-2SD		
MUAC-for-age	<-3SD	<-2SD		
MUAC	<115mm	<125mm		
TSFT	<-3SD	<-2SD		
SSFT	<-3SD	<-2SD		
Children 5–9 years				
Stunting (HAZ)	<-3SD	<-2SD		
Underweight (WAZ)	<-3SD	<-2SD		
BMI-for-age	<-3SD	<-2SD	>+1SD	>+2SD
TSFT		<-2SD	>+1SD	
SSFT		<-2SD	>+1SD	
MUAC-for-age	<-3SD	<-2SD		
Waist circumference		<-2SD	>+1SD	
Adolescents 10–19 years				
Stunting (HAZ)	<-3SD	<-2SD		
BMI-for-age	<-3SD	<-2SD	>+1SD	>+2SD
TSFT		<-2SD	>+1SD	
SSFT		<-2SD	>+1SD	
MUAC-for-age	<-3SD	<-2SD		
Waist circumference		<-2SD	>+1SD	

References: The WHO Child Growth Standards 2006 and WHO Growth Reference data for 5–19 years 2007

Note: BMI, body mass index; MUAC, mid-upper arm circumference; TSFT, triceps skinfold thickness; SSFT, subscapular skinfold thickness

The WHO 2007 height-for-age and BMI for-age charts extend until 19 years of age, the end of adolescence as defined by United Nations. Stunting (low height-for-age) is used to diagnose chronic malnutrition in school-age children and adolescents. Weight-for-age charts extend from 0–4 years and 5–9 years for the benefit of countries like India that routinely measure weight in children in 5 years or older. Weight for-age is not considered adequate for monitoring growth in adolescence due to its inability to distinguish between relative height and body mass (de Onis, 2007).

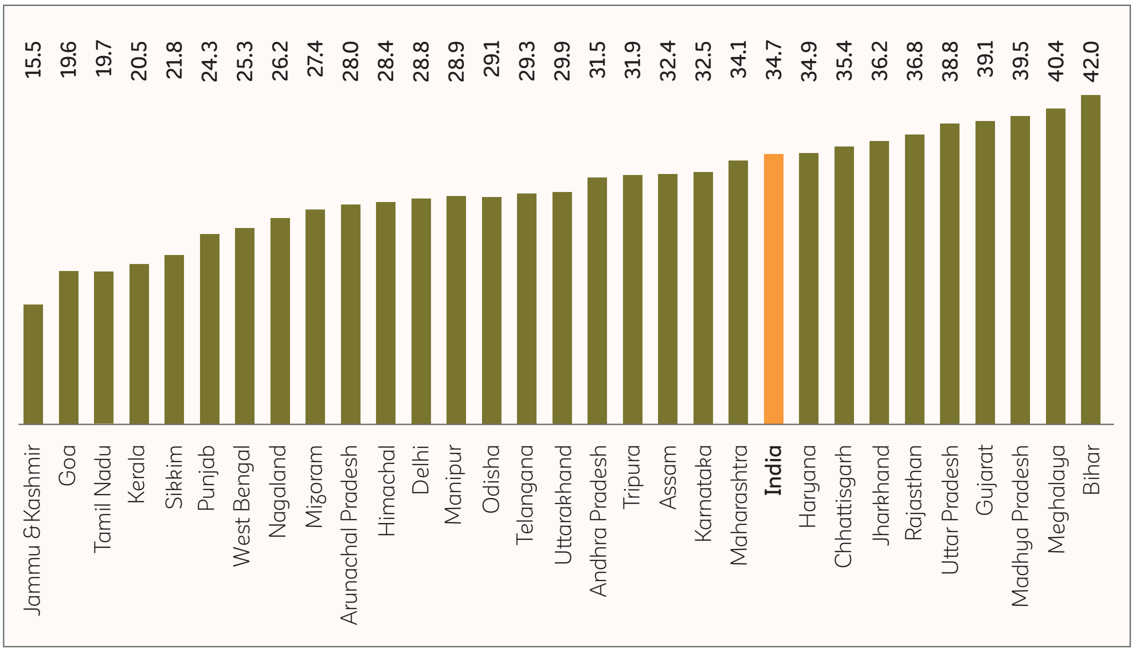
5.3 Prevalence of malnutrition

5.3.1 Stunting, wasting and underweight among children aged 0–4 years

In the CNNS, 35% of Indian children aged 0–4 years were stunted (Table 5.3). A number of the most populous states including Bihar, Madhya Pradesh Rajasthan and Uttar Pradesh, and had a high (37–42%) stunting prevalence (Figure 5.2 & Table 5.4). The lowest prevalence of stunting (16–21%) was found in Goa and Jammu and Kashmir.

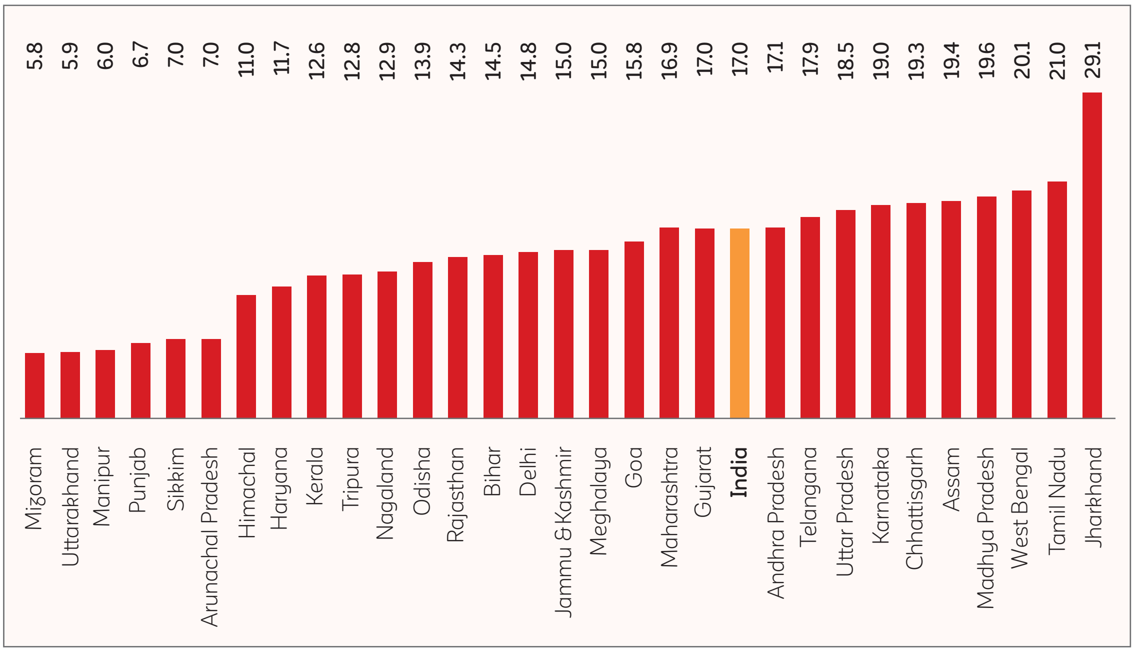
A higher prevalence of stunting in under-fives was found in rural areas (37%) compared to urban areas (27%). Also, children in the poorest wealth quintile were more likely to be stunted (49%), as compared to 19% in the richest quintile (Table 5.3).

Figure 5.2: Percentage of stunting among children aged 0–4 years by state, India, CNNS 2016–18



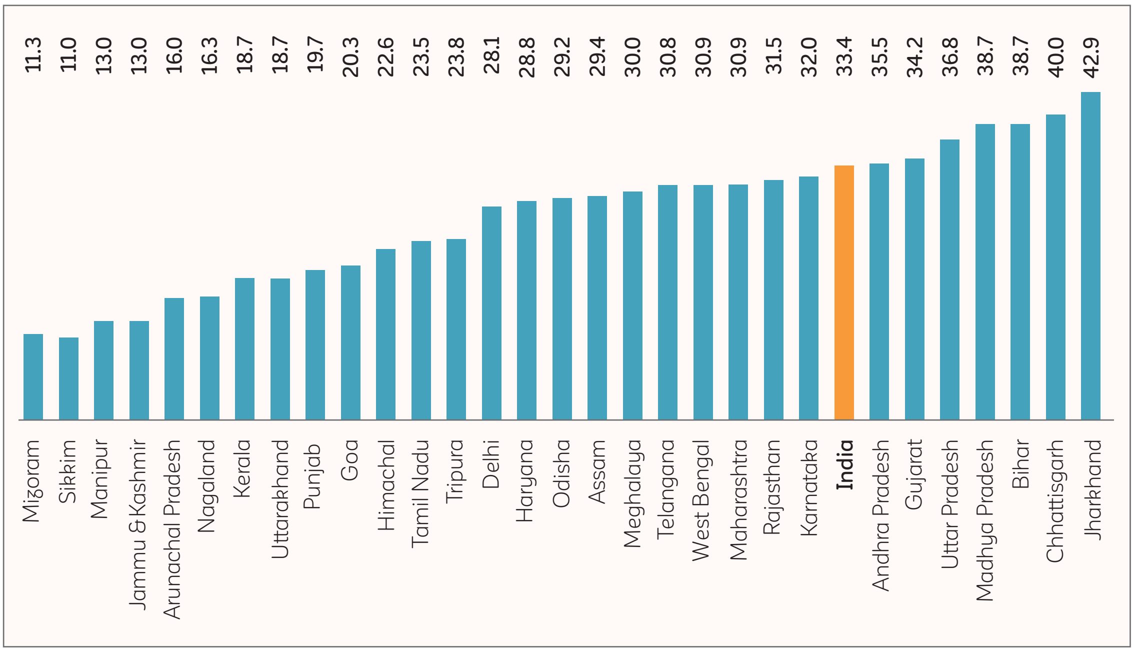
Overall, 17% of Indian children age 0–4 years were wasted (Table 5.3). High prevalence (≥ 20%) states included Madhya Pradesh, West Bengal, Tamil Nadu and Jharkhand (Figure 5.3 & Table 5.4). The states with the lowest prevalence of under-five wasting were Manipur, Mizoram and Uttarakhand (6% each). As season of measure can have a significant effect on the status of acute malnutrition in children under five, the comparisons across states and surveys need to account for seasonal variation. A higher proportion of children under five years of age in the poorest wealth quintile were wasted (21%) compared to those in the highest wealth quintile (13%) (Table 5.3).

Figure 5.3: Percentage of wasting among children aged 0–4 years by state, India, CNNS 2016–18



Overall, 33% of Indian children aged 0–4 years were underweight (Table 5.3). Many states in the north-east of India, such as Mizoram, Sikkim, Manipur, Arunachal Pradesh and Nagaland, had the lowest prevalence (≤ 16%) of underweight (Figure 5.4 & Table 5.4). The states with the highest prevalence (≥ 39%) of underweight were Bihar, Chhattisgarh, Madhya Pradesh and Jharkhand. Rural areas had higher prevalence of underweight in children under five (36%) compared to urban areas (26%). Scheduled tribes had the highest prevalence of underweight (42%) as compared to scheduled castes (36%), other backward classes (33%), and other groups (27%) (Table 5.3). Similar to stunting, children under five from the poorest wealth quintile had a prevalence of underweight more than twice that of the children from households in the richest wealth quintile (48% vs. 19%) (Table 5.3).

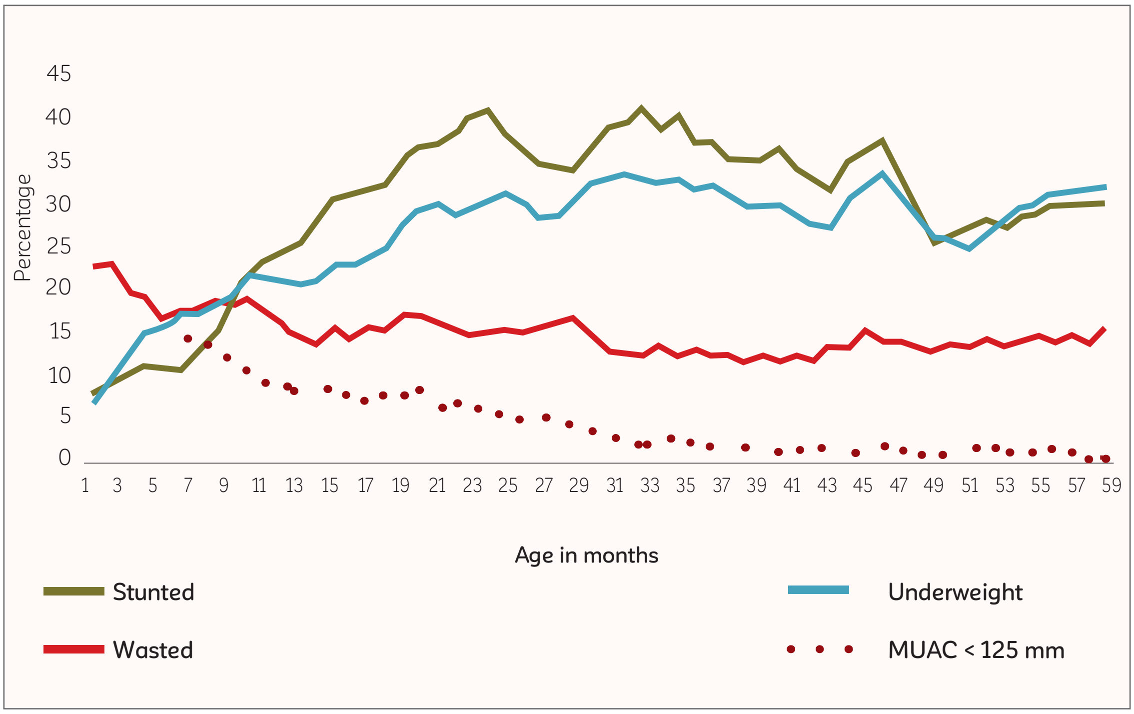
Figure 5.4: Percentage of underweight among children aged 0–4 years by state, India, CNNS 2016–18



The first 1000 days (from conception to age two years) is considered the most important period to intervene to prevent the lifelong damage caused by malnutrition. Figure 5.5 presents the trends of stunting, wasting, underweight, and MUAC < 125 mm in children under five by age observed in the CNNS. These patterns are similar to findings from prior NFHS-3 and NFHS-4 surveys. Of serious public health concern is that close to one quarter of newborns are wasted and the prevalence decreases to only about 17% by six months of age. From one to four years of age, the prevalence of wasting stabilizes to about 15% until the end of the under-five period. The prevalence of acute malnutrition as measured by MUAC < 125 mm was ~15% at six months of age and gradually decreased to ~2% by 36 months of age.

Stunting and underweight prevalence were both about 7% in newborn children, with a steady increase in both indicators until two years of age. The prevalence of stunting peaked at ~40% at approximately two years of age and slowly declined to ~30% by the fifth year of life. The prevalence of underweight was highest (~35%) in the third year of life and ranged from 25% to 34% during 36–59 months of age.

Figure 5.5: Percentage of stunting, wasting, underweight and MUAC < 125 mm among children under five by age in months, India, CNNS 2016–18



Note: Results are smoothed with a three month moving average. MUAC only for 6–59 month children.

5.3.2 Acute malnutrition measured by MUAC among children aged 6–59 months

MUAC-for-age, which is not a globally recognized indicator for acute malnutrition followed similar patterns to those of wasting (Tables 5.7 & 5.8). Overall, 11% of children aged 6–59 months were found to have (MUAC-for-age z-score < -2SD) and 2% had MUAC-for-age z-score < -3SD.

Absolute MUAC (MUAC measured in millmeters) is a globally recognized measure of acute malnutrition (WHO, 2007). Overall, 5% of children aged 6 to 59 months were acutely malnourished as measured by absolute MUAC (MUAC <125 mm) (Table 5.9). The states with the highest prevalence (≥7%) of acute malnutrition by MUAC were Jammu and Kashmir, Uttar Pradesh, Meghalaya, Assam and Nagaland (Table 5.10). The states with the lowest (≤1%) prevalence of acute malnutrition by absolute MUAC (MUAC <125 mm) were Uttarakhand and Arunachal Pradesh. Children from households in the lowest wealth quintile had a higher prevalence of acute malnutrition by MUAC (9%), as compared to those from the highest wealth quintile (3%) (Table 5.7). The prevalence of severe acute malnutrition by absolute MUAC below the global recommended cut-off (MUAC <115 mm) was 1% across all states (Table 5.10).

5.3.3 Overweight measured by WHZ, TSFT, and SSFT among children aged 0–4 years

Overweight and obesity is often associated with diet-related non-communicable diseases in adult populations. From the CNNS data, it is evident that adult diseases are starting in childhood. Poor adolescent and/or maternal nutrition before and during pregnancy can lead to increased risk of maternal anaemia and low birth weight. Undernutrition in utero and early childhood can predispose individuals to become overweight and develop non-communicable diseases such as diabetes and heart disease in adulthood (WHO, 2017). Overweight in mothers is also associated with overweight and obesity in their offspring. Rapid weight gain following acute malnutrition early in life may predispose children to excess weight and the associated risks in adulthood (Bruce, 2010). Poorly functioning food systems, health, living, work and social environments can directly and indirectly lead to undernutrition and overweight or obesity. Poverty has been clearly associated with undernutrition, overweight/obesity and micronutrient deficiencies given the reduced access of poorer individuals/households to often more expensive nutrient-rich foods (WHO, 2017b). Furthermore, the nutrition transition that has resulted from globalization and economic growth has led to greater consumption of high-energy and nutrient – poor processed foods and more sedentary lifestyles, contributes to the rapidly growing overweight and obesity epidemic in India and globally.

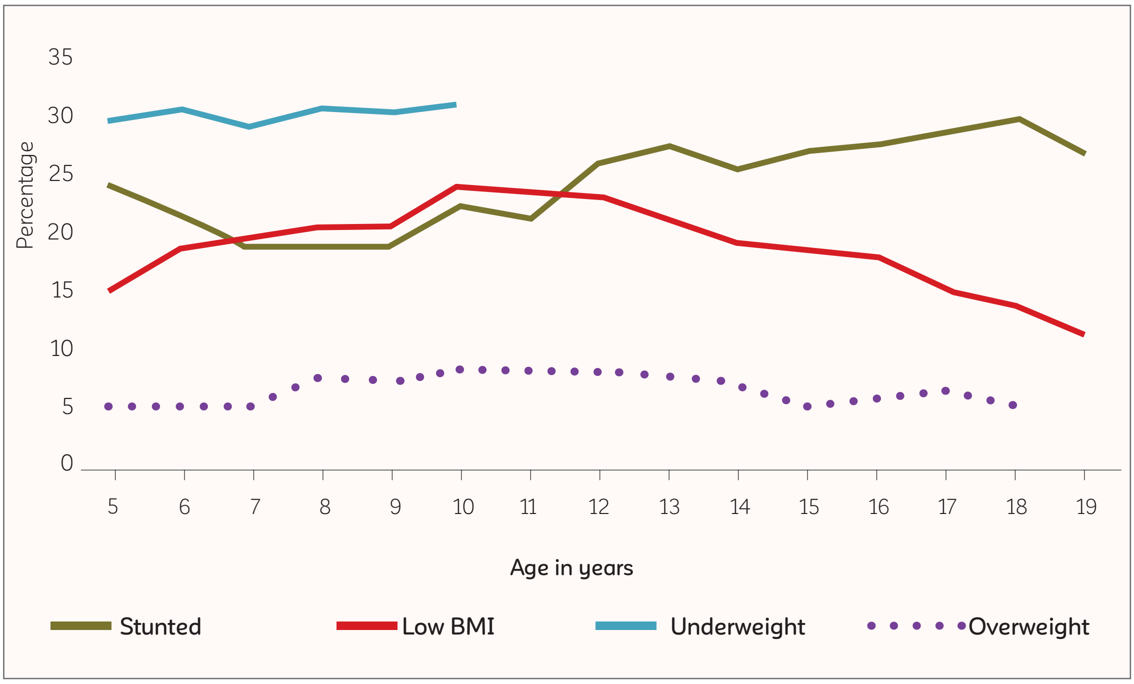
In the CNNS, overall only 2% of children under five years were overweight or obese (WHZ > +2SD) (Table 5.3). This corresponds to what is expected in a normal non-malnourished population. However, as almost 20% of sampled children under five were wasted and the mean WHZ score for the population was -1.0, the prevalence of overweight or obese was significantly higher than expected and could therefore indicate an upsurge of overweight and obesity in the country.

Overall, only 1% of children under five were overweight as measured by TSFT (TSFT–for-age > +2SD) and 2% of children aged 1 to 4 years were overweight as measured by SSFT (SSFT-for-age > +2SD) (Table 5.5). The highest prevalence (≥ 4%) of overweight, as measured by TSFT, was in Mizoram, Tripura and Uttarakhand (Table 5.6). The highest prevalence of overweight (≥ 5%), as measured by SSFT, was in Andhra Pradesh, Karnataka, Mizoram, Tripura and Uttarakhand (Table 5.6). Socio-economic status had a demonstrated effect on overweight as measured by SSFT, with 3% prevalence in the highest wealth quintile versus 1% in the lowest wealth quintile (Table 5.5). No differences were observed in the prevalence of overweight as measured by TSFT based on socio-economic status.

5.3.4 Stunting among children and adolescents aged 5–19 years

The CNNS was the first national survey to measure anthropometry in children aged 5 to 14 years. Overall, 22% of children aged 5 to 9 years were stunted and 6% were severely stunted (Table 5.11). Malnutrition in older children and adolescents has a different pattern from children under five years of age. In older children, the conditions of malnutrition have largely been set and do not vary greatly through later childhood and adolescence. The prevalence of stunting measured close to 25% when children reached five years of age and decreased to ~20% at age seven years (Figure 5.6). This indicates no catch-up growth during this school-age period of childhood. At 10 years of age, the prevalence of stunting began to gradually increase to 30% at 18 years of age. Following the end of puberty, no further height is achieved as long bone growth is completed.

Figure 5.6: Percentage of stunting, low BMI, underweight and overweight among children and adolescents aged 5–19 years by age, India, CNNS 2016–18



Among children aged 5–9 years, the prevalence of stunting varied by schooling status, with a higher percentage of stunting among children who were out of school, compared to school-going children (38% vs. 20%). The prevalence of stunting among children aged 5–9 years was lowest in Tamil Nadu (10%) and Kerala (11%) and highest in Meghalaya (34%) (Table 5.12).

5.3.5 Underweight among children aged 5–9 years

Overall, 35% of children aged 5 to 9 years were underweight, with 10% severely underweight (Table 5.11). The prevalence of underweight was 30% at age five years and remained stable across the five-year period (Figure 5.6). For adolescents, underweight as measured by weight for age is not used . BMI-for-age is recommended to assess underweight and results are presented below in section 5.3.6. The prevalence of underweight varied by the schooling status of children, with a higher prevalence among out of school children, compared to those in school (45% vs. 34%) (Table 5.11). The prevalence of underweight decreased steadily with increased household wealth, with 43%

of children from the lowest wealth quintile being underweight, as compared to 21% among children from the highest wealth quintile (Table 5.11). The prevalence of underweight was lowest in Arunachal Pradesh, Jammu & Kashmir, Manipur and Sikkim (17%) and highest in Jharkhand (45%) (Table 5.12).

5.3.6 Low BMI and overweight among children and adolescents aged 5–19 years

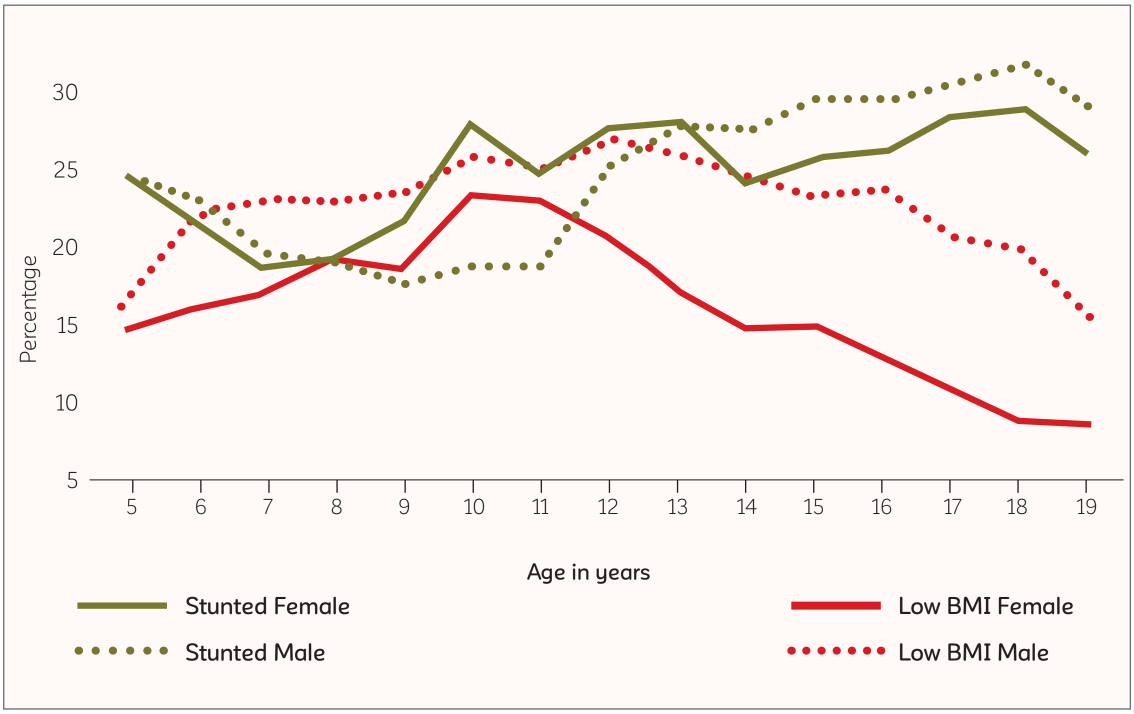
Nearly one-quarter of children aged 5 to 9 years (23%) and adolescents aged 10–19 years (24%) had low BMI (BMI-for-age < -2SD) (Tables 5.13 & 5.15). The prevalence of low BMI was 15% at 5 years of age and slowly increased to 20% by 7 years of age, with the highest prevalence (26%) observed by 10 years of age (Figure 5.6). The prevalence of low BMI declined slowly through adolescence to a prevalence of 12% by age 19 years. A gender differential was observed in the prevalence of low BMI, with boys having a higher prevalence compared to girls, both among children 5–9 years (26% vs. 20%) and adolescents (29% vs. 19%) (Tables 5.13 & 5.15). Among children, the prevalence of low BMI was highest in West Bengal, Karnataka, and Telangana (28%) and lowest in Mizoram (5%) (Table 5.14). For adolescents, the highest and lowest prevalence was observed in Madhya Pradesh (32%) and Manipur (6%), respectively (Table 5.16). The prevalence of low BMI decreased with greater mother's schooling and household wealth among both children and adolescents.

Four percent of children 5–9 years and 5% of adolescents were overweight (BMI > +1SD) (Tables 5.13 & 5.15). There was little variation in overweight over the 5 to 19 year age period, with a prevalence of 5% at age five, 8% at 8 to 9 years, and reducing to 5% by the start of adulthood (Figure 5.6).

As shown in Figure 5.7, The prevalence of stunting was similar for both girls and boys at age five (~25%) and declined for both groups to ~19% by the age of 8 years. Among girls, stunting increased rapidly to a peak of ~28% by age 10 years. However, for boys, as the growth spurt starts later, stunting began to increase after age 11. By age 13, stunting among boys reached ~28% and continued to rise to ~32% by age 18.

In contrast to stunting, sex-specific differences were apparent for low BMI. The prevalence of low BMI was ~15% at the age of five years for both girls and boys and rapidly increased to ~22% in boys by the age of 6 years and reached the highest level (~27%) by age 12 years. As the demands of the growth spurt decreased, boys started to gain weight and the prevalence of low BMI slowly declined to ~15% by age 19. Among girls, the prevalence of low BMI followed the same trajectory but attained a lower peak, increasing from ~15% at age 5 years to a high of ~23% at age 10 years . After age 11 years, the prevalence of low BMI among girls slowly declined to a low of 8% by age 19 years. The CNNS findings for stunting and low BMI are consistent with sex-specific prevalences of stunting and low BMI through the age of puberty that have been observed in smaller research settings (Pal, 2017; de Onis, 2001).

Figure 5.7: Percentage of stunting and low BMI among children and adolescents aged 5–19 years by sex and age, India, CNNS 2016–18



5.3.7 Mid-upper arm circumference among children and adolescents aged 5–19 years

Mid-upper arm circumference is a simple screening measure that can be made with low cost instruments, such as plastic or fibreglass measuring tapes. In school-age children and adolescents, evidence indicates that MUAC and body mass index values are closely correlated and that MUAC is more aligned with fat mass than with fat-free mass (Craig, 2014; Dasgupta, 2010). In addition, the MUAC-for-age z- score has shown to be as effective as the body mass index-for-age z- score for assessing mortality risks associated with severe acute malnutrition (Mramba, 2017). Among adolescent girls, research suggests MUAC is correlated with measures of anaemia and micronutrient deficiencies (Kulathinala, 2016).

In the CNNS, 32% of children aged 5–9 years and 31% of adolescents aged 10–19 years had low MUAC (Tables 5.17 & 5.19). The prevalence was higher among boys compared to girls and decreased with a higher level of mother's schooling and household wealth for both age groups. (Tables 5.17 & 5.19). A higher prevalence was also observed among children and adolescents residing in rural areas, as compared to their urban counterparts. The prevalence of low MUAC was highest in Jharkhand (39%) among children aged 5–9 years and in Himachal Pradesh (41%) for adolescents (Tables 5.18 & 5.20). The lowest prevalence was observed in Arunachal Pradesh for both children (12%) and adolescents (14%) (Tables 5.18 & 5.20).

5.3.8 Overweight and obesity as measured by BMI-for-age among children and adolescents aged 5–19 years

Overweight and obesity are increasing in India (IIPS, 2017) and the onset of overweight and obesity at an early age is of public health concern. Optimal nutrition in childhood and adolescence is very important to ensure that full growth potential is achieved and that young people reach adulthood having good health and wellbeing. In the CNNS, the prevalence of overweight and obesity were 4% and 1%, respectively, in children 5 to 9 years of age (Table 5.14). The states with the highest prevalence of overweight in children 5 to 9 years were Goa and Nagaland (15%) (Table 5.14), while states with the lowest prevalence of overweight in children 5 to 9 years were Jharkhand and Bihar (<1%). Overweight prevalence differed according to socio-economic status, as children from households in the lowest wealth quintile had a prevalence of 1%, while 9% of children in the highest wealth quintile were overweight (Table 5.13).

Among adolescents, the prevalence of overweight and obesity were 5% and 1%, respectively (Table 5.15). Among girls and boys, overweight prevalence was ~5% at age five years, with a rapid increase to a peak of ~10% at age 10 years for boys and a slower increase to a high of ~8% at age 12 years for girls (Figure 5.9). Following the peak in both boys and girls, the prevalence decline until 18 years of age after which steep increases were observed. The states with the highest prevalence (≥12%) of overweight in adolescents were Delhi, Goa and Tamil Nadu (Figure 5.8 & Table 5.16). The states with the lowest prevalence (< 3%) of overweight in adolescents were Bihar, Madhya Pradesh, Uttar Pradesh, Jharkhand and Rajasthan As for children, the prevalence of overweight in adolescents was related to socio-economic status as those in the lowest and highest household wealth quintiles had a prevalence of 1% and 12%, respectively (Table 5.15).

Figure 5.8: Percentage of overweight among adolescents aged 10–19 years by state, India, CNNS 2016–18

The association between BMI and risk of diabetes among Indians is found at a lower cut-off than globally. For this reason, the World Health Organization (WHO, 2000) has lowered the higher end of the cut-off for healthy populations to <23kg/m^2 for Asians. The same tendency exists in school age children and adolescents, but BMI-Age z-scores are used in place of absolute BMI scores as children's bodies are still in their growth phase.

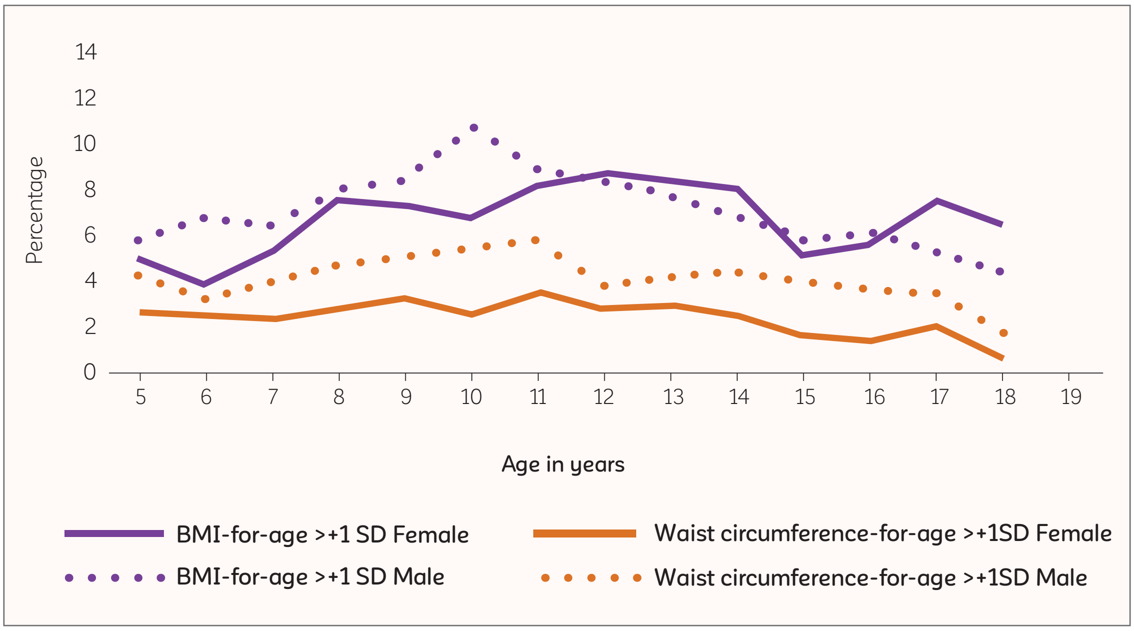
5.3.9 Abdominal obesity among children and adolescents aged 5—19 years

The Indian population has shown to have a disposition for greater truncal adiposity (Ramachandran, 2012). This is considered a less healthy way to store body fat and is associated with metabolic syndrome and a higher risk of NCDs (WHO, 2008). Waist circumference is considered a good indicator of abdominal fat accumulation and visceral adiposity in children and adolescents (Sharma, 2015).

In the CNNS, 2% of children and adolescents had abdominal obesity, as measured by waist circumference-for-age >+1 SD (Tables 5.17 & 5.19). Similar patterns were observed for boys and girls, however the prevalence of abdominal obesity among boys was approximately two percentage points higher than for girls throughout the 5–19 year period (Figure 5.9).

Among children and adolescents, the prevalence of abdominal obesity increased with the level of mother's schooling and household wealth (Tables 5.17 & 5.19). The highest percentage of children with abdominal obesity was observed in Nagaland, Arunachal Pradesh and Goa (7% each), while the lowest percentage was observed in Bihar (0.3%) (Table 5.18). For adolescents, the highest percentage of abdominal obesity was observed in Delhi (7%) and Tamil Nadu (6%) and the lowest percentage was observed in Assam (0.2%) (Tables 5.18 & 5.20).

Figure 5.9: Percentage of overweight and high waist circumference among children and adolescents aged 5–19 years by sex and age, India, CNNS 2016–18



5.3.10 Skinfold thickness among children and adolescents aged 5–19 years

Two percent of children aged 5–9 years and 4% of adolescents aged 10–19 years had a high triceps skinfold thickness (TSFT) for their age (Tables 5.17 & 5.19). The prevalence of high TSFT was positively associated with mother's schooling and household wealth among both children and adolescents. A higher percentage of adolescents residing in urban areas (7%) had high TSFT compared to their rural counterparts (3%) (Table 5.19). The largest prevalence of high TSFT was observed in Goa (8%) among children and in Andhra Pradesh (11%) among adolescents. The lowest prevalence was observed in Chhattisgarh and Bihar for children (0.3%) and in Chhattisgarh for adolescents (0.9%) (Tables 5.18 & 5.20).

Overall, 8% of children aged 5–9 years and 6% of adolescents aged 10–19 years had a high subscapular skinfold thickness (SSFT) for their age (Tables 5.17 & 5.19). A much higher prevalence was observed among children and adolescents residing in urban compared to rural areas (Tables 5.17 & 5.19). As for TSFT, the percentage of children and adolescents with high SSFT increased with the level of mother's schooling and household wealth. The largest prevalence of high SSFT among children and adolescents was observed in Goa (21%) and Delhi (15%), respectively (Tables 5.18 & 5.20) For children, the lowest prevalence of high SSFT was in Madhya Pradesh (3%) and for adolescents in Madhya Pradesh, Chhattisgarh and Assam (2% each) (Tables 5.18 & 5.20).

Overall, 8% of children aged 5–9 years and 6% of adolescents aged 10–19 years had a high subscapular skinfold thickness (SSFT) for their age (Tables 5.17 & 5.19) A much higher prevalence was observed among children and adolescents residing in urban areas as compared to rural settings (Tables 5.17 & 5.19). As for TSFT, the percentage of children and adolescents with high SSFT increased with the level of mother's schooling and household wealth. The largest prevalence of high SSFT among children and adolescents was observed in Goa (21%) and Delhi (15%). respectively For children, the lowest prevalence of high SSFT was in Madhya Pradesh and Jharkhand (3%) and for adolescents in Madhya Pradesh, Chhattisgarh and Assam (2%) (Tables 5.18 & 5.20).

There was a higher prevalence of adiposity among boys compared to girls. Similar to waist circumference, the prevalence of TSFT was higher for boys than for girls throughout the 5–19 year period, with a steep increase for boys starting at about 14 years of age and a peak of 10% at 16 years of age (Figure 5.10). As for TSFT, the prevalence of SSFT was higher for boys than for girls throughout the 5–19 year period, with the highest prevalence for both boys and girls at 7–8 years of age (Figure 5.10).

Figure 5.10: Percentage of high TSFT-for-age and high SSFT-for-age among children and adolescents aged 5–19 years by sex and age, India, CNNS 2016–18

5.3.12 Double burden of malnutrition among pre-schoolers, school-age children and adolescents

The double burden of malnutrition is described by the coexistence of undernutrition along with overweight and obesity, or diet-related NCDs, within individuals, households and populations across the life course. This double burden of malnutrition can exist at the individual level (obesity with a micronutrient deficiency or overweight in an adult who was stunted during childhood), at the household level (an overweight or anemic mother and underweight child or grandparent), and at the population level where there is a prevalence of both undernutrition and overweight in the same community, nation, or region (WHO, 2017a). The most extreme form of double burden of malnutrition is found in individuals. The Figure 5.11 presents the prevalence of the double burden of malnutrition in pre-school (0–4 years) and school-age (5–9 years) children and adolescents aged 10–19 years . While the percentages are small in comparison to stunting and overweight, the actual number of Indian children and adolescents experiencing dual burdens of malnutrition is of public health concern.

Figure 5.11: Double burden of malnutrition in individuals by age groups, India, CNNS 2016–18

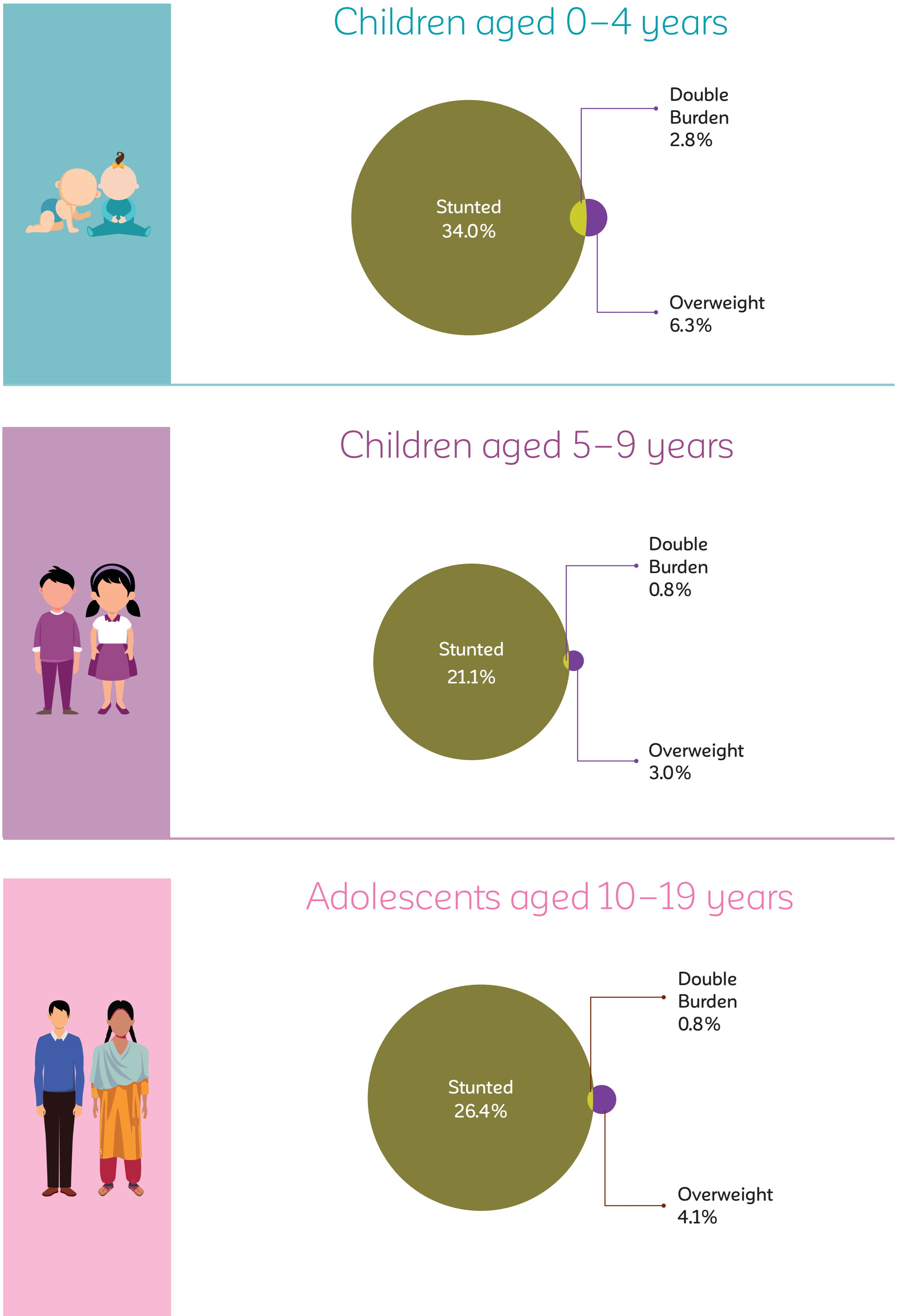


Table 5.3: Percentage of children aged 0–4 years classified as malnourished according to height-for-age, weight-for-height, and weight-for-age by selected background characteristics, India, CNNS 2016–18

Characteristics	Height-for-age[1]				Weight-for-height					Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Percentage above +2SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number
Sex of child													
Male	13.4	35.4	-1.4	18724	5.1	18.3	1.6	-1.0	18440	10.2	32.5	-1.5	18858
Female	12.9	34.0	-1.4	17506	4.8	16.3	1.5	-1.0	17344	10.0	34.4	-1.5	17675
Child age (in months)													
<6	4.5	8.9	0.1	3225	11.2	23.3	3.3	-1.0	3141	5.7	15.1	-0.7	3321
6–8	5.4	16.4	-0.6	1833	8.1	22.4	1.7	-0.9	1820	5.5	24.2	-1.2	1852
9–11	11.5	27.2	-1.1	1826	5.0	19.9	2.4	-0.9	1810	10.1	27.5	-1.3	1859
12–17	14.9	36.5	-1.5	3416	4.7	18.2	1.9	-0.9	3431	9.0	29.6	-1.4	3472
18–23	18.4	44.7	-1.8	3401	5.7	19.3	1.9	-0.9	3352	14.0	37.0	-1.7	3438
24–35	17.3	44.3	-1.8	7411	4.1	15.8	1.2	-0.9	7342	12.3	38.8	-1.7	7451
36–47	14.9	41.2	-1.7	7538	4.0	14.6	1.1	-1.0	7417	11.5	38.0	-1.7	7545
48–59	10.3	30.9	-1.5	7581	2.9	16.0	1.2	-1.0	7470	8.5	35.5	-1.6	7594
Type of diet (Mother)													
Vegetarian	14.1	36.9	-1.5	19,828	4.3	17.0	1.4	-1.0	19,617	11.0	35.5	-1.6	19,987
Vegetarian with egg	12.0	30.3	-1.3	2,241	4.9	16.7	1.9	-1.0	2,210	8.0	29.9	-1.4	2,262
Non-vegetarian	12.2	32.4	-1.3	14,162	6.0	17.9	1.6	-1.0	13,957	9.2	31.1	-1.4	14,284
Mother's age (in years)													
< 20	13.6	28.6	-1.1	986	3.7	16.6	1.7	-0.8	978	7.5	22.3	-1.1	996
20–24	13.2	35.2	-1.4	11233	5.0	17.7	1.5	-1.0	11128	11.1	33.6	-1.5	11342
25–29	12.2	33.8	-1.4	13884	5.2	17.8	1.7	-1.0	13728	9.4	33.5	-1.5	14004
30–34	13.9	35.8	-1.4	6872	4.6	16.5	1.3	-1.0	6739	10.1	33.1	-1.5	6927
≥ 35	15.4	36.4	-1.5	2929	4.5	15.5	1.8	-1.0	2890	10.7	35.6	-1.5	2938
Mother's schooling													
No schooling	19.3	46.0	-1.8	11357	5.7	19.3	1.1	-1.1	11231	14.8	43.4	-1.8	11434
<5 years completed	17.1	41.6	-1.7	2018	4.6	19.2	0.9	-1.1	1990	13.0	37.8	-1.7	2040
5–7 years completed	14.1	37.4	-1.5	5742	5.7	18.5	1.1	-1.0	5651	9.7	35.6	-1.6	5794
8–9 years completed	10.5	31.9	-1.4	5863	3.7	15.8	1.7	-0.9	5801	8.1	29.6	-1.4	5917
10–11 years completed	9.3	28.2	-1.3	4127	4.7	16.5	1.4	-0.9	4044	8.2	29.9	-1.4	4132
≥ 12 years completed	5.9	18.8	-0.8	7102	4.3	14.5	2.8	-0.8	7046	5.1	19.8	-1.0	7193

Characteristics	Height-for-age[1]				Weight-for-height					Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Percentage above +2SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number
Religion													
Hindu	13.4	35.1	-1.4	28781	4.9	17.5	1.4	-1.0	28435	10.4	34.5	-1.5	29031
Muslim	12.6	34.7	-1.4	5783	5.5	17.3	2.1	-0.9	5714	9.1	30.0	-1.4	5826
Christian	12.1	27.4	-1.1	922	5.4	14.8	2.4	-0.8	898	8.8	26.3	-1.2	923
Sikh	6.6	22.1	-1.0	362	2.6	8.5	4.0	-0.5	362	5.1	18.1	-1.0	365
Other	13.8	40.3	-1.6	381	3.7	18.9	3.3	-0.9	375	10.4	37.7	-1.5	389
Caste/Tribe													
Scheduled caste	15.6	39.3	-1.6	8329	4.6	16.1	1.5	-1.0	8255	11.1	36.1	-1.6	8370
Scheduled tribe	16.1	41.5	-1.6	4690	6.9	21.9	1.8	-1.1	4642	13.5	41.5	-1.7	4749
Other backward class	13.0	34.8	-1.4	14276	4.5	17.1	1.2	-1.0	14112	9.8	33.1	-1.5	14413
Other	9.6	26.8	-1.2	8935	4.9	16.5	2.1	-0.9	8776	8.0	27.2	-1.3	9001
Residence													
Urban	9.8	27.3	-1.1	8507	4.7	16.3	2.7	-0.8	8377	7.7	25.9	-1.3	8560
Rural	14.2	37.0	-1.5	27723	5.0	17.6	1.2	-1.0	27407	10.9	35.7	-1.6	27973
Wealth index													
Poorest	20.4	49.2	-1.9	7339	6.1	21.1	0.8	-1.2	7250	16.7	48.1	-1.9	7398
Poor	17.2	41.1	-1.6	7278	5.8	19.2	1.2	-1.1	7234	12.0	38.6	-1.7	7338
Middle	13.0	35.6	-1.5	7225	4.6	17.2	1.3	-1.0	7111	10.2	33.6	-1.6	7304
Rich	9.5	28.0	-1.2	7178	4.5	16.4	1.8	-0.9	7073	6.9	27.5	-1.3	7243
Richest	5.6	19.4	-0.9	7210	3.7	12.6	2.9	-0.7	7116	4.6	19.0	-1.0	7251
Total	13.2	34.7	-1.4	36230#	4.9	17.3	1.6	-1.0	35784##	10.1	33.4	-1.5	36533###

Note: Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Data are based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Recumbent length is measured for children under age 2 years, or in the few cases when the age of the child is unknown and the child is less than 85 cm; standing height is measured for all other children.

[2]Includes children who are below -3 SD from the WHO Child Growth Standards population median

2153 cases were excluded: 1118 were flagged and for 1035 cases height was not measured

2783 cases were excluded: 1661 were flagged and for 1122 cases height/weight was not measured

1724 cases were excluded: 437 were flagged and for 1287 cases weight was not measured

Total includes 30, 27 and 31 children for whom mother's schooling information was missing for height-for-age, weight-for-height, and weight-for-age, respectively.

Table 5.4: Percentage of children aged 0–4 years classified as malnourished according to height-for-age, weight-for-height, and weight-for-age by state, India, CNNS 2016–18

State	Height-for-age[1]				Weight-for-height					Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Percentage above +2SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD2	Mean Z-score	Weighted number
India	**13.2**	**34.7**	**-1.4**	**36230#**	**4.9**	**17.3**	**1.6**	**-1.0**	**35784##**	**10.1**	**33.4**	**-1.5**	**36533###**
North													
Delhi	9.7	28.8	-1.2	1648	3.2	14.8	2.0	-0.9	1640	6.2	28.1	-1.3	1650
Haryana	11.7	34.9	-1.5	1066	2.1	11.7	1.4	-0.8	1059	9.0	28.8	-1.4	1068
Himachal Pradesh	6.7	28.4	-1.1	1156	3.1	11.0	2.7	-0.7	1127	5.4	22.6	-1.1	1148
Jammu & Kashmir	5.8	15.5	-0.3	1079	6.9	14.9	6.1	-0.5	1050	4.9	13.1	-0.6	1125
Punjab	8.0	24.3	-1.1	982	2.3	6.7	3.9	-0.5	979	4.8	19.7	-1.0	989
Rajasthan	13.2	36.8	-1.4	1167	3.6	14.3	1.4	-0.9	1156	9.4	31.5	-1.4	1166
Uttarakhand	9.8	29.9	-1.2	1084	1.4	5.9	2.9	-0.4	1070	3.4	18.7	-1.0	1095
Central													
Chhattisgarh	11.4	35.4	-1.5	1149	5.0	19.3	0.9	-1.1	1114	12.0	40.0	-1.7	1159
Madhya Pradesh	14.1	39.5	-1.6	1114	6.6	19.6	0.4	-1.1	1094	12.5	38.7	-1.7	1125
Uttar Pradesh	15.4	38.8	-1.6	1898	4.7	18.5	1.0	-1.0	1886	12.4	36.8	-1.6	1918
East													
Bihar	18.1	42.0	-1.7	1333	4.2	14.5	0.6	-1.0	1327	11.4	38.7	-1.7	1347
Jharkhand	14.1	36.2	-1.6	1165	6.4	29.1	0.5	-1.4	1163	15.5	42.9	-1.9	1166
Odisha	8.0	29.1	-1.3	1268	2.4	13.9	1.2	-0.9	1256	5.5	29.2	-1.3	1279
West Bengal	7.2	25.3	-1.2	1508	4.3	20.1	1.7	-1.1	1498	7.3	30.9	-1.4	1504

State	Height-for-age[1]				Weight-for-height					Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[2]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[2]	Percentage above +2SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD2	Mean Z-score	Weighted number
Northeast													
Arunachal Pradesh	10.7	28.0	-1.0	1187	1.7	6.8	5.0	-0.2	1174	3.1	15.5	-0.7	1219
Assam	15.1	32.4	-1.1	1378	7.8	19.4	5.0	-0.8	1321	11.3	29.4	-1.3	1423
Manipur	10.4	28.9	-1.2	1132	3.0	6.0	6.0	-0.1	1118	3.0	13.0	-0.7	1164
Meghalaya	17.2	40.4	-1.5	989	4.9	14.7	2.8	-0.7	960	7.9	29.6	-1.3	1018
Mizoram	6.8	27.4	-1.0	967	2.2	5.8	5.4	-0.2	944	1.5	11.3	-0.6	991
Nagaland	10.8	26.2	-0.9	1115	5.3	12.9	8.9	-0.2	1059	5.0	16.3	-0.7	1130
Sikkim	7.1	21.8	-1.0	1047	1.1	6.9	5.3	-0.2	1009	2.3	10.8	-0.7	1053
Tripura	13.4	31.9	-1.2	1049	5.3	12.8	5.9	-0.5	1021	7.5	23.8	-1.1	1064
West													
Goa	5.3	19.6	-0.8	982	5.1	15.8	3.2	-0.8	959	5.2	20.3	-0.9	990
Gujarat	14.2	39.1	-1.5	1018	6.9	17.0	1.7	-1.0	1006	10.2	34.2	-1.5	1034
Maharashtra	14.3	34.1	-1.4	1848	5.2	16.9	4.0	-0.8	1821	9.8	30.9	-1.5	1884
South													
Andhra Pradesh	14.4	31.5	-1.3	1150	5.9	17.1	1.3	-1.0	1124	9.8	33.5	-1.5	1147
Karnataka	12.4	32.5	-1.3	904	4.6	19.3	0.7	-1.1	882	9.5	32.4	-1.5	898
Kerala	5.2	20.5	-1.0	837	2.7	12.6	1.7	-0.7	830	3.2	18.7	-1.1	850
Tamil Nadu	5.8	19.7	-0.7	1758	8.1	20.7	2.9	-1.0	1718	6.5	23.5	-1.2	1784
Telangana	8.7	29.3	-1.3	1015	5.6	17.9	1.5	-1.0	1000	7.3	30.8	-1.5	1012

Note: Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Recumbent length is measured for children under age 2 years, or in the few cases when the age of the child is unknown and the child is less than 85 cm; standing height is measured for all other children

[2]Includes children who are below -3 SD from the WHO Child Growth Standards population median

2153 cases were excluded: 1118 were flagged and for 1035 cases height was not measured

2783 cases were excluded: 1661 were flagged and for 1122 cases height/weight was not measured

1724 cases were excluded: 437 were flagged and for 1287 cases weight was not measured

Table 5.5: Percentage of children aged 0–4 years classified as malnourished by TSFT for age and percentage of children aged 1–4 years classified as malnourished by SSFT for age by selected background characteristics, India, CNNS 2016–18

Characteristics	TSFT-for-age						SSFT-for-age					
	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number
Sex of child												
Male	2.2	9.4	1.0	0.1	-0.5	18088	1.5	8.4	2.0	0.2	-0.3	14990
Female	2.6	10.1	0.9	0.0	-0.5	17037	1.6	8.9	1.5	0.1	-0.4	14235
Age in months												
<6	9.4	19.6	0.6	0.0	-1.0	1865	–	–	–	–	–	–
6–8	5.0	17.3	0.6	0.2	-0.8	1850	–	–	–	–	–	–
9–11	4.6	14.6	0.6	0.1	-0.7	1861	–	–	–	–	–	–
12–17	2.8	11.0	1.3	0.0	-0.5	3467	2.9	12.7	1.8	0.2	-0.5	3388
18–23	2.1	9.7	1.4	0.2	-0.4	3427	3.2	11.1	2.4	0.2	-0.4	3380
24–35	2.0	8.0	1.2	0.1	-0.3	7439	1.0	8.1	2.3	0.2	-0.3	7349
36–47	1.3	7.2	1.0	0.0	-0.4	7583	1.2	7.6	1.6	0.1	-0.3	7515
48–59	1.0	7.9	0.5	0.1	-0.6	7633	1.2	7.3	1.1	0.1	-0.4	7592
Type of diet (Mother)												
Vegetarian	2.7	10.4	0.9	0.1	-0.6	19,148	1.9	9.2	1.6	0.1	-0.4	15,920
Vegetarian with egg	1.5	6.8	1.2	0.2	-0.4	2,181	0.7	7.7	2.4	0.2	-0.3	1,853
Non-vegetarian	2.1	9.2	1.0	0.1	-0.5	13,796	1.3	8.0	1.9	0.2	-0.3	11,452
Mother's age (in years)												
< 20	4.1	12.2	0.4	0.0	-0.7	867	2.1	10.3	2.9	0.0	-0.5	444
20–24	2.2	9.1	0.9	0.1	-0.5	10747	1.8	8.1	1.8	0.2	-0.3	8291
25–29	2.3	9.7	0.9	0.1	-0.5	13560	1.4	8.5	1.7	0.2	-0.3	11608
30–34	2.2	10.0	0.7	0.1	-0.5	6742	1.8	9.1	1.7	0.0	-0.4	6017
≥ 35	3.4	10.4	1.7	0.1	-0.6	2883	1.6	9.6	1.8	0.2	-0.4	2584
Mother's schooling												
No schooling	3.1	11.6	0.6	0.0	-0.6	11123	2.3	11.5	1.4	0.0	-0.5	9441
<5 years completed	2.4	9.1	0.5	0.0	-0.6	1966	0.8	7.5	1.2	0.1	-0.4	1677

Characteristics	TSFT-for-age						SSFT-for-age					
	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number
5–7 years completed	2.0	8.8	0.6	0.0	-0.5	5555	2.1	8.4	1.4	0.0	-0.3	4655
8–9 years completed	2.9	10.9	1.0	0.1	-0.6	5639	1.1	8.5	1.4	0.3	-0.3	4718
10–11 years completed	1.6	7.9	1.2	0.0	-0.5	4003	1.3	5.8	2.0	0.2	-0.2	3285
≥12 years completed	1.5	7.6	1.7	0.2	-0.4	6817	0.7	6.0	2.9	0.4	-0.2	5430
Religion												
Hindu	2.2	9.6	0.9	0.1	-0.5	27896	1.6	8.8	1.8	0.2	-0.4	23241
Muslim	3.2	10.6	0.8	0.1	-0.5	5600	1.8	7.8	1.5	0.1	-0.3	4653
Christian	2.2	10.3	2.7	0.0	-0.4	894	0.7	9.0	2.7	0.1	-0.3	722
Sikh	0.9	7.0	3.1	0.1	-0.5	360	1.2	6.2	1.8	0.1	-0.3	308
Other	1.8	8.7	0.2	0.0	-0.6	376	0.6	8.8	0.8	0.0	-0.3	301
Caste/Tribe												
Scheduled caste	1.5	8.3	1.2	0.0	-0.5	8042	1.3	7.0	2.2	0.1	-0.3	6577
Scheduled tribe	3.9	13.0	0.6	0.0	-0.8	4585	1.9	14.5	0.9	0.0	-0.7	3840
Other backward class	2.3	9.3	0.9	0.1	-0.5	13850	1.7	8.3	1.6	0.1	-0.3	11655
Other	2.5	10.0	1.1	0.1	-0.5	8647	1.5	7.4	2.0	0.4	-0.3	7152
Residence												
Urban	1.8	8.3	1.3	0.2	-0.4	8244	0.7	6.3	2.5	0.3	-0.2	6857
Rural	2.6	10.1	0.9	0.0	-0.6	26881	1.9	9.3	1.5	0.1	-0.4	22367
Wealth index												
Poorest	2.4	11.2	0.5	0.0	-0.6	7188	2.8	13.5	0.9	0.0	-0.6	6010
Poor	3.3	11.2	0.6	0.0	-0.6	7017	2.0	9.5	1.4	0.1	-0.4	5750
Middle	2.4	9.1	0.8	0.1	-0.5	7018	1.2	7.3	1.8	0.1	-0.3	5921
Rich	2.2	9.4	1.3	0.1	-0.5	6923	1.1	7.1	1.7	0.2	-0.3	5745
Richest	1.7	7.6	1.6	0.2	-0.4	6979	0.6	5.6	3.1	0.4	-0.1	5798
Total	2.4	9.7	1.0	0.1	-0.5	35125#	1.6	8.6	1.8	0.2	-0.3	29224##

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards.
[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median
2,962 cases were excluded, 67 were flagged and for 2,895 cases TSFT was not measured
8,587 cases were excluded. 19 were flagged and for 8,568 cases SSFT was not measured
Total includes 259 and 237 children for whom mother's age information was not known/mother died for TSFT and SSFT, respectively
Total includes 30 and 26 children for whom mother's schooling information was not known for TSFT and SSFT, respectively

Table 5.6: Percentage of children aged 0–4 years classified as malnourished by TSFT and percentage of children from 1–4 years classified as malnourished by SSFT for age (Z-score: <-2SD, <-3SD, >+2SD, >+3SD), by state, India, CNNS 2016–18

State	TSFT-for-age						SSFT-for-age					
	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number
India	**2.4**	**9.7**	**1.0**	**0.1**	**-0.5**	**35125#**	**1.6**	**8.6**	**1.8**	**0.2**	**-0.3**	**29224##**
North												
Delhi	0.6	5.0	1.1	0.3	-0.4	1567	1.2	4.9	3.2	0.7	-0.1	1328
Haryana	2.0	7.2	1.7	0.0	-0.4	1041	2.2	8.3	1.2	0.1	-0.3	857
Himachal Pradesh	0.9	10.7	0.6	0.0	-0.6	1122	0.9	10.1	2.1	0.0	-0.3	940
Jammu & Kashmir	6.0	21.1	0.7	0.0	-1.0	1082	1.6	16.1	2.3	0.1	-0.5	871
Punjab	0.9	7.3	2.4	0.1	-0.4	962	1.1	4.9	2.3	0.1	-0.2	823
Rajasthan	0.9	7.0	2.1	0.0	-0.3	1097	1.1	8.0	2.2	0.2	-0.3	925
Uttarakhand	1.7	5.0	4.0	0.3	0.0	1049	1.7	6.6	4.7	0.6	0.0	887
Central												
Chhattisgarh	3.4	15.8	0.3	0.0	-0.7	1105	1.9	11.6	0.8	0.0	-0.5	955
Madhya Pradesh	3.1	9.5	0.2	0.1	-0.6	1083	3.8	13.5	0.9	0.0	-0.6	916
Uttar Pradesh	3.3	13.9	0.5	0.1	-0.8	1833	2.1	10.2	0.8	0.2	-0.5	1496
East												
Bihar	1.1	5.6	0.8	0.0	-0.3	1295	1.1	5.8	2.0	0.0	-0.1	1092
Jharkhand	1.1	9.9	0.4	0.0	-0.6	1130	1.5	11.1	0.9	0.1	-0.5	948
Odisha	2.0	12.3	1.1	0.4	-0.7	1213	1.6	14.3	1.4	0.2	-0.7	1036
West Bengal	1.6	6.9	0.9	0.1	-0.6	1481	1.1	4.8	1.6	0.5	-0.3	1234

State	TSFT-for-age						SSFT-for-age					
	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +2SD	Percentage above +3SD	Mean Z-score	Weighted number
Northeast												
Arunachal Pradesh	0.5	5.8	2.2	0.6	-0.2	1174	1.6	7.1	3.1	0.5	-0.4	953
Assam	8.7	30.7	0.4	0.0	-1.4	1386	2.7	17.3	0.9	0.1	-0.9	1164
Manipur	3.4	8.1	0.7	0.0	-0.3	1115	1.6	6.7	2.2	0.2	-0.2	960
Meghalaya	1.8	8.8	1.2	0.1	-0.4	946	1.3	10.0	1.4	0.0	-0.5	749
Mizoram	2.0	9.8	0.6	0.2	-0.7	946	0.3	4.3	1.7	0.0	-0.3	824
Nagaland	2.8	11.9	1.1	0.0	-0.5	1078	2.3	9.1	2.9	0.2	-0.2	884
Sikkim	0.7	3.3	4.6	0.9	0.2	1041	0.7	3.5	5.2	0.3	0.1	888
Tripura	3.5	12.1	4.8	2.1	-0.4	1033	3.0	7.4	7.3	2.0	-0.2	846
West												
Goa	0.7	4.9	2.1	0.2	-0.3	973	0.7	6.2	4.3	0.7	-0.2	818
Gujarat	9.3	19.4	0.5	0.2	-0.7	972	1.8	11.5	1.3	0.0	-0.5	809
Maharashtra	1.2	4.2	0.5	0.0	-0.4	1813	0.4	4.0	1.3	0.2	-0.1	1538
South												
Andhra Pradesh	0.5	4.4	2.3	0.1	-0.2	1126	0.1	3.4	6.3	0.1	0.1	877
Karnataka	1.1	4.7	3.0	0.3	-0.1	870	0.2	3.7	6.2	0.4	0.3	724
Kerala	1.3	5.9	1.0	0.3	-0.3	820	2.1	15.8	0.5	0.0	-0.9	665
Tamil Nadu	1.7	9.9	0.6	0.0	-0.7	1714	1.1	9.1	0.8	0.0	-0.5	1403
Telangana	0.0	3.8	1.3	0.1	-0.2	991	0.9	3.8	2.7	0.1	-0.1	798

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards.
[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median
2962 cases were excluded, 67 cases are flagged and for 2895 cases TSFT was not measured
8587 cases were excluded. 19 cases are flagged and for 8568 cases SSFT was not measured

Table 5.7: Percentage of children aged 6–59 months classified as malnourished according to MUAC-for-age (Z-score: <-3SD, <-2SD) by selected background characteristics, India, CNNS 2016–18

Characteristics	MUAC-for-age			
	Percentage below -3SD	Percentage below -2SD	Mean Z-score	Weighted number
Sex of child				
Male	1.6	11.2	-0.8	17081
Female	1.7	9.7	-0.8	16162
Age in months				
6–8	0.8	6.7	-0.4	1851
9–11	2.3	8.7	-0.5	1862
12–17	1.8	8.4	-0.6	3468
18–23	3.1	12.1	-0.8	3415
24–35	1.6	9.7	-0.8	7431
36–47	1.4	11.4	-0.9	7585
48–59	1.4	11.9	-0.9	7630
Type of diet (Mother)				
Vegetarian	1.7	11.7	--0.9	19,111
Vegetarian with egg	1.0	8.0	-0.7	2,183
Non-vegetarian	1.7	9.2	–0.7	13,824
Mother's age (in years)				
< 20	2.1	10.0	-0.6	683
20–24	1.3	9.9	-0.8	9988
25–29	1.6	10.4	-0.8	12992
30–34	2.2	11.1	-0.8	6495
≥ 35	1.5	11.4	-0.9	2772
Mother's schooling				
No schooling	2.3	14.5	-1.0	10485
<5 years completed	2.2	10.0	-0.9	1877
5–7 years completed	2.0	10.8	-0.9	5327
8–9 years completed	1.3	9.7	-0.7	5357
10–11 years completed	1.3	7.7	-0.7	3773
≥12 years completed	0.6	6.0	-0.4	6403
Religion				
Hindu	1.7	10.9	-0.8	26396
Muslim	1.6	9.0	-0.7	5323
Christian	1.7	5.9	-0.6	833
Sikh	1.9	8.6	-0.5	339
Other	0.0	9.3	-0.9	352

Characteristics	MUAC-for-age			
	Percentage below -3SD	Percentage below -2SD	Mean Z-score	Weighted number
Caste/Tribe				
Scheduled caste	2.0	11.3	-0.9	7569
Scheduled tribe	1.6	12.5	-0.9	4287
Other backward class	1.4	10.1	-0.8	13184
Other	1.7	9.3	-0.7	8203
Residence				
Urban	1.1	6.9	-0.6	7852
Rural	1.8	11.6	-0.9	25391
Wealth index				
Poorest	3.7	17.3	-1.1	6727
Poor	1.5	12.3	-1.0	6551
Middle	1.2	9.5	-0.8	6754
Rich	0.9	7.7	-0.7	6584
Richest	0.9	5.6	-0.4	6627
Total	1.7	10.5	-0.8	33243#

Note: MUAC: Mid upper arm circumference. MUAC is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards.
Total includes 254 children for whom mother's age information was not known/mother died and 30 children for whom mother's schooling information was not known for MUAC
1562 cases were excluded. 199 cases were flagged and for 1363 cases MUAC was not measured

Table 5.8: Percentage of children aged 6–59 months classified as malnourished according to MUAC-for-age (Z-score: <-3SD, <-2SD) by state, India, CNNS 2016–18

State	Percentage below -3SD	Percentage below -2SD	Mean Z-score	Weighted number
India	**1.7**	**10.5**	**-0.8**	**33243#**
North				
Delhi	0.6	4.3	-0.5	1514
Haryana	2.4	9.7	-0.6	966
Himachal Pradesh	0.8	7.5	-0.6	1052
Jammu & Kashmir	3.2	8.7	-0.3	1005
Punjab	1.6	9.4	-0.5	897
Rajasthan	1.7	12.3	-0.9	1015
Uttarakhand	0.1	2.8	-0.2	985
Central				
Chhattisgarh	0.9	11.2	-0.9	1053
Madhya Pradesh	3.4	13.3	-1.0	1015
Uttar Pradesh	1.5	12.7	-0.9	1723
East				
Bihar	2.0	13.0	-1.0	1234
Jharkhand	1.2	12.5	-1.0	1091
Odisha	0.5	3.8	-0.5	1157
West Bengal	0.8	6.2	-0.6	1415
Northeast				
Arunachal Pradesh	0.1	2.5	-0.1	1125
Assam	4.6	13.3	-0.9	1297
Manipur	0.2	3.5	-0.3	1056
Meghalaya	3.8	13.2	-0.8	894
Mizoram	0.7	3.6	-0.3	911
Nagaland	5.7	12.5	-0.7	1008
Sikkim	1.6	5.4	-0.3	980
Tripura	1.1	7.2	-0.5	951
West				
Goa	0.4	4.6	-0.3	916
Gujarat	1.0	10.7	-0.8	930
Maharashtra	0.7	6.4	-0.7	1713
South				
Andhra Pradesh	1.7	11.1	-0.8	1081
Karnataka	1.3	8.8	-0.6	842
Kerala	0.4	4.0	-0.3	779
Tamil Nadu	1.0	6.3	-0.5	1633
Telangana	2.9	13.2	-1.0	933

Note: MUAC: Mid upper arm circumference. MUAC is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards.
1562 cases were excluded. 199 cases were flagged and for 1363 cases MUAC was not measured

Table 5.9: Percentage of children aged 6–59 months classified as malnourished according to absolute MUAC (< 115 mm, < 125 mm) by selected background characteristics, India, CNNS 2016–18

Characteristics	Percentage below 115 mm	Percentage below 125 mm	Weighted number
Sex of child			
Male	0.5	3.8	17081
Female	1.2	6.0	16162
Age in months			
6–8	1.8	17.0	1851
9–11	3.7	10.8	1862
12–17	2.0	9.6	3468
18–23	2.0	9.9	3415
24–35	0.3	3.8	7431
36–47	0.2	1.4	7585
48–59	0.1	0.8	7630
Type of diet (Mother)			
Vegetarian	1.1	5.6	19,992
Vegetarian with egg	0.9	3.6	2,276
Non-vegetarian	1.0	4.5	14,291
Mother's age (in years)			
< 20	2.3	10.9	683
20–24	1.0	5.8	9988
25–29	0.7	4.4	12992
30–34	1.0	3.9	6495
≥ 35	0.3	4.5	2772
Mother's schooling			
No schooling	1.1	6.2	10485
<5 years completed	0.4	4.9	1877
5–7 years completed	1.0	5.5	5327
8–9 years completed	0.7	4.5	5357
10–11 years completed	0.8	3.8	3773
≥ 12 years completed	0.6	3.1	6403
Religion			
Hindu	0.9	5.1	26396
Muslim	0.9	4.5	5323
Christian	0.9	2.7	833
Sikh	0.6	3.9	339
Other	0.0	1.8	352

Characteristics	Percentage below 115 mm	Percentage below 125 mm	Weighted number
Caste/Tribe			
Scheduled caste	1.0	5.9	7569
Scheduled tribe	0.9	4.7	4287
Other backward class	0.5	4.4	13184
Other	1.3	4.9	8203
Residence			
Urban	0.6	3.4	7852
Rural	0.9	5.3	25391
Wealth index			
Poorest	1.6	8.4	6727
Poor	0.9	5.5	6551
Middle	0.5	4.0	6754
Rich	0.9	3.9	6584
Richest	0.5	2.6	6627
Total	0.9	4.9	33243

Table 5.10: Percentage of children aged 6–59 months classified as malnourished according to absolute MUAC (< 115 mm, < 125 mm) by state, India, CNNS 2016–18

State	Percentage below 115 mm	Percentage below 125 mm	Weighted number
India	**0.9**	**4.9**	**33243**
North			
Delhi	0.3	2.4	1514
Haryana	0.7	4.7	966
Himachal Pradesh	0.6	2.4	1052
Jammu & Kashmir	2.5	6.0	1005
Punjab	1.1	3.7	897
Rajasthan	1.0	5.2	1015
Uttarakhand	0.1	0.8	985
Central			
Chhattisgarh	0.2	3.8	1053
Madhya Pradesh	1.3	5.9	1015
Uttar Pradesh	0.9	6.7	1723
East			
Bihar	1.0	5.8	1234
Jharkhand	0.6	6.2	1091
Odisha	0.4	2.2	1157
West Bengal	0.0	2.0	1415
Northeast			
Arunachal Pradesh	0.1	1.0	1125
Assam	3.7	8.7	1297
Manipur	0.1	1.3	1056
Meghalaya	2.3	8.2	894
Mizoram	0.3	1.5	911
Nagaland	4.5	9.4	1008
Sikkim	1.6	3.2	980
Tripura	0.2	2.8	951
West			
Goa	0.3	2.2	916
Gujarat	0.4	4.7	930
Maharashtra	0.3	3.0	1713
South			
Andhra Pradesh	0.8	3.9	1081
Karnataka	1.0	4.1	842
Kerala	0.9	1.7	779
Tamil Nadu	0.7	3.4	1633
Telangana	0.9	5.2	933

Table 5.11: Percentage of children aged 5–9 years classified as stunted and underweight according to height-for-age (Z-score: <-3SD, <-2SD) and weight-for-age (Z-score: <-3SD, <-2SD) by selected background characteristics, India, CNNS 2016–18

Characteristics	Height-for-age				Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number
Sex of child								
Male	5.8	21.6	-1.1	18651	10.9	35.6	-1.1	18600
Female	5.3	22.1	-1.1	18338	9.2	34.7	-1.1	18355
Age in years								
5–7	5.9	23.5	-1.1	22465	9.6	35.2	-1.1	22446
8–9	4.9	19.3	-1.0	14525	10.8	35.1	-1.0	14509
Schooling Status								
Currently in school	4.8	20.2	-1.0	33565	9.5	34.1	-1.1	33512
Not in school	12.7	38.2	-1.5	3424	15.5	45.2	-1.6	3444
Type of diet (Mother)								
Vegetarian	6.0	22.3	-1.1	20,883	10.5	35.4	-1.1	20,872
Vegetarian with egg	4.8	20.6	-1.1	3,134	9.4	34.5	-1.2	3,135
Non-vegetarian	5.0	21.4	-1.1	12,972	9.5	35.0	-1.1	12,948
Mother's education								
No schooling	6.9	26.4	-1.2	15477	12.6	39.8	-1.2	15467
<5 years completed	5.6	24.2	-1.2	2809	10.4	40.9	-1.2	2804
5–7 years completed	6.8	23.8	-1.2	5763	10.5	38.1	-1.2	5757
8–9 years completed	4.7	18.2	-1.1	5089	9.2	33.5	-1.1	5075
10–11 years completed	2.7	16.4	-0.9	3455	6.0	26.4	-0.9	3455
≥ 12 years completed	2.2	10.6	-0.6	4349	4.3	20.2	-0.6	4353

Characteristics	Height-for-age				Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number
Religion								
Hindu	5.6	21.8	-1.1	29317	10.3	35.5	-1.1	29282
Muslim	5.3	23.2	-1.1	5899	9.7	35.9	-1.1	5900
Christian	4.0	17.8	-1.0	946	8.3	28.8	-1.1	948
Sikh	2.8	10.4	-0.7	395	2.1	15.5	-0.7	395
Other	9.5	26.6	-1.4	431	9.6	34.8	-1.4	431
Caste/Tribe								
Scheduled caste	6.8	24.6	-1.2	8431	12.0	38.3	-1.2	8436
Scheduled tribe	6.4	26.5	-1.3	4827	12.3	41.3	-1.3	4809
Other backward class	5.0	20.0	-1.0	14685	9.0	33.4	-1.1	14686
Other	4.7	19.9	-1.0	9046	8.7	31.9	-1.0	9024
Residence								
Urban	3.7	17.8	-0.9	8844	7.3	28.2	-0.9	8845
Rural	6.1	23.1	-1.1	28145	10.9	37.4	-1.2	28110
Wealth index								
Poorest	9.3	30.3	-1.3	7445	14.3	43.0	-1.4	7431
Poor	6.3	26.2	-1.2	7470	12.0	40.9	-1.2	7456
Middle	5.9	22.2	-1.2	7374	10.8	39.2	-1.2	7359
Rich	3.8	18.4	-1.0	7403	8.6	31.9	-1.0	7414
Richest	2.2	12.0	-0.7	7297	4.3	20.5	-0.7	7296
Total	5.5	21.9	-1.1	36989	10.0	35.2	-1.1	36955

Note: Each of the indices is expressed in SD units from the median of the 2006 WHO Child Growth Standards.
Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.
[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median
Total includes 72 and 71 children for whom mother's schooling information was not known for height-for-age and weight-for-age, respectively

Table 5.12: Percentage of children aged 5–9 years classified as stunted and underweight according to height-for-age (Zp-score: <-3SD, <-2SD) and weight-for-age (Z-score: <-3SD, <-2SD) by state, India, CNNS 2016–18

State	Height-for-age				Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number
India	**5.5**	**21.9**	**-1.1**	**36989**	**10.0**	**35.2**	**-1.1**	**36955**
North								
Delhi	5.5	21.0	-1.1	1637	8.5	30.8	-1.1	1637
Haryana	3.0	16.4	-1.0	1045	5.6	28.7	-1.0	1049
Himachal Pradesh	3.1	20.3	-1.0	1184	9.4	33.5	-1.0	1181
Jammu & Kashmir	4.8	13.3	-0.4	1151	5.4	16.7	-0.4	1158
Punjab	2.5	12.3	-0.7	1029	2.7	18.4	-0.7	1028
Rajasthan	6.1	23.9	-1.0	1237	9.3	33.7	-1.0	1238
Uttarakhand	4.1	20.4	-1.0	1118	6.0	23.5	-1.0	1120
Central								
Chhattisgarh	5.2	21.0	-1.1	1157	9.2	34.1	-1.1	1158
Madhya Pradesh	5.3	21.1	-1.1	1187	9.3	34.4	-1.1	1183
Uttar Pradesh	5.6	21.2	-1.0	1946	11.2	34.9	-1.0	1946
East								
Bihar	9.0	28.5	-1.3	1390	11.4	39.5	-1.3	1386
Jharkhand	8.5	24.9	-1.3	1165	15.0	45.4	-1.3	1167
Odisha	4.7	21.4	-1.2	1322	9.4	37.0	-1.3	1321
West Bengal	4.2	19.0	-1.1	1545	11.7	40.8	-1.2	1528

State	Height-for-age				Weight-for-age			
	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number	Percentage below -3SD	Percentage below -2SD[1]	Mean Z-score	Weighted number
Northeast								
Arunachal Pradesh	5.0	18.2	-0.8	1152	2.6	17.0	-0.8	1157
Assam	9.6	26.1	-1.3	1423	9.6	41.3	-1.3	1429
Manipur	5.7	19.8	-1.0	1173	3.0	17.4	-1.0	1168
Meghalaya	10.0	34.1	-1.4	1017	9.2	31.4	-1.5	1024
Mizoram	5.6	23.6	-1.2	1001	4.6	19.6	-1.2	1007
Nagaland	8.2	24.4	-1.1	1128	4.4	17.6	-1.1	1130
Sikkim	5.2	18.8	-1.1	1048	2.8	17.2	-1.1	1058
Tripura	9.1	27.9	-1.1	1038	11.2	34.1	-1.1	1041
West								
Goa	3.8	14.2	-0.8	1044	7.1	24.9	-0.8	1042
Gujarat	5.1	26.4	-1.4	1063	11.3	40.0	-1.4	1065
Maharashtra	4.6	24.7	-1.2	1943	10.5	36.3	-1.2	1934
South								
Andhra Pradesh	4.3	21.2	-1.0	1204	8.5	31.4	-1.0	1200
Karnataka	4.5	21.5	-1.2	935	11.3	39.5	-1.2	937
Kerala	1.1	11.2	-0.8	845	5.3	21.5	-0.8	844
Tamil Nadu	2.2	9.7	-0.7	1752	5.7	23.4	-0.7	1763
Telangana	2.5	15.5	-0.8	976	8.7	33.3	-0.8	980

Note: Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.
[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median

Table 5.13: Percentage of children aged 5–9 years classified as malnourished according to BMI-for-age (Z-score: <-3SD, <-2SD, >+1SD, >+2SD) by selected background characteristics, India, CNNS 2016–18

Characteristics	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Sex of child						
Male	5.9	25.7	4.2	1.8	-1.3	18448
Female	3.9	20.3	3.3	0.9	-1.2	18231
Age in years						
5–7	4.6	21.3	3.1	1.1	-1.2	22271
8–9	5.2	25.7	4.7	1.6	-1.3	14408
Schooling status						
Currently in school	4.8	23.3	3.8	1.4	-1.2	33272
Not in school	5.6	20.0	2.8	1.0	-1.2	3407
Type of diet (Mother)						
Vegetarian	4.6	23.4	2.5	0.8	-1.3	20,718
Vegetarian with egg	4.8	23.3	4.9	2.2	-1.2	3,113
Non-vegetarian	5.3	22.4	5.4	1.9	-1.2	12,848
Mother's schooling						
No schooling	5.0	24.7	1.6	0.6	-1.4	15355
<5 years completed	5.2	25.2	3.1	0.7	-1.3	2792
5–7 years completed	5.2	23.8	3.5	1.0	-1.3	5706
8–9 years completed	5.2	22.9	4.2	1.6	-1.2	5034
10–11 years completed	3.5	19.3	6.1	2.2	-1.0	3435
≥12 years completed	4.3	17.7	9.6	3.5	-0.8	4312

Characteristics	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Religion						
Hindu	4.9	23.1	3.5	1.2	-1.3	29071
Muslim	5.0	24.0	3.6	1.1	-1.2	5855
Christian	4.5	19.9	7.6	2.6	-1.0	934
Sikh	1.6	12.7	7.8	3.8	-0.7	392
Other	3.6	18.3	8.8	4.0	-0.8	427
Caste/Tribe						
Scheduled caste	4.9	23.9	3.1	1.1	-1.3	8348
Scheduled tribe	5.3	24.9	2.8	1.1	-1.3	4771
Other backward class	4.6	22.8	3.6	1.3	-1.2	14586
Other	5.0	21.5	5.1	1.8	-1.1	8974
Residence						
Urban	4.7	19.8	7.5	2.8	-1.0	8761
Rural	4.9	24.0	2.6	0.9	-1.3	27917
Wealth index						
Poorest	4.4	24.0	1.0	0.3	-1.4	7377
Poor	6.1	26.3	1.7	0.8	-1.4	7402
Middle	5.4	24.9	2.9	0.8	-1.3	7323
Rich	4.8	22.1	4.5	1.4	-1.2	7348
Richest	3.6	17.6	8.7	3.4	-0.8	7230
Total	4.9	23.0	3.7	1.3	-1.2	36679#

Note: BMI: Body Mass Index. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median

2,097 cases were excluded. 497 cases were flagged and in 1,600 cases height/weight was not measured

Total includes 71 children for whom mother's schooling information was not known for BMI

Table 5.14: Percentage of children aged 5–9 years classified as malnourished according to BMI-for-age (Z-score: <-3SD, <-2SD, >+1SD, >+2SD) by state, India, CNNS 2016–18

State	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
India	**4.9**	**23.0**	**3.7**	**1.3**	**-1.2**	**36679#**
North						
Delhi	3.1	18.5	6.0	2.0	-1.0	1634
Haryana	3.4	20.4	3.7	1.2	-1.1	1042
Himachal Pradesh	4.6	22.2	3.8	1.2	-1.2	1169
Jammu & Kashmir	6.7	16.6	9.0	3.4	-0.8	1133
Punjab	2.2	11.9	7.9	2.8	-0.8	1024
Rajasthan	3.9	22.1	1.6	0.4	-1.3	1235
Uttarakhand	3.7	14.2	6.1	1.9	-0.9	1110
Central						
Chhattisgarh	5.9	23.7	1.8	0.3	-1.3	1137
Madhya Pradesh	5.3	21.8	1.4	0.7	-1.4	1178
Uttar Pradesh	4.8	25.9	1.6	0.5	-1.3	1925
East						
Bihar	4.2	21.4	0.8	0.2	-1.3	1383
Jharkhand	4.9	27.9	0.5	0.3	-1.5	1163
Odisha	3.8	18.8	7.8	2.9	-1.0	1314
West Bengal	7.3	28.3	4.4	1.8	-1.4	1515

State	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Northeast						
Arunachal Pradesh	2.6	9.4	9.5	2.9	-0.4	1145
Assam	5.9	24.6	7.4	2.8	-1.1	1409
Manipur	2.0	6.1	8.5	2.5	-0.5	1149
Meghalaya	3.3	9.4	6.4	1.8	-0.7	1006
Mizoram	1.5	5.1	9.4	3.0	-0.4	986
Nagaland	2.1	7.9	14.7	4.3	-0.4	1115
Sikkim	2.4	9.0	10.6	4.2	-0.4	1048
Tripura	5.8	19.6	11.6	4.5	-0.9	1015
West						
Goa	5.4	21.1	14.5	5.5	-0.8	1034
Gujarat	3.3	21.2	5.5	1.6	-1.1	1047
Maharashtra	5.0	23.4	6.8	2.2	-1.1	1921
South						
Andhra Pradesh	4.8	20.8	8.2	3.3	-1.0	1198
Karnataka	6.7	28.2	3.8	1.1	-1.3	926
Kerala	4.0	16.3	9.6	4.0	-0.8	843
Tamil Nadu	5.9	19.2	9.5	4.2	-0.9	1743
Telangana	7.7	28.1	4.9	1.4	-1.3	973

Note: BMI: Body Mass Index. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Includes children who are below -3 SD from the WHO Child Growth Standards population median

2,097 cases were excluded. 497 cases were flaggedand in 1,600 cases height/weight was not measured

Table 5.15: Percentage of adolescents aged 10–19 years classified as malnourished according to BMI-for-age (Z-score: <-3SD, <-2SD, >+1SD, >+2SD) by selected background characteristics, India, CNNS 2016–18

Characteristics	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Sex of child						
Male	8.7	29.4	4.9	1.1	-1.3	16043
Female	4.3	18.9	4.7	1.1	-1.0	16253
Age in years						
5–7	8.0	27.3	5.3	1.3	-1.2	17952
8–9	4.6	20.1	4.2	0.8	-1.1	14344
Schooling status						
Currently in school	6.8	24.7	5.3	1.2	-1.2	24794
Not in school	5.3	22.1	3.3	0.7	-1.1	7503
Type of diet (Mother)						
Vegetarian	6.9	25.7	3.5	0.9	-1.2	18,183
Vegetarian with egg	6.3	23.1	5.2	0.9	-1.1	2,683
Non-vegetarian	5.9	21.8	6.8	1.4	-1.0	11,430
Mother's schooling						
No schooling	6.6	25.6	2.3	0.4	-1.3	17185
<5 years completed	7.9	26.4	4.1	0.7	-1.3	2197
5–7 years completed	6.4	23.1	6.5	1.4	-1.1	4277
8–9 years completed	6.0	23.0	7.1	1.3	-1.0	3847
10–11 years completed	6.0	21.7	8.2	2.6	-0.9	2418
≥12 years completed	5.7	17.0	13.6	3.7	-0.6	2372

Characteristics	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Religion						
Hindu	6.5	24.4	4.5	1.0	-1.2	26071
Muslim	7.3	24.7	5.5	1.2	-1.1	4794
Christian	3.9	16.7	6.2	1.2	-0.8	714
Sikh	3.5	17.2	11.6	2.7	-0.8	378
Other	4.0	17.5	5.5	1.9	-0.9	340
Caste						
Scheduled caste	5.8	22.9	4.0	0.8	-1.2	7316
Scheduled tribe	5.3	22.2	2.1	0.4	-1.2	3559
Other backward class	7.4	26.5	4.6	1.0	-1.2	13461
Other	6.1	22.1	7.1	1.8	-1.0	7959
Residence						
Urban	6.0	20.4	9.7	2.2	-0.9	7779
Rural	6.6	25.3	3.2	0.7	-1.2	24518
Wealth index						
Poorest	7.3	27.2	0.8	0.1	-1.4	6695
Poor	6.6	26.6	2.1	0.2	-1.3	6558
Middle	7.1	26.0	3.5	0.7	-1.2	6434
Rich	6.2	22.2	6.4	1.5	-1.0	6323
Richest	5.2	18.2	11.6	3.0	-0.8	6286
Total	6.5	24.1	4.8	1.1	-1.1	32296#

Note: BMI: Body Mass Index. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Includes adolescents who are below -3 SD from the WHO Child Growth Standards population median

3420 cases were excluded: 198 cases were flaggedand for 3,222 cases height/weight was not measured

Table 5.16: Percentage of adolescents aged 10–19 years classified as malnourished according to BMI-for-age (Z-score: <-3SD, <-2SD, >+1SD, >+2SD) by state, India, CNNS 2016–18

State	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
India	**6.5**	**24.1**	**4.8**	**1.1**	**-1.1**	**32296#**
North						
Delhi	4.9	21.3	12.3	3.3	-0.8	1349
Haryana	5.6	20.6	4.9	1.3	-1.1	954
Himachal Pradesh	9.9	31.2	5.5	1.2	-1.3	1075
Jammu & Kashmir	4.0	13.3	9.0	1.8	-0.6	1026
Punjab	2.9	17.8	9.1	2.8	-0.9	891
Rajasthan	7.4	29.3	2.9	0.3	-1.4	1102
Uttarakhand	2.2	15.2	5.2	1.0	-0.8	974
Central						
Chhattisgarh	5.4	18.3	4.2	0.9	-1.1	973
Madhya Pradesh	8.3	31.9	2.3	0.3	-1.4	1058
Uttar Pradesh	5.9	22.4	2.3	0.5	-1.2	1695
East						
Bihar	4.8	22.8	1.9	0.1	-1.3	1259
Jharkhand	6.3	28.4	2.4	0.2	-1.3	976
Odisha	3.9	18.4	7.8	1.8	-0.9	1138
West Bengal	6.9	25.1	7.7	2.0	-1.1	1132

State	Percentage below -3SD	Percentage below -2SD[1]	Percentage above +1SD	Percentage above +2SD	Mean Z-score	Weighted number
Northeast						
Arunachal Pradesh	1.6	7.8	11.0	2.1	-0.3	990
Assam	7.4	19.6	4.2	1.3	-1.0	1258
Manipur	1.1	6.1	8.5	2.5	-0.4	1025
Meghalaya	1.2	6.6	3.4	0.2	-0.6	883
Mizoram	0.8	6.4	7.8	0.9	-0.4	898
Nagaland	1.8	10.0	9.4	1.5	-0.5	974
Sikkim	1.4	9.9	9.3	2.0	-0.6	921
Tripura	4.7	16.2	9.2	1.9	-0.8	921
West						
Goa	6.7	21.8	14.2	4.9	-0.8	896
Gujarat	10.5	30.2	7.9	1.7	-1.2	910
Maharashtra	7.6	24.5	6.9	1.8	-1.1	1733
South						
Andhra Pradesh	5.5	19.7	9.4	2.2	-0.9	1012
Karnataka	8.8	26.5	7.2	2.2	-1.1	802
Kerala	6.0	20.1	9.5	2.4	-0.8	714
Tamil Nadu	6.3	19.4	14.4	3.5	-0.6	1663
Telangana	9.1	28.7	5.6	1.5	-1.2	852

Note: BMI: Body Mass Index. Each of the indices is expressed in standard deviation (SD) units from the median of the 2006 WHO Child Growth Standards. Table is based on children with valid dates of birth (month and year) and valid measurement of both height and weight.

[1]Includes adolescents who are below -3 SD from the WHO Child Growth Standards population median

3420 cases were excluded of which 198 cases were flaggedand for 3,222 cases height/weight was not measured

Table 5.17: Percentage of children aged 5–9 years classified as malnourished or overweight/obese according to TSFT, SSFT, MUAC and waist circumference, by selected background characteristics, India, CNNS 2016–18

Characteristics	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Sex of child											
Male	11.9	2.6	18653	0.2	9.4	18652	36.5	2.6	18516	1.9	18511
Female	15.5	1.2	18392	0.1	5.6	18392	27.6	1.9	18332	1.1	18327
Age in years											
5–7	14.1	1.5	22513	0.3	7.5	22512	35.3	1.8	22382	1.5	22373
8–9	13.1	2.5	14532	0.1	7.5	14533	27.1	3.0	14466	2.4	14465
Schooling status											
Currently in school	13.5	2.0	33609	0.2	7.6	33610	30.9	2.4	33432	1.9	33427
Not in school	15.5	0.7	3436	0.3	6.7	3434	43.4	1.1	3417	1.9	3410
Type of diet (Mother)											
Vegetarian	15.6	1.3	20,907	0.2	5.7	20,908	34.5	1.5	20,788	1.3	20,837
Vegetarian with egg	12.3	2.1	3,135	0.0	8.9	3,135	31.0	2.5	3,126	1.2	3,104
Non-vegetarian	11.1	2.8	13,003	0.1	10.2	13,002	28.5	3.4	12,934	2.0	12,895
Mother's schooling											
No schooling	19.2	0.4	15489	0.2	4.2	15491	38.1	0.8	15435	0.8	15427
<5 years completed	11.5	1.1	2814	0.2	6.8	2816	31.3	1.6	2797	0.4	2793
5–7 years completed	10.3	1.5	5777	0.2	7.0	5776	32.2	1.5	5719	1.6	5746
8–9 years completed	11.5	2.1	5101	0.2	8.3	5101	28.9	2.5	5058	1.9	5066
10–11 years completed	7.9	4.0	3464	0.1	11.8	3463	26.0	4.3	3456	3.0	3447
≥ 12 years completed	7.7	6.2	4353	0.1	16.2	4350	19.5	7.2	4336	6.1	4311

Characteristics	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Religion											
Hindu	14.3	1.9	29364	0.2	7.2	29363	32.9	2.2	29205	1.8	29213
Muslim	11.6	1.4	5908	0.3	8.1	5909	29.4	2.1	5883	1.6	5862
Christian	11.7	2.7	948	0.3	11.1	948	26.9	4.1	939	2.9	942
Sikh	9.6	4.2	394	0.0	9.7	394	27.0	5.7	391	5.5	392
Other	15.1	2.4	431	1.3	8.8	431	26.8	2.0	431	2.9	428
Caste/Tribe											
Scheduled caste	13.2	1.5	8449	0.2	7.1	8451	35.0	1.9	8385	1.2	8412
Scheduled tribe	24.4	0.9	4836	0.3	3.8	4835	37.9	0.9	4817	1.2	4813
Other backward class	11.8	1.7	14706	0.2	7.5	14705	31.3	2.2	14629	1.8	14630
Other	11.6	3.0	9054	0.1	10.0	9054	27.5	3.5	9017	3.2	8983
Residence											
Urban	6.0	4.6	8858	0.1	14.5	8857	23.7	5.1	8840	4.3	8801
Rural	16.1	1.0	28188	0.2	5.3	28188	34.7	1.4	28008	1.1	28036
Wealth index											
Poorest	23.6	0.0	7455	0.3	1.7	7456	41.7	0.2	7418	0.2	7431
Poor	17.5	0.3	7484	0.2	3.7	7484	37.4	0.6	7448	0.4	7442
Middle	12.7	1.3	7379	0.2	6.8	7381	32.7	1.3	7306	1.5	7334
Rich	9.2	2.5	7422	0.2	9.9	7422	28.5	2.7	7398	1.9	7376
Richest	5.5	5.5	7305	0.1	15.7	7301	19.8	6.6	7278	5.2	7254
Total	13.7	1.9	37045	0.2	7.5	37045	32.1	2.3	36848	1.5	36837

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness; MUAC: Mid-upper arm circumference; WC: Waist circumference. Each of the indices is expressed in standard deviation (SD) units calculated from the LMS (lambda, mu, and sigma) method. Total includes 72 children and 38 children for whom mother's schooling information was not known for TSFT/SSFT and WC, respectively, and are not shown separately.

Source (TSFT & SSFT): O Yaw Addo, John H Himes, Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents, The American Journal of Clinical Nutrition, Volume 91, Issue 3, March 2010, Pages 635–642,

Source (MUAC): Abdel-Rahman SM1, Bi C, Thaete K (2017). Construction of Lambda, Mu, Sigma Values for Determining Mid-Upper Arm Circumference z Scores in U.S. Children Aged 2 Months Through 18 Years. Nutr Clin Pract. 32(1):68–76.

Source (WC): Sharma, A. K., D. L. Metzger, et al. (2015). "LMS tables for waist-circumference and waist-height ratio Z-scores in children aged 5–19 y in NHANES III: association with cardio-metabolic risks." Pediatric Research 78: 723.

Table 5.18: Percentage of children aged 5–9 years classified as malnourished or overweight/obese according to TSFT, SSFT, MUAC and waist circumference by state, India, CNNS 2016–18

States	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
India	**13.7**	**1.9**	**37045**	**0.2**	**7.5**	**37045**	**32.1**	**2.3**	**36848**	**1.5**	**36837**
North											
Delhi	8.7	4.5	1640	0.0	12.9	1638	21.9	5.1	1640	3.9	1620
Haryana	12.7	2.5	1049	0.0	6.5	1049	27.8	3.1	1039	1.9	1047
Himachal Pradesh	12.5	0.7	1183	0.4	5.3	1184	34.0	2.8	1174	0.8	1183
Jammu & Kashmir	11.4	1.3	1156	0.0	9.6	1161	20.0	8.9	1147	4.1	1148
Punjab	8.9	4.1	1027	0.2	10.5	1027	27.4	5.8	1017	3.8	1019
Rajasthan	17.1	0.8	1237	0.3	5.2	1237	37.3	1.0	1236	0.6	1233
Uttarakhand	9.7	3.6	1121	0.1	11.3	1121	23.4	3.0	1118	2.3	1121
Central											
Chhattisgarh	21.3	0.3	1157	0.3	4.6	1157	33.4	0.7	1155	1.4	1150
Madhya Pradesh	15.2	0.5	1186	0.2	2.8	1186	35.7	0.4	1185	0.6	1185
Uttar Pradesh	21.6	0.7	1948	0.4	4.9	1949	36.1	1.0	1935	0.9	1938
East											
Bihar	12.2	0.3	1390	0.1	4.1	1390	35.9	0.4	1374	0.3	1387
Jharkhand	23.3	0.4	1166	0.2	2.9	1165	39.3	0.3	1162	0.6	1162
Odisha	19.0	5.7	1326	0.3	9.3	1324	25.3	6.1	1326	4.4	1321
West Bengal	9.9	3.4	1554	0.0	10.5	1554	25.6	3.6	1549	2.0	1551

States	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Northeast											
Arunachal Pradesh	8.9	3.9	1157	0.8	10.7	1158	12.4	5.1	1155	7.1	1154
Assam	15.4	0.6	1431	0.1	4.4	1431	30.9	2.2	1388	1.0	1336
Manipur	8.5	2.3	1169	0.3	7.8	1173	16.8	2.7	1171	3.5	1171
Meghalaya	11.3	1.4	1028	0.2	5.7	1028	27.7	2.5	1016	2.4	1006
Mizoram	14.8	2.0	1011	0.3	6.3	1011	15.8	3.6	1009	2.5	1004
Nagaland	9.5	0.9	1130	0.1	10.3	1130	23.1	4.6	1116	6.8	1115
Sikkim	1.9	6.9	1058	0.2	13.0	1058	18.9	3.6	1054	6.2	1054
Tripura	8.9	5.8	1041	0.2	18.3	1039	28.9	6.1	1040	4.1	1033
West											
Goa	4.8	7.8	1045	0.1	21.1	1044	19.5	10.9	1043	6.8	1040
Gujarat	8.7	3.3	1065	0.1	8.2	1064	33.0	3.4	1062	3.2	1061
Maharashtra	8.9	1.9	1943	0.2	10.8	1943	27.2	2.2	1935	1.2	1937
South											
Andhra Pradesh	6.5	4.0	1209	0.0	19.2	1208	32.2	3.7	1203	1.2	1203
Karnataka	4.8	4.4	941	0.2	16.2	941	26.9	3.1	939	1.7	933
Kerala	3.0	5.6	845	0.2	11.0	844	17.4	8.4	843	5.4	842
Tamil Nadu	2.7	3.9	1762	0.1	12.3	1762	20.5	7.9	1762	4.3	1735
Telangana	4.1	5.2	976	0.0	14.0	977	37.8	2.5	969	1.1	972

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness; MUAC: Mid-upper arm circumference; WC: Waist circumference. Each of the indices is expressed in standard deviation (SD) units calculated from the LMS (lambda, mu, and sigma) method. Total includes 72 children and 38 children for whom mother's schooling information was not known for TSFT/SSFT and WC, respectively, who are not shown separately.

Source (TSFT & SSFT): O Yaw Addo, John H Himes, Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents, The American Journal of Clinical Nutrition, Volume 91, Issue 3, March 2010, Pages 635–642,

Source (MUAC): Abdel-Rahman SM1, Bi C, Thaete K (2017). Construction of Lambda, Mu, Sigma Values for Determining Mid-Upper Arm Circumference z Scores in U.S. Children Aged 2 Months Through 18 Years. Nutr Clin Pract. 32(1):68–76.

Source (WC): Sharma, A. K., D. L. Metzger, et al. (2015). "LMS tables for waist-circumference and waist-height ratio Z-scores in children aged 5–19 y in NHANES III: association with cardio-metabolic risks." Pediatric Research 78: 723.

Table 5.19: Percentage of children aged 10–19 years classified as malnourished or overweight/obese according to TSFT, SSFT, MUAC and waist circumference by selected background characteristics, India, CNNS 2016–18

Characteristics	TSFT-for-age			SSFT-for-age			MUAC-for-gage			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Sex of child											
Male	4.8	5.5	17134	0.8	7.2	17128	39.2	2.0	16949	2.2	17019
Female	11.4	1.8	17085	1.4	4.4	17060	23.2	2.1	16957	1.2	17011
Age in years											
10–14	10.1	3.1	18036	0.5	6.6	18027	29.3	2.6	17936	2.3	17932
15–19	5.9	4.3	16183	1.7	4.9	16161	33.3	1.5	15970	2.0	16098
Schooling Status											
Currently in school	7.6	4.1	25845	0.9	6.4	25822	30.9	2.4	25636	2.4	25722
Not in school	9.7	2.2	8373	1.9	3.9	8367	32.1	1.2	8269	1.2	8309
Type of diet (Mother)											
Vegetarian	9.7	2.6	19,149	1.2	4.5	19,141	32.5	1.4	18,963	1.2	19,087
Vegetarian with egg	6.4	4.5	2,831	0.7	7.4	2,827	32.7	1.9	2,811	1.6	2,807
Non-vegetarian	6.1	5.1	12,239	1.0	7.6	12,220	28.8	3.1	12,132	2.5	12,137
Mother's education											
No schooling	9.8	1.7	18163	1.2	3.3	18158	33.7	0.7	17987	0.9	18060
<5 years completed	7.3	2.6	2354	0.7	4.7	2350	35.4	1.1	2336	1.3	2341
5–7 years completed	7.4	4.1	4594	1.5	6.2	4591	28.8	2.8	4548	2.3	4571
8–9 years completed	6.3	5.5	4077	1.2	7.5	4069	27.8	3.4	4043	3.6	4056
10–11 years completed	3.9	7.5	2563	0.4	11.1	2559	27.9	4.0	2533	4.2	2549
≥12 years completed	4.9	11.2	2468	0.6	15.7	2461	21.9	7.2	2458	7.1	2452

Characteristics	TSFT-for-age			SSFT-for-age			MUAC-for-gage			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Religion											
Hindu	8.6	3.5	27575	1.1	5.6	27549	31.4	1.9	27336	2.1	27431
Muslim	6.8	3.9	5100	0.9	6.5	5098	30.5	2.6	5055	2.1	5071
Christian	4.1	5.3	757	1.5	7.4	754	27.3	2.1	744	3.4	750
Sikh	5.2	6.9	418	1.2	7.5	418	27.0	4.7	409	4.7	416
Other	4.6	4.5	368	0.0	7.7	368	34.0	1.3	363	0.9	361
Caste											
Schedule Caste	7.7	2.9	7693	0.8	5.0	7690	30.8	1.5	7622	1.3	7664
Schedule Tribe	12.3	0.9	3765	2.1	2.2	3763	31.9	0.8	3702	0.7	3741
Other backward class	8.0	3.8	14313	1.0	5.9	14295	32.9	2.1	14215	2.1	14255
Other	6.9	5.4	8448	1.0	7.8	8440	28.3	3.1	8367	3.7	8370
Residence											
Urban	4.7	7.1	8328	0.8	10.4	8317	27.5	4.0	8254	4.8	8278
Rural	9.2	2.5	25890	1.2	4.3	25871	32.4	1.4	25652	1.3	25753
Wealth index											
Poorest	13.8	0.3	6882	1.4	1.1	6881	36.5	0.3	6810	0.3	6842
Poor	9.9	1.5	6911	1.5	2.6	6910	34.8	0.6	6833	0.5	6875
Middle	7.8	2.1	6852	1.0	3.9	6840	31.9	1.6	6797	1.0	6802
Rich	5.1	4.5	6805	0.8	8.2	6794	28.4	2.3	6758	2.9	6769
Richest	3.8	9.8	6769	0.7	13.2	6763	24.0	5.7	6708	6.1	6743
Total	8.1	3.6	34219	1.1	5.8	34188	31.2	2.1	33906	1.7	34031

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness; MUAC: Mid-upper arm circumference; WC: Waist circumference. Each of the indices is expressed in standard deviation (SD) units calculated from the LMS (lambda, mu, and sigma) method.

Source (TSFT & SSFT): O Yaw Addo, John H Himes, Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents, The American Journal of Clinical Nutrition, Volume 91, Issue 3, March 2010, Pages 635–642,

Source (MUAC): Abdel-Rahman SM1, Bi C, Thaete K (2017). Construction of Lambda, Mu, Sigma Values for Determining Mid-Upper Arm Circumference z Scores in U.S. Children Aged 2 Months Through 18 Years. Nutr Clin Pract. 32(1):68–76.

Source (WC): Sharma, A. K., D. L. Metzger, et al. (2015). "LMS tables for waist-circumference and waist-height ratio Z-scores in children aged 5–19 y in NHANES III: association with cardio-metabolic risks." Pediatric Research 78: 723.

Table 5.20: Percentage of children aged 10–19 years classified as malnourished or overweight/obese according to TSFT, SSFT, MUAC and waist circumference by state, India, CNNS 2016–18

States	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
India	**8.1**	**3.6**	**34219**	**1.1**	**5.8**	**34188**	**31.2**	**2.1**	**33906**	**1.7**	**34031**
North											
Delhi	3.3	10.5	1461	0.2	14.9	1461	26.6	5.0	1450	6.6	1457
Haryana	7.9	4.5	1024	0.2	7.4	1023	27.7	1.8	1020	1.6	1022
Himachal Pradesh	12.8	3.7	1133	1.2	6.6	1133	40.6	2.7	1113	1.7	1118
Jammu & Kashmir	7.2	4.4	1137	1.6	5.6	1137	21.8	2.5	1121	1.8	1125
Punjab	5.2	5.5	973	0.8	5.8	973	26.6	3.1	954	2.5	968
Rajasthan	12.1	1.9	1169	0.9	3.9	1169	34.7	0.9	1161	0.7	1167
Uttarakhand	5.1	4.4	1041	0.2	7.1	1039	25.0	1.6	1033	1.3	1034
Central											
Chhattisgarh	12.7	0.9	1045	3.3	2.1	1045	30.6	1.6	1034	0.7	1043
Madhya Pradesh	13.0	1.0	1107	2.6	2.2	1107	39.0	0.4	1093	0.5	1098
Uttar Pradesh	10.7	1.8	1744	1.2	4.3	1744	29.6	0.7	1730	0.8	1738
East											
Bihar	7.1	1.2	1337	0.4	3.6	1335	35.1	1.0	1334	0.5	1336
Jharkhand	7.0	1.7	1021	0.3	3.5	1021	28.3	1.0	1019	0.8	1021
Odisha	11.1	5.1	1233	1.3	8.4	1232	19.7	4.4	1232	3.4	1230
West Bengal	6.4	6.6	1213	0.2	8.7	1213	27.4	4.1	1203	3.1	1207

States	TSFT-for-age			SSFT-for-age			MUAC-for-age			WC-for-age	
	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage below -2SD	Percentage above +1SD	Weighted number	Percentage above +1SD	Weighted number
Northeast											
Arunachal Pradesh	2.9	5.1	1052	0.3	7.2	1052	14.1	3.8	1032	2.9	1048
Assam	11.9	1.3	1347	3.5	1.8	1346	34.7	1.7	1303	0.2	1327
Manipur	4.3	3.6	1107	0.4	6.4	1107	15.0	2.4	1102	2.0	1102
Meghalaya	2.9	1.1	915	0.7	4.6	917	23.9	0.7	907	0.4	906
Mizoram	7.1	1.5	943	0.5	6.4	943	20.4	1.7	931	1.4	939
Nagaland	9.3	1.3	1057	1.7	2.6	1057	30.8	1.6	986	2.2	1045
Sikkim	1.5	5.7	971	1.4	8.0	968	22.7	3.8	950	3.3	967
Tripura	6.5	5.1	984	0.4	10.5	984	30.5	2.5	951	2.3	978
West											
Goa	3.1	6.6	976	0.5	12.3	976	27.5	6.6	969	4.6	971
Gujarat	7.4	4.9	984	1.4	5.6	983	36.1	3.4	965	2.9	981
Maharashtra	4.9	4.1	1893	0.9	6.6	1892	36.1	1.7	1869	2.1	1871
South											
Andhra Pradesh	3.5	10.7	1100	0.9	13.6	1100	32.2	2.8	1086	2.1	1094
Karnataka	2.6	8.0	858	0.2	12.4	854	26.7	3.8	854	3.8	847
Kerala	1.4	6.1	754	1.0	5.6	753	21.3	5.0	749	4.0	749
Tamil Nadu	3.4	6.9	1771	0.7	8.4	1764	22.4	7.4	1759	5.9	1757
Telangana	2.5	9.1	935	0.4	11.4	930	36.1	2.6	931	1.5	924

Note: TSFT: Triceps skinfold thickness; SSFT: Subscapular skinfold thickness; MUAC: Mid-upper arm circumference; WC: Waist circumference. Each of the indices is expressed in standard deviation (SD) units calculated from the LMS (lambda, mu, and sigma) method.

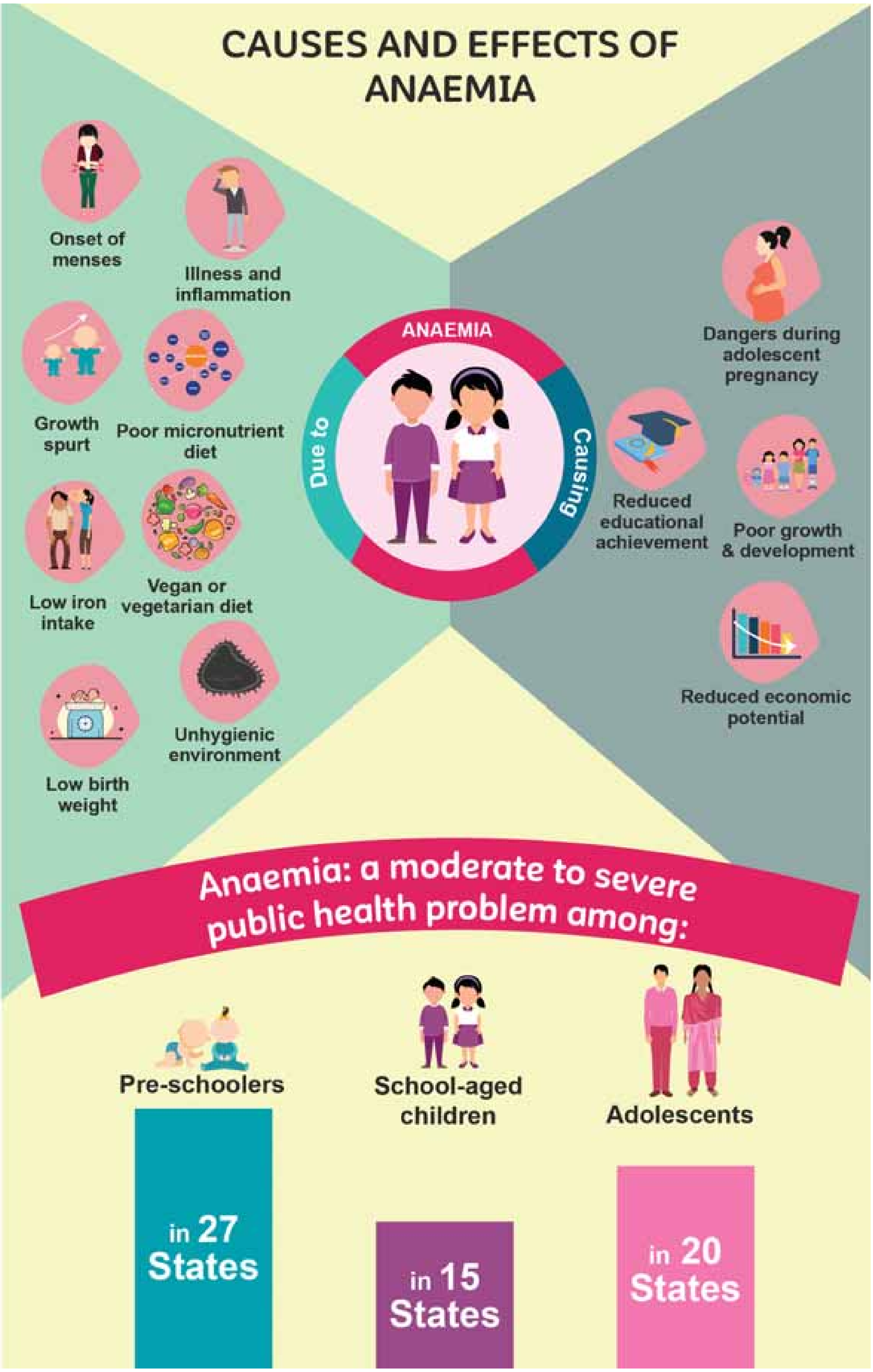
Source (TSFT & SSFT): O Yaw Addo, John H Himes, Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents, The American Journal of Clinical Nutrition, Volume 91, Issue 3, March 2010, Pages 635–642, https://doi.org/10.3945/ajcn.2009.28385

Source (MUAC): Abdel-Rahman SM1, Bi C, Thaete K (2017). Construction of Lambda, Mu, Sigma Values for Determining Mid-Upper Arm Circumference z Scores in U.S. Children Aged 2 Months Through 18 Years. Nutr Clin Pract. 32(1):68–76.

Source (WC): Sharma, A. K., D. L. Metzger, et al. (2015). "LMS tables for waist-circumference and waist-height ratio Z-scores in children aged 5–19 y in NHANES III: association with cardio-metabolic risks." Pediatric Research 78: 723

CHAPTER 6

Anaemia and iron deficiency



CAUSES AND EFFECTS OF ANAEMIA
Onset of menses
Illness and inflammation
Growth spurt
Poor micronutrient diet
Low iron intake
Vegan or vegetarian diet
Low birth weight
Unhygienic environment
ANAEMIA
Due to
Causing
Dangers during adolescent pregnancy
Reduced educational achievement
Poor growth & development
Reduced economic potential
Anaemia: a moderate to severe public health problem among:
Pre-schoolers
in 27 States
School-aged children
in 15 States
Adolescents
in 20 States

Key findings

- Forty-one percent of pre-schoolers, 24% of school-age children and 28% of adolescents were anaemic
- Anaemia was most prevalent among children under two years of age
- Female adolescents had a higher prevalence of anaemia (40%) compared to their male counterparts (18%)
- Anaemia was a moderate or severe public health problem among pre-schoolers in 27 states, among school-age children in 15 states, and among adolescents in 20 states
- Thirty-two percent of pre-schoolers, 17% of school-age children and 22% of adolescents had iron deficiency (low serum ferritin)
- Female adolescents had a higher prevalence of iron deficiency (31%) compared to male adolescents (12%)
- Children and adolescents in urban areas had a higher prevalence of iron deficiency compared to their rural counterparts

This chapter presents the prevalence of anaemia by severity and iron deficiency based on low serum ferritin status among pre-schoolers, school-age children, and adolescents.

6.1. Anaemia

Anaemia is a condition marked by low haemoglobin (Hb) concentration and is an important risk factor for the poor health and development of children and adolescents. It adversely affects psychomotor (Sen, 2006; Soliman, 2014) and brain development; causes weakness, fatigue and poor productivity; and predisposes individuals to infections. Low haemoglobin is caused by inadequate bioavailability of micronutrients (iron, folate, vitamin B12); parasitic infections such as malaria and helminthic infestation of hookworms and other parasitic worms and flukes; genetic haemoglobinopathies such as thalassaemia and sickle cell disease; chronic infection and inflammation; and chronic disease conditions such as renal failure (Black, 2013; Balarajan, 2011; WHO, 2017).

The WHO guidelines for haemoglobin concentrations for the diagnosis of anaemia in children and adolescents are presented below.

Haemoglobin levels to diagnose anaemia among children and adolescents

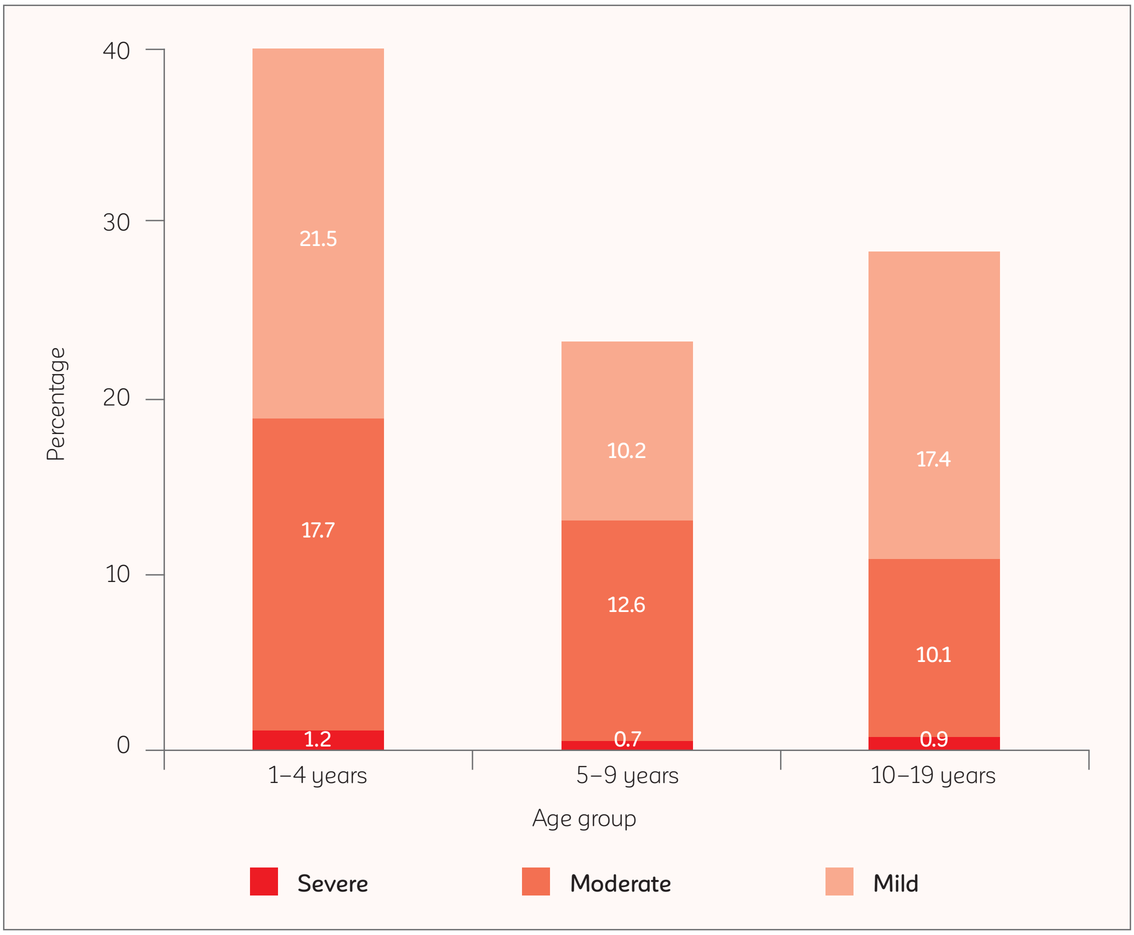
Anaemia status	Haemoglobin level (g/dl)			
	Children aged 1–4 years	Children aged 5–11 years	Adolescents aged 12–14 years	Adolescents aged 15 -19 years
Any anaemia	<11.0 g/dl	<11.5 g/dl	< 12.0 g/dl	Girls: < 12.0 g/dl Boys: < 13.0 g/dl
Mild	10.0–10.9 g/dl	11.0–11.4 g/dl	11.0–11.9 g/dl	Girls: : 11.0–11.9 g/dl Boys: : 11.0–12.9 g/dl
Moderate	7.0–9.9 g/dl	8.0–10.9 g/dl	8.0–10.9 g/dl	8.0–10.9 g/dl
Severe	<7.0 g/dl	<8.0 g/dl	<8.0 g/dl	<8.0 g/dl

Note: Haemoglobin (Hb) levels were adjusted for altitude in survey enumeration areas > 1,000 metres.
Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011

In the CNNS, anaemia was assessed based on haemoglobin concentration obtained from venous whole blood, using the cyanmethaemoglobin method. The haemoglobin levels were adjusted for altitude in enumeration areas above 1000 metres of altitude.

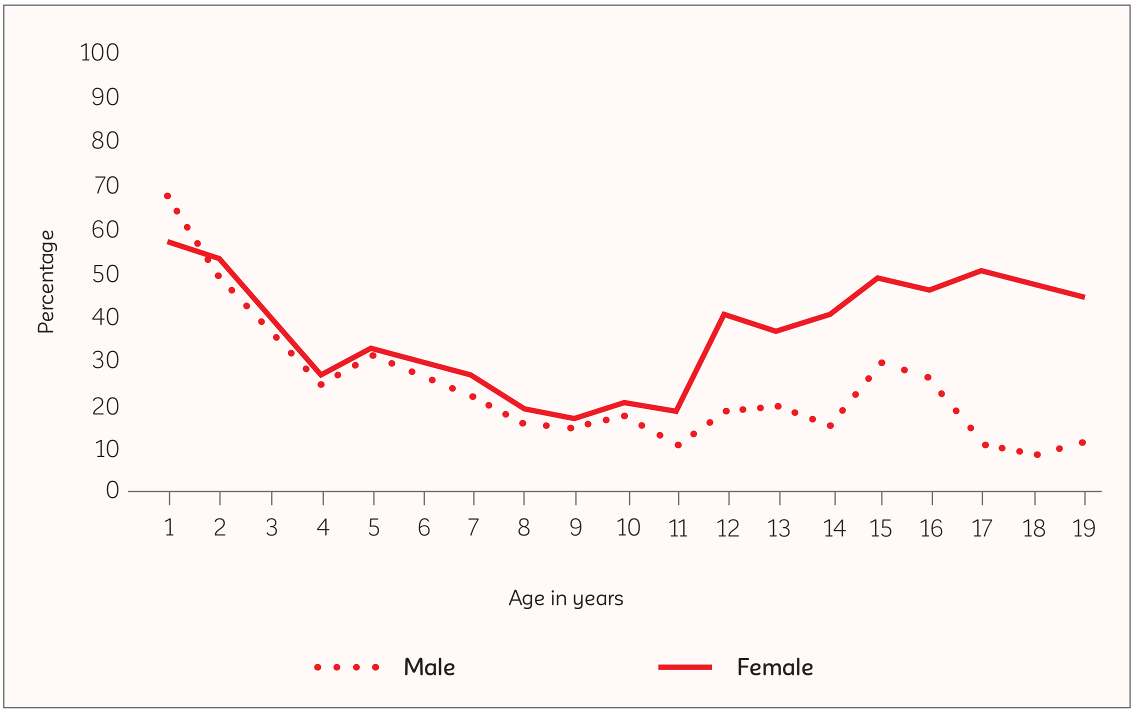
Overall, 41% of pre-schoolers aged 1–4 years, 24% of school-age children aged 5–9 years and 28% of adolescents aged 10–19 years had some degree of anaemia (Tables 6.1, 6.3 & 6.5). The severity of anaemia varied across age groups. Among pre-schoolers, 22% had mild anaemia, 18% had moderate anaemia and 1% had severe anaemia (Figure 6.1). Among school-age children, 10% had mild anaemia, 13% had moderate anaemia, and 1% had severe anaemia. Among adolescents, 17% had mild anaemia, 10% had moderate anaemia and 1% had severe anaemia (Figure 6.1).

Figure 6.1: Severity of anaemia across the three age groups, India, CNNS 2016–18



Anaemia was most prevalent (>50%) among both boys and girls under two years of age and thereafter, decreased steadily to 11 years of age to about 15% (Figure 6.2). An increased prevalence was observed among older adolescents. Anaemia was more prevalent among female adolescents 12 years of age and older (~40%) compared to their male counterparts (~18%).

Figure 6.2: Prevalence of anaemia by sex among children and adolescents aged 1–19 years, India, CNNS 2016–18

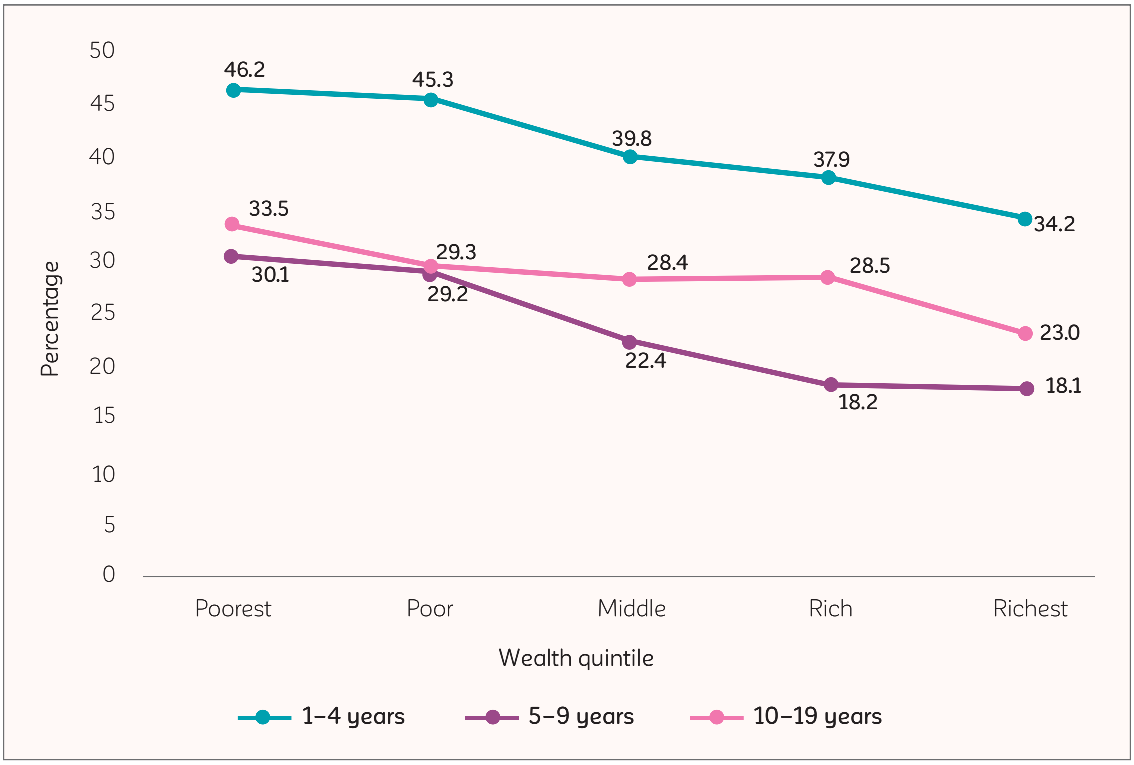


The prevalence of anaemia varied by the schooling status of children and adolescents. Compared to those currently in school, anaemia prevalence was higher among out-of-school children aged 5 to 9 years (32% vs. 23%) and adolescents aged 10–19 years (36% vs. 26%) (Tables 6.3 & 6.5). Additionally, the prevalence of anaemia decreased with a higher level of mother's schooling among both school-age children and adolescents (Tables 6.1, 6.3 & 6.5).

In all three age groups, anaemia was most prevalent among scheduled tribes, followed by scheduled castes. More than half (53%) of pre-schoolers and more than one-third of school-age children and adolescents (38% each) belonging to scheduled tribes were anaemic (Tables 6.1, 6.3 & 6.5).

The prevalence of anaemia decreased steadily with an increase in household wealth in all three age groups. Anaemia prevalence in the lowest vs. highest wealth quintiles was as follows: 46% vs. 34% among pre-schoolers aged 1–4 years; 30% vs. 18% among school-age children aged 5–9 years; and 34% vs. 23% among adolescents aged 10–19 years (Figure 6.3).

Figure 6.3: Prevalence of anaemia by household wealth quintile among children and adolescents, India, CNNS 2016–18



Among pre-schoolers, the prevalence of anaemia was highest in Madhya Pradesh (54%), followed by Haryana (48%) and Delhi (47%) and was lowest in Nagaland (8%) and Manipur (10%) (Table 6.2).Among school-age children, Tripura (41%), Assam (35%) and Jharkhand (34%) and West Bengal (34%) had the highest prevalence of anaemia and Kerala (3%), Jammu & Kashmir (7%) and Manipur (7%) had the lowest prevalence (Table 6.4). Among adolescents, West Bengal (46%), Tripura (41%) and Assam (37%) had the highest prevalence of anaemia, while Nagaland (8%) and Kerala (9%) had the lowest prevalence (Table 6.6).

Definition of public health significance of anaemia prevalence

Prevalence of anaemia (%)	Category of public health significance
< 5%	No public health problem
5% - 19.9%	Mild public health problem
20% - 39.9%	Moderate public health problem
≥ 40%	Severe public health problem

Source: Department of Nutrition for Health and Development, World Health Organization, 2011

Based on the prevalence of anaemia, states were classified according to the level of public health problem: mild, moderate or severe. Maps illustrating the level of public health significance for the three age groups across all states are presented in Figures 6.4a, 6.4b and 6.4c. Anaemia was at least a mild public health problem for school-age children 5–9 years in all states except for Kerala. Anaemia was a moderate or severe public health problem among pre-schoolers in 27 states, among school-age children in 15 states and among adolescents in 20 states.'

Figure 6.4a: Prevalence of anaemia as a public health problem among children aged 1–4 years, India, CNNS 2016–18

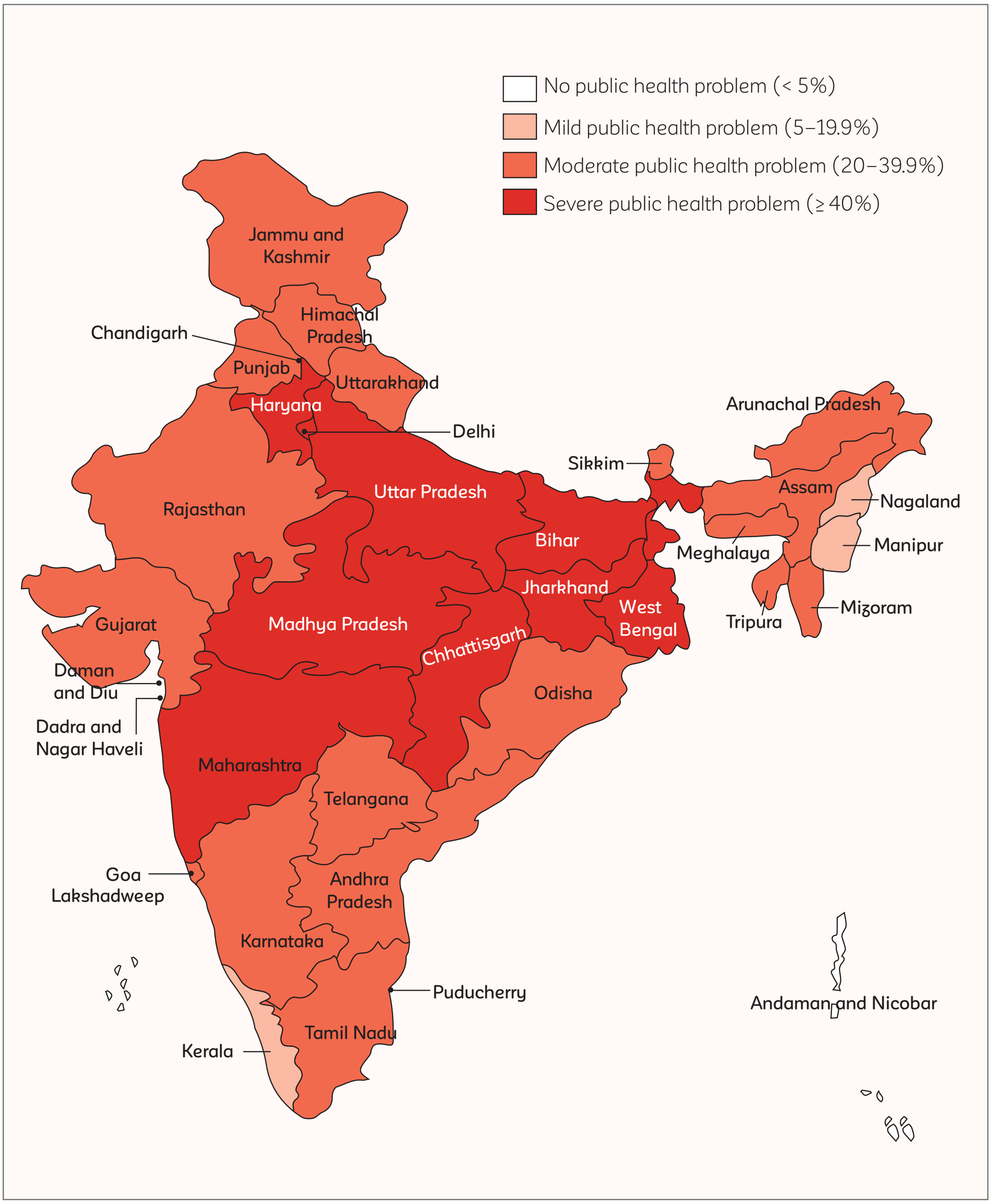


Figure 6.4b: Prevalence of anaemia as a public health problem among children aged 5–9 years, India, CNNS 2016–18

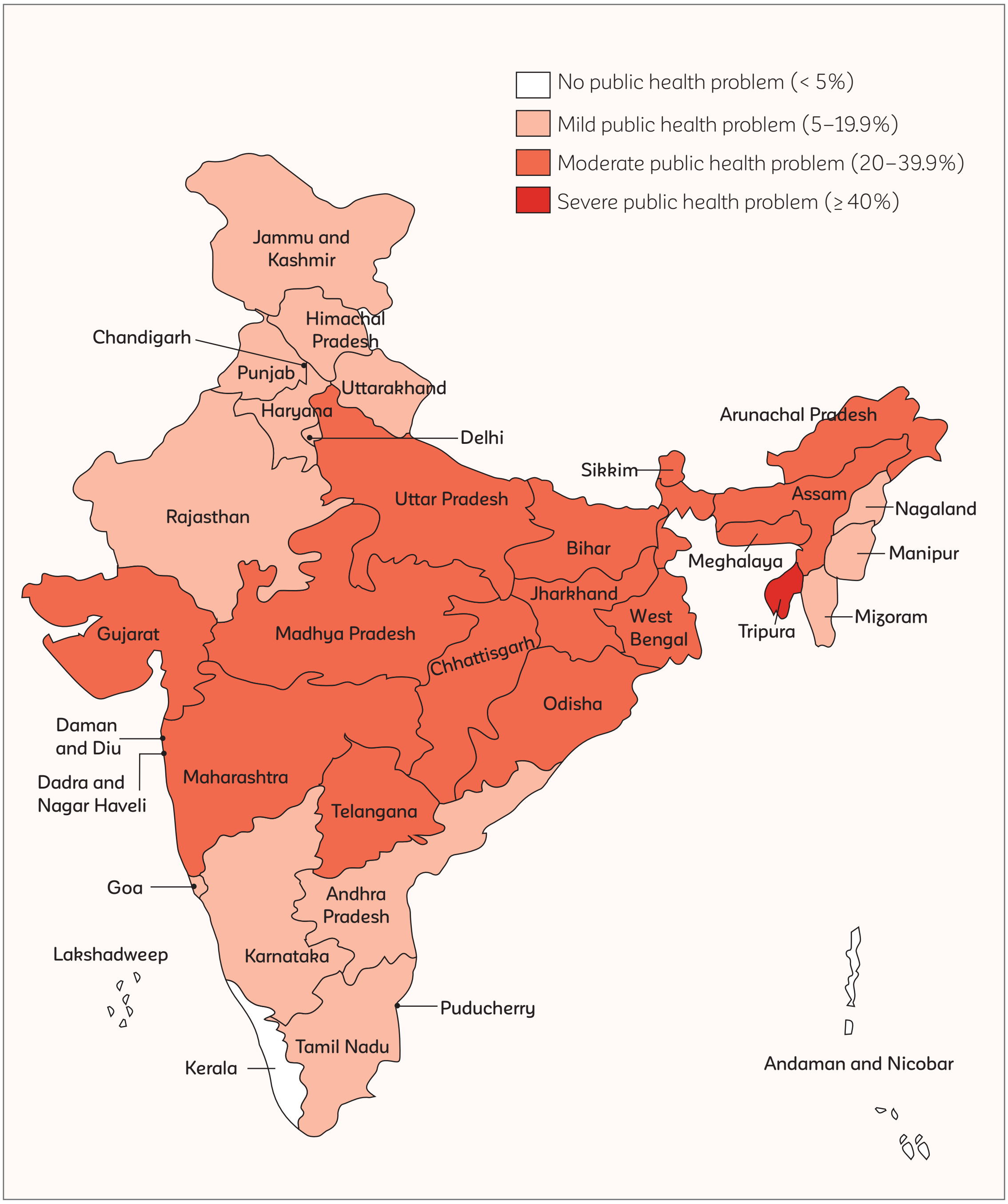
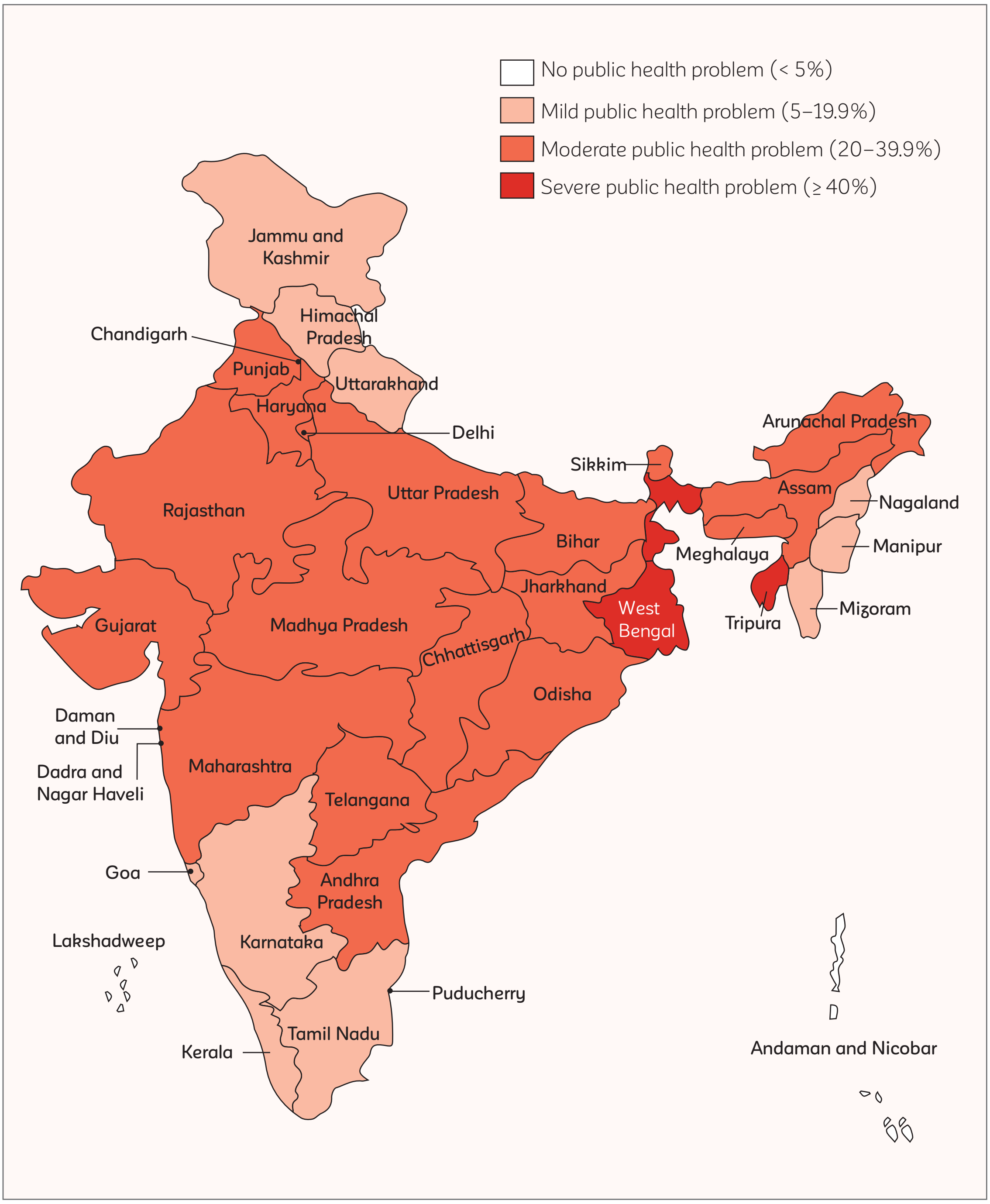


Figure 6.4c: Prevalence of anaemia as a public health problem among adolescents aged 10–19 years, India, CNNS 2016–18



6.2 Iron deficiency

Iron deficiency is one of the most common nutritional deficiencies worldwide. It has negative effects on work capacity (Haas, 2001) and on motor and cognitive development in children and adolescents (Abdullah, 2011; Grantham-McGregor, 2001). About half of anaemia cases worldwide are estimated to be due to iron deficiency (WHO, 2007 & 2017). Iron deficiency without anaemia also has been associated with negative impacts on cognitive development in children and adolescents (WHO, 2017). In the CNNS, low serum ferritin among children and adolescents with normal C-reactive protein levels was considered as a biomarker for iron deficiency. Serum ferritin was assessed using the direct chemiluminescence method.

The WHO guidelines for serum ferritin concentration for the assessment of iron status and iron deficiency in children and adolescents are presented below.

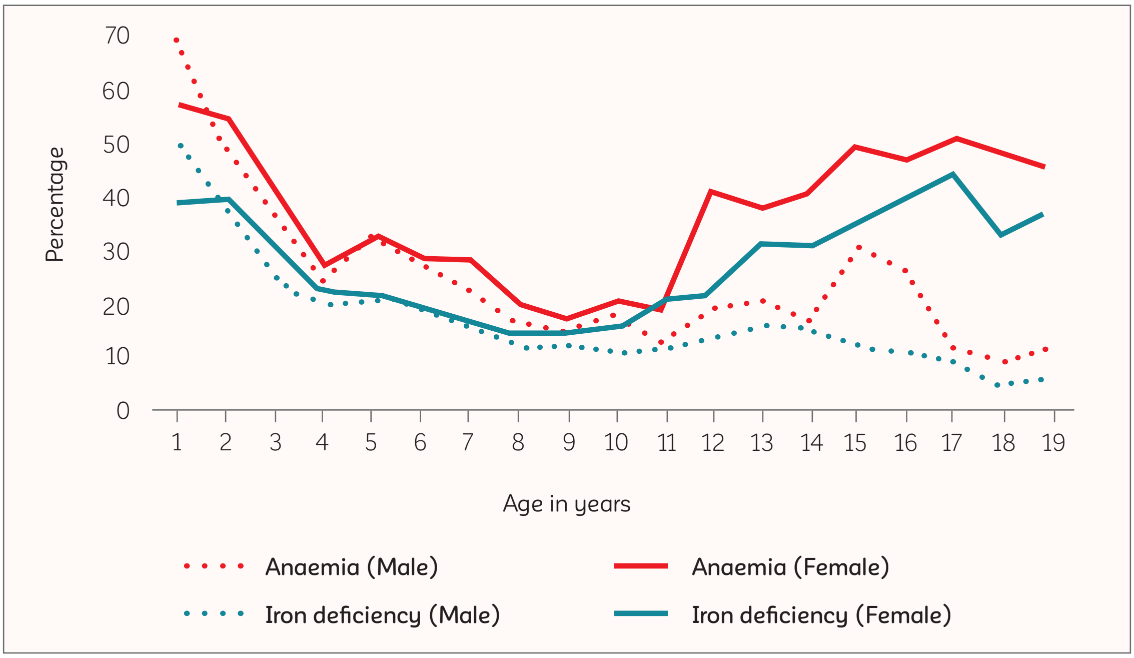
Serum ferritin levels to assess iron deficiency[a]

Age group	Iron deficiency
Children aged 1 – 4 years	Serum ferritin <12 μg/l
Children aged ≥ 5 years	Serum ferritin <15 μg/l

a All cases with C-reactive protein > 5 mg/L were excluded.
Source: Serum ferritin concentrations for the assessment of iron status and iron deficiency in populations, Geneva, WHO, 2011

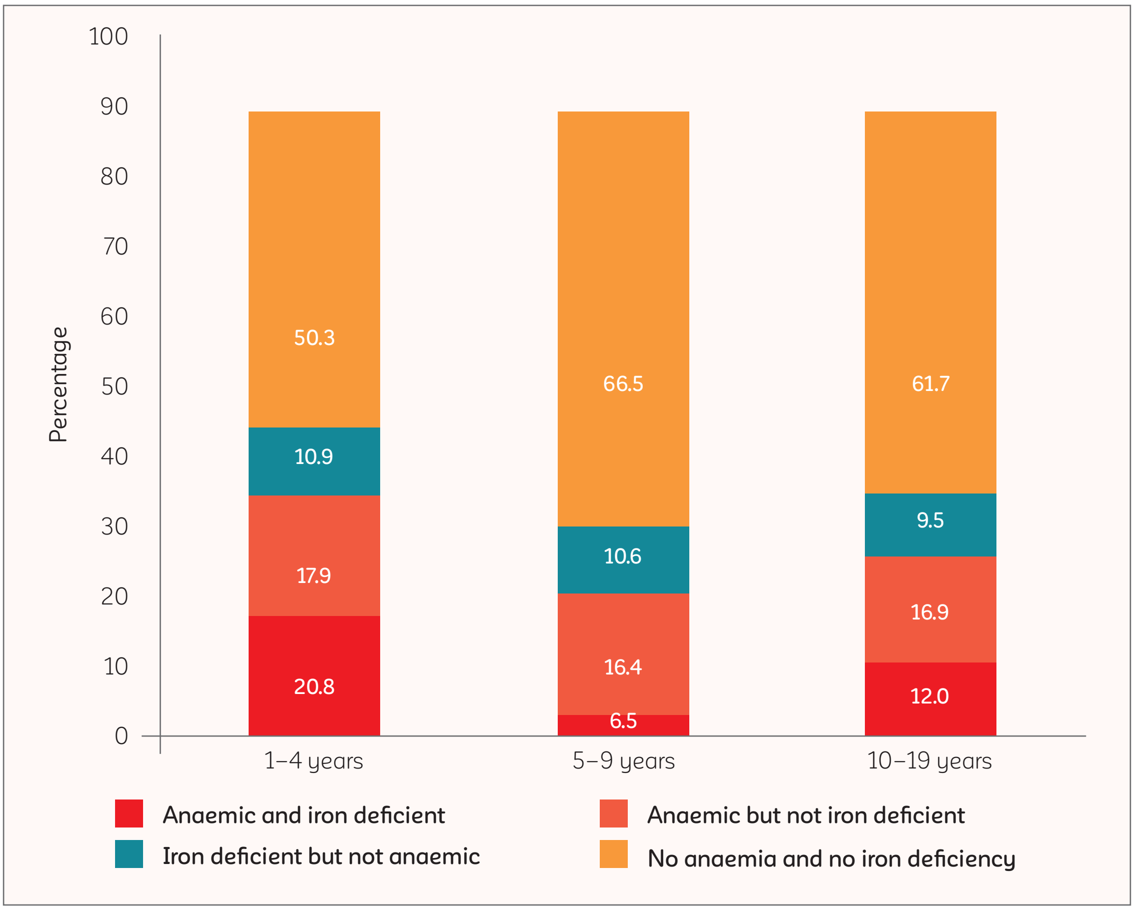
Overall, 32% of pre-schoolers, 17% of school-age children and 22% of adolescents had iron deficiency (Tables 6.1, 6.3 & 6.5). The prevalence of iron deficiency followed a similar pattern to anaemia among both boys and girls, with the highest prevalence among children under two years of age and a steady decline to 10 years of age. Among male adolescents, the declining trend in the prevalence of iron deficiency continued with age. However, among female adolescents, the prevalence increased steadily with age due to the start of menstruation (Figure 6.5). Overall, a gender differential in the prevalence of iron deficiency was observed among adolescents, with girls having almost a three times higher prevalence compared to adolescent boys (31% vs. 12%) (Table 6.5).

Figure 6.5: Prevalence of anaemia and iron deficiency by sex among children and adolescents aged 1–19 years, India, CNNS 2016–18



Overall, among pre-schoolers, 21% were both anaemic and iron deficient, 11% were iron deficient but not anaemic, and 18% were anaemic but not iron deficient. Among school-age children, 6% were anaemic and iron deficient, 11% were iron deficient but not anaemic, and 16% were anaemic but not iron deficient. Among adolescents 12% had anaemia and iron deficiency, 10% were iron deficient but not anaemic, and 17% had anaemia but no iron deficiency (Figure 6.6).

Figure 6.6: Prevalence of anaemia and iron deficiency among children and adolescents, India, CNNS 2016–18



NOTE: This analysis was undertaken for a sub-population with both haemoglobin and serum ferritin results available.

The prevalence of iron deficiency was much higher among children and adolescents belonging to the Sikh religion, as compared to other religions (Tables 6.1, 6.3 & 6.5). The prevalence of iron deficiency was higher among adolescents belonging to the scheduled castes, as compared to other castes (27% vs. 21%). This difference was not observed among children 1–4 and 5–9 years of age (Tables 6.1, 6.3 & 6.5).

Interestingly, children and adolescents residing in urban areas had a higher (7%-12%) prevalence of iron deficiency compared to their rural counterparts (Tables 6.1, 6.3 & 6.5). An unexpected finding was the higher prevalence of iron deficiency among wealthier households across all three age groups. Iron deficiency prevalence in the lowest vs. highest wealth quintiles was as follows: (20% vs. 43% among pre-schoolers, 12% vs. 27% among school-age children, and 15% vs. 27% among adolescents (Tables 6.1, 6.3 & 6.5).

There was wide inter-state variability in the prevalence of iron deficiency. In all three age groups, Punjab had the highest prevalence (67% among pre-schoolers, 51% among school-age children, 45% among adolescents) and Mizoram had the lowest prevalence of iron deficiency (4% among pre-schoolers, 2% among school-age children, 9% among adolescents) (Figures 6.7, 6.8 & 6.9).

Figure 6.7: Prevalence of iron deficiency among children aged 1–4 years by state, India, CNNS 2016–18

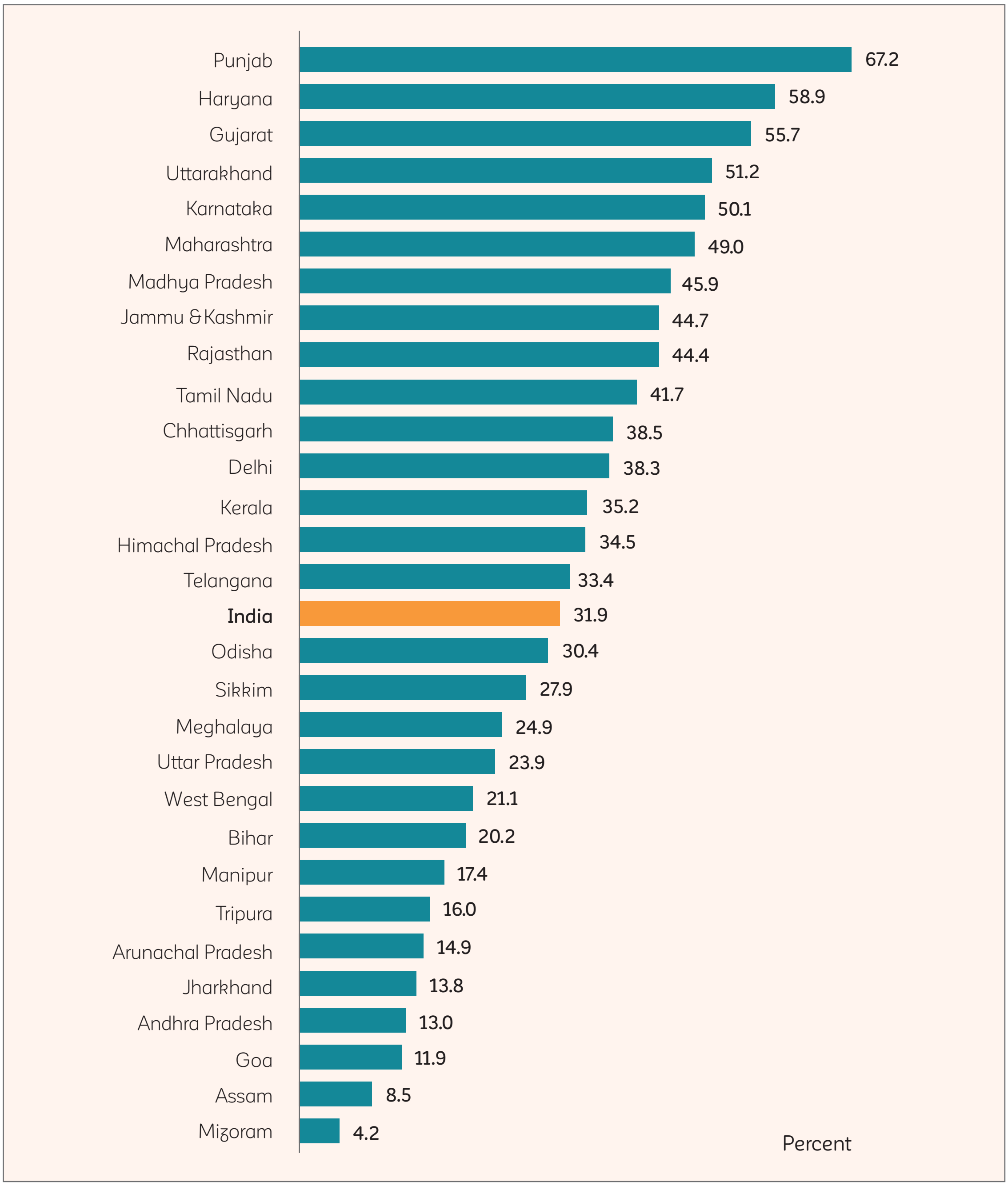


Figure 6.8: Prevalence of iron deficiency among children aged 5–9 years by state, India, CNNS 2016–18

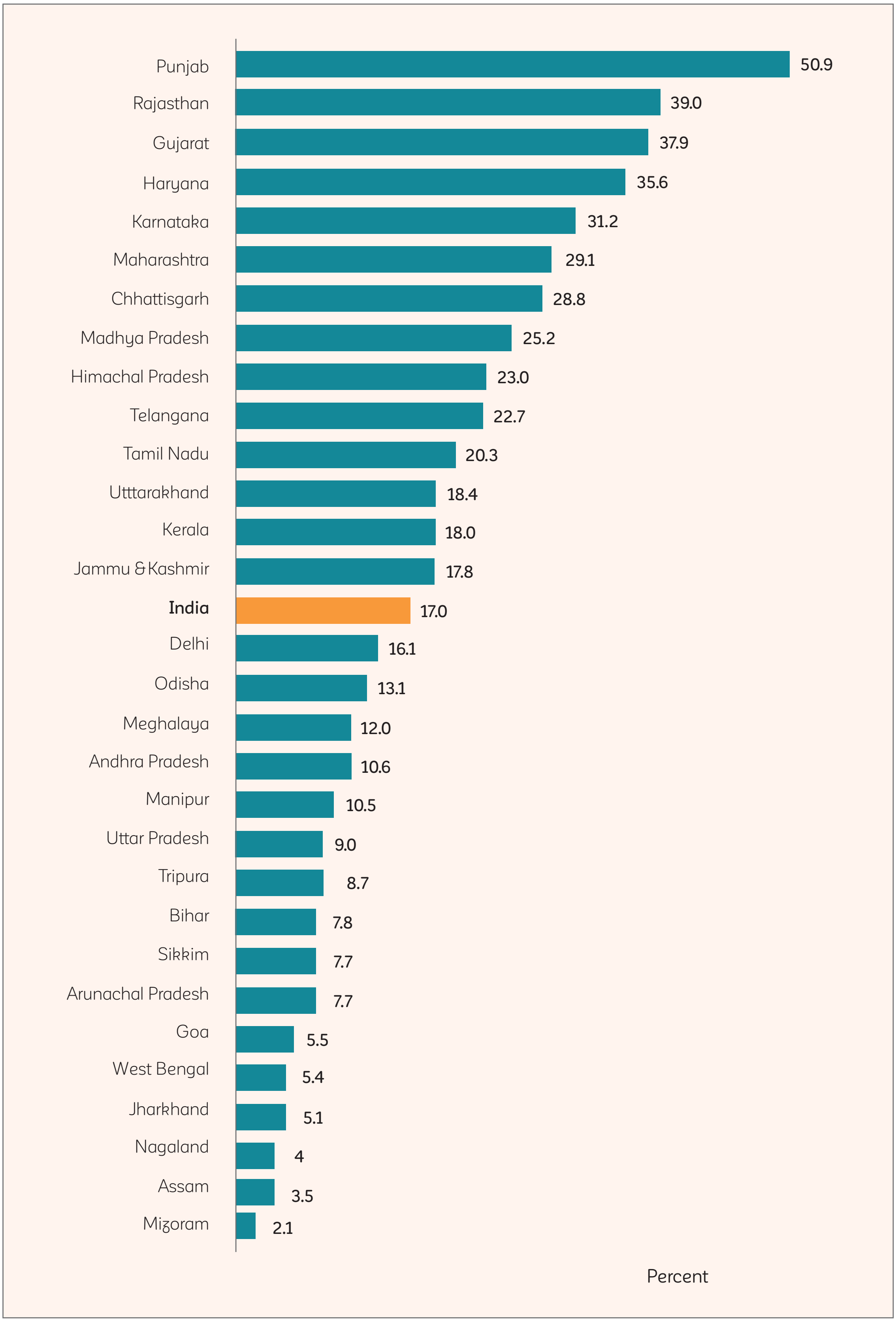


Figure 6.9: Prevalence of iron deficiency among adolescents aged 10–19 years by state, India, CNNS 2016–18

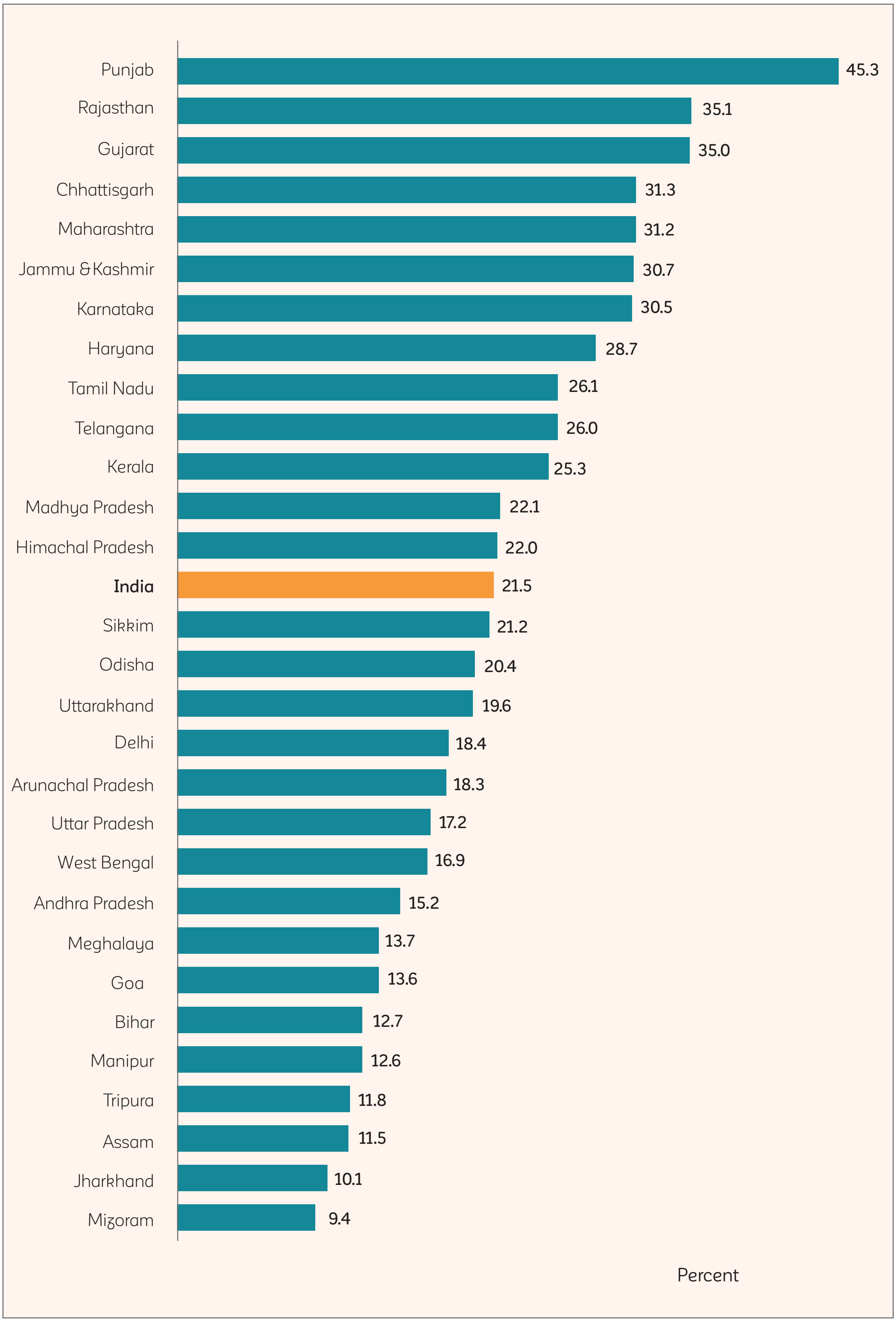


Table 6.1: Percentage of children aged 1–4 years classified as having anaemia and iron deficiency by selected background characteristics, India, CNNS 2016–18

Characteristics	Anaemia status by haemoglobin level [a]					Iron deficiency [b]	
	Any (<11.0 g/dl)	Mild (10.0–10.9 g/dl)	Moderate (7.0–9.9 g/dl)	Severe (<7.0 g/dl)	Weighted number	Percent	Weighted number
Sex of child							
Male	40.6	22.5	17.3	0.9	5,851	31.3	4,157
Female	40.2	20.4	18.1	1.6	5,381	32.6	3,677
Child age (in months)							
12–17	65.2	24.0	38.8	2.4	808	48.5	536
18–23	60.1	26.9	32.1	1.2	896	48.1	677
24–35	51.0	23.8	25.8	1.3	2,587	41.1	1,771
36–47	37.7	23.3	12.8	1.5	3,291	28.1	2,246
48–59	25.5	16.8	7.9	0.7	3,651	21.6	2,603
Type of diet							
Vegetarian	43.2	23.2	19.1	0.9	5,759	32.4	3,943
Vegetarian with egg	39.4	19.0	17.9	2.9	804	39.6	611
Non-vegetarian	37.5	20.3	15.8	1.4	4,669	30.2	3,279
Mother's age (in years)							
< 20	59.3	30.8	25.9	2.7	154	31.9	114
20–24	43.3	24.7	17.6	1.0	3,088	32.1	2,249
25–29	41.9	20.5	19.9	1.4	4,475	33.8	3,092
30–34	34.8	19.2	14.6	1.1	2,371	30.0	1,672
≥ 35	35.9	19.4	15.2	1.3	1,025	27.8	639
Mother's schooling							
No schooling	44.1	22.9	19.6	1.6	3,134	27.1	2,107
<5 years completed	39.6	22.5	16.3	0.7	697	24.8	500
5–7 years completed	38.3	20.6	16.4	1.3	1,949	31.2	1,236
8–9 years completed	47.4	22.3	23.6	1.5	1,812	36.2	1,290
10–11 years completed	35.8	18.9	16.3	0.6	1,409	33.6	1,094
≥ 12 years completed	34.6	21.1	12.5	1.1	2,225	36.4	1,604
Religion							
Hindu	41.5	22.0	18.2	1.3	9,032	32.8	6,297
Muslim	34.4	17.3	16.6	0.5	1,646	25.1	1,139
Christian	32.2	19.6	10.7	2.0	305	20.1	223
Sikh	38.3	21.2	15.9	1.2	125	70.8	117
Other	64.5	44.5	13.3	6.7	125	34.3	57
Caste/Tribe							
Scheduled caste	43.7	25.0	17.2	1.5	2,532	30.9	1,870
Scheduled tribe	53.1	26.6	24.7	1.8	1,423	35.4	839
Other backward class	36.4	18.6	16.8	1.0	4,663	31.6	3,299
Other	37.7	20.7	15.9	1.1	2,615	31.9	1,825
Residence							
Urban	37.1	17.4	18.1	1.6	2,848	40.6	1,970
Rural	41.6	22.9	17.5	1.1	8,384	29.0	5,863
Wealth index							
Poorest	46.2	24.8	19.6	1.8	1,751	20.4	1,189
Poor	45.3	26.3	18.3	0.7	2,360	23.9	1,539
Middle	39.8	21.3	17.2	1.3	2,496	31.4	1,804
Rich	37.9	19.1	17.5	1.3	2,376	37.3	1,681
Richest	34.2	16.6	16.3	1.2	2,250	43.1	1,620
Total	40.5	21.5	17.7	1.2	11,237	31.9	7,838

a Haemoglobin levels were adjusted for altitude (above 1,000 metres). Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011. b Iron deficiency defined as serum ferritin <12 µg/l; all cases with C-reactive protein > 5 mg/L were excluded. **Source:** Serum ferritin concentrations for the assessment of iron status and iron deficiency in populations, Geneva, WHO, 2011.

Table 6.2: Percentage of children aged 1–4 years classified as having anaemia and iron deficiency by state, India, CNNS 2016–18

State	Anaemia status by haemoglobin level					Iron deficiency		C-Reactive Protein (CRP) >5 mg/ L	
	Any (<11.0 g/dl)	Mild (10.0–10.9 g/dl)	Moderate (7.0–9.9 g/dl)	Severe (<7.0 g/dl)	Unweighted Number	Percent	Weighted number	Percent	Weighted number
India	**40.5**	**21.5**	**17.7**	**1.2**	**11,655**	**31.9**	**7,838**	**7.3**	**13,498**
North									
Delhi	47.0	18.7	27.4	0.9	527	38.3	393	11.3	599
Haryana	48.3	22.9	23.1	2.2	313	58.9	245	8.1	318
Himachal Pradesh	29.7	17.4	12.1	0.1	273	34.5	168	2.1	355
Jammu & Kashmir	27.1	14.6	9.5	3.0	321	44.7	216	7.8	316
Punjab	39.8	19.1	19.9	0.8	363	67.2	349	6.1	437
Rajasthan	32.4	15.2	16.0	1.1	139	44.3	58	5.7	263
Uttarakhand	32.4	12.9	14.1	5.4	338	51.2	269	7.4	493
Central									
Chhattisgarh	40.8	23.3	16.9	0.6	378	38.5	447	6.0	560
Madhya Pradesh	53.5	23.6	27.7	2.2	212	45.9	81	9.4	201
Uttar Pradesh	43.0	22.4	20.4	0.2	315	23.9	228	5.2	525
East									
Bihar	43.7	24.3	18.4	1.1	442	20.2	298	10.7	621
Jharkhand	43.7	30.3	13.2	0.2	637	13.8	405	12.2	529
Odisha	37.2	23.8	12.3	1.1	598	30.4	610	6.7	833
West Bengal	45.7	31.2	14.3	0.3	644	21.1	606	12.3	771
Northeast									
Arunachal Pradesh	28.3	19.3	8.8	0.2	375	14.9	392	8.2	530
Assam	33.7	24.8	8.3	0.6	349	8.5	227	7.9	313
Manipur	10.0	7.3	2.8	0.0	736	17.4	316	7.8	811
Meghalaya	32.9	22.0	8.7	2.2	221	24.9	206	2.7	307
Mizoram	24.4	19.1	5.1	0.3	269	4.2	188	8.7	305
Nagaland	8.0	8.0	0.0	0.0	103	–	8	–	19
Sikkim	33.0	21.1	11.4	0.5	513	27.9	464	12.4	632
Tripura	33.0	23.0	9.7	0.3	291	16.0	247	9.3	397
West									
Goa	22.1	17.2	4.2	0.7	184	11.9	157	3.0	306
Gujarat	38.2	16.0	21.5	0.8	487	55.7	312	3.5	601
Maharashtra	41.6	18.5	20.7	2.4	670	49.0	259	4.5	350
South									
Andhra Pradesh	39.6	22.7	13.4	3.5	401	13.0	250	8.5	326
Karnataka	34.7	15.5	16.0	3.3	383	50.1	338	7.4	445
Kerala	12.5	9.2	2.8	0.5	324	35.2	235	4.6	355
Tamil Nadu	27.3	14.6	12.0	0.7	460	41.7	392	5.3	483
Telangana	37.8	17.5	19.6	0.8	389	33.4	281	5.0	355

– N < 50 and results are not presented.

Note: Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude (above 1,000 metres). Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011. Haemoglobin levels are shown in grams per decilitre (g/dl).

Iron deficiency: if serum ferritin <12 μg/l; all cases with C-reactive protein > 5 mg/L were excluded;

Source: Serum ferritin concentration for the assessment of iron status and iron deficiency in population, Geneva, WHO, 2011

Table 6.3: Percentage of children aged 5–9 years classified as having anaemia and iron deficiency by selected background characteristics, India, CNNS 2016–18

Background Characteristics	Anaemia status by haemoglobin level					Iron deficiency	
	Any (<11.5 g/dl)	Mild (11.0–11.4 g/dl)	Moderate (8.0–10.9 g/dl)	Severe (<8.0 g/dl)	Weighted number	Percent	Weighted number
Sex of child							
Male	22.2	9.7	11.9	0.7	7,475	16.5	5,463
Female	24.7	10.6	13.4	0.7	7,188	17.5	5,219
Age in years							
5–7	27.8	12.0	15.0	0.8	8,756	19.0	6,292
8–9	17.1	7.5	9.2	0.5	5,907	14.1	4,391
Type of diet							
Vegetarian	23.4	9.7	13.2	0.4	8,121	18.2	5,960
Vegetarian with egg	20.5	10.1	9.1	1.4	1,386	18.2	987
Non-vegetarian	24.5	11.0	12.7	0.9	5,157	15.0	3,736
Schooling Status							
Currently in school	22.7	10.0	12.1	0.7	13,528	17.1	9,879
Not in school	32.0	12.0	19.5	0.6	1,135	16.1	804
Mother's schooling							
No schooling	27.7	11.3	15.7	0.7	5,690	14.2	4,066
<5 years completed	25.8	12.8	12.0	1.0	1,281	15.4	936
5–7 years completed	24.7	11.2	12.6	1.0	2,374	19.8	1,719
8–9 years completed	22.1	10.5	11.2	0.3	2,118	16.1	1,560
10–11 years completed	15.9	7.0	8.6	0.3	1,516	19.3	1,146
≥ 12 years completed	14.2	5.4	8.2	0.6	1,649	22.9	1,232
Religion							
Hindu	23.2	9.8	12.7	0.7	11,821	17.0	8,615
Muslim	23.7	12.8	10.6	0.3	2,155	14.0	1,568
Christian	28.0	7.5	19.5	1.0	369	15.3	278
Sikh	11.3	4.4	6.8	0.0	158	48.3	146
Other	41.5	14.3	23.3	4.0	160	25.8	75
Caste/Tribe							
Scheduled caste	24.1	10.6	12.7	0.8	3,327	17.4	2,519
Scheduled tribe	37.8	12.8	23.5	1.5	1,780	17.1	1,173
Other backward class	20.6	9.7	10.4	0.6	5,890	17.0	4,394
Other	20.5	9.3	10.9	0.3	3,667	16.6	2,597
Residence							
Urban	20.6	9.7	10.3	0.6	3,635	22.5	2,529
Rural	24.4	10.3	13.4	0.7	11,028	15.3	8,154
Wealth Index							
Poorest	30.1	11.8	17.7	0.6	2,602	12.2	1,808
Poor	29.2	12.3	15.7	1.2	3,014	10.3	2,237
Middle	22.4	9.8	12.2	0.4	3,095	15.0	2,311
Rich	18.2	7.5	10.2	0.5	3,159	20.3	2,340
Richest	18.1	9.8	7.7	0.6	2,793	27.3	1,986
Total	23.5	10.2	12.6	0.7	14,664	17.0	10,682

Note: Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude (above 1,000 metres). Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011. Haemoglobin levels are shown in grams per decilitre (g/dl).
Iron deficiency: if serum ferritin <15 µg/l; all cases with C-reactive protein > 5 mg/L were excluded;
Source: Serum ferritin concentration for the assessment of iron status and iron deficiency in population, Geneva, WHO, 2011

Table 6.4: Percentage of children aged 5–9 years classified as having anaemia and iron deficiency by state, India, CNNS 2016–18

State	Anaemia status by haemoglobin level					Iron deficiency		C-reactive protein (CRP) >5 mg/ L	
	Any (<11.5 g/dl)	Mild (11.0–11.4 g/dl)	Moderate (8.0–10.9 g/dl)	Severe (<8.0 g/dl)	Unweighted Number	Percent	Weighted number	Percent	Weighted number
India	**23.5**	**10.2**	**12.6**	**0.7**	**15,139**	**17.0**	**10,682**	**5.1**	**15,060**
North									
Delhi	19.6	7.8	11.1	0.6	689	16.1	544	5.6	728
Haryana	18.3	7.6	10.5	0.2	427	35.6	335	2.2	419
Himachal Pradesh	13.9	5.3	7.7	0.9	439	23.0	292	2.4	491
Jammu & Kashmir	6.7	3.1	3.6	0.0	379	17.8	299	1.4	391
Punjab	12.4	5.2	7.0	0.2	466	50.9	429	4.2	501
Rajasthan	18.2	8.2	9.9	0.2	454	39.0	238	5.0	448
Uttarakhand	8.4	5.4	3.0	0.0	483	18.4	382	3.7	564
Central									
Chhattisgarh	28.9	10.9	17.7	0.3	537	28.4	478	3.0	597
Madhya Pradesh	22.0	8.7	11.2	2.1	481	25.2	248	4.3	338
Uttar Pradesh	21.9	10.7	10.8	0.4	528	9.0	432	6.1	692
East									
Bihar	27.6	12.3	15.2	0.1	645	7.8	468	4.7	758
Jharkhand	34.4	16.6	17.6	0.2	585	5.1	386	8.8	486
Odisha	27.2	12.8	14.1	0.4	699	13.1	604	2.5	780
West Bengal	34.2	15.9	18.1	0.2	798	5.4	696	10.5	851
Northeast									
Arunachal Pradesh	25.2	12.9	12.3	0.0	550	7.7	468	2.8	577
Assam	34.6	14.2	20.1	0.3	505	3.5	397	3.6	437
Manipur	6.5	2.8	3.5	0.2	660	10.5	345	4.3	677
Meghalaya	31.3	10.2	19.5	1.6	300	12.0	286	1.4	371
Mizoram	14.4	8.2	6.2	0.0	424	2.1	327	6.1	440
Nagaland	9.4	2.5	6.9	0.0	187	–	17	–	40
Sikkim	23.3	12.0	11.1	0.1	568	7.7	487	10.4	607
Tripura	41.1	15.7	25.0	0.4	358	8.7	248	3.9	384
West									
Goa	10.8	5.9	5.0	0.0	316	5.5	271	6.3	372
Gujarat	28.8	10.8	17.3	0.6	497	37.9	318	2.7	547
Maharashtra	21.5	7.8	12.2	1.5	840	29.1	357	3.9	445
South									
Andhra Pradesh	19.2	5.3	11.1	2.8	603	10.6	440	7.1	510
Karnataka	14.8	7.7	6.4	0.7	385	31.2	351	1.7	444
Kerala	3.1	1.7	1.2	0.2	351	18.0	241	2.1	356
Tamil Nadu	10.4	3.9	6.5	0.0	529	20.3	455	4.2	549
Telangana	27.2	10.9	14.4	1.9	456	22.7	377	2.7	439

– N < 50 and results are not presented.
Note: Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude (above 1,000 metres).
Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011. Haemoglobin levels are shown in grams per decilitre (g/dl).
Iron deficiency: if serum ferritin <15 μg/l; all cases with C-reactive protein > 5 mg/L were excluded;
Source: Serum ferritin concentration for the assessment of iron status and iron deficiency in population, Geneva, WHO, 2011

Table 6.5: Percentage of adolescents aged 10–19 years classified as having anaemia and iron deficiency by selected background characteristics, India, CNNS 2016–18

Background Characteristics	Anaemia status by haemoglobin level					Iron deficiency	
	Any	Mild	Moderate	Severe	Weighted number	Percent	Weighted number
Sex of child							
Male	17.5	13.1	4.0	0.4	7,245	11.5	5,179
Female	39.6	21.9	16.5	1.5	7,062	31.3	5,306
Age in years							
10–14	24.1	15.0	8.6	0.7	7,489	18.9	5,576
15–19	33.2	20.2	11.9	1.2	6,812	24.5	4,909
Type of diet							
Vegetarian	30.2	18.4	11.0	0.8	7,658	22.9	5,513
Vegetarian with egg	23.7	14.8	7.6	1.6	1,366	21.7	1,078
Non-vegetarian	27.1	16.7	9.6	0.9	5,277	19.4	3,894
Schooling Status							
Currently in school	26.3	16.0	9.6	0.8	11,057	20.5	8,131
Not in school	35.7	22.4	11.8	1.5	3,243	24.9	2,354
Mother's schooling							
No schooling	31.1	18.5	11.7	1.0	7,403	20.4	5,227
<5 years completed	27.4	17.7	8.3	1.4	1,104	21.4	825
5–7 years completed	26.3	16.4	9.5	0.8	2,067	21.7	1,588
8–9 years completed	25.4	15.6	9.4	0.4	1,765	21.7	1,355
10–11 years completed	22.7	15.1	6.7	0.9	975	24.1	752
≥ 12 years completed	24.4	17.1	6.8	0.5	986	25.7	738
Religion							
Hindu	28.1	17.3	9.9	0.9	11,702	21.7	8,472
Muslim	31.7	19.9	11.4	0.6	1,950	19.7	1,541
Christian	19.6	10.4	8.6	0.5	333	12.3	241
Sikh	23.0	12.5	8.2	2.2	180	39.7	163
Other	40.0	19.0	16.8	4.2	135	27.3	67
Caste/Tribe							
Scheduled caste	31.4	19.0	11.3	1.3	3,207	26.7	2,422
Scheduled tribe	37.6	22.0	14.0	1.6	1,473	19.1	972
Other backward class	23.7	14.0	9.0	0.7	5,976	19.8	4,430
Other	29.7	19.9	9.4	0.7	3,644	20.5	2,661
Residence							
Urban	26.8	15.3	10.8	0.9	3,678	26.6	2,704
Rural	29.0	18.2	9.9	0.9	10,622	19.7	7,781
Wealth Index							
Poorest	33.4	20.9	11.8	0.8	2,573	15.2	1,798
Poor	29.0	18.8	9.2	1.1	2,961	16.5	2,138
Middle	28.4	17.1	10.2	1.2	2,951	21.3	2,241
Rich	28.6	16.9	11.1	0.6	3,037	27.0	2,231
Richest	23.1	13.9	8.5	1.0	2,779	26.5	2,077
Total	28.4	17.4	10.1	0.9	14,308	21.5	10,485

Note: Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude (above 1,000 metres). Anaemia levels classified according to age and sex of adolescents.

For adolescent boys: Severe anaemia <8.0 g/dl; Moderate anaemia 8.0–10.9 g/dl; Mild anaemia 11.0–11.4 g/dl for 10–11 years, 11.0–11.9 g/dl for 12–14 years and 11.0–12.9 g/dl for 15–19 years; Any anaemia <11.5 g/dl for 10–11 years, <12.0 g/dl for 12–14 years and <13.0 g/dl for 15–19 years.
For adolescent girls: Severe anaemia <8.0 g/dl; Moderate anaemia 8.0–10.9 g/dl; Mild anaemia 11.0–11.4 g/dl for 10–11 years, 11.0–11.9 g/dl for 12–14 years and 11.0–11.9 g/dl for 15–19 years; Any anaemia <11.5 g/dl for 10–11 years, <12.0 g/dl for 12–14 years and <12.0 g/dl for 15–19 years.
Haemoglobin levels are shown in grams per decilitre (g/dl).

Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011.
Iron deficiency: if serum ferritin <15 μg/l; all cases with C-reactive protein > 5 mg/L were excluded;

Source: Serum ferritin concentration for the assessment of iron status and iron deficiency in population, Geneva, WHO, 2011

Table 6.6: Percentage of adolescents aged 10–19 years classified as having anaemia and iron deficiency by state, India, CNNS 2016–18

State	Anaemia status by haemoglobin level					Iron deficiency		C-reactive protien (CRP) >5 mg/ L	
	Any	Mild	Moderate	Severe	Unweighted Number	Percent	Weighted number	Percent	Weighted number
India	**28.4**	**17.4**	**10.1**	**0.9**	**14,676**	**21.5**	**10,485**	**4.4**	**13,968**
North									
Delhi	29.2	19.1	9.8	0.3	640	18.4	518	5.9	668
Haryana	29.9	16.0	12.9	1.0	489	28.7	386	2.2	487
Himachal Pradesh	16.2	10.9	5.0	0.3	430	22.0	341	3.6	457
Jammu & Kashmir	15.8	6.0	9.4	0.4	336	30.7	267	2.1	344
Punjab	25.9	15.7	8.3	1.9	496	45.3	447	4.1	509
Rajasthan	26.0	14.4	10.9	0.7	528	35.1	271	3.4	440
Uttarakhand	15.7	10.7	5.0	0.0	467	19.6	341	3.6	506
Central									
Chhattisgarh	31.2	19.9	8.5	3.0	480	31.3	457	2.8	509
Madhya Pradesh	21.2	13.1	7.6	0.5	501	22.1	253	3.2	315
Uttar Pradesh	31.6	21.8	9.4	0.5	473	17.2	386	5.0	576
East									
Bihar	28.1	18.2	9.3	0.5	654	12.7	490	3.2	710
Jharkhand	34.0	22.4	10.1	1.6	508	10.1	352	3.6	409
Odisha	29.5	19.9	8.6	1.0	696	20.4	566	3.2	746
West Bengal	45.5	27.2	18.2	0.1	700	16.9	584	10.7	723
Northeast									
Arunachal Pradesh	26.4	17.0	8.7	0.8	520	18.3	429	2.9	528
Assam	36.9	24.2	11.9	0.9	475	11.5	378	2.1	398
Manipur	10.5	8.6	1.6	0.3	654	12.6	314	3.4	666
Meghalaya	31.8	16.9	13.5	1.3	304	13.7	277	0.5	367
Mizoram	17.9	9.9	6.7	1.2	368	9.4	294	5.3	377
Nagaland	8.4	5.6	1.8	1.0	196	–	18	–	40
Sikkim	25.8	15.0	9.7	1.1	580	21.2	535	9.3	629
Tripura	41.4	23.0	17.2	1.2	346	11.8	214	4.0	366
West									
Goa	13.6	8.2	4.7	1.3	342	13.6	292	3.9	356
Gujarat	33.4	17.8	12.9	2.7	466	35.0	333	2.0	507
Maharashtra	28.3	16.4	11.3	1.0	808	31.2	347	2.9	442
South									
Andhra Pradesh	21.7	11.1	9.2	2.0	546	15.2	379	7.2	437
Karnataka	17.2	8.7	7.6	0.8	348	30.5	320	3.9	405
Kerala	9.1	6.7	2.5	0.0	348	25.3	215	2.3	340
Tamil Nadu	16.4	9.1	6.5	1.1	546	26.1	490	3.4	572
Telangana	32.1	14.5	14.8	3.2	432	26.0	359	3.4	406

– N < 50 and results are not presented.

Note: Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude (above 1,000 metres). Anaemia levels classified according to age and sex of adolescents.

For adolescent boys: Severe anaemia <8.0 g/dl; Moderate anaemia 8.0–10.9 g/dl; Mild anaemia 11.0–11.4 g/dl for 10–11 years, 11.0–11.9 g/dl for 12–14 years and 11.0–12.9 g/dl for 15–19 years; Any anaemia <11.5 g/dl for 10–11 years, <12.0 g/dl for 12–14 years and <13.0 g/dl for 15–19 years.

For adolescent girls: Severe anaemia <8.0 g/dl; Moderate anaemia 8.0–10.9 g/dl; Mild anaemia 11.0–11.4 g/dl for 10–11 years, 11.0–11.9 g/dl for 12–14 years and 11.0–11.9 g/dl for 15–19 years; Any anaemia <11.5 g/dl for 10–11 years, <12.0 g/dl for 12–14 years and <12.0 g/dl for 15–19 years.

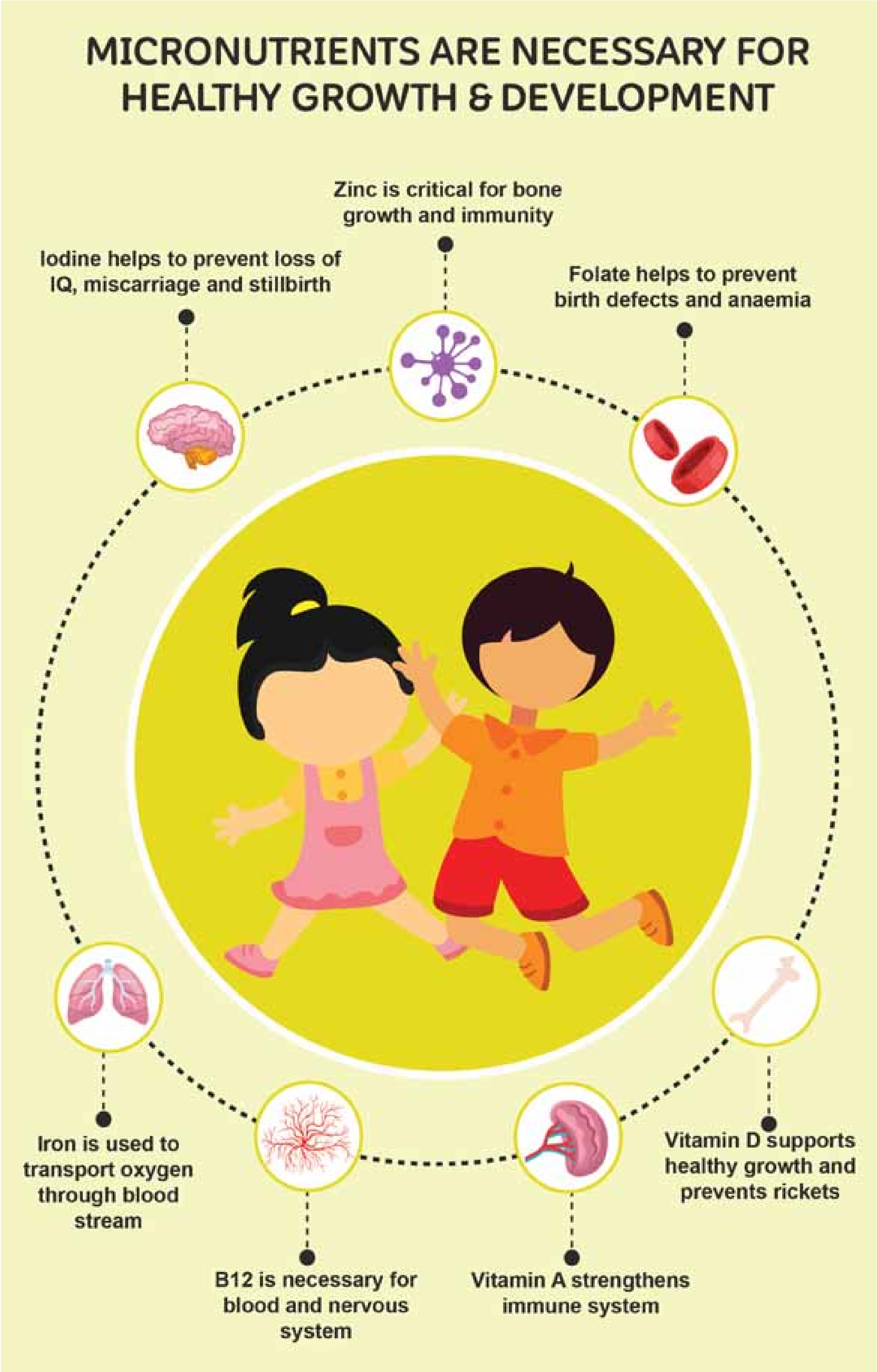
Haemoglobin levels are shown in grams per decilitre (g/dl).

Source: Haemoglobin concentration for diagnosis of anaemia and assessment of severity, Geneva, WHO, 2011.

Iron deficiency: if serum ferritin <15 μg/l; all cases with C-reactive protein > 5 mg/L were excluded; Source: Serum ferritin concentration for the assessment of iron status and iron deficiency in population, Geneva, WHO, 2011

CHAPTER 7

Micronutrients



Source: Shergill – Bonner, 2013

Key findings

- The prevalence of vitamin A deficiency was 18% among pre-school children, 22% among school-age children and 16% among adolescents
- Vitamin D deficiency was found among 14% of pre-school children, 18% of school-age children and 24% of adolescents
- Nearly one-fifth of pre-school children (19%), 17% of school-age children and 32% of adolescents had zinc deficiency
- The prevalence of vitamin B12 deficiency was 14% among pre-school children, 17% among school-age children and 31% among adolescents
- Nearly one-quarter (23%) of pre-school children, 28% of school aged children and 37% of adolescents had folate deficiency
- Adequate iodine status (median urinary iodine concentration ≥100 µg/L and ≤ 300 µg/L) was observed in all three age groups - 213 µg/L among pre-school children, 175 µg/L among school-age children and 173 µg/L among adolescents
- Children and adolescents in all states, except Tamil Nadu had adequate levels of urinary iodine concentration. The estimate from Tamil Nadu showed the urinary iodine concentration was just at the lower limit of excess intake (median ~320 µg/L)

Micronutrients are necessary for all normal growth and body functioning. Vitamins and minerals are vital chemical compounds that the body can't produce itself and must take in small doses from external sources. While deficiencies of individual micronutrients can have an adverse effect, multiple micronutrient deficiencies can have a disabling effect on children and adolescents even when deficiencies are mild to moderate.

This chapter presents the prevalence of the following six micronutrient deficiencies among children and adolescents across all 30 states in India:

- vitamin A
- vitamin B12
- vitamin D
- folate
- iodine
- zinc

Micronutrient deficiencies are an important cause of morbidity and mortality, accounting for a considerable loss of Disability Adjusted Life Years (DALYs), especially in infants and pre-school children (Black, 2008; Bhutta, 2008; Murray, 2012; Black, 2013). Available evidence indicates that even mild or moderate deficiencies of micronutrients among children can lead to impaired cognitive development, poor physical growth, increased morbidity and decreased work productivity in adulthood (FAO/WHO, 2005). While iron, vitamin A, iodine and zinc are generally considered of high public health importance in childhood and adolescence, in recent years, folate, vitamin B12 and vitamin D have also gained significance in maternal and child health research and programmes.

7.1 Vitamin A deficiency

Vitamin A is an essential micronutrient that is particularly important for immune function. Vitamin A is critical during periods of rapid growth and inadequate intake can lead to deficiency which, in severe cases, may cause visual impairment (night blindness) and increase the risk of morbidity and mortality from common childhood infections (UNICEF, 2018). The global burden of vitamin A deficiency is high and, in settings where it is a public health problem, the WHO recommends high-dose vitamin A supplementation for infants and children 6 to 59 months of age (WHO, 2011).

In the CNNS, Vitamin A deficiency (VAD) was measured by serum retinol concentration in blood using HPLC reversed-phase chromatography. According to WHO guidelines presented below, a cut-off of <20 µg/dL was used to define vitamin A deficiency among children aged 1–9 years and adolescents aged 10–19 years. All individuals with C-reactive protein (CRP) > 5 mg/L were excluded from the analysis.

Serum retinol concentration to diagnose vitamin A deficiency among children and adolescents

Age	Vitamin A deficiency
1–9 years	Serum retinol concentration <20 µg/dL
10–19 years	Serum retinol concentration <20 µg/dL

Note: Individuals with C-reactive protein > 5mg/L were excluded from analysis
Source: World Health Organisation, 2009

Among pre-school children aged 1–4 years, 18% were vitamin A deficient (Table 7.1). Vitamin A deficiency prevalence increased with age to 22% among school-age children aged 5–9 years and 16% among adolescents aged 10–19 years (Tables 7.2 & 7.3). The prevalence of vitamin A deficiency was higher among early adolescents aged 10–14 years, compared to late adolescents aged 15–19 years (18% vs. 13%) (Table 7.3).

Across the three age groups, vitamin A deficiency prevalence did not differ by sex of the child/adolescent or place of residence (urban or rural). Vitamin A deficiency prevalence was higher among children in poorer households. Among pre-schoolers in the poorest households, vitamin A deficiency prevalence was more than double that of the richest households (27% vs. 11%) (Table 7.1). Such differences were also observed for children aged 5–9 years, with a prevalence of 28% in the poorest households, compared to vs

16% in the richest households (Table 7.2). Wealth differences were not as apparent for adolescents. Vitamin A deficiency prevalence was lowest (9%) among adolescents whose mother had higher education (> 12 years of schooling) (Table 7.3).

The prevalence of vitamin A deficiency among children and adolescents varied widely by state. Among pre-schoolers, the lowest prevalence was observed in Goa (2%) and highest prevalence in Jharkhand (43%) (Table 7.4). Among school-age children, the prevalence of vitamin A deficiency was lowest in Rajasthan (1%) and West Bengal (4%) and highest in Mizoram (47%) and Jharkhand (42%) (Table 7.5). Among the adolescents, Rajasthan (2%), Himachal Pradesh (3%), Goa (4%), and Sikkim and West Bengal (5% each) had low prevalence of vitamin A deficiency, while the highest prevalence was observed in Jharkhand (30%) and Chhattisgarh (26%) (Table 7.6).

According to the WHO guideline of prevalence ≥ 20% (WHO, 2007), vitamin A deficiency was identified as a severe public health problem in 12 states among pre-school children and in four states among adolescents (Figures 7.1, 7.2a, 7.2b & 7.3c).

Figure 7.1: Prevalence of vitamin A deficiency among children and adolescents by state, India, CNNS 2016–18

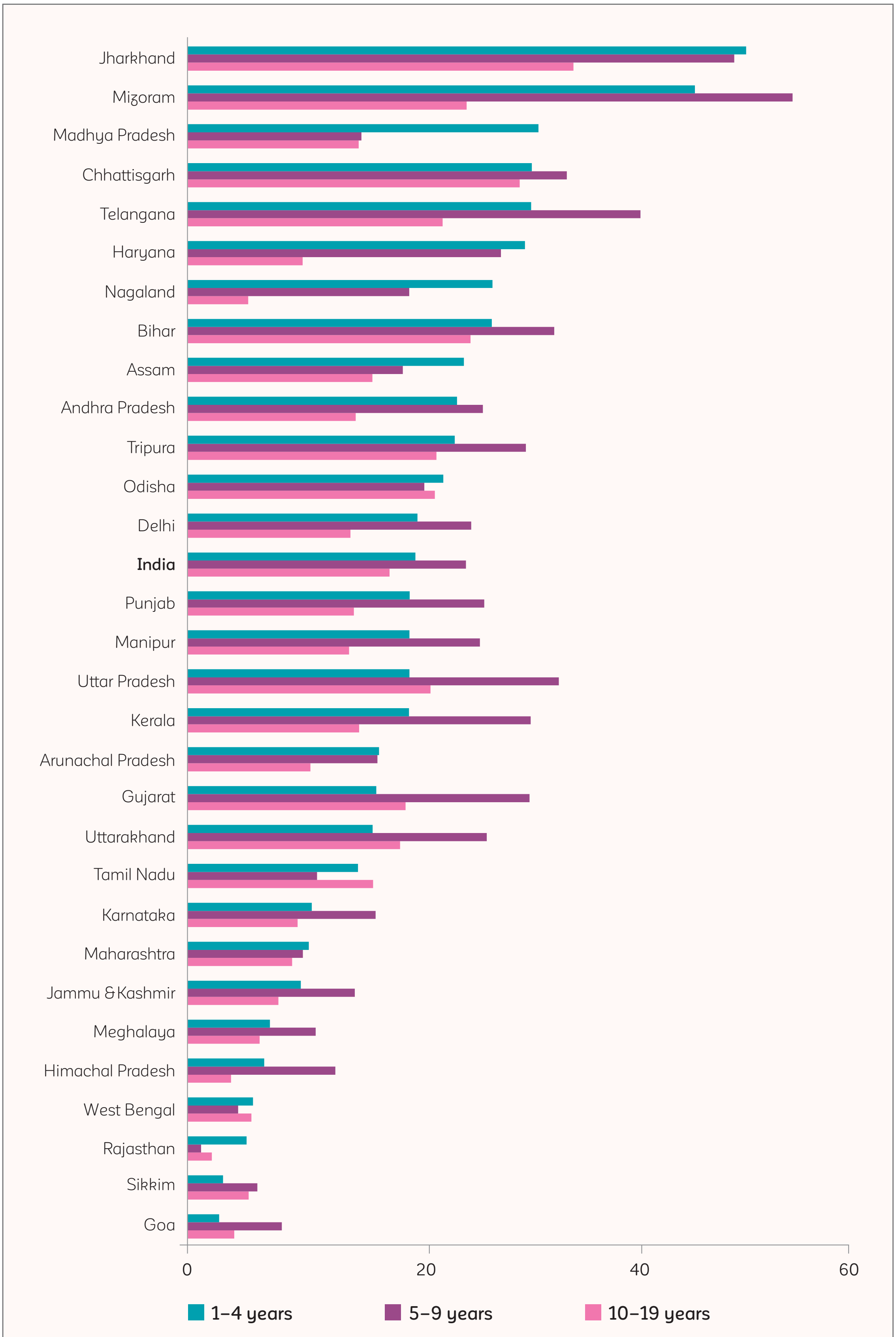


Figure 7.2a: Prevalence of vitamin A deficiency as a public health problem among children aged 1–4 years, India, CNNS 2016–18

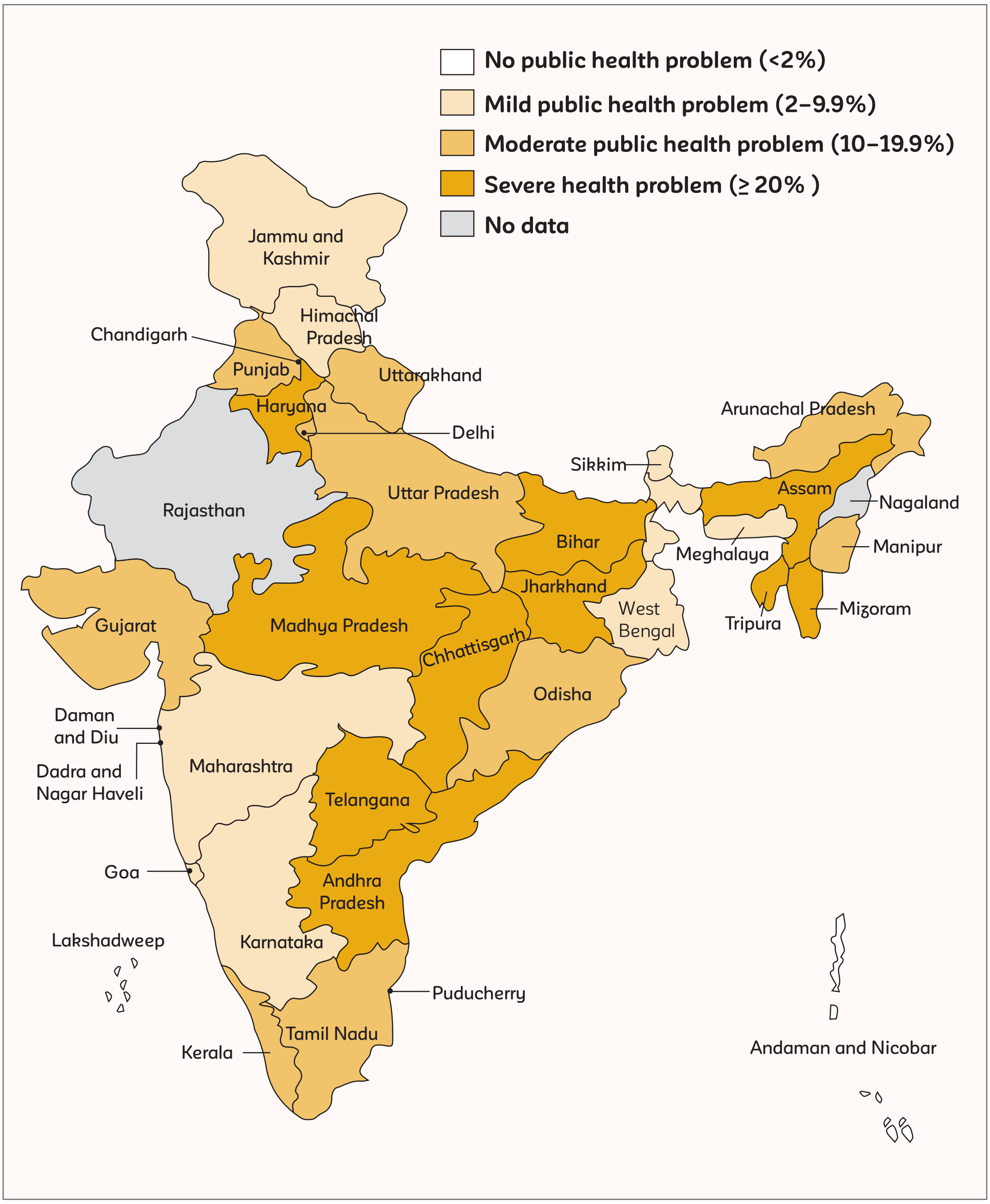


Figure 7.2b: Prevalence of vitamin A deficiency as a public health problem among children aged 5–9 years, India, CNNS 2016–18

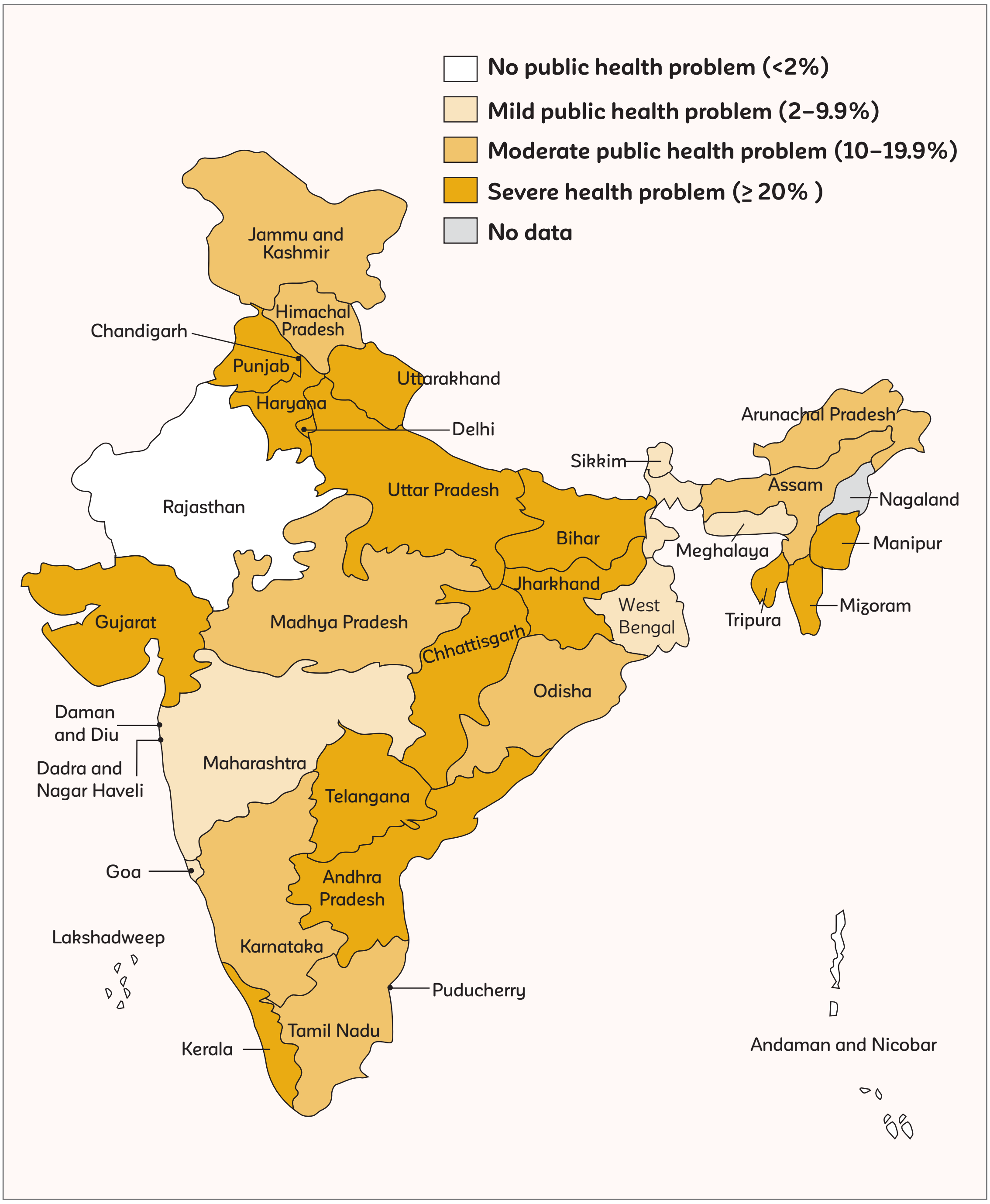
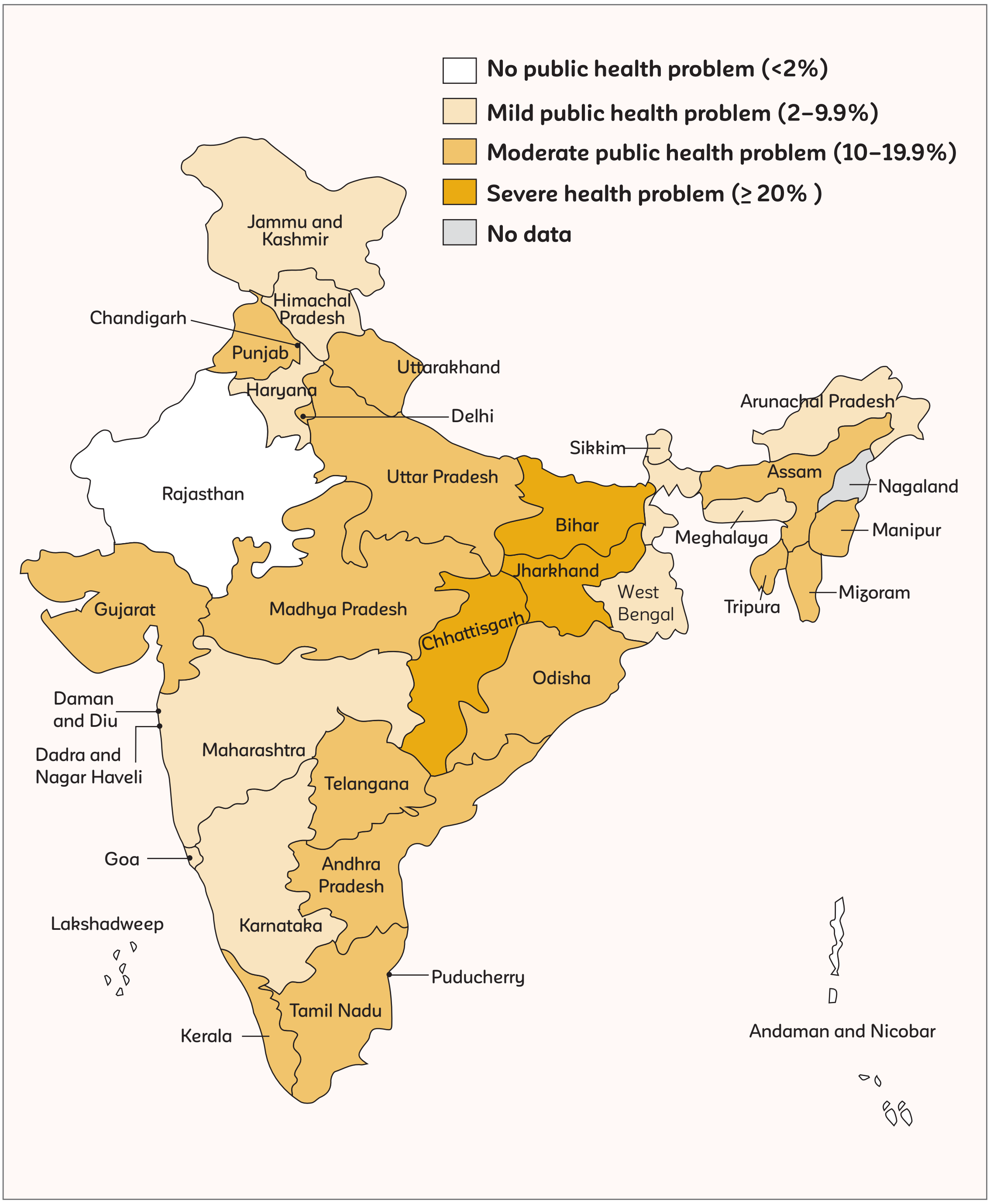


Figure 7.2c: Prevalence of vitamin A deficiency as a public health problem among adolescents aged 10–19 years, India, CNNS 2016–18



7.2 Vitamin D deficiency

Vitamin D is essential for bone health and adequate intake is required to prevent growth faltering in children. The risk of vitamin D deficiency is high where there is low consumption of foods rich in vitamin D and there is inadequate exposure to ultraviolet B (UVB) radiation from sunlight (Roth, 2018), In the CNNS, vitamin D status was assessed by measuring serum 25(OH)D concentration with an antibody competitive immunoassay using direct chemiluminescence (Siemens Centaur). According to Institute of Medicine guidelines presented in Table 7.2 below, a cut-off of < 12 ng/mL (30 nmol/L) was used to define vitamin D deficiency among children aged 1–9 years and adolescents aged 10–19 years.

Serum 25(OH)D concentration to diagnose vitamin D deficiency among children and adolescents

Age	Vitamin D deficiency
1–9 years	Serum 25(OH)D concentration <12ng/mL (30 nmol/L)
10–19 years	Serum 25(OH)D concentration <12ng/mL (30 nmol/L)

Source: Institute of Medicine (IOM), 2011

Fourteen percent of pre-school children aged 1–4 years, 18% of school-age children aged 5–9 years and 24% of adolescents aged 10–19 years had vitamin D deficiency (Tables 7.1, 7.2 &7.3). Among children 1–4 years old, vitamin D deficiency was more common in urban (19%) compared to rural (12%) areas, in the wealthiest (18%) compared to poorest (14%) households, and among children following a vegetarian (18%) versus non-vegetarian (9%) diet (Table 7.1). Among children aged 5–9 years, these differences were greater, with a 28% versus 15% prevalence in urban and rural areas, respectively, and a 30% prevalence among children in the richest households, compared to 13% in the poorest households (Table 7.2 & Figure 7.3). As for the younger children, vitamin D deficiency was more common among children aged 5–9 years who had a vegetarian diet (21%), compared to non-vegetarians (15%). Nineteen percent of children aged 5–9 years who were attending school had vitamin D deficiency, compared to 10% of children not attending school at the time of survey. Differences in vitamin D deficiency based on area of residence (33% urban vs. 21% rural) and household wealth quintile (33% for richest and 19% for poorest households) were also apparent for adolescents (Figure 7.3 & Table 7.3).

In all three age groups, two segments of the population had consistently high and low prevalence of vitamin D deficiency – Sikhs and scheduled tribes, respectively. In the CNNS, 50%, 72% and 68% of Sikh pre-school, school-age children and adolescents had vitamin D deficiency, respectively. This contrasts to the 9%, 15% and 15% prevalence among scheduled tribes for pre-school and school-age children and adolescents, respectively (Tables 7.1, 7.2 &7.3).

Furthermore, for all three age groups, vitamin D deficiency varied considerably across states (Tables 7.4, 7.5 &7.6; Figure 7.4). While 25%–50% of pre-schoolers were vitamin D deficient in Delhi, Gujarat, Haryana, Jammu & Kashmir, Manipur, Punjab, Rajasthan and Uttarakhand, less than 10% of children were deficient in vitamin D in 13 states. Among school-age children and adolescents, vitamin D deficiency prevalence was highest in the same eight states. In all three age groups, the highest proportions of children and adolescents with vitamin D deficiency were in Punjab, with a 52% prevalence among children aged 1–4 years, 76% among children aged 5–9 years and 68% among adolescents aged 10–19 years (Tables 7.4, 7.5 &7.6; Figure 7.4).

Figure 7.3: Prevalence of vitamin D deficiency among children aged 5–9 years and 10–19 years by residence and household wealth index, India, CNNS 2016–18

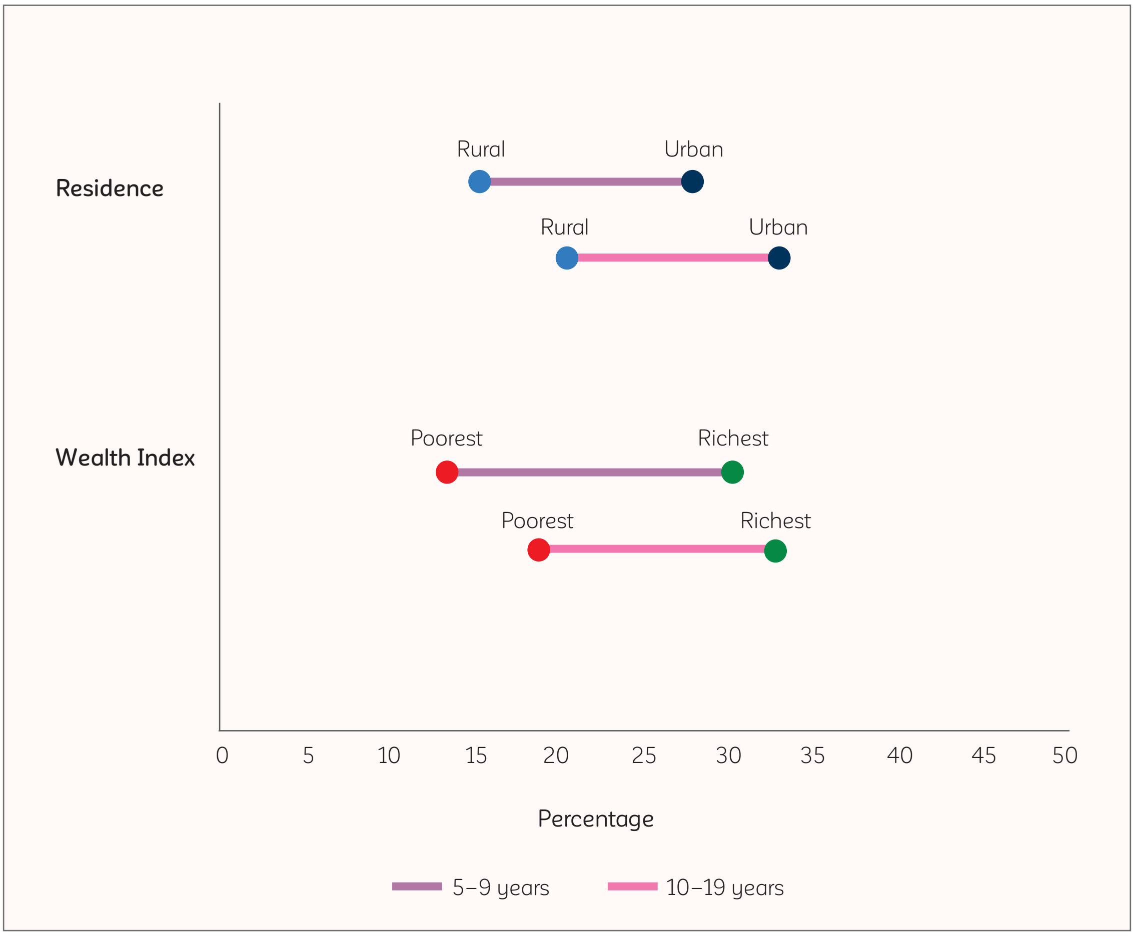
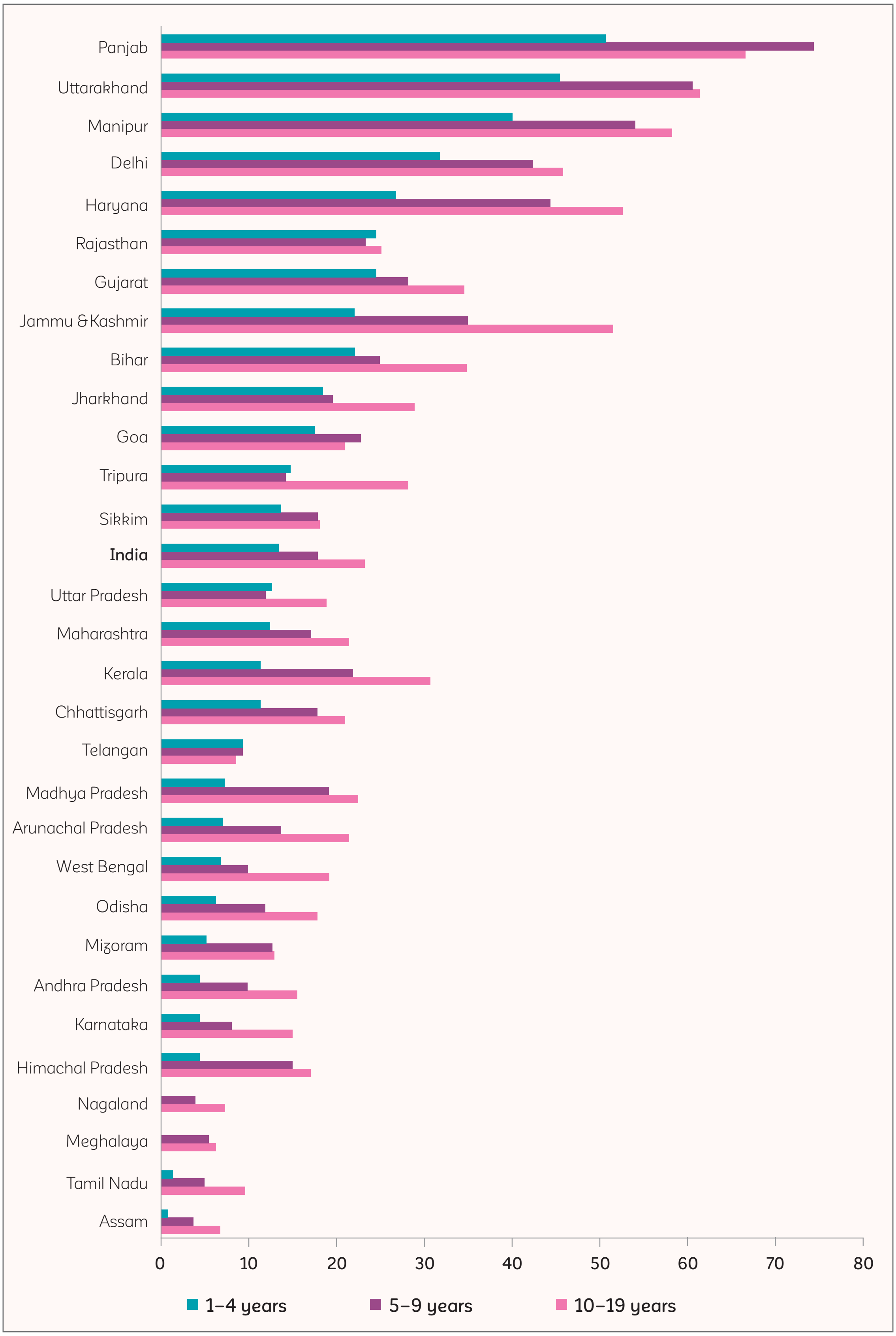


Figure 7.4: Prevalence of vitamin D deficiency among children and adolescents by state, India, CNNS 2016–18



7.3 Zinc deficiency

Zinc deficiency is characterized by growth retardation, loss of appetite, and impaired immune function. In more severe cases, zinc deficiency causes hair loss, diarrhoea, delayed sexual maturation, impotence, hypogonadism in males, and eye and skin lesions (WHO, 2004).

Serum zinc concentration to diagnose zinc deficiency among children and adolescents

<table>
<tr><th rowspan="3">Time of day and fasting status[a]</th><th colspan="3">Age</th></tr>
<tr><td>< 10 years</td><td colspan="2">≥ 10 years</td></tr>
<tr><td>Males and females</td><td>Non-pregnant females</td><td>Males</td></tr>
<tr><td>Morning fasting</td><td rowspan="2"><65 µg/dl</td><td><70 µg/dl</td><td><74 µg/dl</td></tr>
<tr><td>Morning non-fasting</td><td><66 µg/dl</td><td><70 µg/dl</td></tr>
</table>

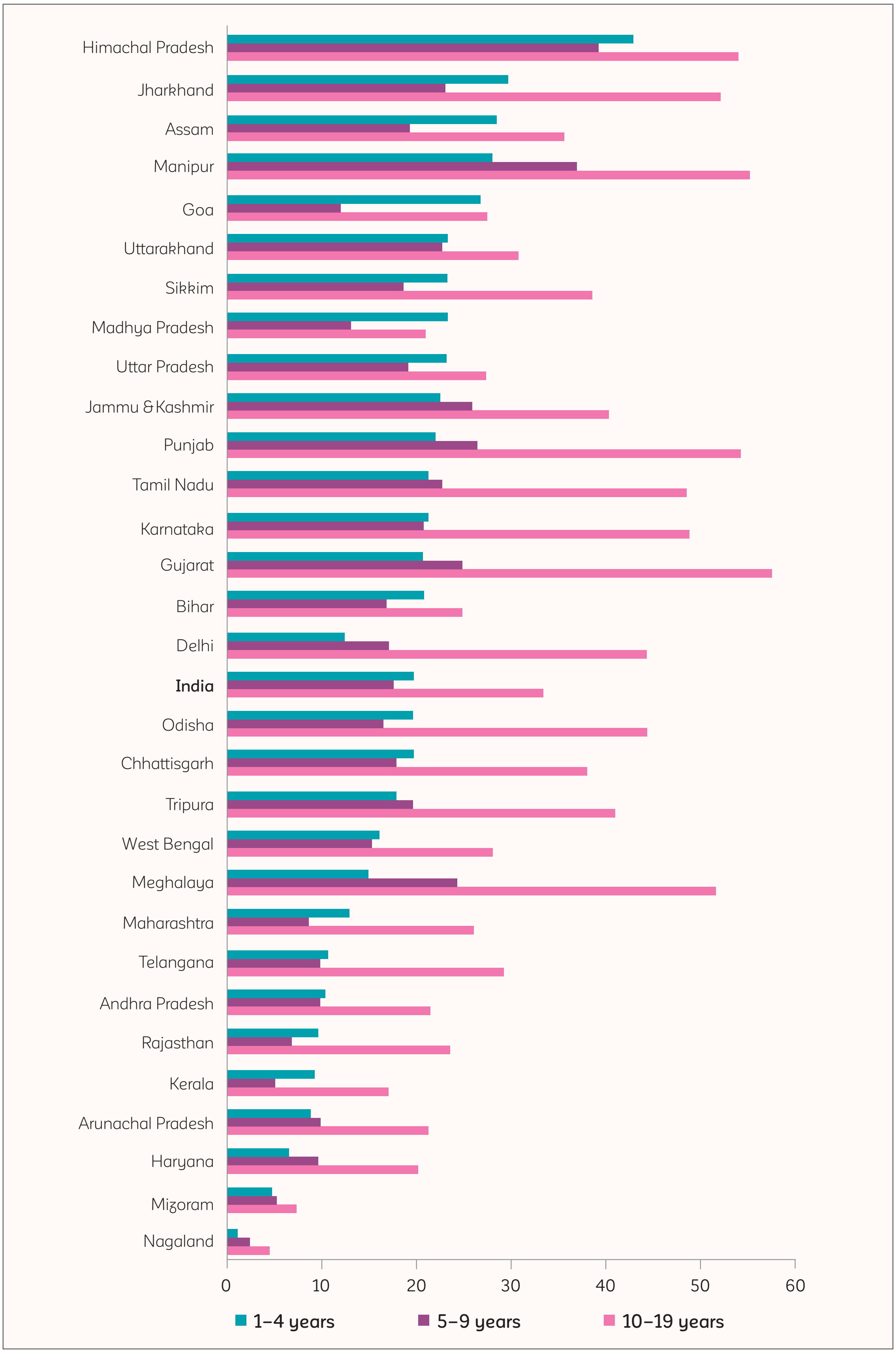
[a] Fasting is defined as no food or beverage consumption for at least 8 hours

Source: International Zinc Nutrition Consultative Group, 2012

Nearly one-fifth (19%) of pre-school children aged 1–4 years and 17% of school-age children aged 5–9 years had zinc deficiency (Tables 7.1 &7.2). Nearly one-third (32%) of adolescents aged 10–19 years were zinc deficient (Table 7.3). Among children aged 1–4 years, zinc deficiency was more common in rural areas (20%) compared to urban areas (16%) and in the poorest households (24%) compared to the richest households (16%) (Table 7.1). Among children aged 5–9 years, similar differences were observed, with a prevalence of 18% and 14% in rural and urban areas, respectively, and 20% and 16% among the poorest and richest households, respectively (Table 7.2). In addition, the prevalence of zinc deficiency was lower among children who were attending school (16%), compared to those not in school (21%). More male adolescents were zinc deficient, as compared to female adolescents (35% vs. 28%) (Table 7.3).

The prevalence of zinc deficiency also varied across states, with a low of 1% in Nagaland to a high of 41% in Himachal Pradesh among children aged 1–4 years. Among children aged 5–9 years, zinc deficiency ranged from 2% in Nagaland to 38% in Himachal Pradesh and among adolescents aged 10–19 years from 4% in Nagaland to 55% in Gujarat (Tables 7.4, 7.5 &7.6; Figure 7.5).

Figure 7.5: Prevalence of zinc deficiency among children and adolescents by state, India, CNNS 2016–18



7.4 Vitamin B12 and folate deficiency

Vitamin B12 and folate are necessary for the formation of healthy red blood cells, repair of body cells and tissues, and for the synthesis of DNA. Vitamin B12 is also important for maintaining normal nerve function. A deficiency in vitamin B12 or folate can lead to macrocytic (enlarged red blood cell) anaemia. Vitamin B12 is found primarily in foods of animal origin and risks for deficiency are therefore higher where access to these foods is limited (Food and Nutrition Bulletin, 2008)

In the CNNS, vitamin B12 and folate levels were assessed by estimating circulating levels of serum B12 and erythrocyte folate by a competitive immunoassay using direct chemiluminescence (Siemens Centaur). According to WHO guidelines, Vitamin B12 deficiency was defined as serum vitamin B12 < 203 pg/ml and folate deficiency was defined as serum erythrocyte folate level < 151 ng/ml (WHO, 2008).

Serum vitamin B12 concentration and serum erythrocyte folate concentration to diagnose deficiency among children and adolescents

Age	Vitamin B12 deficiency	Folate deficiency
1–9 years	Serum vitamin B12 < 203 pg/ml	Serum erythrocyte folate < 151 ng/ml
10–19 years	Serum vitamin B12 < 203 pg/ml	Serum erythrocyte folate < 151 ng/ml

Source: World Health Organisation, 2008

7.4.1 Vitamin B12 deficiency

Overall, 14% of pre-schoolchildren aged 1–4 years, 17% of school-age children aged 5–9 years and 31% of adolescents aged 10–19 years had vitamin B12 deficiency (Tables 7.7, 7.8 & 7.9). Differences based on individual, mother and household characteristics were not observed among children aged 1–9 years, with the exception of a higher prevalence among Sikh children aged 5–9 years (25%) and adolescents (51%). Among adolescents, differences in prevalence were observed by sex (35% for boys vs. 27% for girls) and adolescent age, with 28% and 34% prevalence among adolescents aged 10–14 and 15–19 years, respectively (Tables 7.7, 7.8 & 7.9).

The prevalence of vitamin B12 deficiency ranged from 2% in West Bengal to 29% in Gujarat among children aged 1–4 years, from 0% in Nagaland and 1% in Kerala to 31% in Uttar Pradesh and 32% in Punjab among children aged 5–9 years, and from 2% in Kerala and Nagaland to 48% in Gujarat among adolescents aged 10–19 years (Tables 7.10, 7.11 & 7.12).

7.4.2 Folate deficiency

About one-quarter (23%) of children aged 1–4 years had folate deficiency. Prevalence was higher among children aged 5–9 years (28%) and adolescents aged 10–19 years (37%) (Tables 7.7, 7.8 &7.9). Among pre-schoolers, there was little variability in the prevalence of folate deficiency according to socio-demographic characteristics, with the exception of notable differences by religion and caste/tribe. Similar patterns in prevalence based on religion and caste were also observed for other age groups. Additionally, a higher proportion of children aged 5–9 years and adolescents aged 10–19 years from the wealthiest quintile were folate deficient, compared to those from the poorest households: 30% vs. 21% among children aged 5–9 years and 43% vs. 28% among adolescents aged 10–19 years (Tables 7.8 &7.9). There was wide state-level variation in the proportion of children and adolescents with folate deficiency (Tables 7.10, 7.11 & 7.12).

7.5 Urinary iodine status

Iodine is an essential nutrient and is needed for the production of thyroid hormone. Iodine deficiency disorders (IDD) can lead to enlargement of the thyroid, hypothyroidism and, in severe cases, to mental retardation (WHO, UNICEF, ICCIDD, 2007). Goitre is the most visible indication of iodine deficiency. National salt iodization programmes have substantially reduced the global burden of iodine deficiency (Biban, 2017).

The CNNS provided national and state level estimates of median urinary iodine concentrations (mUIC) among children and adolescents using the simple microplate method based on the Sandell-Kolthoff reaction (Machado, 2017). According to WHO/UNICEF/ICCIDD guidelines, mUIC ≤50 µg/l was used to classify suboptimal iodine intake at the population level.

Age	Iodine status
1–9 years	Adequate: mUIC ≥ 100 µg/L and ≤ 300 µg/L Suboptimal: mUIC ≤ 50 µg/L
10–19 years	Adequate: mUIC ≥ 100 µg/L and ≤ 300 µg/L Suboptimal: mUIC ≤ 50 µg/L

Source: WHO/UNICEF/ICCIDD, 2007

In the CNNS, children and adolescents had adequate levels of urinary iodine. The mUIC was 213 µg/L among pre-school children, 175 µg/L among school-age children and 173 µg/L among adolescents (Tables 7.13, 7.14 &7.15). In all states, except Tamil Nadu where mUIC was > 300 µg/L for all three age groups, both children and adolescents had adequate urinary iodine status (Tables 7.16, 7.17&7.18).

Table 7.1: Percentage of children aged 1–4 years classified as having vitamin A, vitamin D and zinc deficiency by selected background characteristics, India, CNNS 2016–18

Characteristics	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
Sex of child						
Male	17.9	3,524	13.8	5,245	17.9	4,484
Female	17.3	3,165	13.8	4,719	20.0	4,177
Child age (in months)						
12–17	19.8	445	15.5	686	21.7	553
18–23	12.5	590	11.2	865	23.5	784
24–35	14.5	1,512	13.1	2,337	17.4	1,955
36–47	20.8	1,947	15.9	2,875	19.8	2,495
48–59	17.6	2,195	12.4	3,201	17.6	2,875
Type of diet						
Vegetarian	18.7	3,278	17.5	5,065	20.5	4,200
Vegetarian with egg	18.0	525	11.8	751	14.3	662
Non-vegetarian	16.2	2,886	9.3	4,148	18.1	3,800
Mother's age (in years)						
< 20	14.8	97	7.2	154	14.8	130
20–24	15.9	1,859	13.4	2,851	15.8	2,393
25–29	19.3	2,704	13.8	3,891	19.3	3,466
30–34	16.7	1,413	15.6	2,137	22.4	1,843
≥ 35	18.0	569	13.2	812	20.7	750
Mother's schooling						
No schooling	23.6	1,874	13.6	2,769	22.3	2,436
<5 years completed	13.3	401	9.0	610	23.5	555
5–7 years completed	16.4	972	14.2	1,637	19.1	1,458
8–9 years completed	19.5	1,043	13.7	1,621	17.7	1,292
10–11 years completed	14.3	970	12.9	1,314	11.9	1,186
≥ 12 years completed	12.6	1,424	15.9	2,009	18.1	1,727
Religion						
Hindu	19.1	5,345	13.4	7,997	18.6	6,872
Muslim	9.3	1,024	14.0	1,448	21.5	1,332
Christian	19.8	186	6.8	292	18.4	263
Sikh	16.9	96	50.3	130	17.4	118
Other	26.3	39	18.0	97	8.4	76
Caste/Tribe						
Scheduled caste	20.6	1,688	17.4	2,286	15.6	2,034
Scheduled tribe	17.2	692	8.7	1,280	18.7	1,085
Other backward class	19.0	2,742	13.6	4,059	19.8	3,608
Other	12.1	1,568	13.5	2,339	20.9	1,935
Residence						
Urban	16.9	1,658	19.1	2,517	15.8	2,285
Rural	17.8	5,031	12.0	7,447	20.0	6,377
Wealth index						
Poorest	26.6	1,022	14.1	1,586	24.2	1,381
Poor	17.8	1,350	13.1	2,050	22.9	1,715
Middle	18.2	1,530	9.6	2,206	15.2	1,850
Rich	16.8	1,432	14.4	2,113	17.6	1,907
Richest	10.9	1,356	18.3	2,010	16.2	1,810
Total	17.6	6,694	13.8	9,964	18.9	8,662

a Serum retinol concentration <20 μg/dl; all cases with CRP >5mg/L were excluded.
b Serum 25(OH)D concentration <12ng/mL (30 nmol/L).
c Serum zinc concentration < 65 μg/dl in males and females age <10 years.

Table 7.2: Percentage of children aged 5–9 years classified as having vitamin A, vitamin D and zinc deficiency by selected background characteristics, India, CNNS 2016–18

Characteristics	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
Sex of child						
Male	20.6	4,516	17.4	6,632	17.0	5,933
Female	22.4	4,269	19.1	6,282	16.5	5,623
Age in years						
5–7	22.9	5,222	16.7	7,698	16.7	6,808
8–9	19.4	3,563	20.5	5,216	16.9	4,748
Type of diet						
Vegetarian	23.9	4,750	21.2	7,057	16.5	6,216
Vegetarian with egg	18.5	739	15.3	1221	20.9	1083
Non-vegetarian	18.8	3,296	14.5	4,636	16.1	4,256
Schooling Status						
Currently in school	21.7	8,077	18.9	11,911	16.4	10,682
Not in school	19.3	708	9.9	1,003	21.2	874
Mother's schooling						
No schooling	23.2	3,400	16.6	5,043	18.1	4,396
<5 years completed	25.5	763	13.4	1,112	15.6	1,052
5–7 years completed	21.1	1,355	18.4	2,062	18.8	1,860
8–9 years completed	18.8	1,231	19.0	1,847	15.1	1,679
10–11 years completed	18.2	986	18.8	1,355	15.7	1,263
≥12 years completed	18.8	1030	25.3	1,460	13.3	1,284
Religion						
Hindu	22.7	6,988	17.9	10,426	17.0	9,181
Muslim	15.9	1,396	15.5	1,867	15.7	1,811
Christian	17.7	228	17.9	350	13.8	301
Sikh	20.0	114	72.0	153	20.5	147
Other	23.2	60	18.3	119	18.2	117
Caste/Tribe						
Scheduled caste	23.9	2,234	19.9	2,927	18.8	2,693
Scheduled tribe	17.5	880	15.2	1,593	19.1	1,340
Other backward class	23.2	3,436	17.1	5,220	16.6	4,619
Other	18.0	2,236	20.0	3,174	14.0	2,904
Residence						
Urban	22.2	2,004	27.8	3,143	14.2	2,928
Rural	21.3	6,782	15.2	9,771	17.6	8,628
Wealth index						
Poorest	28.2	1,548	13.3	2,282	20.4	1,982
Poor	22.8	1,827	13.2	2,708	17.9	2,271
Middle	21.2	1,978	14.8	2,742	15.0	2,519
Rich	19.8	1,839	20.4	2,798	15.3	2,539
Richest	15.9	1,594	30.2	2,383	15.9	2,245
Total	21.5	8,785	18.2	12,914	16.8	11,556

a Serum retinol concentration <20 μg/dl; all cases with CRP >5mg/L were excluded.
b Serum 25(OH)D concentration <12ng/mL (30 nmol/L).
c Serum zinc concentration < 65 μg/dl in males and females age <10 years.

Table 7.3: Percentage of adolescent aged 10–19 years classified as having vitamin A, vitamin D and zinc deficiency by selected background characteristics, India, CNNS 2016–18

Characteristics	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
Sex of child						
Male	15.7	4361	13.8	6384	35.1	5638
Female	15.5	4495	34.3	6211	28.4	5737
Age in years						
10–14	18.2	4,739	25.0	6,633	31.5	5,952
15–19	12.6	4,117	22.7	5,954	32.0	5,416
Type of diet						
Vegetarian	15.2	4,588	26.9	6,583	30.7	5,877
Vegetarian with egg	22.3	885	19.6	1,247	32.9	1,116
Non-vegetarian	14.4	3,382	20.9	4,757	32.8	4,375
Schooling Status						
Currently in school	16.3	6,897	25.1	9,761	31.0	8,838
Not in school	13.0	1,959	19.7	2,826	34.2	2,530
Mother's schooling						
No Schooling	16.0	4,452	22.2	6,354	30.9	5,683
<5 years complete	17.3	675	22.3	988	35.6	863
5–7 years complete	19.7	1,272	23.0	1,872	32.0	1,713
8–9 years complete	11.4	1,165	26.7	1,625	33.3	1,453
10–11 years complete	16.9	645	27.0	878	36.4	814
≥ 12 years complete	9.3	646	31.3	871	25.8	842
Religion						
Hindu	16.8	7,133	22.3	10,223	31.0	9,197
Muslim	10.2	1,336	30.6	1,783	34.2	1,657
Christian	9.7	211	13.5	300	34.5	268
Sikh	12.4	127	68.1	176	49.4	168
Other	–	48	23.5	104	22.8	77
Caste/Tribe						
Scheduled caste	18.1	2,180	26.8	2,823	35.4	2,596
Scheduled tribe	18.1	697	15.2	1,292	29.8	1,048
Other backward class	15.7	3,663	21.8	5,201	31.4	4,704
Other	12.3	2,316	28.1	3,271	29.9	3,019
Residence						
Urban	16.1	2,196	33.2	3,289	32.9	2,941
Rural	15.4	6,660	20.6	9,298	31.3	8,427
Wealth index						
Poorest	16.7	1,564	18.9	2,243	30.2	1,993
Poor	18.0	1,843	18.8	2,541	32.5	2,310
Middle	14.5	1,870	19.8	2,657	31.1	2,332
Rich	13.4	1,856	28.7	2,678	30.3	2,471
Richest	15.5	1,723	32.9	2,468	34.7	2,261
Total	15.6	8,856	23.9	12,594	31.7	11,375

a Serum retinol concentration < 20 µg/dl; all cases with CRP > 5mg/L were excluded.
b Serum 25(OH)D concentration < 12ng/mL (30 nmol/L).
c Serum zinc concentration < 70 µg/dl (morning fasting) and < 66 µg/dl (morning non-fasting) in non-pregnant females and < 74 µg/dl (morning fasting) and < 70 µg/dl (morning non-fasting) in males.
– N < 50

Table 7.4: Percentage of children age 1–4 years classified as having vitamin A, vitamin D and zinc deficiency by state, India, CNNS 2016–18

State	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
India	**17.6**	**6,694**	**13.8**	**9,964**	**18.9**	**8,662**
North						
Delhi	17.8	424	32.5	469	18.9	479
Haryana	26.1	127	27.6	273	6.2	147
Himachal Pradesh	5.9	194	4.6	179	41.1	244
Jammu & Kashmir	8.7	226	22.9	241	21.4	236
Punjab	17.2	280	52.1	379	21.0	361
Rajasthan	*	*	25.2	93	9.1	58
Uttarakhand	14.3	243	46.4	315	22.4	319
Central						
Chhattisgarh	26.6	446	10.5	481	18.6	356
Madhya Pradesh	27.1	37	7.7	146	22.3	114
Uttar Pradesh	17.1	226	13.2	265	22.1	198
East						
Bihar	23.5	336	22.7	361	19.7	389
Jharkhand	43.2	163	19.2	630	28.4	321
Odisha	19.8	523	6.7	666	18.7	583
West Bengal	5.0	586	7.0	752	15.2	649
Northeast						
Arunachal Pradesh	14.8	360	7.3	442	8.4	331
Assam	21.4	193	1.1	295	27.1	238
Manipur	17.1	226	41.2	613	26.6	687
Meghalaya	6.3	204	2.1	228	14.3	202
Mizoram	39.2	160	5.5	240	4.6	150
Nagaland	–	–	2.2	59	–	–
Sikkim	2.7	456	14.2	584	22.4	507
Tripura	20.6	252	15.2	341	17.1	278
West						
Goa	2.4	144	18.2	185	25.6	162
Gujarat	14.6	143	25.2	400	19.8	462
Maharashtra	9.4	134	12.8	475	12.3	386
South						
Andhra Pradesh	20.8	211	4.9	375	10.0	313
Karnataka	9.6	272	4.8	372	20.1	410
Kerala	17.1	202	11.8	292	9.0	296
Tamil Nadu	13.1	349	1.4	423	20.1	425
Telangana	26.5	270	9.6	368	10.1	330

a Serum retinol concentration < 20 μg/dl; all cases with CRP > 5mg/L were excluded.
b Serum 25(OH)D concentration < 12ng/mL (30 nmol/L).
c Serum zinc concentration < 65 μg/dl in males and females age < 10 years.
– N < 50

Table 7.5: Percentage of children aged 5–9 years classified as having vitamin A, vitamin D and zinc deficiency by state, India, CNNS 2016–18

State	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
India	**21.5**	**8,785**	**18.2**	**12,914**	**16.8**	**11,556**
North						
Delhi	21.9	614	43.4	589	28.6	636
Haryana	24.2	172	45.5	348	9.1	208
Himachal Pradesh	11.4	382	15.4	302	37.7	375
Jammu & Kashmir	12.9	288	36.0	309	24.7	288
Punjab	22.9	351	76.1	451	25.2	452
Rajasthan	1.0	80	23.9	331	6.5	218
Uttarakhand	23.1	373	62.0	402	21.6	436
Central						
Chhattisgarh	29.3	494	18.5	508	17.1	469
Madhya Pradesh	13.4	115	19.7	392	12.3	281
Uttar Pradesh	28.7	434	12.3	487	18.3	414
East						
Bihar	28.3	465	25.8	515	16.1	544
Jharkhand	42.3	109	20.0	560	21.9	318
Odisha	18.3	555	12.4	630	15.8	649
West Bengal	3.9	683	10.2	834	14.4	805
Northeast						
Arunachal Pradesh	14.7	442	14.3	491	9.2	385
Assam	16.6	327	4.0	476	18.2	369
Manipur	22.6	255	55.5	553	35.3	609
Meghalaya	9.9	271	5.8	299	23.3	294
Mizoram	46.8	289	9.0	401	5.0	248
Nagaland	–	–	4.1	85	2.1	74
Sikkim	5.4	482	18.3	575	17.8	532
Tripura	26.1	259	14.7	332	18.7	316
West						
Goa	7.3	268	23.3	322	11.4	292
Gujarat	26.4	144	29.0	399	23.6	466
Maharashtra	8.9	193	17.6	616	8.1	535
South						
Andhra Pradesh	22.8	390	10.3	600	9.4	496
Karnataka	14.5	295	8.5	365	19.8	408
Kerala	26.5	219	22.6	295	4.8	339
Tamil Nadu	10.0	364	5.4	483	21.8	481
Telangana	35.0	373	5.5	418	9.3	396

a Serum retinol concentration < 20 μg/dl; all cases with CRP > 5mg/L were excluded.
b Serum 25(OH)D concentration < 12ng/mL (30 nmol/L).
c Serum zinc concentration < 65 μg/dl in males and females age < 10 years.
– N < 50

Table 7.6: Percentage of adolescents aged 10–19 years classified as having vitamin A, vitamin D and zinc deficiency by state, India, CNNS 2016–18

State	Vitamin A deficiency [a]		Vitamin D deficiency [b]		Zinc deficiency [c]	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
India	**15.6**	**8,856**	**23.9**	**12,594**	**31.7**	**11,375**
North						
Delhi	12.6	539	47.1	570	42.6	552
Haryana	8.9	173	53.8	399	19.4	226
Himachal Pradesh	3.3	399	17.6	358	51.6	433
Jammu & Kashmir	7.0	280	52.8	285	38.6	274
Punjab	12.8	370	68.0	476	51.8	480
Rajasthan	1.9	117	25.8	371	22.6	265
Uttarakhand	16.4	357	62.9	366	29.2	420
Central						
Chhattisgarh	25.7	441	21.6	471	36.2	445
Madhya Pradesh	13.2	100	23.0	413	19.9	294
Uttar Pradesh	18.8	408	19.4	433	26.3	391
East						
Bihar	21.9	498	35.7	525	23.7	536
Jharkhand	29.8	138	29.6	476	49.8	272
Odisha	19.1	508	18.4	616	42.4	650
West Bengal	4.9	562	19.5	711	26.6	676
Northeast						
Arunachal Pradesh	9.5	382	21.9	446	20.1	362
Assam	14.3	314	7.1	459	33.9	345
Manipur	12.5	238	59.8	543	52.8	585
Meghalaya	5.6	252	6.6	294	49.3	290
Mizoram	21.5	243	13.4	347	6.8	173
Nagaland	–	–	7.4	103	4.3	70
Sikkim	4.7	518	18.8	611	36.8	564
Tripura	19.2	216	28.8	305	39.3	309
West						
Goa	3.6	282	21.5	331	25.8	323
Gujarat	16.8	153	35.5	397	55.1	438
Maharashtra	8.1	180	22.1	631	25.1	506
South						
Andhra Pradesh	13.0	347	15.9	530	20.6	449
Karnataka	8.5	263	15.6	341	46.8	389
Kerala	13.2	188	31.6	269	17.2	321
Tamil Nadu	14.3	436	9.8	510	46.3	539
Telangana	19.7	357	8.8	405	27.9	383

a Serum retinol concentration < 20 µg/dl; all cases with CRP > 5mg/L were excluded.
b Serum 25(OH)D concentration < 12ng/mL (30 nmol/L).
c Serum zinc concentration < 70 µg/dl (morning fasting) and < 66 µg/dl (morning non-fasting) in non-pregnant females and < 74 µg/dl (morning fasting) and < 70 µg/dl (morning non-fasting) in males.
– N < 50

Table 7.7: Percentage of children aged 1–4 years classified as having vitamin B12 deficiency and folate deficiency by selected background characteristics, India, CNNS 2016–18

Background Characteristics	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	14.2	4,797	23.2	5,490
Female	13.4	4,275	23.5	4,974
Child age (in months)				
12–17	23.0	604	23.9	750
18–23	16.9	797	17.5	856
24–35	11.1	2,105	20.8	2,439
36–47	16.9	2,603	24.4	3,068
48–59	10.3	2,965	25.7	3,351
Type of diet				
Vegetarian	15.8	4,669	18.4	5,356
Vegetarian with egg	13.5	691	30.4	761
Non-vegetarian	11.4	3,713	28.4	4,346
Mother's age (in years)				
below 20	14.9	138	22.2	145
20–24	13.4	2,605	23.4	2,855
25–29	13.1	3,527	24.8	4,113
30–34	17.1	1,931	22.9	2,248
35 and above	9.3	765	19.4	986
Mother's schooling				
No schooling	17.3	2,531	24.2	2,946
<5 years completed	12.4	572	33.1	661
5–7 years completed	12.4	1,511	28.6	1,778
8–9 years completed	12.6	1,489	21.3	1,622
10–11 years completed	11.5	1,171	23.0	1,339
≥ 12 years completed	13.0	1,796	16.4	2,110
Religion				
Hindu	13.8	7,301	23.9	8,397
Muslim	14.5	1,323	16.7	1,570
Christian	10.9	250	46.7	274
Sikh	16.4	118	10.1	123
Other	6.0	81	30.5	99
Caste/Tribe				
Scheduled caste	16.0	2,080	19.5	2,391
Scheduled tribe	14.1	1,111	42.4	1,262
Other backward class	14.7	3,735	23.1	4,382
Other	9.9	2,147	17.8	2,429
Residence				
Urban	14.4	2,265	24.0	2,683
Rural	13.6	6,808	23.1	7,780
Wealth index				
Poorest	13.8	1,444	20.1	1,646
Poor	14.9	1,921	23.6	2,140
Middle	14.0	2,020	26.8	2,302
Rich	13.1	1,889	24.6	2,258
Richest	13.2	1,799	20.5	2,116
Total	13.8	9,073	23.3	10,468

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.

Table 7.8: Percentage of children aged 5–9 years classified as having deficiency of vitamin B12 and Folate by selected background characteristics, India, CNNS 2016–18

Characteristics	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	16.6	6,016	28.1	6,955
Female	17.8	5,651	28.3	6,666
Age in years				
5–7	15.8	6,992	28.2	8,127
8–9	19.2	4,675	28.2	5,495
Type of diet				
Vegetarian	22.1	6,430	22.9	7,513
Vegetarian with egg	14.9	1,067	35.1	1,253
Non-vegetarian	10.2	4,170	34.6	4,856
Schooling Status				
Currently in school	17.3	10,759	28.7	12,555
Not in school	16.0	0	22.8	1,067
Mother's schooling				
No schooling	20.3	4,576	25.4	5,317
<5 years complete	21.1	966	28.1	1,197
5–7 years complete	13.6	1,835	34.9	2,161
8–9 years complete	14.7	1,684	28.2	1,940
10–11 years complete	14.3	1,248	28.7	1,425
≥ 12 years complete	15.0	1,322	28.9	1,547
Religion				
Hindu	18.4	9,410	28.8	10,989
Muslim	12.4	1,731	21.6	2,010
Christian	5.4	288	44.5	322
Sikh	25.0	150	15.1	155
Other	9.1	87	55.2	145
Caste/Tribe				
Scheduled caste	18.6	2,685	25.4	3,172
Scheduled tribe	15.6	1,406	47.2	1,582
Other backward class	17.7	4,733	28.7	5,455
Other	15.8	2,843	21.3	3,412
Residence				
Urban	15.6	2,764	31.8	3,418
Rural	17.7	8,903	27.0	10,204
Wealth index				
Poorest	22.1	2,107	21.2	2,447
Poor	14.7	2,477	24.2	2,751
Middle	17.9	2,503	30.1	2,857
Rich	16.7	2,451	34.5	2,951
Richest	14.9	2,129	29.9	2,616
Total	17.2	11,667	28.2	13,621

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.

Table 7.9: Percentage of adolescents aged 10–19 years classified as having deficiency of vitamin B12 and Folate by selected background characteristics, India, CNNS 2016–18

Characteristics	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	34.9	5,779	39.3	6,706
Female	26.8	5,661	34.1	6,547
Age in years				
10–14	28.1	6,029	35.9	6,940
15–19	34.1	5,403	37.7	6,306
Type of diet				
Vegetarian	37.1	6,001	30.1	7,081
Vegetarian with egg	33.4	1,114	47.7	1,264
Non-vegetarian	21.7	4,317	43.5	4,900
Schooling Status				
Currently in school	31.0	8,832	37.7	10,233
Not in school	30.8	2,600	33.5	3,013
Mother's schooling				
No schooling	31.9	5,818	32.3	6,841
<5 years complete	26.5	907	40.4	1,025
5–7 years complete	33.7	1,625	42.7	1,920
8–9 years complete	28.0	1,465	38.7	1,640
10–11 years complete	30.3	810	48.8	911
≥ 12 years complete	29.1	807	37.7	909
Religion				
Hindu	33.0	9,240	38.6	10,839
Muslim	20.1	1,696	22.4	1,842
Christian	10.7	243	68.8	275
Sikh	50.9	168	20.7	177
Other	36.1	85	40.4	113
Caste/Tribe				
Scheduled caste	30.1	2,580	30.6	3,022
Scheduled tribe	29.9	1,103	59.1	1,219
Other backward class	33.7	4,729	41.7	5,564
Other	27.6	3,020	26.1	3,441
Residence				
Urban	30.3	2,887	42.1	3,409
Rural	31.1	8,545	34.9	9,837
Wealth index				
Poorest	30.5	2,041	28.2	2,416
Poor	28.0	2,343	32.8	2,706
Middle	29.9	2,448	37.6	2,719
Rich	33.4	2,395	41.5	2,794
Richest	32.9	2,206	42.7	2,610
Total	30.9	11,440	36.7	13,253

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.

Table 7.10: Percentage of children aged 1–4 years classified as having deficiency of vitamin B12 and Folate in blood by state, India, CNNS 2016–18

State	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Weighted number	Percent	Weighted number
India	**13.8**	**9,073**	**23.3**	**10,468**
North				
Delhi	7.8	456	1.3	540
Haryana	11.6	259	14.6	262
Himachal Pradesh	6.9	165	4.6	250
Jammu & Kashmir	7.9	213	5.9	294
Punjab	17.1	352	9.8	360
Rajasthan	15.6	88	34.0	108
Uttarakhand	19.0	285	17.6	331
Central				
Chhattisgarh	21.1	468	43.7	390
Madhya Pradesh	11.6	124	57.6	135
Uttar Pradesh	23.2	237	6.1	307
East				
Bihar	13.8	351	6.1	434
Jharkhand	17.6	605	5.3	546
Odisha	7.2	646	34.4	605
West Bengal	1.9	741	0.3	665
Northeast				
Arunachal Pradesh	7.0	383	38.0	381
Assam	2.8	270	59.9	260
Manipur	4.3	513	6.4	728
Meghalaya	8.5	187	26.1	224
Mizoram	6.3	235	17.9	258
Nagaland	12.4	52	74.1	88
Sikkim	6.5	543	0.1	537
Tripura	6.0	304	1.0	299
West				
Goa	3.2	176	16.6	165
Gujarat	29.2	347	39.4	483
Maharashtra	11.8	379	42.2	527
South				
Andhra Pradesh	11.1	324	62.7	373
Karnataka	15.4	321	36.0	372
Kerala	3.4	253	18.4	325
Tamil Nadu	6.6	380	23.9	457
Telangana	12.4	333	46.8	364

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.

Table 7.11: Percentage of children aged 5–9 years classified as having deficiency of vitamin B12 and Folate in blood by state, India, CNNS 2016–18

State	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Weighted number	Percent	Weighted number
India	**17.2**	**11,667**	**28.2**	**13,621**
North				
Delhi	10.8	569	1.5	700
Haryana	8.6	406	23.5	360
Himachal Pradesh	13.5	279	2.3	444
Jammu & Kashmir	10.8	277	5.6	374
Punjab	32.3	426	12.9	454
Rajasthan	22.7	268	35.2	364
Uttarakhand	14.2	359	17.3	475
Central				
Chhattisgarh	26.9	482	60.1	526
Madhya Pradesh	22.4	271	62.4	325
Uttar Pradesh	31.2	459	4.5	527
East				
Bihar	14.2	510	6.5	622
Jharkhand	12.9	537	12.5	484
Odisha	5.8	595	47.9	708
West Bengal	3.7	811	0.3	832
Northeast				
Arunachal Pradesh	4.1	423	35.3	537
Assam	3.1	452	62.8	341
Manipur	5.9	467	6.8	651
Meghalaya	5.0	206	57.0	311
Mizoram	4.3	387	20.5	419
Nagaland	0.0	74	–	–
Sikkim	5.1	546	0.3	566
Tripura	2.9	253	1.4	362
West				
Goa	3.9	313	29.1	299
Gujarat	27.6	341	54.8	503
Maharashtra	15.8	472	56.8	710
South				
Andhra Pradesh	8.4	558	68.7	564
Karnataka	15.4	309	50.5	385
Kerala	0.9	262	27.1	353
Tamil Nadu	7.4	392	41.5	526
Telangana	13.2	400	45.8	439

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.
– N < 50

Table 7.12: Percentage of adolescents aged 10–19 years classified as having deficiency of vitamin B12 and Folate by state, India, CNNS 2016–18

State	Vitamin B12 deficiency [a]		Folate deficiency [b]	
	Percent	Unweighted number	Percent	Unweighted number
India	**30.9**	**11,440**	**36.7**	**13,253**
North				
Delhi	31.2	538	3.7	633
Haryana	34.3	385	33.5	423
Himachal Pradesh	32.7	351	5.6	436
Jammu & Kashmir	25.5	233	8.8	338
Punjab	46.4	455	18.8	485
Rajasthan	47.4	312	52.7	424
Uttarakhand	27.4	324	19.5	449
Central				
Chhattisgarh	47.1	434	68.2	460
Madhya Pradesh	42.0	338	74.5	361
Uttar Pradesh	42.1	408	5.2	476
East				
Bihar	24.7	524	11.6	631
Jharkhand	22.0	454	23.8	452
Odisha	15.6	561	68.5	708
West Bengal	3.7	694	0.0	718
Northeast				
Arunachal Pradesh	12.5	372	47.9	500
Assam	10.0	437	73.3	365
Manipur	11.0	444	6.7	647
Meghalaya	9.7	225	61.5	296
Mizoram	10.6	327	22.2	355
Nagaland	2.3	76	88.9	126
Sikkim	16.0	606	0.8	588
Tripura	9.7	261	3.8	338
West				
Goa	14.0	314	48.4	333
Gujarat	47.7	336	59.3	470
Maharashtra	37.7	470	71.7	645
South				
Andhra Pradesh	20.7	488	82.6	498
Karnataka	45.5	287	70.4	354
Kerala	2.3	236	53.2	344
Tamil Nadu	18.9	467	63.0	536
Telangana	29.1	389	63.7	424

a Serum vitamin B12 level < 203 pg/ml.
b Serum erythrocyte folate level < 151 ng/ml.

Table 7.13: Iodine status as measured by median urinary iodine concentration among children aged 1–4 years by selected background characteristics, India, CNNS 2016–18[a]

Background Characteristics	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
Sex of child			
Male	210	4.5	6,658
Female	217	4.8	5,785
Child age (in months)			
12–17	217	5.1	1,020
18–23	275	4.2	1,195
24–35	228	4.4	3,110
36–47	213	3.7	3,520
48–59	175	5.8	3,598
Type of diet			
Vegetarian	209	5.5	6,969
Vegetarian with egg	208	5.3	804
Non-vegetarian	220	3.3	4,671
Mother's age (in years)			
below 20	239	2.9	155
20–24	208	4.6	3,429
25–29	223	4.9	4,977
30–34	212	4.4	2,634
35 and above	198	4.4	1,125
Mother's schooling			
No schooling	199	6.1	3,792
<5 years completed	185	5.3	785
5–7 years completed	201	2.5	1,931
8–9 years completed	222	5.0	1,955
10–11 years completed	247	3.1	1,472
≥12 years completed	231	4.4	2,500
Religion			
Hindu	217	4.9	9,964
Muslim	205	3.3	1,929
Christian	211	2.2	293
Sikh	182	6.7	164
Other	141	5.6	93
Caste/Tribe			
Scheduled caste	236	3.0	2,843
Scheduled tribe	191	5.5	1,476
Other backward class	225	4.1	5,076
Other	181	6.6	3,048
Residence			
Urban	248	2.2	2940
Rural	198	5.4	9,503
Wealth index			
Poorest	194	6.5	2,325
Poor	202	5.2	2,554
Middle	208	3.9	2,536
Rich	247	3.8	2,501
Richest	223	3.8	2,528
Total	213	4.6	12,448

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient.

Table 7.14: Iodine status (urinary iodine concentration: median and low) in children aged 5–9 years by selected background characteristics, India, CNNS 2016–18

Characteristics	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
Sex of child			
Male	184	3.8	7,001
Female	168	4.9	6,732
Age in years			
5–7	186	4.1	8,158
8–9	165	4.8	5,574
Type of diet			
Vegetarian	169	4.3	7,966
Vegetarian with egg	186	5.0	1,139
Non-vegetarian	187	4.3	4,628
Schooling Status			
Currently in school	174	4.5	12,611
Not in school	180	3.0	1,121
Mother's schooling			
No schooling	158	5.0	5,431
<5 years complete	206	6.6	1,115
5–7 years complete	173	2.9	2,206
8–9 years complete	167	4.7	2,006
10–11 years complete	191	3.3	1,412
≥12 years complete	229	3.5	1,530
Religion			
Hindu	179	3.8	11,018
Muslim	163	7.3	2,054
Christian	190	5.7	350
Sikh	167	2.9	175
Other	188	3.2	136
Caste/Tribe			
Scheduled caste	199	2.8	3,210
Scheduled tribe	157	4.6	1,569
Other backward class	175	4.8	5,574
Other	164	5.1	3,380
Residence			
Urban	231	2.8	3,233
Rural	161	4.9	10,500
Wealth index			
Poorest	140	4.7	2,594
Poor	168	5.3	2,821
Middle	168	4.7	2,822
Rich	188	4.3	2,826
Richest	234	2.8	2,670
Total	**175**	**4.4**	**13,733**

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient.

Table 7.15: Iodine status (urinary iodine concentration: median and low) in adolescents aged 10–19 years by selected background characteristics, India, CNNS 2016–18

Characteristics	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
Sex of child			
Male	180	5.1	6,470
Female	167	5.4	6,272
Age in years			
10–14	176	4.9	6,865
15–19	169	5.6	5,870
Type of diet			
Vegetarian	170	5.3	6,955
Vegetarian with egg	148	5.9	1,209
Non-vegetarian	189	4.9	4,571
Schooling Status			
Currently in school	175	5.1	9,879
Not in school	168	5.8	2,856
Mother's schooling			
No schooling	153	5.5	6,472
<5 years complete	163	5.9	970
5–7 years complete	198	4.9	1,855
8–9 years complete	188	6.3	1,657
10–11 years complete	226	4.2	875
≥12 years complete	202	2.3	906
Religion			
Hindu	177	5.4	10,300
Muslim	149	4.7	1,860
Christian	230	2.4	308
Sikh	188	2.8	183
Other	231	8.9	84
Caste/Tribe			
Scheduled caste	203	3.6	2,838
Scheduled tribe	154	7.3	1,155
Other backward class	179	4.9	5,433
Other	148	6.4	3,309
Residence			
Urban	214	3.2	3,232
Rural	162	5.9	9,503
Wealth index			
Poorest	148	5.7	2,284
Poor	149	6.3	2,677
Middle	163	6.3	2,707
Rich	183	4.2	2,576
Richest	229	3.4	2,492
Total	**173**	**5.2**	**12,742**

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient.

Table 7.16: Iodine status (urinary iodine concentration: median and low) in children aged 1–4 years by state, India, CNNS 2016–18

State	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
India	**213**	**4.6**	**12,448**
North			
Delhi	241	0.7	453
Haryana	252	1.7	285
Himachal Pradesh	101	11.0	321
Jammu & Kashmir	221	5.2	311
Punjab	188	2.7	498
Rajasthan	208	8.2	303
Uttarakhand	167	9.5	534
Central			
Chhattisgarh	234	2.8	636
Madhya Pradesh	132	8.9	293
Uttar Pradesh	211	5.2	405
East			
Bihar	259	3.1	549
Jharkhand	150	4.5	325
Odisha	197	3.5	917
West Bengal	239	1.4	680
Northeast			
Arunachal Pradesh	266	0.9	766
Assam	132	9.8	314
Manipur	170	5.9	837
Meghalaya	264	1.6	448
Mizoram	243	0.5	264
Nagaland	100	12.0	126
Sikkim	273	2.2	773
Tripura	218	1.9	447
West			
Goa	142	1.3	270
Gujarat	187	3.6	666
Maharashtra	136	7.2	459
South			
Andhra Pradesh	150	5.8	281
Karnataka	282	1.0	407
Kerala	206	5.7	492
Tamil Nadu	315	0.4	336
Telangana	299	0.7	243

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient

Table 7.17: Iodine status (urinary iodine concentration: median and low) in children aged 5–9 years by state, India, CNNS 2016–18

State	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
India	**175**	**4.4**	**13733**
North			
Delhi	236	1.3	622
Haryana	247	1.7	311
Himachal Pradesh	168	3.3	441
Jammu & Kashmir	194	5.7	372
Punjab	183	1.7	520
Rajasthan	176	6.1	448
Uttarakhand	183	5.2	553
Central			
Chhattisgarh	234	3.6	573
Madhya Pradesh	135	4.8	392
Uttar Pradesh	158	4.3	548
East			
Bihar	176	3.6	705
Jharkhand	122	9.2	361
Odisha	196	1.1	790
West Bengal	238	1.8	697
Northeast			
Arunachal Pradesh	230	3.5	643
Assam	99	14.2	445
Manipur	164	3.1	694
Meghalaya	187	2.2	421
Mizoram	239	0.4	390
Nagaland	139	6.1	147
Sikkim	251	1.6	650
Tripura	150	1.8	400
West			
Goa	138	2.2	346
Gujarat	188	4.3	572
Maharashtra	123	8.5	554
South			
Andhra Pradesh	138	6.8	498
Karnataka	247	2.6	432
Kerala	192	3.5	418
Tamil Nadu	342	0.6	411
Telangana	290	0.2	318

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient.

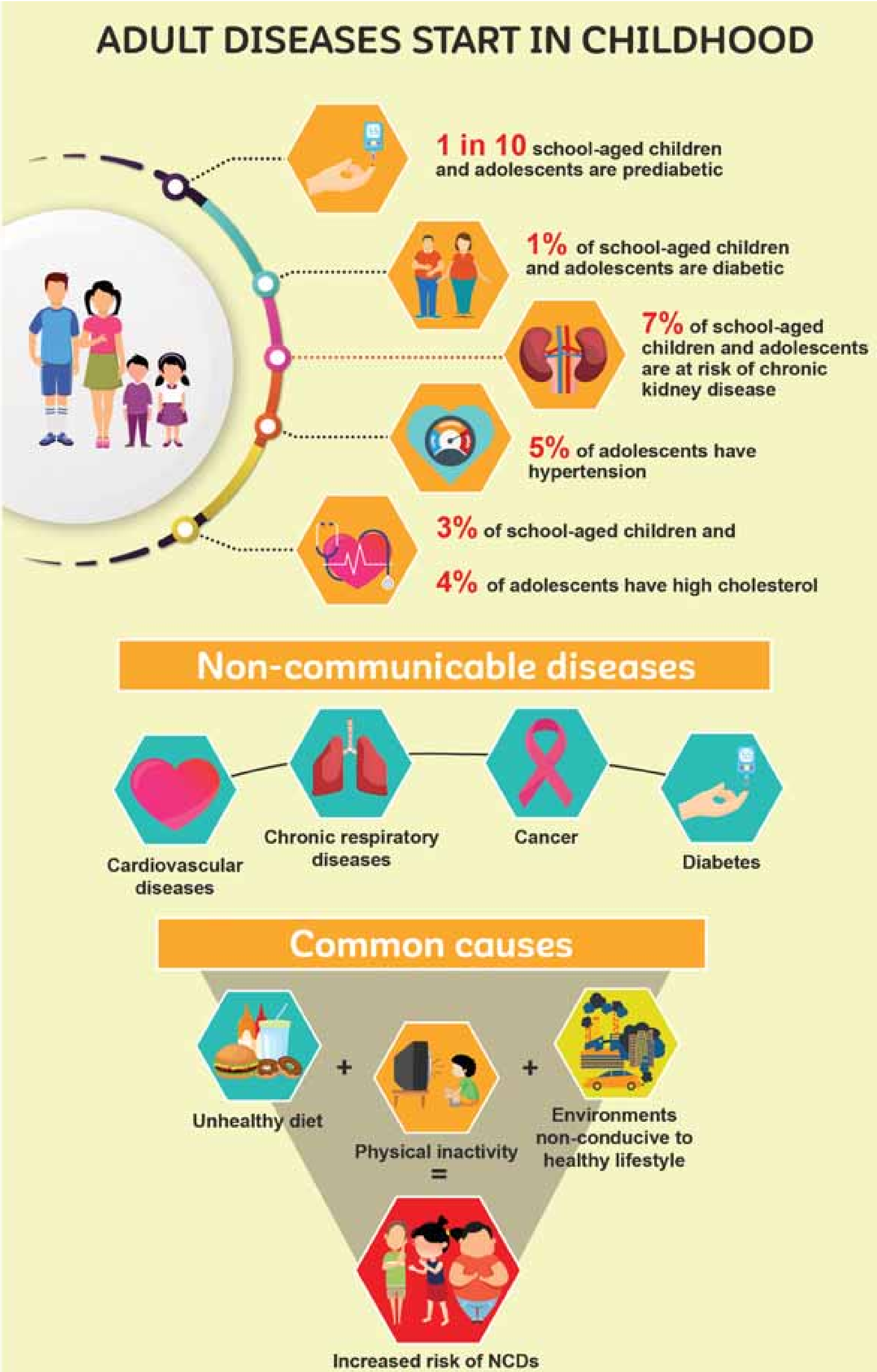
Table 7.18: Iodine status (urinary iodine concentration: median and low) in adolescents aged 10–19 years by state, India, CNNS 2016–18

State	Urinary Iodine Concentration[a]		
	Median	Percent low	Weighted number
India	**173**	**5.2**	**12,742**
North			
Delhi	188	2.2	603
Haryana	292	3.2	277
Himachal Pradesh	166	3.7	412
Jammu & Kashmir	207	6.9	323
Punjab	190	2.5	506
Rajasthan	194	8.1	398
Uttarakhand	199	5.0	466
Central			
Chhattisgarh	204	6.5	496
Madhya Pradesh	189	7.2	392
Uttar Pradesh	148	2.5	496
East			
Bihar	189	5.5	640
Jharkhand	121	18.6	274
Odisha	205	2.4	768
West Bengal	150	3.2	601
Northeast			
Arunachal Pradesh	243	1.5	554
Assam	100	17.0	421
Manipur	186	3.7	698
Meghalaya	208	3.9	386
Mizoram	233	0.0	341
Nagaland			0
Sikkim	242	3.4	624
Tripura	149	3.1	367
West			
Goa	137	2.1	335
Gujarat	180	4.7	519
Maharashtra	120	14.5	542
South			
Andhra Pradesh	131	7.3	400
Karnataka	234	2.8	375
Kerala	184	4.6	357
Tamil Nadu	312	0.1	446
Telangana	254	0.0	303

a Median Urinary Iodine Concentration (mUIC) <50 μg/l was used to classify suboptimal iodine intake. If mUIC was ≥ 50 μg/l, the population as a whole was considered to be iodine sufficient.

CHAPTER 8

Markers of non-communicable diseases



Source: WHO, 2018

Key findings

- There is a growing risk of non-communicable diseases among children aged 5 to 9 years and adolescents aged 10–19 years in India
- One in ten school-age children and adolescents were pre-diabetic with fasting plasma glucose >100 mg/dl & ≤126 mg/dl or with glycosylated haemoglobin (HbA1c) between 5.7%–6.4%
- One percent of school-age children and adolescents were diabetic with fasting plasma glucose >126 mg/dl
- Three percent of school-age children and 4% of adolescents had high total cholesterol (≥ 200 mg/dl) and high low-density lipoprotein (LDL) (≥ 130 mg/dl)
- One-quarter (26%) of school-age children and 28% of adolescents had low high-density lipoprotein (HDL) (<40 mg/dl)
- One-third (34%) of school-age children (≥ 100 mg/dl) and 16% of adolescents (≥ 130 mg/dl) had high serum triglycerides
- Seven percent of school-age children and adolescents were at risk for chronic kidney disease (serum creatinine > 0.7 mg/dl for 5–12 years and > 1.0 mg/dl for ≥ 13 years)
- Five percent of adolescents were classified as having hypertension (systolic blood pressure >139 mmHg or diastolic blood pressure >89 mmHg)

India has been going through an epidemiological transition with an increase in the proportion of disease burden attributable to non-communicable diseases (NCDs) as compared to that due to infectious disease. NCDs account for 60% of all deaths in India (Nethan, 2017). The major metabolic risk factors for NCDs are elevated blood glucose, elevated total cholesterol and LDL levels and raised blood pressure. For the first time in India, the CNNS provides a comprehensive set of biomarkers of NCDs for children and adolescents at the national and state level, including:

- fasting plasma glucose
- glycosylated haemoglobin (HbA1c)
- lipid profile: High total cholesterol, low HDL, high LDL and high triglycerides
- serum creatinine levels
- blood pressure levels

8.1 Fasting plasma glucose and HbA1c

Fasting plasma glucose and glycosylated haemoglobin (HbA1c) are diagnostic tests used to screen persons for diabetes (WHO, 2011). Previously blood glucose estimation was the only method used to detect diabetes. About 2010, HbA1c was introduced as a screening test for diabetes with the benefit of not relying on a fasting blood sample. HbA1c reflects average plasma glucose levels over the previous 8 to 12 weeks. In the CNNS, both fasting plasma glucose using Spectrophotometry, Hexokinase and HbA1c using HPLC were measured to screen for diabetes among children aged 5–9 years and adolescents aged 10–19 years. Pre-diabetic and diabetic status were assessed based on the International Diabetes Federation guidelines 2011 cut-off.

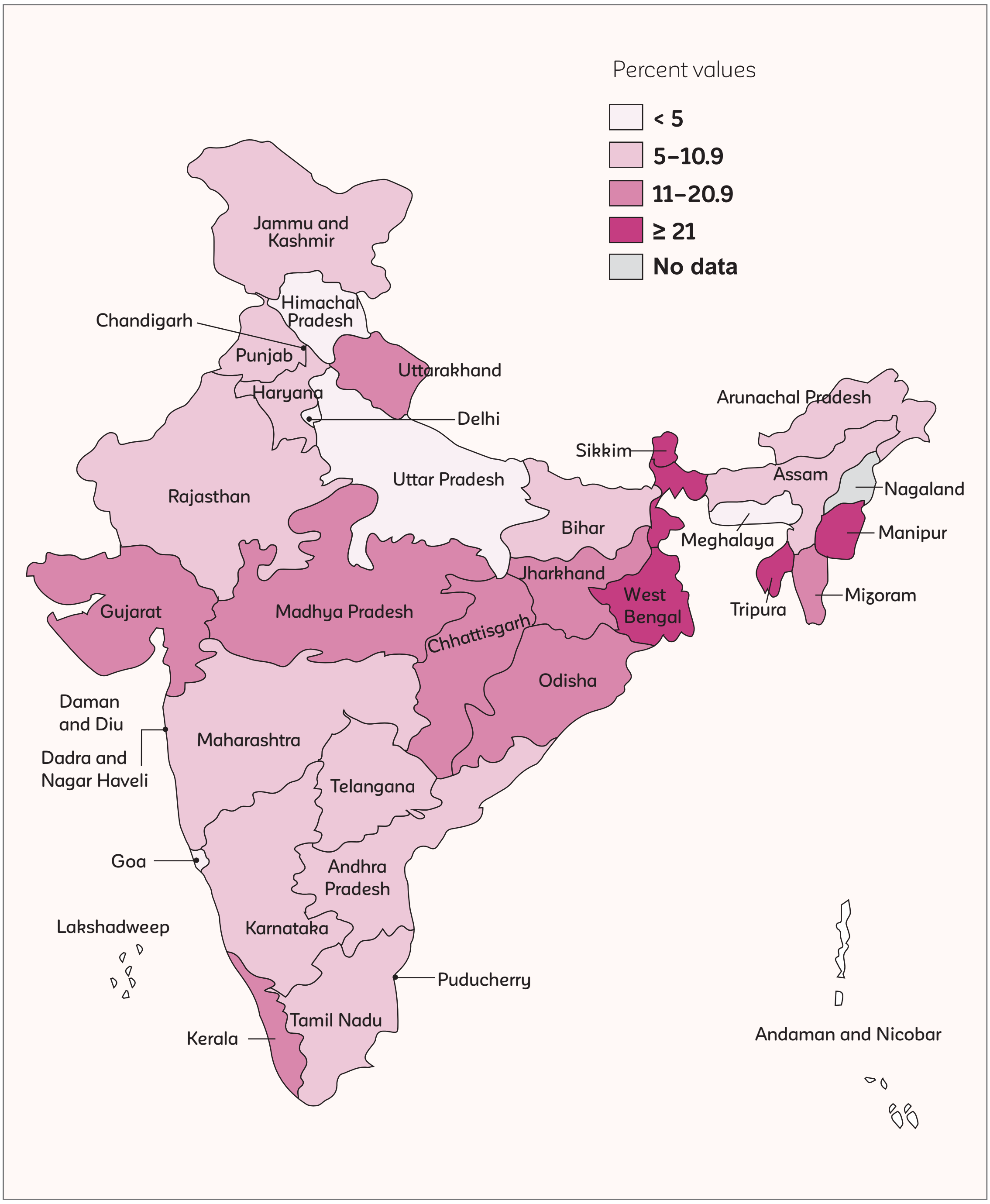
Fasting plasma glucose and glycosylated haemoglobin concentrations for pre-diabetic and diabetic status among children and adolescents

Age	Fasting plasma glucose	HbA1c
5–9 years	Pre-diabetic: > 100 mg/dl & ≤ 126 mg/dl Diabetic: > 126 mg/dl	Pre-diabetic: > 5.6% & ≤ 6.4% Diabetic: >6.4%
10–19 years	Pre-diabetic: >100 mg/dl & ≤ 126 mg/dl Diabetic: > 126 mg/dl	Pre-diabetic: > 5.6% & ≤ 6.4% Diabetic: > 6.4%

Source: Global IDF/ ISPAD guidelines for diabetes in childhood and adolescence. International Diabetes Federation, International Society of Pediatric and Adolescent Diabetes. 2011

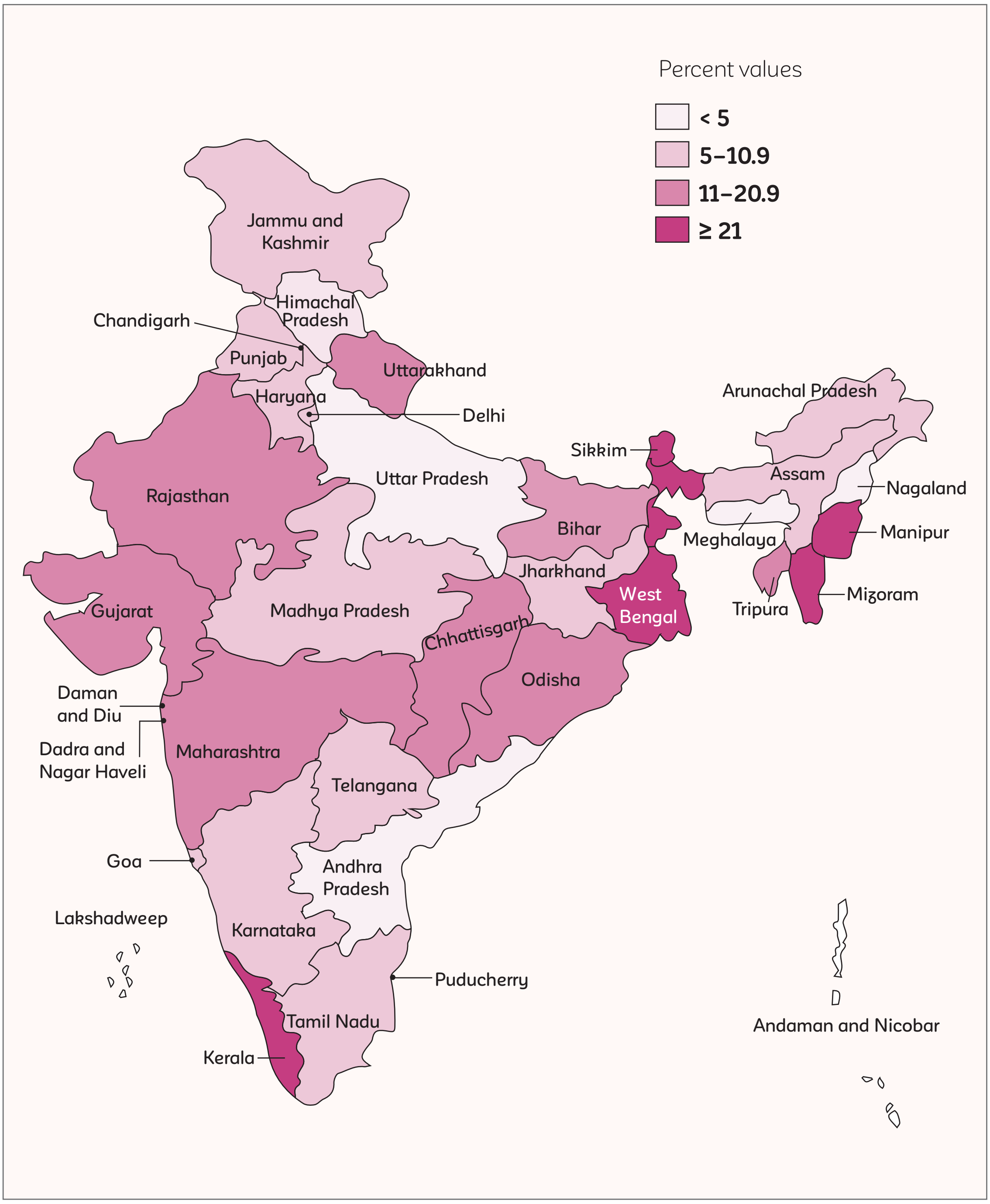
In the CNNS, 10% of school-age children and adolescents were classified as pre-diabetic, based on fasting plasma glucose >100 mg/dl & ≤126 mg/dl (Tables 8.1 & 8.2). Among both age groups, there was wide variability in pre-diabetic prevalence across states, with a low of 2% in Goa to ≥ 20% in six states among school-age children (Figure 8.1), and a low of 1% in Himachal Pradesh and Nagaland to a high of >20% in six states among adolescents (Tables 8.3 & 8.4). Among adolescents, the prevalence of pre-diabetic fasting plasma glucose levels was > 21% in Manipur, Kerala, Sikkim, Mizoram and West Bengal (Figure 8.2). The prevalence of diabetes was low (~1%) among both children and adolescents (Tables 8.1 & 8.2).

Figure 8.1: Prevalence of pre-diabetic status among children aged 5–9 years, India, CNNS 2016–18



Note: Pre-diabetic status defined as fasting plasma glucose >100 mg/dl & ≤126 mg/dl.

Figure 8.2: Prevalence of pre-diabetic status among adolescents aged 10–19 years, India, CNNS 2016–18



Note: Diabetic status defined as fasting plasma glucose >100 mg/dl & ≤126 mg/dl.

8.2 Lipid profile

Lipid disorders include high levels of low-density lipoprotein (LDL) cholesterol, or fats called triglycerides, or both in blood. High levels of these lipoproteins and fats increase the risk for developing heart disease. The early onset of lipid disorders including elevated total or low-density lipoprotein (LDL) cholesterol levels, low levels of high-density lipoprotein (HDL) cholesterol, and high levels of triglycerides (fats) is alarming as these conditions in childhood are predictive of elevated risk for cardiovascular disease in adulthood (Holly, 2010).

In the CNNS, the lipid profile of children aged 5–9 years and adolescents aged 10–19 years was assessed based on measurements of the following indicators listed below. Risk status was determined based on values for plasma lipid and lipoprotein levels from the US National Cholesterol Education Programme Expert Panel on Cholesterol Levels in Children also given below.

- total cholesterol (assessed by spectrophotometry using cholesterol oxidase esterase peroxidase)
- high-density lipoprotein (HDL) cholesterol (assessed by spectrophotometry and direct measure polyethylene glycol modified cholesterol oxidase)
- low-density lipoprotein (LDL) (assessed by spectrophotometry and direct measure cholesterol oxidase
- serum triglycerides (assessed by spectrophotometry and enzymatic endpoint method)

Plasma lipid and lipoprotein concentrations for children and adolescents

Age	Plasma lipid and lipoprotein concentrations
Children (5–9 years) and adolescents (10–19 years)	■ High total cholesterol ≥ 200 mg/dl ■ High LDL ≥ 130 mg/dl ■ Low HDL < 40 mg/dl ■ High serum triglycerides: for 5–9 years ≥ 100 mg/dl; for 10–19 years ≥ 130 mg/dl

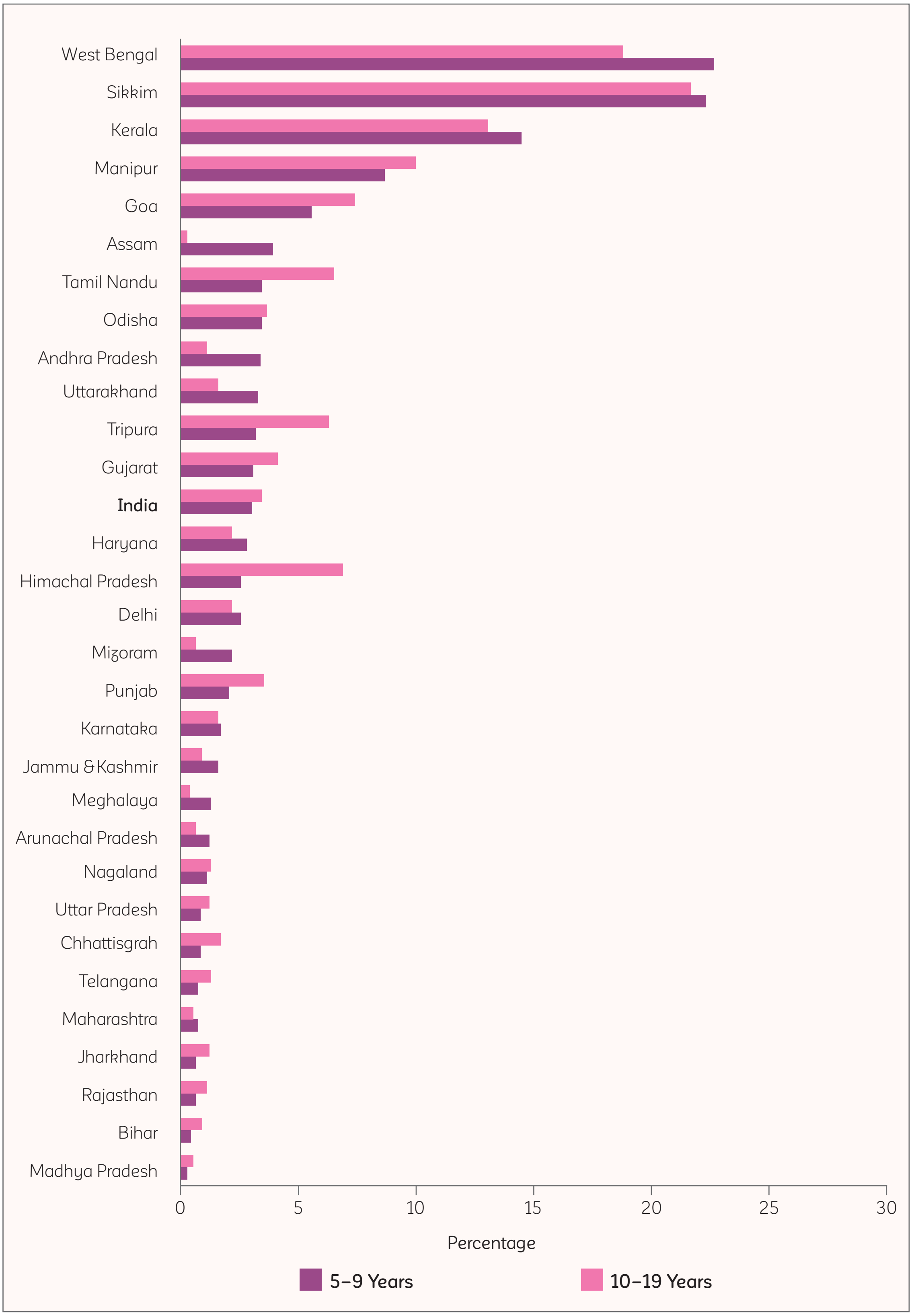
Source: National Cholesterol Education Programme(, Expert Panel on Cholesterol Levels in Children, 2012

The prevalence of high total cholesterol was 3% and 4% among school-age children and adolescents, respectively (Tables 8.9 & 8.10). Though the prevalence of high total cholesterol varied across states, the majority had <5% prevalence for both school-age children and adolescents (Figure 8.3). The prevalence of high LDL cholesterol was also 3%

and 4% among school-age children and adolescents, respectively, with similar patterns across states (Tables 8.11 & 8.12). In Sikkim and West Bengal, >20% of school-age children and adolescents had high total cholesterol (Tables 8.11 & 8.12).

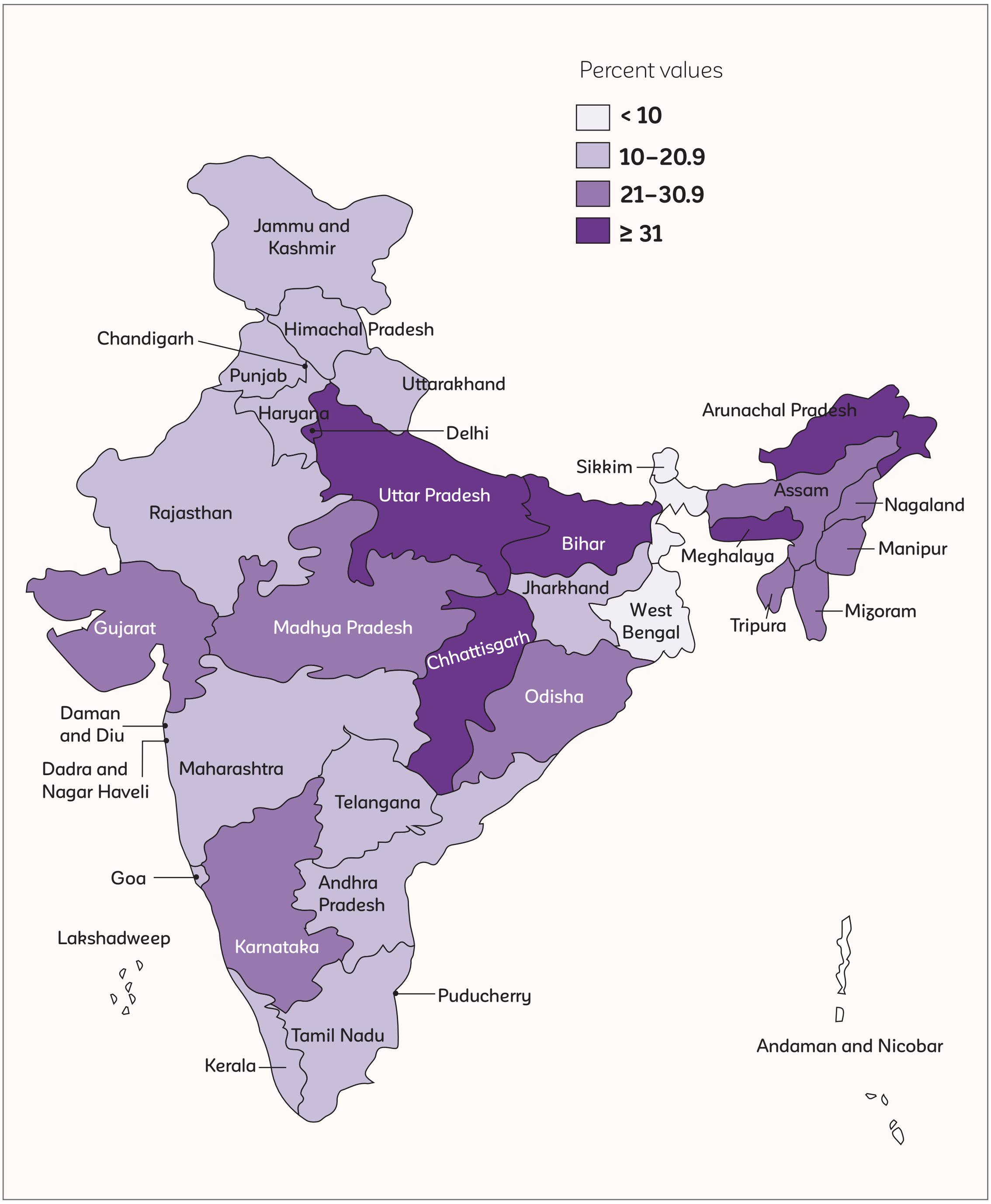
The prevalence of low HDL cholesterol was 26% and 28% among school-age children and adolescents, respectively (Tables 8.9 & 8.10). State level variation was also observed for low HDL cholesterol among both age groups, with >30% prevalence in Arunachal Pradesh, Chhattisgarh, Uttar Pradesh, Bihar and Meghalaya for school-age children (Figure 8.4 & Table 8.11) and > 30% prevalence in the same states, and Karnataka for adolescents (Figure 8.5 & Table 8.12). A higher prevalence of low HDL cholesterol was observed among children and adolescents who resided in rural areas, belonged to households in the poorest wealth quintile, and among those whose mother had no schooling (Figure 8.6; Tables 8. 9 & 8.10).

Figure 8.3: Prevalence of high total cholesterol among children aged 5–9 years and adolescents aged 10–19 years by state, India, CNNS 2016–18



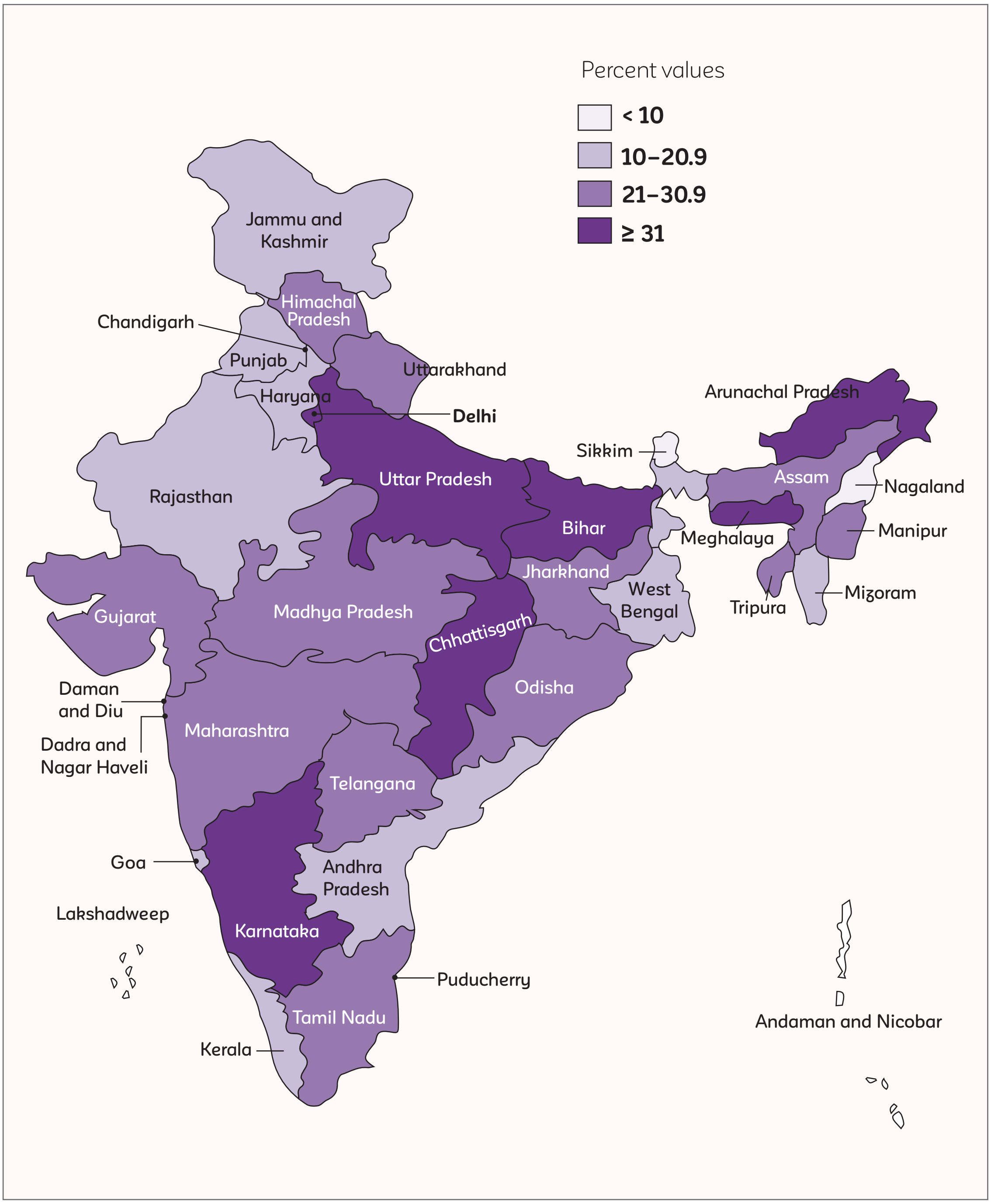
Note: High Total Cholesterol defined as ≥ 200 mg/dl

Figure 8.4: Prevalence of low HDL cholesterol among children aged 5–9 years, India, CNNS 2016–18



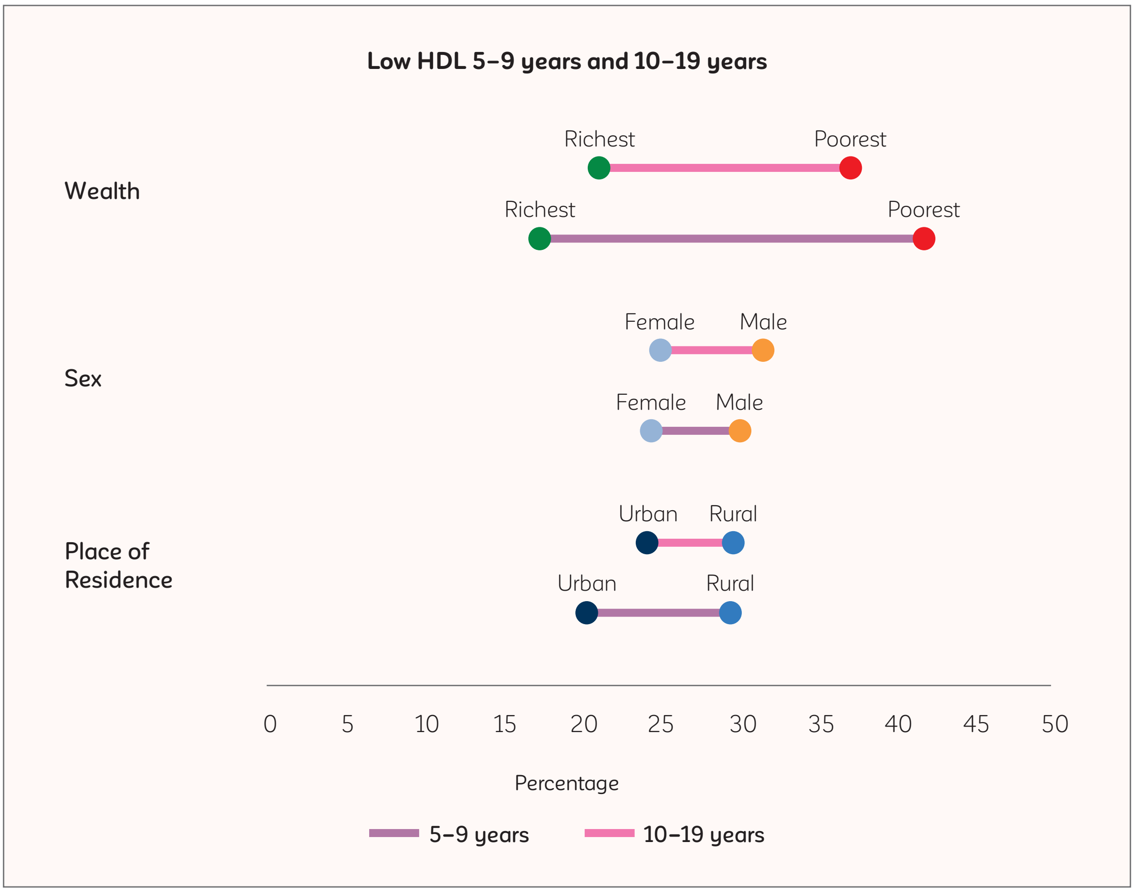
Note: Low HDL cholesterol defined as <40 mg/dl.

Figure 8.5: Prevalence of low HDL cholesterol among adolescents aged 10–19 years, India, CNNS 2016–18



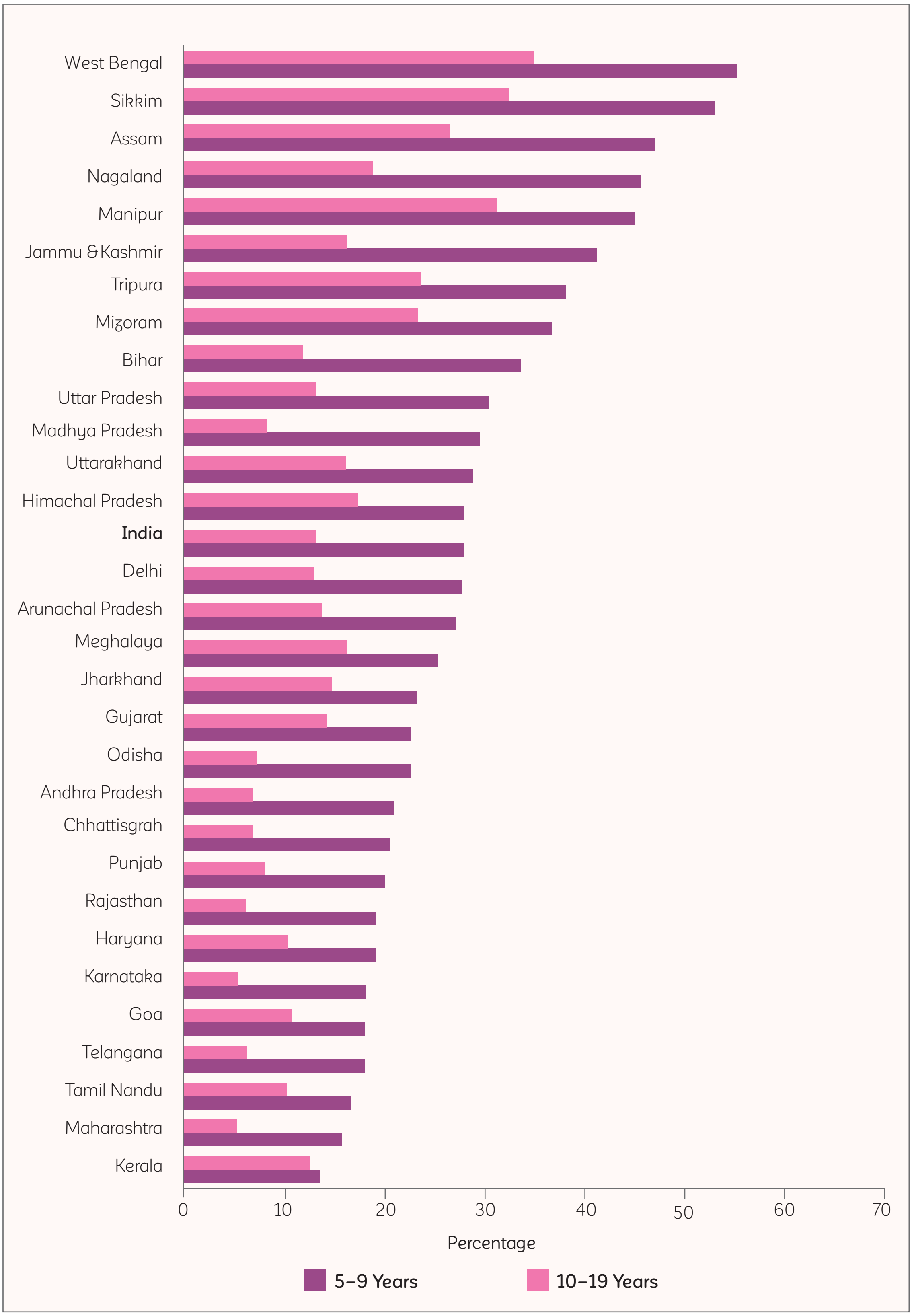
Note: Low HDL cholesterol defined as <40 mg/dl.

Figure 8.6: Prevalence of low HDL cholesterol among children aged 5–9 years and adolescents aged 10–19 years by wealth, sex and place of residence, India, CNNS 2016–18



The prevalence of high serum triglyceride levels among school-age children was more than double that of adolescents (34% vs 16%) (Tables 8.9 & 8.10). For school-age children, the lowest prevalence was in Kerala (17%) and the highest in West Bengal (67%) (Figure 8.7 & Table 8.11). Among adolescents, Maharashtra (6%) and West Bengal (43%) had the lowest and highest prevalence, respectively (Figure 8.7 & Table 8.12).

Figure 8.7: Prevalence of high serum triglycerides among children aged 5–9 years and adolescents aged 10–19 years by state, India, CNNS 2016–18



Note: High Serum Triglycerides: for 5–9 years ≥ 100 mg/dl; for 10–19 years ≥ 130 mg/dl

8.3 Renal function

Recent cross-sectional data confirms that chronic kidney disease (CKD) is reaching epidemic proportions in specific geographical areas in India and tending to afflict relatively younger adults as compared to western populations (Rajapurkar, 2012). There is evidence to suggest that CKD may start in childhood. In the CNNS, renal function among children and adolescents was assessed by estimating serum creatinine by the spectrophotometry, Alkaline picrate - kinetic IFCC IDMS standardized Jaffe rate method (NHANES, 2007–2008). Renal function was assessed based on guidelines in Wallach's Interpretation of Diagnostic Tests 2013.

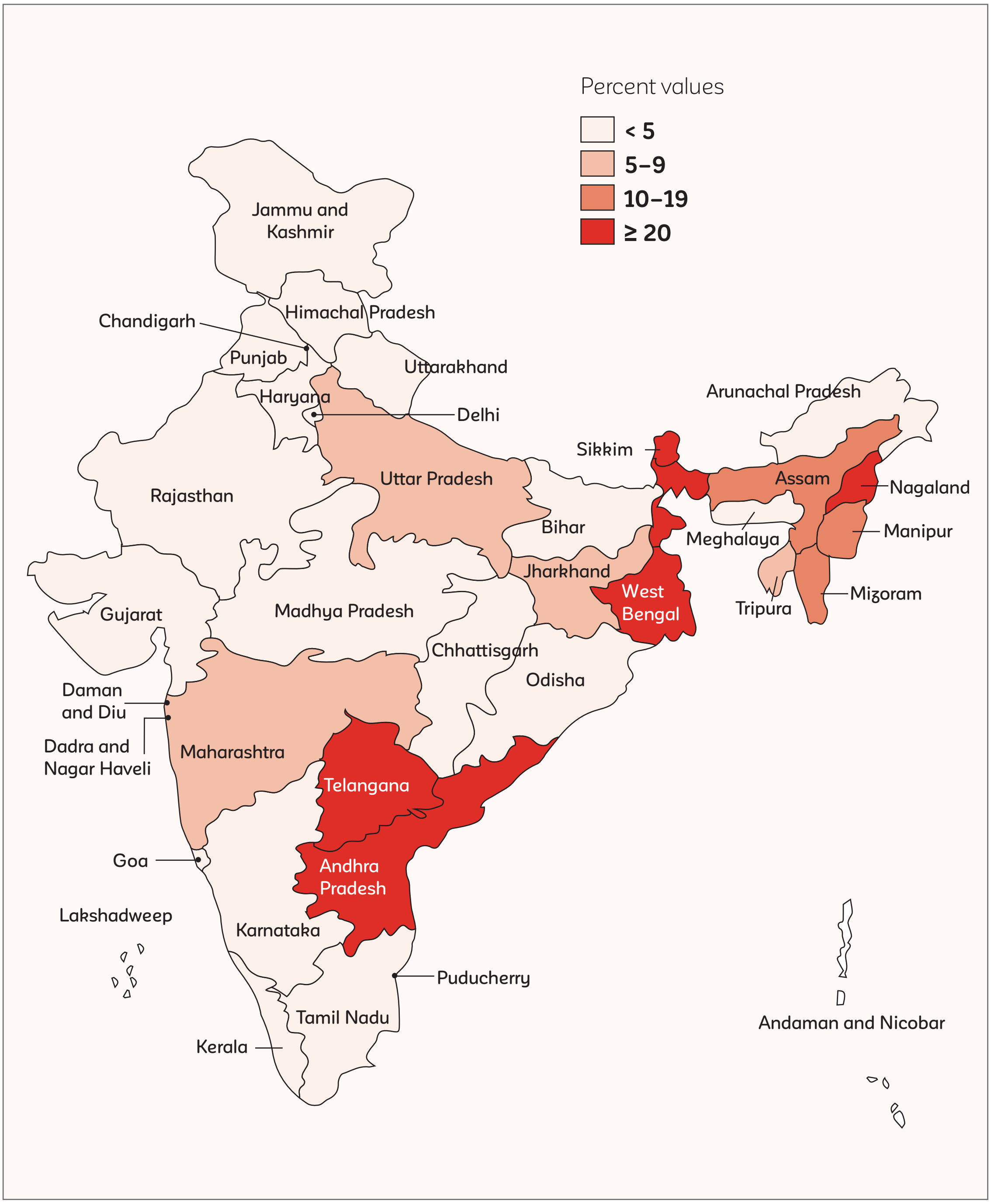
Serum creatinine concentrations for assessing renal function among children and adolescents

Age	Serum creatinine concentrations
5–12 years	Serum creatinine > 0.7 mg/dl
> 12 years	Serum creatinine > 1.0 mg/dl

Source: Wallach's Interpretation of Diagnostic Tests (Interpretation of Diagnostics Tests, 9th Edition), 2012

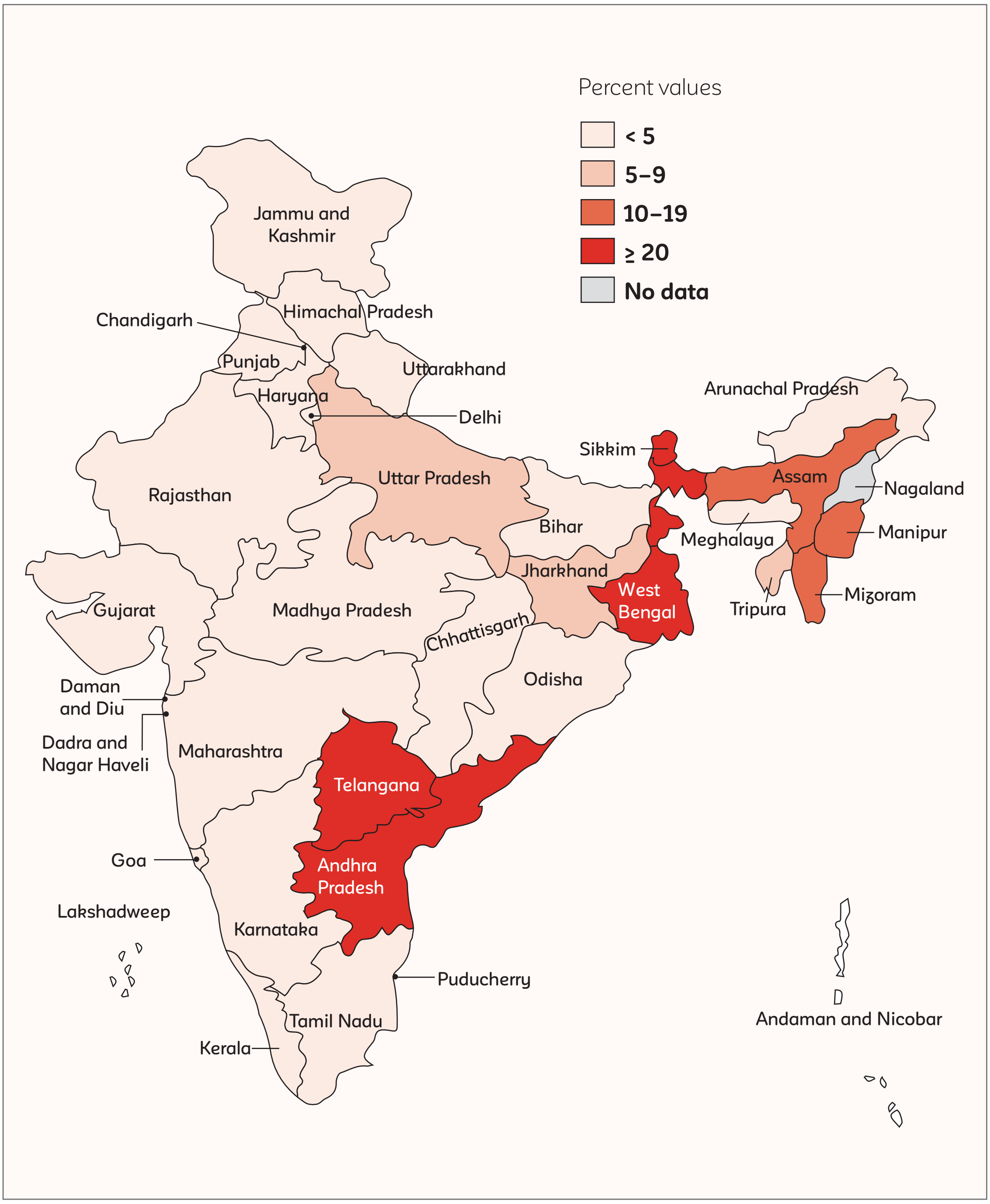
In the CNNS, 7% of school-age children and adolescents were determined to be at risk for chronic kidney disease (CKD), as measured by high serum creatinine (Tables 8.13 & 8.14). The majority of states had a < 5% prevalence of high serum creatinine. Higher prevalence (≥ 20%) was observed in Andhra Pradesh, Sikkim, Nagaland, Telangana and West Bengal, for both children and adolescents (Figures 8.8 & 8.9).

Figure 8.8: Prevalence of high serum creatinine among children aged 5–9 years, India, CNNS 2016–18



Note: High serum creatinine defined as >0.7 mg/dl.

Figure 8.9: Prevalence of high serum creatinine among adolescents aged 10–19 years, India, CNNS 2016–18



Note: High serum creatinine for 10–12 years old defined as >0.7 mg/dl and for >12 years old as >1.0 mg/dl.

8.4 Blood pressure

In the CNNS, blood pressure (BP) recording and analysis for adolescents were performed following the recommendations of the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (NIH, 2005). Automated devices were used to measure blood pressure to minimize observer bias or digit preference. The cuff used was appropriate to the size of the adolescent's upper right arm. Three blood pressure readings were taken with a gap of at least two minutes. The mean of the last two readings was used for the analysis. Hypertension was assessed based on guidelines used in the 2017 National Family Health Survey – 4 (Table 8.4).

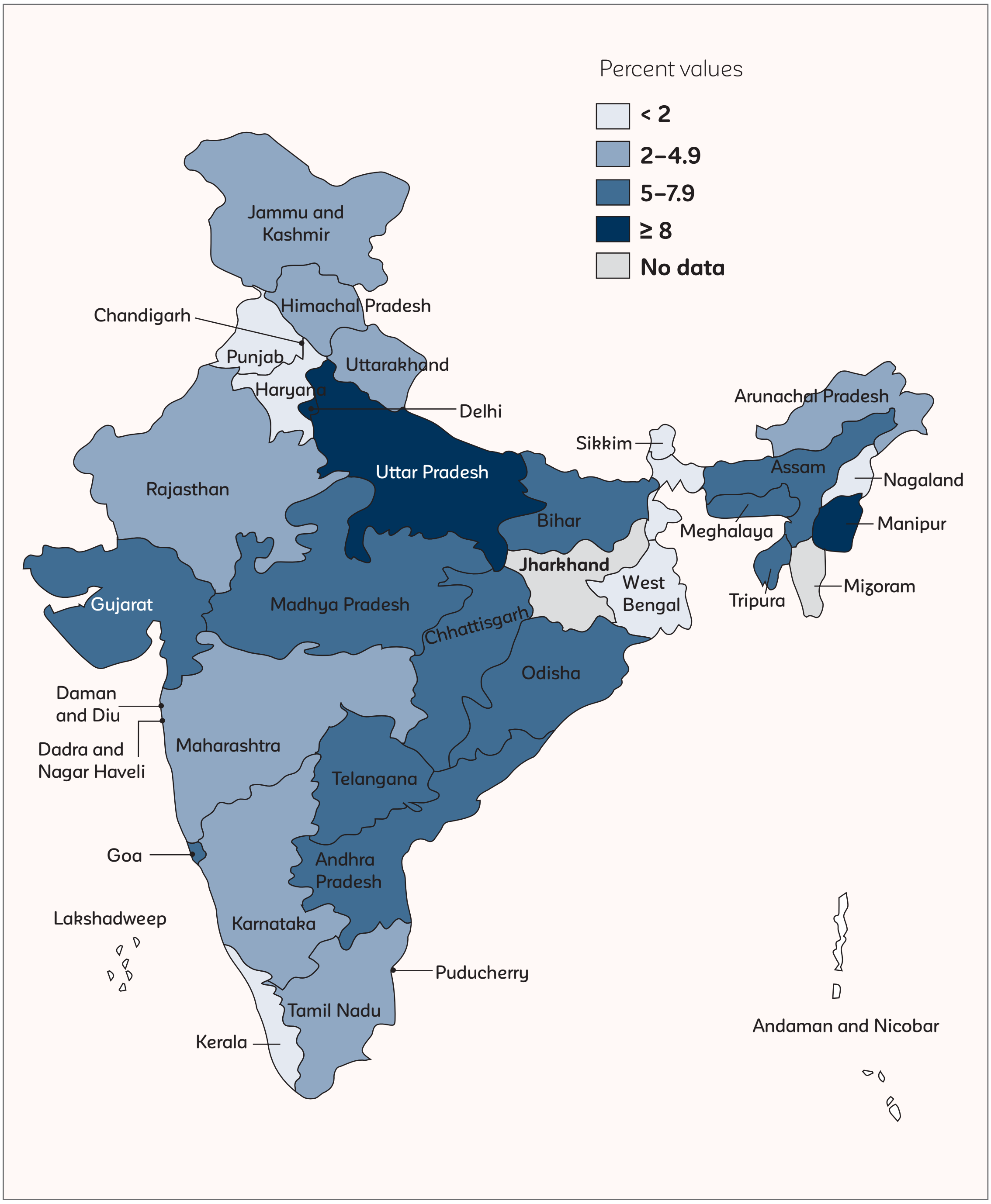
Blood pressure levels for hypertension among adolescents aged 10–19 years

Age	Blood pressure levels for hypertension
10–19 years	• a systolic blood pressure level ≥ 140 mmHg, or • a diastolic blood pressure level ≥ 90 mmHg

Source: National Family Health Survey – 4, 2017

In the CNNS, 5% of adolescents were classified as being hypertensive (Table 8.17). The prevalence of hypertension ranged from 0% to 10% across states (Table 8.18). States with the highest (≥ 8%) prevalence of hypertension among adolescents were Delhi, Uttar Pradesh and Manipur (Figure 8.10).

Figure 8.10: Prevalence of hypertension among adolescents aged 10–19 years, India, CNNS 2016–18



Note: Hypertensive defined as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.

Table 8.1: Percentage of children aged 5–9 years with pre-diabetic and diabetic status by selected background characteristics, India, CNNS 2016–18

Characteristics	Pre-diabetic		Diabetic	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	11.2	5,060	1.3	5,060
Female	9.2	4,613	1.1	4,613
Child age (in years)				
5–7	10.2	5,590	1.3	5,590
8–9	10.4	4,083	1.1	4,083
Type of diet				
Vegetarian	9.1	5,149	0.9	5,149
Vegetarian with egg	12.8	985	2.7	985
Non-vegetarian	12.1	3,539	1.2	3,539
Schooling status				
Currently in school	10.1	9,020	1.2	9,020
Not in school	12.5	653	2.0	653
Mother's schooling				
No schooling	9.8	3,728	1.6	3,728
<5 years completed	10.8	820	1.0	820
5–7 years completed	11.2	1,573	1.0	1,573
8–9 years completed	10.8	1,410	0.6	1,410
10–11 years completed	11.4	964	1.4	964
≥ 12 years completed	8.4	1,155	1.0	1,155
Religion				
Hindu	9.8	7,810	1.3	7,810
Muslim	12.9	1,444	1.0	1,444
Christian	14.0	205	1.9	205
Sikh	7.7	111	0.0	111
Other	8.7	103	1.5	103
Caste/Tribe				
Scheduled caste	8.2	2,219	1.3	2,219
Scheduled tribe	13.8	1,155	1.6	1,155
Other backward class	9.0	3,939	1.3	3,939
Other	12.6	2,360	0.8	2,360
Residence				
Urban	9.1	2,457	1.1	2,457
Rural	10.7	7,216	1.3	7,216
Wealth index				
Poorest	9.1	1,742	1.9	1,742
Poor	11.5	2,046	1.1	2,046
Middle	10.4	1,965	1.4	1,965
Rich	10.0	2,098	1.2	2,098
Richest	10.2	1,823	0.6	1,823
Total	10.3	9,673	1.2	9,673

Note: Pre-diabetic: fasting plasma glucose > 100 mg/dl & ≤ 126 mg/dl.
Diabetic: fasting plasma glucose > 126 mg/dl.

Table 8.2: Percentage of adolescents aged 10–19 years with pre-diabetic and diabetic status by selected background characteristics, India, CNNS 2016–18

Background Characteristics	Pre-diabetic		Diabetic	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	11.4	5,114	0.7	5,114
Female	9.3	4,921	0.4	4,921
Age in years				
10–14	10.7	5,304	0.7	5,304
15–19	10.0	4,730	0.5	4,730
Type of diet				
Vegetarian	9.9	5,175	0.5	5,175
Vegetarian with egg	8.6	964	07	964
Non-vegetarian	11.5	3,896	0.6	3,896
Schooling status				
Currently in school	10.0	7,911	0.5	7,911
Not in school	11.8	2,123	0.7	2,123
Mother's Schooling				
No schooling	9.6	4,976	0.7	4,976
<5 years completed	12.1	812	0.4	812
5–7 years completed	11.9	1,440	0.5	1,440
8–9 years completed	9.5	1,319	0.3	1,319
10–11 years completed	8.1	788	0.5	788
≥12 years completed	15.1	699	0.3	699
Religion				
Hindu	9.8	8,277	0.6	8,277
Muslim	14.2	1,361	0.3	1,361
Christian	9.0	182	1.0	182
Sikh	8.2	123	0.3	123
Other	10.1	90	0.2	90
Caste/Tribe				
Scheduled caste	10.0	2,292	0.3	2,292
Scheduled tribe	14.1	987	1.7	987
Other backward class	8.4	4,172	0.5	4,172
Other	12.5	2,583	0.4	2,583
Residence				
Urban	10.9	2,595	0.5	2,595
Rural	10.2	7,440	0.6	7,440
Wealth index				
Poorest	11.1	1,753	0.8	1,753
Poor	10.1	2,070	0.6	2,070
Middle	11.1	2,127	0.5	2,127
Rich	8.8	2,090	0.6	2,090
Richest	10.9	1,994	0.4	1,994
Total	10.4	10,034	0.6	10,034

Note: Pre-diabetic: fasting plasma glucose > 100 mg/dl & ≤ 126 mg/dl.
Diabetic: fasting plasma glucose: > 126 mg/dl.

Table 8.3: Percentage of children aged 5–9 years with pre-diabetic and diabetic status by state, India, CNNS 2016–18

State	Pre-diabetic		Diabetic	
	Percent	Weighted number	Percent	Weighted number
India	**10.3**	**9,673**	**1.2**	**9,673**
North				
Delhi	4.5	540	0.7	540
Haryana	6.0	264	0.0	264
Himachal Pradesh	3.8	377	0.4	377
Jammu & Kashmir	7.6	269	0.2	269
Punjab	8.9	293	0.0	293
Rajasthan	8.0	155	0.0	155
Uttarakhand	12.8	333	1.7	333
Central				
Chhattisgarh	14.6	453	1.3	453
Madhya Pradesh	16.9	170	0.0	170
Uttar Pradesh	4.2	266	1.1	266
East				
Bihar	6.6	549	0.5	549
Jharkhand	11.0	560	3.5	560
Odisha	19.2	584	1.6	584
West Bengal	21.7	753	1.0	753
Northeast				
Arunachal Pradesh	9.0	414	2.1	414
Assam	6.4	236	1.8	236
Manipur	22.0	578	2.7	578
Meghalaya	4.8	204	8.8	204
Mizoram	19.7	302	2.9	302
Nagaland	–	–	–	–
Sikkim	21.6	513	1.3	513
Tripura	21.1	287	4.3	287
West				
Goa	1.8	277	2.4	277
Gujarat	20.8	349	1.3	349
Maharashtra	10.4	563	2.4	563
South				
Andhra Pradesh	5.1	252	0.5	252
Karnataka	5.0	335	0.0	335
Kerala	18.7	313	2.1	313
Tamil Nadu	7.4	327	3.2	327
Telangana	8.0	310	0.0	310

Note: Pre-diabetic: fasting plasma glucose > 100 mg/dl & ≤ 126 mg/dl.
Diabetic: fasting plasma glucose: > 126 mg/dl.
– N < 50 and results are not presented

Table 8.4: Percentage of adolescents aged 10–19 years with pre-diabetic and diabetic status by state, India, CNNS 2016–18

State	Pre-diabetic		Diabetic	
	Percent	Weighted number	Percent	Weighted number
India	**10.4**	**10,034**	**0.6**	**10,034**
North				
Delhi	5.3	506	0.0	506
Haryana	6.4	358	0.2	358
Himachal Pradesh	1.4	379	0.0	379
Jammu & Kashmir	9.7	285	0.0	285
Punjab	9.7	321	0.2	321
Rajasthan	13.6	235	1.1	235
Uttarakhand	12.3	334	0.3	334
Central				
Chhattisgarh	12.2	408	1.3	408
Madhya Pradesh	10.8	200	0.8	200
Uttar Pradesh	3.2	292	0.0	292
East				
Bihar	6.2	575	0.0	575
Jharkhand	8.8	495	1.8	495
Odisha	18.9	603	0.6	603
West Bengal	22.1	668	0.6	668
Northeast				
Arunachal Pradesh	9.7	382	0.3	382
Assam	8.9	246	1.3	246
Manipur	21.3	567	2.5	567
Meghalaya	2.6	197	3.0	197
Mizoram	23.7	288	2.5	288
Nagaland	0.7	56	0.0	56
Sikkim	25.8	566	0.8	566
Tripura	16.5	288	4.9	288
West				
Goa	9.4	317	0.0	317
Gujarat	20.9	392	2.9	392
Maharashtra	13.9	521	0.4	521
South				
Andhra Pradesh	4.0	234	0.0	234
Karnataka	7.1	332	0.0	332
Kerala	32.2	304	0.5	304
Tamil Nadu	9.2	410	1.0	410
Telangana	8.6	309	1.1	309

Note: Pre-diabetic: fasting plasma glucose > 100 mg/dl & ≤126 mg/dl.
Diabetic: fasting plasma glucose: > 126 mg/dl.

Table 8.5: Percentage of children aged 5–9 years with elevated glycosylated haemoglobin concentration (HbA1c) by selected background characteristics, India, CNNS 2016–18

Background Characteristics	HbA1c (> 5.7 & ≤ 6.4%)		HbA1c (> 6.4%)	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	10.1	6,793	0.1	6,793
Female	8.3	6,394	0.1	6,394
Age in years				
5–7	9.4	7,855	0.1	7,855
8–9	8.9	5,332	0.2	5,332
Type of diet				
Vegetarian	9.4	7,478	0.1	7,478
Vegetarian with egg	15.0	1,190	0.1	1,190
Non-vegetarian	7.5	4,519	0.1	4,519
Schooling status				
Currently in school	9.5	12,189	0.1	12,189
Not in school	6.5	997	0.0	997
Mother's Schooling				
No schooling	8.7	5,083	0.1	5,083
<5 years completed	9.4	1,109	0.1	1,109
5–7 years completed	11.0	2,126	0.1	2,126
8–9 years completed	9.2	1,888	0.2	1,888
10–11 years completed	8.5	1,403	0.1	1,403
≥ 12 years completed	9.5	1,545	0.0	1,545
Religion				
Hindu	9.2	10,659	0.1	10,659
Muslim	8.7	1,955	0.1	1,955
Christian	11.9	298	0.0	298
Sikh	12.5	157	0.0	157
Other	8.7	117	0.0	117
Caste/Tribe				
Scheduled caste	7.8	3,080	0.1	3,080
Scheduled tribe	10.2	1,434	0.1	1,434
Other backward class	10.4	5,315	0.2	5,315
Other	8.3	3,357	0.0	3,357
Residence				
Urban	8.2	3,291	0.1	3,291
Rural	9.6	9,896	0.1	9,896
Wealth index				
Poorest	6.3	2,242	0.1	2,242
Poor	8.6	2,621	0.1	2,621
Middle	12.1	2,824	0.2	2,824
Rich	8.9	2,885	0.0	2,885
Richest	9.7	2,615	0.2	2,615
Total	9.2	13,187	0.1	13,187

Table 8.6: Percentage of adolescents aged 10–19 years with elevated glycosylated haemoglobin concentration (HbA1c) by selected background characteristics, India, CNNS 2016–18

Background Characteristics	HbA1c (> 5.7 & ≤ 6.4%)		HbA1c (> 6.4%)	
	Percent	Weighted number	Percent	Weighted number
Sex of child				
Male	11.3	6,583	0.2	6,583
Female	7.6	6,493	0.2	6,493
Age in years				
10–14	9.9	6,882	0.2	6,882
15–19	9.1	6,187	0.2	6,187
Type of diet				
Vegetarian	9.7	7,095	0.1	7,095
Vegetarian with egg	9.2	1,215	0.0	1,215
Non-vegetarian	9.2	4,759	0.4	4,759
Schooling status				
Currently in school	9.6	10,089	0.2	10,089
Not in school	9.1	2,980	0.1	2,980
Mother's Schooling				
No schooling	10.4	1,888	0.0	1,888
<5 years completed	10.3	1,011	0.1	1,011
5–7 years completed	10.4	1,888	0.0	1,888
8–9 years completed	9.9	1,599	0.3	1,599
10–11 years completed	9.1	902	0.3	902
≥ 12 years completed	9.6	924	0.1	924
Religion				
Hindu	9.5	10,663	0.1	10,663
Muslim	8.2	1,810	0.6	1,810
Christian	14.8	302	0.0	302
Sikh	13.7	180	0.0	180
Other	13.1	113	0.0	113
Caste/Tribe				
Scheduled caste	8.6	2,989	0.0	2,989
Scheduled tribe	13.8	1,179	0.2	1,179
Other backward class	9.4	5,491	0.2	5,491
Other	8.9	3,409	0.3	3,409
Residence				
Urban	9.3	3,365	0.1	3,365
Rural	9.6	9,704	0.2	9,704
Wealth index				
Poorest	7.6	2,299	0.2	2,299
Poor	10.5	2,687	0.2	2,687
Middle	9.5	2,712	0.1	2,712
Rich	8.5	2,805	0.0	2,805
Richest	11.2	2,565	0.4	2,565
Total	9.5	13,076	0.2	13,076

Table 8.7: Percentage of children aged 5–9 years with elevated glycosylated haemoglobin concentration (HbA1c) by state, India, CNNS 2016–18

State	HbA1c (> 5.7 & ≤ 6.4%)		HbA1c (> 6.4%)	
	Percent	Weighted number	Percent	Weighted number
India	**9.2**	**13187**	**0.1**	**13187**
North				
Delhi	6.3	693	0.0	693
Haryana	23.8	395	0.0	395
Himachal Pradesh	7.5	432	0.1	432
Jammu & Kashmir	6.9	378	0.0	378
Punjab	13.2	462	0.0	462
Rajasthan	14.0	423	0.5	423
Uttarakhand	8.6	494	0.0	494
Central				
Chhattisgarh	13.4	477	0.4	477
Madhya Pradesh	12.6	390	0.5	390
Uttar Pradesh	5.1	524	0.0	524
East				
Bihar	4.1	521	0.0	521
Jharkhand	15.8	436	0.6	436
Odisha	10.1	616	0.3	616
West Bengal	5.7	824	0.0	824
Northeast				
Arunachal Pradesh	8.1	531	0.0	531
Assam	9.0	255	0.0	255
Manipur	10.5	641	0.7	641
Meghalaya	6.1	276	0.0	276
Mizoram	10.7	416	0.0	416
Nagaland	–	–	–	–
Sikkim	2.0	586	0.0	586
Tripura	11.0	335	2.2	335
West				
Goa	26.4	307	0.0	307
Gujarat	16.8	460	0.0	460
Maharashtra	8.0	702	0.0	702
South				
Andhra Pradesh	13.6	502	0.0	502
Karnataka	10.2	380	0.0	380
Kerala	6.8	327	0.0	327
Tamil Nadu	6.3	501	0.0	501
Telangana	15.4	433	0.1	433

Note: – N < 50 and results are not presented

Table 8.8: Percentage of adolescents aged 10–19 years with elevated glycosylated haemoglobin concentration (HbA1c) by state, India, CNNS 2016–18

State	HbA1c (> 5.7 & ≤ 6.4%)		HbA1c (> 6.4%)	
	Percent	Weighted Number	Percent	Weighted Number
India	**9.5**	**13076**	**0.2**	**13076**
North				
Delhi	7.3	638	0.0	638
Haryana	24.8	485	0.0	485
Himachal Pradesh	4.9	402	0.0	402
Jammu & Kashmir	8.5	341	0.0	341
Punjab	14.0	489	0.0	489
Rajasthan	12.5	479	1.2	479
Uttarakhand	6.7	465	0.0	465
Central				
Chhattisgarh	13.2	424	0.3	424
Madhya Pradesh	13.5	440	0.1	440
Uttar Pradesh	4.5	488	0.0	488
East				
Bihar	3.4	529	0.0	529
Jharkhand	12.8	367	1.0	367
Odisha	12.6	625	0.0	625
West Bengal	6.3	714	0.0	714
Northeast				
Arunachal Pradesh	7.7	480	0.0	480
Assam	13.0	225	4.4	225
Manipur	14.9	634	0.7	634
Meghalaya	7.8	263	0.0	263
Mizoram	7.6	367	0.1	367
Nagaland	1.9	64	0.0	64
Sikkim	2.5	620	0.0	620
Tripura	12.3	326	1.4	326
West				
Goa	24.5	321	0.0	321
Gujarat	18.8	437	0.1	437
Maharashtra	8.7	673	0.0	673
South				
Andhra Pradesh	13.3	477	0.0	477
Karnataka	15.9	344	0.0	344
Kerala	7.2	323	0.0	323
Tamil Nadu	7.8	538	0.2	538
Telangana	15.2	405	0.0	405

Table 8.9: Percentage of children aged 5–9 years with high total cholesterol, high LDL, low HDL and high triglycerides by selected background characteristics, India, CNNS 2016–18

Background Characteristics	High total cholesterol		High LDL		Low HDL		High triglycerides	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
Sex of child								
Male	3.0	6,746	3.0	6,736	23.2	6,721	29.9	6,741
Female	3.4	6,406	3.7	6,395	29.0	6,386	38.3	6,393
Age in years								
5–7	3.3	7,840	3.6	7,824	27.7	7,809	35.3	7,835
8–9	3.1	5,313	2.9	5,306	23.7	5,297	32.2	5,299
Type of diet								
Vegetarian	2.0	7,275	2.5	7,272	30.7	7,258	32.7	7,260
Vegetarian with egg	3.4	1,211	3.6	1,207	19.2	1,205	28.3	1,211
Non-vegetarian	5.2	4,667	4.6	4,652	20.6	4,644	37.6	4,663
Schooling status								
Currently in school	3.1	12,112	3.3	12,094	25.1	12,072	33.2	12,097
Not in school	4.9	1,040	4.4	1,037	37.4	1,035	43.6	1,037
Mother's Schooling								
No schooling	1.9	5,114	2.0	5,100	35.7	5,089	38.4	5,104
<5 years completed	5.3	1,146	3.6	1,146	24.4	1,145	37.0	1,142
5–7 years completed	3.7	2,094	3.9	2,092	20.9	2,091	32.2	2,093
8–9 years completed	4.2	1,898	4.5	1,894	18.6	1,891	30.7	1,897
10–11 years completed	4.7	1,364	5.2	1,363	22.2	1,358	32.0	1,363
≥12 years completed	3.2	1,502	3.7	1,501	14.6	1,498	25.2	1,501
Religion								
Hindu	2.4	10,597	2.8	10,589	26.9	10,566	31.7	10,591
Muslim	6.8	1,945	4.5	1,935	23.9	1,935	46.9	1,932
Christian	10.3	330	15.3	326	21.0	326	39.4	330
Sikh	3.1	165	2.7	165	7.3	165	25.5	165
Other	1.2	115	1.5	115	24.7	115	27.6	115
Caste/Tribe								
Scheduled caste	2.5	3,059	3.3	3,055	27.2	3,044	33.4	3,058
Scheduled tribe	3.8	1,519	4.2	1,512	30.1	1,509	36.9	1,519
Other backward class	1.9	5,272	2.7	5,264	26.0	5,254	29.1	5,257
Other	5.7	3,303	4.0	3,299	23.3	3,299	41.2	3,300
Residence								
Urban	3.1	3,197	3.5	3,190	18.9	3,184	26.9	3,195
Rural	3.3	9,955	3.3	9,941	28.4	9,923	36.3	9,939
Wealth index								
Poorest	1.6	2,292	1.4	2,288	41.2	2,288	42.6	2,289
Poor	3.5	2,728	4.1	2,720	32.5	2,716	37.4	2,717
Middle	3.9	2,843	3.2	2,835	25.4	2,826	34.9	2,840
Rich	3.6	2,839	3.6	2,839	17.1	2,834	30.1	2,841
Richest	3.3	2,450	4.1	2,448	15.9	2,442	25.9	2,447
Total	3.2	13,153	3.3	13,131	26.1	13,107	34.0	13,134

Note: High total cholesterol: ≥ 200 mg/dl; **High LDL:** ≥ 130 mg/dl; **Low HDL:** < 40 mg/dl; **High triglyceride:** ≥ 100 mg/dl

Table 8.10: Percentage of adolescents aged 10–19 years with high total cholesterol, high LDL, low HDL and high triglycerides by selected background characteristics, India, CNNS 2016–18

Background Characteristics	High total cholesterol		High LDL		Low HDL		High triglycerides	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
Sex of child								
Male	3.4	6,582	3.4	6,580	31.5	6,511	14.1	6,587
Female	4.0	6,424	4.2	6,424	24.9	6,408	18.1	6,429
Age in years								
10–14	3.8	6,841	3.8	6,832	25.8	6,813	16.4	6,844
15–19	3.5	6,158	3.8	6,164	30.8	6,099	15.7	6,164
Type of diet								
Vegetarian	2.3	6,932	2.5	6,926	30.0	6,915	15.3	6,933
Vegetarian with egg	2.2	1,273	3.2	1,276	26.8	1,230	10.8	1,276
Non-vegetarian	6.0	4,794	5.9	4,795	26.0	4,767	18.5	4,800
Schooling status								
Currently in school	3.7	10,060	3.9	10,056	27.5	9,981	15.9	10,069
Not in school	3.4	2,938	3.6	2,940	30.4	2,931	16.5	2,939
Mother's Schooling								
No schooling	4.8	1,908	5.0	1,910	24.6	1,861	14.1	1,909
<5 years completed	6.6	1,012	8.4	1,013	25.3	1,013	20.0	1,012
5–7 years completed	4.8	1,908	5.0	1,910	24.6	1,861	14.1	1,909
8–9 years completed	5.0	1,685	4.3	1,688	21.8	1,683	14.1	1,691
10–11 years completed	1.6	928	2.6	922	23.1	923	15.4	929
≥ 12 years completed	6.2	885	7.5	885	19.2	882	17.1	885
Religion								
Hindu	3.0	10,565	3.2	10,561	29.8	10,491	14.4	1,0573
Muslim	7.1	1,851	6.1	1,853	22.0	1,839	25.6	1,853
Christian	7.6	294	11.1	293	24.2	293	17.8	294
Sikh	5.0	185	5.4	185	10.6	185	10.0	185
Other	1.5	104	2.0	104	19.7	104	17.2	104
Caste/Tribe								
Scheduled caste	3.0	3,037	3.0	3036	31.2	3,029	15.8	3,037
Scheduled tribe	2.3	1,256	2.5	1,257	32.5	1,248	15.0	1,257
Other backward class	3.4	5,314	4.0	5,314	29.0	5,248	14.5	5,320
Other	5.2	3,391	4.7	3,389	22.6	3,387	19.2	3,394
Residence								
Urban	4.5	3,291	5.8	3,282	24.0	3,227	14.8	3,292
Rural	3.4	9,708	3.1	9,714	29.6	9,685	16.5	9,716
Wealth index								
Poorest	2.1	2,337	1.6	2,338	37.0	2,329	16.4	2,337
Poor	3.6	2,671	3.5	2,673	33.5	2,659	18.4	2,674
Middle	5.0	2,745	4.9	2,748	24.9	2,748	14.1	2,749
Rich	3.1	2,693	3.7	2,686	25.5	2,680	17.1	2,693
Richest	4.3	2,553	5.1	2,551	20.7	2,496	14.2	2,554
Total	**3.7**	**13,006**	**3.8**	**13,004**	**28.2**	**12,919**	**16.1**	**13,016**

Note: High total cholesterol: ≥ 200 mg/dl; **High LDL:** ≥ 130 mg/dl; **Low HDL:** < 40 mg/dl; **High triglyceride:** ≥ 130 mg/dl

Table 8.11: Percentage of children aged 5–9 years with high total cholesterol, high LDL, low HDL and high triglycerides by state, India, CNNS 2016–18

State	High total cholesterol		High LDL		Low HDL		High triglycerides	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
India	**3.2**	**13,153**	**3.3**	**13,131**	**26.1**	**13,107**	**34.0**	**13,134**
North								
Delhi	2.7	677	2.9	677	31.2	677	33.8	677
Haryana	3.0	377	2.1	377	12.3	377	23.3	377
Himachal Pradesh	2.7	416	3.5	416	14.6	416	34.1	416
Jammu & Kashmir	1.7	358	0.9	358	12.3	358	50.2	358
Punjab	2.2	471	1.9	471	11.7	471	24.4	471
Rajasthan	0.7	356	2.5	356	15.4	356	23.3	356
Uttarakhand	3.5	490	1.7	484	15.5	484	35.1	484
Central								
Chhattisgarh	0.9	517	0.3	517	35.7	514	25.3	517
Madhya Pradesh	0.3	375	0.4	375	26.1	375	35.8	375
Uttar Pradesh	0.9	524	1.4	524	43.3	524	37.1	524
East								
Bihar	0.5	562	2.6	558	37.8	558	40.9	558
Jharkhand	0.7	421	2.0	419	13.1	417	28.4	420
Odisha	3.7	673	3.4	673	22.9	670	27.5	673
West Bengal	24.1	798	13.1	793	9.0	789	67.1	792
Northeast								
Arunachal Pradesh	1.3	543	2.5	544	38.7	544	33.1	544
Assam	4.2	431	8.2	431	24.1	431	57.1	431
Manipur	9.2	464	8.7	465	21.8	464	54.7	464
Meghalaya	1.4	335	3.2	334	50.9	332	30.8	335
Mizoram	2.3	332	2.1	332	21.9	331	44.7	332
Nagaland	1.2	91	0.0	91	25.2	90	55.5	91
Sikkim	23.7	570	12.5	569	3.4	564	64.6	573
Tripura	3.4	332	3.4	328	21.4	328	46.4	333
West								
Goa	5.9	312	11.0	312	15.4	312	22.0	312
Gujarat	3.3	426	3.4	425	24.3	424	27.6	425
Maharashtra	0.8	616	2.4	616	17.4	616	19.1	616
South								
Andhra Pradesh	3.6	534	5.4	534	12.4	534	25.5	534
Karnataka	1.8	400	3.3	398	27.8	398	22.1	402
Kerala	15.4	311	16.3	311	10.8	310	16.6	311
Tamil Nadu	3.7	500	6.0	500	16.7	493	20.4	499
Telangana	0.8	412	0.7	412	16.2	412	21.9	412

Note: High total cholesterol: ≥ 200 mg/dl; **High LDL:** ≥ 130 mg/dl; **Low HDL:** < 40 mg/dl; **High triglyceride:** ≥ 100 mg/dl

Table 8.12: Percentage of adolescents aged 10–19 years with high total cholesterol, high LDL, low HDL and high triglycerides by state, India, CNNS 2016–18

State	High total cholesterol		High LDL		Low HDL		High triglycerides	
	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number	Percent	Weighted number
India	**3.7**	**13,006**	**3.8**	**13,004**	**28.2**	**12,919**	**16.1**	**13,016**
North								
Delhi	2.3	629	1.8	629	39.9	629	15.7	629
Haryana	2.3	450	2.5	450	12.9	450	12.7	450
Himachal Pradesh	7.3	433	6.0	433	27.4	433	21.1	433
Jammu & Kashmir	1.0	317	2.0	317	15.7	317	19.8	317
Punjab	3.8	497	3.3	497	11.7	497	9.8	497
Rajasthan	1.2	413	2.7	411	18.3	413	7.6	413
Uttarakhand	1.7	447	3.2	446	21.5	446	19.6	446
Central								
Chhattisgarh	1.8	465	1.1	465	46.6	463	8.4	465
Madhya Pradesh	0.6	384	1.7	384	27.0	384	10.0	384
Uttar Pradesh	1.3	486	1.5	486	39.9	486	16.1	486
East								
Bihar	1.0	585	0.4	582	36.1	583	14.4	583
Jharkhand	1.3	380	1.4	383	23.6	381	18.1	383
Odisha	3.9	646	4.3	646	26.4	646	9.1	646
West Bengal	20.0	678	12.3	682	11.7	668	42.5	683
Northeast								
Arunachal Pradesh	0.7	482	1.3	482	40.2	479	16.7	482
Assam	0.3	420	0.8	421	24.8	421	32.2	421
Manipur	10.6	431	10.4	430	24.8	430	38.0	434
Meghalaya	0.4	311	0.6	311	49.9	311	19.8	311
Mizoram	0.7	292	0.8	290	18.8	290	28.4	292
Nagaland	1.4	95	0.0	95	6.9	94	22.9	95
Sikkim	23.0	608	13.2	613	9.8	601	39.4	609
Tripura	6.7	309	5.6	309	22.1	307	28.9	309
West								
Goa	7.9	318	15.3	318	17.5	318	13.1	318
Gujarat	4.4	407	6.0	406	25.4	404	17.4	407
Maharashtra	0.6	632	2.9	632	24.7	632	6.4	632
South								
Andhra Pradesh	1.2	488	3.1	488	16.8	488	8.4	488
Karnataka	1.7	372	4.1	369	38.9	365	6.6	373
Kerala	13.9	285	14.9	285	20.6	283	15.4	285
Tamil Nadu	6.9	525	9.5	525	23.4	503	12.4	524
Telangana	1.4	405	1.7	405	25.4	405	7.7	405

Note: High total cholesterol: ≥ 200 mg/dl; **High LDL:** ≥ 130 mg/dl; **Low HDL:** < 40 mg/dl; **High triglyceride:** ≥ 130 mg/dl

Table 8.13: Percentage of children aged 5–9 years with high serum creatinine by selected background characteristics, India, CNNS 2016–18

Background Characteristics	High serum creatinine	
	Percent	Weighted number
Sex of child		
Male	6.7	6,073
Female	7.4	5,721
Age in years		
5–7	7.3	7,011
8–9	6.7	4,783
Type of diet		
Vegetarian	6.1	6,597
Vegetarian with egg	7.7	1,092
Non-vegetarian	8.4	4,105
Schooling status		
Currently in school	7.0	10,866
Not in school	7.0	928
Mother's Schooling		
No schooling	7.6	4,619
<5 years completed	9.3	998
5–7 years completed	7.2	1,812
8–9 years completed	6.4	1,729
10–11 years completed	6.5	1,206
≥ 12 years completed	4.8	1,394
Religion		
Hindu	6.5	9,548
Muslim	8.8	1,753
Christian	19.3	242
Sikh	0.2	161
Other	5.2	90
Caste/Tribe		
Scheduled caste	7.9	2,766
Scheduled tribe	7.3	1,358
Other backward class	4.7	4,761
Other	10.0	2,908
Residence		
Urban	4.5	2,883
Rural	7.9	8,911
Wealth index		
Poorest	6.3	2,163
Poor	9.4	2,457
Middle	9.2	2,486
Rich	6.2	2,512
Richest	3.6	2,177
Total	7.0	11,794

Note: High serum creatinine: > 0.7 mg/dl

Table 8.14: Percentage of adolescents aged 10–19 years with high serum creatinine by selected background characteristics, India, CNNS 2016–18

Background Characteristics	High serum creatinine	
	Percent	Weighted number
Sex of child		
Male	8.3	5,891
Female	4.9	5,769
Age in years		
10–14	7.8	6,205
15–19	5.4	5,448
Type of diet		
Vegetarian	5.4	6,245
Vegetarian with egg	6.0	1,172
Non-vegetarian	9.0	4,236
Schooling status		
Currently in school	6.4	9,033
Not in school	7.7	2,619
Mother's schooling		
No schooling	5.2	1,713
<5 years completed	7.9	891
5–7 years completed	5.2	1,713
8–9 years completed	7.5	1,536
10–11 years completed	5.1	834
≥ 12 years completed	3.4	824
Religion		
Hindu	5.6	9,488
Muslim	11.2	1,670
Christian	18.4	229
Sikh	3.8	184
Other	3.8	81
Caste/Tribe		
Scheduled caste	6.3	2,762
Scheduled tribe	7.2	1,050
Other backward class	5.1	4,756
Other	9.2	3,085
Residence		
Urban	4.3	2,955
Rural	7.4	8,698
Wealth index		
Poorest	8.9	2,191
Poor	7.4	2,375
Middle	7.5	2,398
Rich	5.0	2,375
Richest	4.6	2,314
Total	6.6	11,660

Note: High serum creatinine: > 0.7 mg/dl for adolescents aged 10–12 years and > 1.0 mg/dl for adolescents aged 13 and above

Table 8.15: Percentage of children aged 5–9 years with high serum creatinine by state, India, CNNS 2016–18

State	High serum creatinine	
	Percent	Weighted number
India	**7.0**	**11,794**
North		
Delhi	3.2	680
Haryana	1.0	380
Himachal Pradesh	0.8	417
Jammu & Kashmir	2.7	357
Punjab	0.2	472
Rajasthan	2.6	220
Uttarakhand	0.7	484
Central		
Chhattisgarh	0.9	511
Madhya Pradesh	3.0	238
Uttar Pradesh	7.4	519
East		
Bihar	3.6	556
Jharkhand	8.8	418
Odisha	0.2	677
West Bengal	24.8	756
Northeast		
Arunachal Pradesh	0.9	538
Assam	16.8	272
Manipur	18.3	455
Meghalaya	0.7	329
Mizoram	16.9	324
Nagaland	21.8	51
Sikkim	27.3	535
Tripura	7.8	329
West		
Goa	0.6	312
Gujarat	3.8	396
Maharashtra	5.0	494
South		
Andhra Pradesh	34.5	229
Karnataka	0.0	398
Kerala	0.0	310
Tamil Nadu	0.1	495
Telangana	23.6	381

Note: High serum creatinine: > 0.7 mg/dl

Table 8.16: Percentage of adolescents aged 10–19 years with high serum creatinine by state, India, CNNS 2016–18

State	High serum creatinine	
	Percent	Weighted number
India	**6.6**	**11,660**
North		
Delhi	3.2	615
Haryana	0.3	451
Himachal Pradesh	0.6	433
Jammu & Kashmir	0.2	316
Punjab	2.0	497
Rajasthan	0.5	245
Uttarakhand	0.1	447
Central		
Chhattisgarh	0.6	462
Madhya Pradesh	1.6	241
Uttar Pradesh	8.1	486
East		
Bihar	1.6	578
Jharkhand	8.6	376
Odisha	1.2	648
West Bengal	22.8	666
Northeast		
Arunachal Pradesh	0.6	484
Assam	16.7	269
Manipur	15.3	432
Meghalaya	0.5	301
Mizoram	15.0	290
Nagaland	–	–
Sikkim	20.1	582
Tripura	9.0	301
West		
Goa	2.2	316
Gujarat	4.0	380
Maharashtra	1.8	428
South		
Andhra Pradesh	30.1	229
Karnataka	1.1	372
Kerala	0.5	287
Tamil Nadu	0.1	522
Telangana	24.3	372

Note: High serum creatinine: > 0.7 mg/dl for adolescent age 10–12 years and > 1.0 mg/dl for adolescents aged 13 and above
– N < 50 and results are not presented

Table 8.17: Percentage of adolescents aged 10–19 years classified as hypertensive by selected background characteristics, India, CNNS 2016–18

Background Characteristics	Hypertensive	
	Percent	Weighted number
Sex of child		
Male	4.7	5,623
Female	5.1	5,301
Age in years		
10–14	4.9	5,765
15–19	5.0	5,160
Schooling status		
Currently in school	4.2	8,536
Not in school	7.3	2,389
Mother's schooling		
No schooling	5.0	5,326
<5 years completed	5.2	916
5–7 years completed	3.5	1,662
8–9 years completed	6.1	1,409
10–11 years completed	6.8	811
≥12 years completed	2.9	800
Religion		
Hindu	4.8	8,852
Muslim	5.5	1,488
Christian	7.6	329
Sikh	0.6	144
Other	1.1	111
Caste/Tribe		
Scheduled caste	4.4	2,475
Scheduled tribe	5.0	1,222
Other backward class	4.4	4,516
Other	6.3	2,712
Residence		
Urban	5.4	2,862
Rural	4.8	8,063
Wealth index		
Poorest	5.5	1,782
Poor	5.9	2,284
Middle	3.7	2,307
Rich	3.6	2,372
Richest	6.2	2,180
Total	4.9	10,925

Note: Hypertensive: Systolic >139 mmHg or Diastolic >89 mmHg

Table 8.18: Percentage of adolescents aged 10–19 years classified as hypertensive by state, India, CNNS 2016–18

State	Hypertensive	
	Percent	Weighted number
India	**4.9**	**10,925**
North		
Delhi	10.1	398
Haryana	0.0	56
Himachal Pradesh	2.9	232
Jammu & Kashmir	2.0	332
Punjab	0.2	430
Rajasthan	2.3	404
Uttarakhand	3.6	397
Central		
Chhattisgarh	7.0	484
Madhya Pradesh	5.6	350
Uttar Pradesh	8.6	229
East		
Bihar	5.5	589
Jharkhand	–	–
Odisha	5.4	603
West Bengal	0.7	718
Northeast		
Arunachal Pradesh	3.6	533
Assam	6.4	459
Manipur	8.3	667
Meghalaya	5.1	341
Mizoram	–	–
Nagaland	1.7	188
Sikkim	1.5	628
Tripura	5.3	364
West		
Goa	6.6	344
Gujarat	6.4	499
Maharashtra	4.3	708
South		
Andhra Pradesh	5.2	491
Karnataka	3.1	402
Kerala	0.5	347
Tamil Nadu	4.3	541
Telangana	6.7	364

Note: Hypertensive: Systolic > 139 mmHg or Diastolic > 89 mmHg
– N < 50 and results are not presented

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Annexes

Annex 1

Tables and figures

Table A1: Sampling errors for anthropometric indicators for total sample by age groups, India, CNNS 2016–18

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 0–4 years)								
Children who are stunted (height-for-age : below -2sd)	0.347	0.006	35,907	36,230	2.405	0.017	0.336	0.359
Children who are severely stunted (height-for-age : below -3sd)	0.132	0.005	35,907	36,230	2.524	0.034	0.123	0.141
Children who are wasted (weight-for-height : below -2sd)	0.173	0.005	35,278	35,784	2.363	0.027	0.164	0.183
Children who are severely wasted (weight-for-height : below -3sd)	0.049	0.003	35,278	35,784	2.368	0.055	0.044	0.055
Children who are underweight (weight-for-age : below -2sd)	0.334	0.006	36,336	36,533	2.552	0.019	0.322	0.347
Children who are severely underweight (weight-for age : below -3sd)	0.101	0.004	36,336	36,533	2.766	0.042	0.093	0.110
Children aged 6–59 months with MUAC <12.5cm	0.050	0.003	33,418	33,312	2.482	0.058	0.045	0.057
Children aged 6–59 months with MUAC <11.5cm	0.010	0.001	34,852	34,451	2.375	0.124	0.008	0.013
Children aged 6–59 months with MUAC-for-age (below -2 SD)	0.105	0.004	33,303	33,243	2.393	0.038	0.097	0.113
Children aged 6–59 months with MUAC-for-age (below -3 SD)	0.017	0.002	33,303	33,243	2.901	0.121	0.013	0.021
Children with TSFT-for-age (below -2 SD)	0.097	0.004	35,099	35,125	2.838	0.045	0.089	0.106
Children with TSFT-for-age (below -3 SD)	0.024	0.002	35,099	35,125	2.343	0.080	0.020	0.028
Children with TSFT-for-age (above +2 SD)	0.010	0.001	35,099	35,125	1.866	0.095	0.008	0.012
Children with TSFT-for-age (above +3 SD)	0.001	0.000	35,099	35,125	1.309	0.250	0.001	0.001
Children aged 1–4 years with SSFT-for-age (below -2 SD)	0.086	0.004	29,460	29,224	2.685	0.050	0.078	0.095
Children aged 1–4 years with SSFT-for-age (below -3 SD)	0.016	0.002	29,460	29,224	3.141	0.139	0.012	0.021
Children aged 1–4 years with SSFT-for-age (above +2 SD)	0.018	0.001	29,460	29,224	1.774	0.074	0.015	0.020
Children aged 1–4 years with SSFT-for-age (above +3 SD)	0.002	0.000	29,460	29,224	1.369	0.200	0.001	0.002

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 5–9 years)								
Children who are stunted (height-for-age : below -2sd)	0.219	0.006	36,775	36,989	2.557	0.025	0.208	0.230
Children who are severely stunted (height-for-age : below -3sd)	0.055	0.003	36,775	36,989	2.223	0.047	0.050	0.061
Children who are moderate or severely thin (BMI-for-age : below -2 SD)	0.230	0.005	36,431	36,679	2.330	0.022	0.220	0.240
Children who are severely thin (BMI-for-age : below -3 SD)	0.049	0.002	36,431	36,679	2.105	0.047	0.044	0.054
Children who are overweight or obese (BMI-for-age : above +1SD)	0.037	0.002	36,431	36,679	2.081	0.054	0.034	0.042
Children who are obese (BMI-for-age : above +2 SD)	0.013	0.001	36,431	36,679	1.711	0.076	0.011	0.015
Anthropometric indicators (adolescents aged 10–19 years)								
Children who are moderate or severely thin (BMI-for-age : below -2 SD)	0.240	0.006	32,326	32,579	2.646	0.026	0.228	0.252
Children who are severely thin (BMI-for-age : below -3 SD)	0.065	0.003	32,326	32,579	2.258	0.046	0.059	0.071
Children who are overweight or obese (BMI-for-age : above +1SD)	0.050	0.002	32,326	32,579	2.025	0.048	0.045	0.055
Children who are obese (BMI-for-age : above +2 SD)	0.011	0.001	32,326	32,579	1.589	0.081	0.009	0.013

Table A2: Sampling errors for anthropometric indicators for urban sample by age groups, India, CNNS 2016–18

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 0–4 years)								
Children who are stunted (height-for-age : below -2sd)	0.273	0.008	16,283	8,507	2.375	0.030	0.257	0.289
Children who are severely stunted (height-for-age : below -3sd)	0.097	0.005	16,283	8,507	2.256	0.053	0.088	0.108
Children who are wasted (weight-for-height : below -2sd)	0.163	0.006	15,963	8,377	1.937	0.034	0.152	0.175
Children who are severely wasted (weight-for-height : below -3sd)	0.047	0.003	15,963	8,377	1.820	0.064	0.041	0.053
Children who are underweight (weight-for-age : below -2sd)	0.258	0.007	16,450	8,560	2.140	0.028	0.244	0.273
Children who are severely underweight (weight-for age : below -3sd)	0.076	0.004	16,450	8,560	2.158	0.058	0.068	0.085
Children aged 6–59 months with MUAC <12.5cm	0.035	0.003	15,205	7,863	2.086	0.089	0.029	0.042
Children aged 6–59 months with MUAC <11.5cm	0.006	0.001	16,028	8,233	1.647	0.161	0.005	0.009
Children aged 6–59 months with MUAC-for-age (below -2 SD)	0.069	0.004	15,149	7,852	1.972	0.058	0.061	0.077
Children aged 6–59 months with MUAC-for-age (below -3 SD)	0.011	0.002	15,149	7,852	2.091	0.155	0.008	0.015
Children with TSFT-for-age (below -2 SD)	0.083	0.006	15,920	8,244	2.600	0.067	0.073	0.095
Children with TSFT-for-age (below -3 SD)	0.018	0.003	15,920	8,244	2.636	0.148	0.014	0.025
Children with TSFT-for-age (above +2 SD)	0.013	0.002	15,920	8,244	1.733	0.120	0.010	0.016
Children with TSFT-for-age (above +3 SD)	0.002	0.001	15,920	8,244	1.643	0.263	0.001	0.003
Children aged 1–4 years with SSFT-for-age (below -2 SD)	0.063	0.005	13,440	6,857	2.197	0.073	0.055	0.073
Children aged 1–4 years with SSFT-for-age (below -3 SD)	0.007	0.001	13,440	6,857	1.428	0.149	0.005	0.009
Children aged 1–4 years with SSFT-for-age (above +2 SD)	0.025	0.002	13,440	6,857	1.692	0.088	0.021	0.030
Children aged 1–4 years with SSFT-for-age (above +3 SD)	0.003	0.001	13,440	6,857	1.227	0.200	0.002	0.004

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 5–9 years)								
Children who are stunted (height-for-age : below -2sd)	0.178	0.007	16,601	8,844	2.499	0.042	0.164	0.193
Children who are severely stunted (height-for-age : below -3sd)	0.037	0.003	16,601	8,844	1.898	0.073	0.032	0.043
Children who are moderate or severely thin (BMI-for-age : below -2 SD)	0.198	0.006	16,448	8,761	2.091	0.032	0.185	0.211
Children who are severely thin (BMI-for-age : below -3 SD)	0.047	0.003	16,448	8,761	2.044	0.071	0.041	0.054
Children who are overweight or obese (BMI-for-age : above +1SD)	0.075	0.004	16,448	8,761	2.132	0.058	0.067	0.084
Children who are obese (BMI-for-age : above +2 SD)	0.028	0.002	16,448	8,761	1.803	0.083	0.024	0.033
Anthropometric indicators (adolescents aged 10–19 years)								
Children who are moderately or severely thin (BMI-for-age : below -2 SD)	0.204	0.007	14,274	7,779	1.967	0.032	0.192	0.218
Children who are severely thin (BMI-for-age : below -3 SD)	0.060	0.004	14,274	7,779	2.018	0.066	0.053	0.069
Children who are overweight or obese (BMI-for-age : above +1SD)	0.097	0.005	14,274	7,779	1.859	0.047	0.089	0.107
Children who are obese (BMI-for-age : above +2 SD)	0.022	0.002	14,274	7,779	1.636	0.091	0.018	0.026

Table A3: Sampling errors for anthropometric indicators for rural sample by age groups, India, CNNS 2016–18

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 0–4 years)								
Children who are stunted (height-for-age : below -2sd)	0.370	0.007	19,624	27,723	2.080	0.019	0.356	0.385
Children who are severely stunted (height-for-age : below -3sd)	0.142	0.006	19,624	27,723	2.235	0.039	0.132	0.153
Children who are wasted (weight-for-height : below -2sd)	0.176	0.006	19,315	27,407	2.178	0.033	0.165	0.189
Children who are severely wasted (weight-for-height : below -3sd)	0.050	0.003	19,315	27,407	2.192	0.068	0.044	0.057
Children who are underweight (weight-for-age : below -2sd)	0.357	0.008	19,886	27,973	2.240	0.021	0.343	0.372
Children who are severely underweight (weight-for age : below -3sd)	0.109	0.005	19,886	27,973	2.482	0.050	0.099	0.120
Children aged 6–59 months with MUAC <12.5cm	0.055	0.004	18,213	25,449	2.201	0.067	0.048	0.063
Children aged 6–59 months with MUAC <11.5cm	0.011	0.002	18,824	26,218	2.127	0.148	0.008	0.015
Children aged 6–59 months with MUAC-for-age (below -2 SD)	0.116	0.005	18,154	25,391	2.106	0.043	0.106	0.126
Children aged 6–59 months with MUAC-for-age (below -3 SD)	0.018	0.003	18,154	25,391	2.603	0.137	0.014	0.024
Children with TSFT-for-age (below -2 SD)	0.101	0.006	19,179	26,882	2.583	0.055	0.091	0.113
Children with TSFT-for-age (below -3 SD)	0.026	0.002	19,179	26,882	2.061	0.090	0.021	0.031
Children with TSFT-for-age (above +2 SD)	0.009	0.001	19,179	26,882	1.757	0.128	0.007	0.011
Children with TSFT-for-age (above +3 SD)	0.000	0.000	19,179	26,882	1.217	0.250	0.000	0.001
Children aged 1–4 years with SSFT-for-age (below -2 SD)	0.093	0.006	16,020	22,367	2.401	0.059	0.083	0.105
Children aged 1–4 years with SSFT-for-age (below -3 SD)	0.019	0.003	16,020	22,367	2.751	0.156	0.014	0.025
Children aged 1–4 years with SSFT-for-age (above +2 SD)	0.015	0.002	16,020	22,367	1.666	0.105	0.012	0.019
Children aged 1–4 years with SSFT-for-age (above +3 SD)	0.001	0.000	16,020	22,367	1.354	0.273	0.001	0.002

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Anthropometric indicators (children aged 5–9 years)								
Children who are stunted (height-for-age : below -2sd)	0.231	0.007	20,174	28,145	2.284	0.029	0.218	0.245
Children who are severely stunted (height-for-age : below -3sd)	0.061	0.003	20,174	28,145	1.979	0.054	0.055	0.068
Children who are moderate or severely thin (BMI-for-age : below -2 SD)	0.240	0.006	19,983	27,917	2.128	0.027	0.228	0.253
Children who are severely thin (BMI-for-age : below -3 SD)	0.049	0.003	19,983	27,917	1.919	0.059	0.044	0.055
Children who are overweight or obese (BMI-for-age : above +1SD)	0.026	0.002	19,983	27,917	1.889	0.082	0.022	0.030
Children who are obese (BMI-for-age : above +2 SD)	0.009	0.001	19,983	27,917	1.622	0.116	0.007	0.011
Anthropometric indicators (adolescents aged 10–19 years)								
Children who are moderately or severely thin (BMI-for-age : below -2 SD)	0.253	0.008	17,667	24,518	2.458	0.032	0.237	0.269
Children who are severely thin (BMI-for-age : below -3 SD)	0.066	0.004	17,667	24,518	2.084	0.059	0.059	0.074
Children who are overweight or obese (BMI-for-age : above +1SD)	0.032	0.002	17,667	24,518	1.848	0.074	0.028	0.038
Children who are obese (BMI-for-age : above +2 SD)	0.007	0.001	17,667	24,518	1.552	0.125	0.006	0.010

Table A4: Sampling errors for biochemical indicators for total sample by age groups, India, CNNS 2016–18

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Biochemical indicators (children aged 1–4 years)								
Key indicators of micronutrient deficiencies								
Prevalence of anaemia	0.405	0.010	11,655	11,321	2.283	0.025	0.384	0.425
Prevalence of low serum ferritin	0.319	0.013	8,794	7,893	2.618	0.041	0.294	0.345
Prevalence of folate deficiency	0.233	0.014	11,110	10,548	3.398	0.058	0.208	0.261
Prevalence of vitamin B12 deficiency	0.138	0.011	10,015	9,100	3.330	0.083	0.117	0.162
Prevalence of serum 25-hydroxy vitamin D deficiency	0.138	0.009	11,048	10,021	2.846	0.067	0.121	0.157
Prevalence of vitamin A deficiency	0.176	0.012	7,483	6,710	2.730	0.068	0.154	0.201
Prevalence of zinc deficiency	0.189	0.011	9,683	8,728	2.686	0.056	0.169	0.211
Biochemical indicators (children aged 5–9 years)								
Key indicators of micronutrient deficiencies								
Prevalence of anaemia	0.235	0.009	15,139	14,664	2.483	0.036	0.218	0.252
Prevalence of low serum ferritin	0.170	0.008	11,302	10,682	2.267	0.047	0.155	0.186
Prevalence of folate deficiency	0.282	0.014	14,235	13,621	3.687	0.049	0.256	0.310
Prevalence of vitamin B12 deficiency	0.172	0.010	12,264	11,667	2.983	0.059	0.153	0.193
Prevalence of serum 25-hydroxy vitamin D deficiency	0.182	0.009	13,479	12,914	2.705	0.049	0.165	0.201
Prevalence of vitamin A deficiency	0.215	0.015	9,737	8,785	3.655	0.071	0.187	0.246
Prevalence of zinc deficiency	0.168	0.008	12,331	11,556	2.269	0.045	0.153	0.183
Key indicators of non-communicable disease risks								
Prevalence of high total cholesterol	0.032	0.005	13,648	13,153	3.064	0.143	0.024	0.043
Prevalence of high LDL cholesterol	0.033	0.004	13,629	13,131	2.648	0.120	0.026	0.042
Prevalence of low HDL cholesterol	0.261	0.011	13,591	13,107	3.025	0.043	0.239	0.284
Prevalence of high triglycerides	0.096	0.006	13,642	13,134	2.489	0.065	0.084	0.109

Variable	Value (R)	Standard Error (SE)	Number of cases		Design effect (DEFT)	Relative standard error (SE/R)	Confidence limits	
			Unweighted (N)	Weighted (WN)			R-2SE	R+2SE
Prevalence of high fasting plasma glucose	0.103	0.006	11,029	9,673	2.077	0.058	0.092	0.115
Prevalence of very high fasting plasma glucose	0.012	0.002	11,029	9,673	2.317	0.195	0.008	0.018
Prevalence of glycosylated haemoglobin concentration (5.7–6.4)	0.092	0.007	13,773	13,187	2.643	0.070	0.080	0.106
Prevalence of glycosylated haemoglobin concentration (≥ 6.5)	0.001	0.000	13,773	13,187	1.407	0.364	0.001	0.002
Prevalence of high serum creatinine	0.070	0.007	12,574	11,794	3.077	0.099	0.058	0.086
Biochemical indicators (adolescents aged 10–19 years)								
Key indicators of micronutrient deficiencies								
Prevalence of anaemia	0.284	0.008	14,671	14,308	2.201	0.029	0.268	0.300
Prevalence of low serum ferritin	0.215	0.009	10,944	10,485	2.258	0.041	0.198	0.233
Prevalence of folate deficiency	0.367	0.016	13,840	13,253	4.013	0.045	0.335	0.400
Prevalence of vitamin B12 deficiency	0.309	0.013	11,793	11,440	3.023	0.041	0.284	0.335
Prevalence of serum 25-hydroxy vitamin D deficiency	0.239	0.011	13,067	12,594	2.847	0.044	0.219	0.260
Prevalence of vitamin A deficiency	0.156	0.014	9,335	8,856	3.598	0.087	0.131	0.184
Prevalence of zinc deficiency	0.317	0.012	11,953	11,375	2.835	0.038	0.294	0.341
Key indicators of non-communicable disease risks								
Prevalence of high total cholesterol	0.037	0.006	13,220	13,006	3.611	0.159	0.027	0.050
Prevalence of high LDL cholesterol	0.038	0.005	13,220	13,004	3.256	0.142	0.029	0.050
Prevalence of low HDL cholesterol	0.282	0.011	13,174	12,919	2.854	0.039	0.261	0.305
Prevalence of high triglycerides	0.097	0.007	13,231	13,016	2.887	0.076	0.084	0.113
Prevalence of high fasting plasma glucose	0.104	0.006	11,120	10,034	2.224	0.062	0.092	0.117
Prevalence of very high fasting plasma glucose	0.006	0.001	11,120	10,034	1.351	0.158	0.004	0.008
Prevalence of glycosylated haemoglobin concentration (5.7–6.4)	0.095	0.005	13,400	13,076	2.103	0.056	0.085	0.106
Prevalence of glycosylated haemoglobin concentration (≥ 6.5)	0.002	0.001	13,400	13,076	1.939	0.389	0.001	0.004
Prevalence of high serum creatinine	0.066	0.008	12,111	11,660	3.452	0.117	0.053	0.084

Result of anthropometric standardization

Table A5: Summary statistics of technical error of measurement (TEM) of height by state, India, CNNS 2016–18

STATE	Inter-observer TEM						Intra-observer TEM			N
	Comparison with gold readings			Comparison with median readings			Comparison with repeated readings			
	Median	Range		Median	Range		Median	Range		
		Low	High		Low	High		Low	High	
Andhra Pradesh	0.29	0.21	0.41	0.14	0.12	0.28	0.22	0.07	0.55	9
Arunachal Pradesh	0.36	0.27	0.46	0.22	0.11	0.30	0.28	0.12	0.47	12
Assam	0.32	0.23	0.42	0.23	0.13	0.30	0.36	0.19	0.51	8
Bihar	0.31	0.23	0.50	0.20	0.13	0.36	0.35	0.17	0.41	7
Chhattisgarh	0.37	0.24	0.64	0.30	0.10	0.51	0.44	0.27	0.62	10
Goa	0.56	0.37	0.61	0.18	0.10	0.27	0.29	0.15	0.40	10
Gujarat	0.26	0.23	0.66	0.19	0.12	0.68	0.31	0.19	0.67	9
Haryana	0.45	0.32	0.54	0.21	0.11	0.36	0.26	0.12	0.41	10
Himachal Pradesh	0.52	0.49	0.71	0.19	0.13	0.38	0.32	0.18	0.56	8
Jammu and Kashmir	0.57	0.48	0.73	0.25	0.14	0.47	0.32	0.09	0.61	12
Jharkhand	0.35	0.24	0.40	0.24	0.14	0.36	0.26	0.07	0.47	10
Karnataka	0.19	0.16	12.21	0.19	0.14	12.15	0.28	0.14	17.23	10
Kerala	0.24	0.18	0.29	0.21	0.17	0.25	0.29	0.21	0.34	8
Madhya Pradesh	0.67	0.57	0.80	0.25	0.18	0.33	0.35	0.17	0.66	6
Maharashtra	0.57	0.50	0.77	0.25	0.13	0.47	0.39	0.22	0.68	11
Manipur	0.23	0.17	0.66	0.20	0.13	0.61	0.26	0.20	0.38	12
Meghalaya	0.37	0.31	0.41	0.18	0.13	0.23	0.27	0.16	0.41	9
Mizoram	0.35	0.28	0.39	0.22	0.21	0.27	0.35	0.23	0.43	8
Nagaland	0.37	0.24	0.74	0.31	0.14	0.73	0.37	0.23	1.01	7
NCT of Delhi	0.34	0.31	0.40	0.24	0.21	0.35	0.37	0.25	0.46	4
Odisha	0.37	0.24	0.64	0.26	0.14	0.66	0.42	0.19	1.08	11
Punjab	0.36	0.30	0.54	0.22	0.13	0.39	0.34	0.15	0.89	11
Rajasthan	0.29	0.12	0.47	0.17	0.07	0.38	0.09	0.04	0.29	9
Sikkim	0.44	0.37	1.01	0.29	0.21	0.91	0.34	0.19	0.67	8
Tamil Nadu	3.17	0.25	3.23	0.34	0.15	3.06	0.27	0.14	1.01	20
Telangana	0.34	0.26	1.23	0.21	0.14	1.20	0.32	0.16	1.80	11
Tripura	0.31	0.15	0.44	0.26	0.19	0.46	0.30	0.20	0.53	7
Uttar Pradesh	0.67	0.57	0.80	0.25	0.18	0.33	0.35	0.17	0.66	6
Uttarakhand	0.27	0.22	0.33	0.19	0.12	0.25	0.28	0.18	0.46	10
West Bengal	0.56	0.25	1.82	0.23	0.14	1.69	0.38	0.13	2.43	18

Note: The TEM calculation is TEM = ((∑D2)/ (2 *M))1/2 . D is the difference between measurements. M is the number of measurements. For the calculation of inter-observer TEM based on gold readings, D measurers the difference between readings of gold measurer and observer. For the calculation of inter-observer TEM based on median readings, D measurers the difference between the median of the measurements by all the selected observers (including the gold readings) and observer's readings. For the calculation of intra-observer TEM, D measurers the difference between the repeated readings between the two rounds by selected observers. N is representative of all the observers who passed and were involved in data collection. Global cut-offs for inter-observer and intra-observer TEM for height are 0.95 and 0.96, respectively.

Table A6: Summary statistics of technical error of measurement (TEM) of MUAC by state, India, CNNS 2016–18

STATE	Inter-observer TEM						Intra-observer TEM			N
	Comparison with gold readings			Comparison with median readings			Comparison with repeated readings			
	Median	Range		Median	Range		Median	Range		
		Low	High		Low	High		Low	High	
Andhra Pradesh	0.32	0.12	0.46	0.16	0.07	0.32	0.16	0.08	0.38	9
Arunachal Pradesh	0.18	0.10	0.40	0.17	0.08	0.39	0.16	0.10	0.51	12
Assam	0.17	0.16	0.20	0.10	0.07	0.15	0.17	0.14	0.25	8
Bihar	0.20	0.17	0.31	0.16	0.09	0.24	0.17	0.10	0.36	7
Chhattisgarh	0.20	0.13	0.46	0.15	0.07	0.40	0.12	0.07	0.62	10
Goa	0.29	0.20	0.83	0.17	0.08	0.71	0.22	0.11	0.96	10
Gujarat	0.29	0.15	0.47	0.14	0.07	0.24	0.12	0.09	0.19	9
Haryana	0.17	0.09	0.24	0.13	0.07	0.18	0.11	0.06	0.30	10
Himachal Pradesh	0.23	0.18	0.34	0.14	0.07	0.26	0.12	0.11	0.23	8
Jammu and Kashmir	0.27	0.20	2.62	0.14	0.08	2.55	0.14	0.08	0.25	12
Jharkhand	0.23	0.10	0.41	0.12	0.06	0.25	0.14	0.07	0.27	10
Karnataka	0.41	0.21	0.54	0.15	0.11	0.26	0.19	0.10	0.50	10
Kerala	0.18	0.10	0.20	0.13	0.11	0.17	0.13	0.08	0.23	8
Madhya Pradesh	0.20	0.13	0.27	0.14	0.10	0.20	0.18	0.08	0.22	6
Maharashtra	0.25	0.16	0.44	0.16	0.06	0.50	0.17	0.11	0.39	11
Manipur	0.26	0.17	0.82	0.14	0.08	0.88	0.19	0.07	1.21	12
Meghalaya	0.19	0.10	0.28	0.17	0.04	0.28	0.19	0.06	0.31	9
Mizoram	0.23	0.20	1.35	0.14	0.07	1.31	0.18	0.06	1.92	8
Nagaland	0.54	0.27	2.09	0.38	0.13	2.10	0.30	0.20	2.85	7
NCT of Delhi	0.22	0.17	0.35	0.20	0.14	0.34	0.18	0.15	0.56	4
Odisha	0.29	0.14	0.39	0.13	0.08	0.20	0.14	0.07	0.25	11
Punjab	0.21	0.13	0.35	0.11	0.07	0.25	0.13	0.05	0.34	11
Rajasthan	0.17	0.11	0.27	0.14	0.04	0.21	0.07	0.03	0.18	9
Sikkim	0.30	0.23	0.43	0.24	0.08	0.34	0.30	0.11	0.43	8
Tamil Nadu	0.62	0.12	1.68	0.40	0.09	1.58	0.18	0.04	2.08	20
Telangana	0.17	0.11	0.34	0.14	0.09	0.32	0.18	0.10	0.41	11
Tripura	0.32	0.19	0.65	0.14	0.07	0.61	0.14	0.07	0.98	7
Uttar Pradesh	0.20	0.13	0.27	0.14	0.10	0.20	0.18	0.08	0.22	6
Uttarakhand	0.23	0.16	0.32	0.11	0.07	0.21	0.08	0.04	0.29	10
West Bengal	0.37	0.13	0.80	0.13	0.07	0.47	0.16	0.07	0.33	18

Note: The TEM calculation is TEM = ((∑D2)/ (2 *M))1/2 . D is the difference between measurements. M is the number of measurements. For the calculation of inter-observer TEM based on gold readings, D measurers the difference between readings of gold measurer and observer. For the calculation of inter-observer TEM based on median readings, D measurers the difference between the median of the measurements by all the selected observers (including the gold readings) and observer's readings. For the calculation of intra-observer TEM, D measurers the difference between the repeated readings between the two rounds by selected observers. N is representative of all the observers who passed and were involved in data collection. Global cut-offs for inter-observer and intra-observer TEM for MUAC are 0.43 and 0.35, respectively.

Table A7a: Summary statistics of technical error of measurement (TEM) of TSFT by state, India, CNNS 2016–18

STATE	Inter-observer TEM						Intra-observer TEM			N
	Comparison with gold readings			Comparison with median readings			Comparison with repeated readings			
	Median	Range		Median	Range		Median	Range		
		Low	High		Low	High		Low	High	
Andhra Pradesh	0.55	0.37	1.16	0.57	0.28	1.03	0.66	0.36	1.37	9
Arunachal Pradesh	0.45	0.25	0.80	0.36	0.17	0.76	0.34	0.12	1.34	12
Assam	0.49	0.39	0.72	0.27	0.22	0.47	0.38	0.26	0.60	8
Bihar	0.50	0.40	1.81	0.29	0.19	1.74	0.38	0.14	2.70	7
Chhattisgarh	0.38	0.22	0.47	0.33	0.16	0.48	0.35	0.09	0.73	10
Goa	0.60	0.48	1.10	0.42	0.30	0.77	0.45	0.14	1.44	10
Gujarat	0.32	0.26	0.50	0.25	0.09	0.44	0.33	0.16	0.67	9
Haryana	0.56	0.32	1.06	0.47	0.18	1.02	0.36	0.23	0.41	10
Himachal Pradesh	0.70	0.51	1.04	0.36	0.21	0.61	0.42	0.22	0.66	8
Jammu and Kashmir	0.58	0.42	0.82	0.38	0.21	0.56	0.34	0.20	0.57	12
Jharkhand	0.85	0.64	1.53	0.48	0.29	0.85	0.42	0.13	0.67	10
Karnataka	0.70	0.29	1.48	0.52	0.33	1.23	0.58	0.21	1.28	10
Kerala	0.85	0.52	1.36	0.59	0.38	1.08	0.56	0.37	1.12	8
Madhya Pradesh	0.62	0.56	1.89	0.56	0.34	1.55	0.48	0.34	0.64	6
Maharashtra	1.06	0.80	1.32	0.67	0.32	1.18	0.62	0.19	1.68	11
Manipur	0.56	0.32	0.93	0.36	0.21	0.62	0.44	0.24	0.79	12
Meghalaya	0.94	0.44	1.88	0.67	0.55	1.70	0.41	0.24	2.33	9
Mizoram	2.11	1.74	2.33	0.51	0.42	0.75	0.89	0.51	1.07	8
Nagaland	0.80	0.52	1.79	0.69	0.39	1.42	0.56	0.46	0.84	7
NCT of Delhi	0.55	0.30	0.59	0.50	0.27	0.56	0.48	0.29	0.62	4
Odisha	0.50	0.43	1.62	0.36	0.27	1.63	0.40	0.15	2.28	11
Punjab	0.51	0.41	0.78	0.30	0.20	0.65	0.35	0.24	0.79	11
Rajasthan	0.47	0.30	0.75	0.37	0.17	0.59	0.18	0.06	0.73	9
Sikkim	0.47	0.30	0.75	1.09	0.56	1.66	1.03	0.79	1.82	8
Tamil Nadu	0.51	0.33	1.06	0.39	0.18	0.96	0.41	0.18	1.21	20
Telangana	0.59	0.46	1.31	0.62	0.49	1.25	0.68	0.32	1.70	11
Tripura	0.57	0.41	0.98	0.40	0.30	0.90	0.57	0.41	1.31	7
Uttar Pradesh	0.62	0.56	1.89	0.56	0.34	1.55	0.48	0.34	0.64	6
Uttarakhand	0.76	0.54	1.10	0.38	0.19	0.80	0.46	0.12	1.13	10
West Bengal	0.70	0.47	1.62	0.40	0.20	1.27	0.54	0.12	0.91	18

Note: The TEM calculation is TEM = ((∑D2)/ (2 *M))1/2 . D is the difference between measurements. M is the number of measurements. For the calculation of inter-observer TEM based on gold readings, D measurers the difference between readings of gold measurer and observer. For the calculation of inter-observer TEM based on median readings, D measurers the difference between the median of the measurements by all the selected observers (including the gold readings) and observer's readings. For the calculation of intra-observer TEM, D measurers the difference between the repeated readings between the two rounds by selected observers. N is representative of all the observers who passed and were involved in data collection. Global cut-offs for inter-observer and intra-observer TEM for TSFT are 1.89 and 0.8, respectively.

Table A7b: Summary statistics of technical error of measurement (TEM) of SSFT by state, India, CNNS 2016–18

STATE	Inter-observer TEM						Intra-observer TEM			N
	Comparison with gold readings			Comparison with median readings			Comparison with repeated readings			
	Median	Range		Median	Range		Median	Range		
		Low	High		Low	High		Low	High	
Andhra Pradesh	0.85	0.48	1.04	0.50	0.41	0.76	0.70	0.19	1.28	9
Arunachal Pradesh	0.38	0.17	0.69	0.34	0.19	0.69	0.43	0.22	0.85	12
Assam	0.22	0.14	0.31	0.16	0.09	0.24	0.26	0.05	0.41	8
Bihar	0.20	0.14	0.44	0.18	0.12	0.41	0.20	0.12	0.35	7
Chhattisgarh	0.55	0.24	0.89	0.27	0.13	0.54	0.33	0.17	0.51	10
Goa	0.28	0.23	0.55	0.22	0.13	0.45	0.30	0.17	0.68	10
Gujarat	0.29	0.24	0.33	0.18	0.16	0.23	0.21	0.09	0.32	9
Haryana	0.63	0.29	0.97	0.46	0.20	0.73	0.27	0.15	0.78	10
Himachal Pradesh	0.47	0.41	0.61	0.18	0.11	0.38	0.32	0.17	0.42	8
Jammu and Kashmir	0.37	0.24	0.63	0.25	0.16	0.47	0.36	0.12	0.49	12
Jharkhand	0.63	0.30	1.25	0.41	0.25	1.22	0.30	0.16	1.28	10
Karnataka	0.83	0.33	2.06	0.60	0.25	1.67	0.61	0.38	1.02	10
Kerala	0.87	0.72	1.04	0.24	0.11	0.38	0.26	0.16	0.51	8
Madhya Pradesh	0.74	0.62	1.03	0.69	0.32	1.05	0.53	0.17	0.87	6
Maharashtra	0.92	0.67	2.35	0.49	0.30	2.25	0.55	0.35	1.79	11
Manipur	0.43	0.20	1.02	0.28	0.21	0.83	0.32	0.21	0.83	12
Meghalaya	0.55	0.37	0.90	0.42	0.18	0.59	0.43	0.20	1.05	9
Mizoram	0.46	0.31	0.73	0.37	0.19	0.59	0.32	0.19	0.69	8
Nagaland	1.12	0.35	2.36	0.71	0.29	1.62	0.58	0.17	1.65	7
NCT of Delhi	0.32	0.22	0.64	0.30	0.08	0.54	0.36	0.29	0.47	4
Odisha	0.43	0.28	0.77	0.39	0.16	0.71	0.40	0.22	0.76	11
Punjab	0.48	0.41	0.67	0.27	0.16	0.73	0.30	0.19	0.63	11
Rajasthan	0.40	0.29	0.50	0.34	0.13	0.40	0.14	0.06	0.55	9
Sikkim	0.62	0.36	1.22	0.59	0.37	1.04	0.62	0.25	1.12	8
Tamil Nadu	0.85	0.60	1.16	0.38	0.21	0.98	0.32	0.18	1.30	20
Telangana	0.66	0.44	0.83	0.40	0.26	0.67	0.52	0.38	0.94	11
Tripura	0.35	0.19	0.52	0.26	0.23	0.49	0.34	0.21	0.85	7
Uttar Pradesh	0.74	0.62	1.03	0.69	0.32	1.05	0.53	0.17	0.87	6
Uttarakhand	0.63	0.50	0.81	0.36	0.14	0.65	0.24	0.13	0.39	10
West Bengal	0.72	0.39	1.63	0.47	0.13	1.42	0.43	0.12	1.69	18

Note: The TEM calculation is TEM = ((∑D2)/ (2 *M))1/2 . D is the difference between measurements. M is the number of measurements. For the calculation of inter-observer TEM based on gold readings, D measurers the difference between readings of gold measurer and observer. For the calculation of inter-observer TEM based on median readings, D measurers the difference between the median of the measurements by all the selected observers (including the gold readings) and observer's readings. For the calculation of intra-observer TEM, D measurers the difference between the repeated readings between the two rounds by selected observers. N is representative of all the observers who passed and were involved in data collection. Global cut-offs for inter-observer and intra-observer TEM for SSFT are 1.83 and 1.53, respectively.

Anthropometric data quality report

Table A8a: Percentage of children aged under five years with missing data on Z-scores of anthropometric measurements by state, India, CNNS 2016–18

State	Weight for Height (<5 years)	Height for Age (<5 years)	Weight for Age (<5 years)	Mid-Upper Arm Circumference (<5 years)	Body Mass Index (<5 years)	Triceps skinfold for age (<5 years)	Unweighted Number (<5 years)	Subscapular Skinfold for age (1–4 years)	Unweighted Number (1–4 years)
India	**4.7**	**2.8**	**3.4**	**7.5**	**3.9**	**7.6**	**38,060**	**5.1**	**31,058**
Andhra Pradesh	1.1	0.8	0.8	3.3	0.8	3.5	1173	8.5	1003
Arunachal Pradesh	3.9	1.6	2.3	6.1	2.6	6.3	1268	3.7	995
Assam	3.2	0.1	1.3	4.4	2.2	4.8	1452	2.6	1209
Bihar	3.6	2.8	3.1	7.0	3.3	7.0	1407	2.2	1137
Chhattisgarh	4.5	1.7	3.3	8.3	3.8	8.3	1200	4.5	998
Goa	3.4	2.2	1.7	5.9	3.1	5.9	1036	3.6	866
Gujarat	3.4	2.6	2.7	6.8	2.9	8.1	1066	6.2	882
Haryana	2.6	1.9	2.0	5.1	2.1	5.0	1090	2.9	873
Himachal Pradesh	2.7	1.8	1.9	4.9	1.9	4.8	1192	1.8	980
Jammu and Kashmir	3.8	0.7	0.8	6.7	0.9	6.4	1156	0.9	847
Jharkhand	4.5	3.4	3.8	7.4	4.3	7.3	1226	4.2	1018
Karnataka	4.8	4.3	4.3	8.0	4.3	8.5	949	8.3	791
Kerala	6.3	2.1	4.5	8.0	5.8	8.4	898	9.0	755
Madhya Pradesh	3.0	0.9	1.6	5.5	1.8	5.5	1152	2.0	941
Maharashtra	1.2	0.7	0.6	4.3	0.9	4.5	1921	1.5	1564
Manipur	5.3	0.5	1.9	7.9	4.2	8.0	1206	5.3	1013
Meghalaya	9.7	3.5	5.9	13.2	7.5	13.1	1114	12.3	894
Mizoram	3.1	0.1	1.0	5.7	1.4	5.7	1009	1.4	841
Nagaland	5.5	2.0	3.6	9.1	4.0	9.0	1199	4.5	965
NCT of Delhi	6.3	5.8	5.8	10.4	6.1	10.4	1735	7.2	1437
Odisha	3.4	1.2	1.7	7.5	2.6	8.0	1313	3.5	1090
Punjab	2.1	0.8	1.5	4.5	1.6	4.5	1004	1.9	827
Rajasthan	4.3	3.7	3.7	9.5	3.7	9.4	1221	4.6	977
Sikkim	5.3	1.6	3.2	6.2	3.6	6.4	1121	4.0	924
Tamil Nadu	5.9	2.9	3.4	7.3	3.7	7.3	1906	4.0	1512
Telangana	2.4	1.2	1.5	4.8	2.0	5.1	1037	7.8	859
Tripura	5.6	1.3	3.6	7.6	4.5	7.8	1133	4.6	893
Uttar Pradesh	2.5	1.6	1.9	5.7	2.3	5.6	1965	3.3	1589
Uttarakhand	4.3	3.6	3.7	8.3	3.9	8.4	1134	4.2	920
West Bengal	19.5	17.8	18.3	20.8	18.7	20.9	1777	19.5	1458

Note: Flagged data are included. while calculating the percentage. Missing data on Z-score of subscapular skinfold for age is measured for the children aged 1–4 years

Observations:

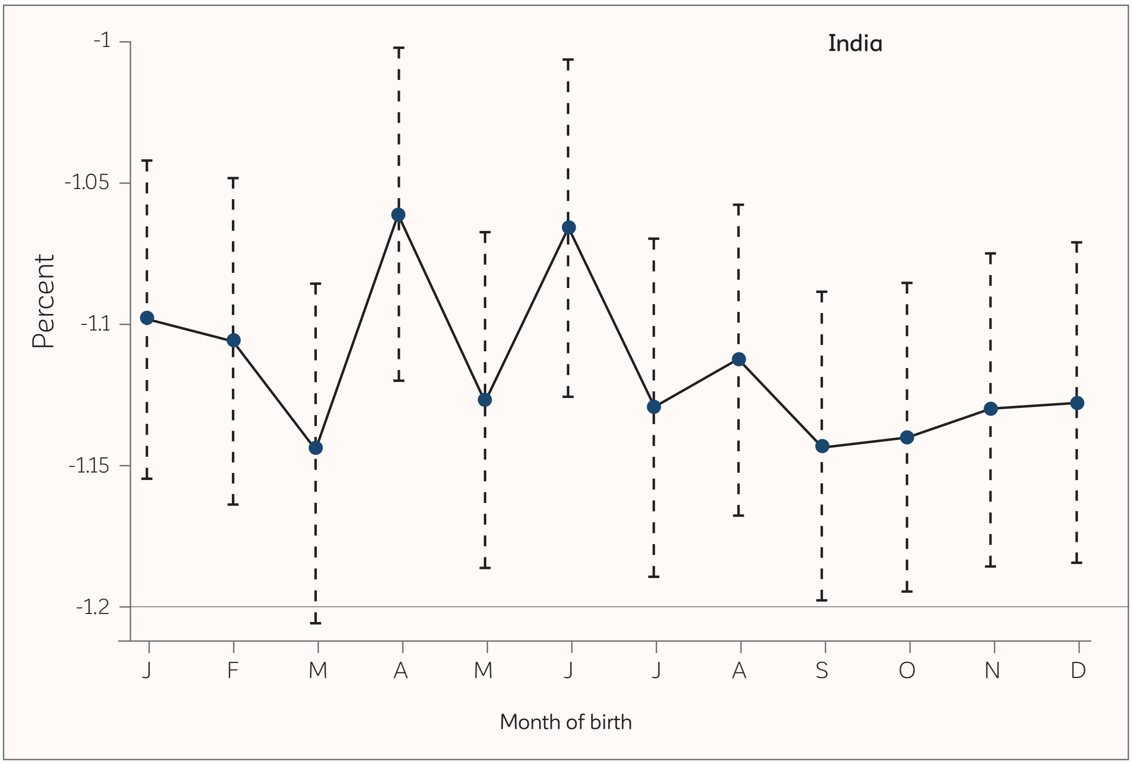
- Overall, missing data on the anthropometric outcomes WHZ, HAZ, WAZ, BMI is less than 8 percent.
- Meghalaya, NCT of Delhi and West Bengal have higher missing information of height, weight, MUAC and TSFT.
- Missing data on the MUAC and TSFT is higher in Chhattisgarh, Kerala, Manipur, Meghalaya, Nagaland, NCT of Delhi, Rajasthan, and West Bengal than the national level.
- Missing data for the SSFT is higher in Andhra Pradesh, Gujarat, Karnataka, Kerala, Manipur, NCT of Delhi, Telangana and West Bengal than the national level.

Table A8b: Percentage of children aged under five years with flagged cases on Z-scores of anthropometric measurements by state, India, CNNS 2016–18

State	Weight for Height (<5 years)	Height for Age (<5 years)	Weight for Age (<5 years)	Mid-Upper Arm Circumference (<5 years)	Body Mass Index (<5 years)	Triceps skinfold for age (<5 years)	Unweighted Number (<5 years)	Subscapular Skinfold for age (1–4 years)	Unweighted Number (1–4 years)
India	**2.7**	**3.0**	**1.2**	**0.3**	**3.5**	**0.2**	**38,060**	**0.1**	**31,058**
Andhra Pradesh	2.6	0.9	1.0	0.3	2.8	0.0	1173	0.1	1003
Arunachal Pradesh	3.5	4.3	1.0	0.3	4.2	0.0	1268	0.0	995
Assam	6.6	5.2	0.8	0.4	6.8	0.4	1452	0.0	1209
Bihar	0.7	1.2	0.2	0.2	0.8	0.0	1407	0.1	1137
Chhattisgarh	3.4	3.4	0.9	0.5	4.0	0.1	1200	0.0	998
Goa	3.5	2.6	2.4	0.5	3.9	0.1	1036	0.3	866
Gujarat	2.2	1.5	0.7	0.2	2.9	0.7	1066	0.0	882
Haryana	0.9	0.9	0.6	0.0	1.4	0.0	1090	0.1	873
Himachal Pradesh	2.9	1.7	1.4	0.5	4.0	0.1	1192	0.0	980
Jammu and Kashmir	6.3	5.7	1.8	0.8	7.8	0.1	1156	0.0	847
Jharkhand	0.3	1.6	0.6	0.1	0.5	0.1	1226	0.3	1018
Karnataka	3.2	1.2	1.4	0.5	3.7	0.1	949	0.0	791
Kerala	1.5	4.6	1.5	0.1	2.2	0.5	898	0.0	755
Madhya Pradesh	1.9	2.7	1.3	0.1	2.9	0.1	1152	0.0	941
Maharashtra	3.6	2.5	0.8	0.1	3.8	0.1	1921	0.0	1564
Manipur	1.8	5.5	0.8	0.5	2.8	0.4	1206	0.0	1013
Meghalaya	2.6	6.8	1.9	0.5	5.4	0.6	1114	0.0	894
Mizoram	4.0	4.0	0.9	0.0	4.9	0.0	1009	0.4	841
Nagaland	6.2	5.8	2.4	1.4	7.6	0.6	1199	0.0	965
NCT of Delhi	0.9	1.0	0.6	0.4	1.0	0.1	1735	0.0	1437
Odisha	0.9	2.3	1.0	0.3	1.9	0.2	1313	0.2	1090
Punjab	1.1	1.7	0.5	0.3	1.2	0.0	1004	0.0	827
Rajasthan	1.5	1.0	1.2	0.2	2.1	0.2	1221	0.1	977
Sikkim	4.2	4.6	2.8	1.0	5.7	0.6	1121	0.1	924
Tamil Nadu	4.2	4.7	1.8	0.1	6.2	0.2	1906	0.0	1512
Telangana	1.6	1.3	1.4	0.2	1.9	0.1	1037	0.1	859
Tripura	4.0	6.0	1.9	0.5	5.4	0.0	1133	0.0	893
Uttar Pradesh	1.2	1.7	0.5	0.2	1.5	0.1	1965	0.0	1589
Uttarakhand	1.1	1.3	0.3	0.3	1.4	0.1	1134	0.0	920
West Bengal	1.9	2.5	2.3	0.4	3.0	0.2	1777	0.0	1458

Note: WHO recommended flags are used. Z-score values of Height for Age and Weight for Age exceeding the range of [-6, 6] and [-6, 5], respectively, are considered as flagged cases. Z-score values of Weight for Height, MUAC, BMI, TSFT for age and SSFT for age exceeding the range of [-5, 5] are considered as flagged cases.
Flagged data on Z-score of subscapular skinfold for age is measured for the children aged 1–4 years.

Figure A1: Mean height-for-age z-score (HAZ) by month of birth of children under five years, India, CNNS 2016–18



Note: Sampling weights have not been used in this analysis. Flagged data are excluded.

Figure A2: Distribution of month of birth of children under 5 years, India, CNNS 2016–18.

Notes: Sampling weights have not been used in this analysis.

Table A9: Distribution of the month of birth of children under 5 years old by state, India, CNNS 2016–18

State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Unweighted Number (0–4 years)	P-value
India	**8.5**	**8.2**	**7.6**	**7.9**	**7.7**	**7.7**	**7.7**	**8.9**	**9.0**	**9.2**	**9.0**	**8.7**	**38,061**	**0.000**
Andhra Pradesh	10.2	5.8	6.7	8.8	8.9	8.3	6.5	8.0	9.5	8.4	8.9	10.0	1173	0.002
Arunachal Pradesh	8.8	9.0	7.6	8.2	7.9	6.3	7.6	8.1	8.7	9.1	9.2	9.5	1268	0.266
Assam	9.8	10.6	9.4	8.7	9.0	7.4	6.0	8.9	6.6	8.3	7.1	8.3	1452	0.000
Bihar	7.4	8.2	6.8	7.8	5.9	6.2	8.1	10.4	10.4	9.8	10.0	9.0	1407	0.000
Chhattisgarh	10.2	8.7	7.8	8.3	8.9	7.0	7.3	8.4	7.8	7.7	8.8	9.2	1200	0.329
Goa	8.4	7.6	9.5	7.8	9.5	6.4	6.9	7.1	8.7	9.5	9.1	9.5	1037	0.092
Gujarat	8.3	7.1	6.3	7.6	8.3	8.7	8.5	9.0	7.7	9.4	10.6	8.3	1066	0.101
Haryana	8.3	7.7	6.9	7.2	6.2	7.0	8.5	10.1	9.3	10.7	8.2	9.8	1090	0.003
Himachal Pradesh	7.6	8.9	8.6	6.8	7.6	7.7	8.5	8.1	9.3	8.1	10.6	8.2	1192	0.185
Jammu and Kashmir	7.6	9.3	8.6	9.1	9.9	10.2	7.1	8.0	7.2	7.4	7.7	8.0	1156	0.088
Jharkhand	9.5	8.1	5.7	7.4	8.1	9.6	7.5	10.0	8.6	8.2	8.7	8.6	1226	0.028
Karnataka	8.1	7.5	9.1	7.9	8.6	9.2	7.1	8.3	8.0	8.9	7.5	9.9	949	0.667
Kerala	7.3	8.0	6.5	9.9	8.0	8.8	7.5	7.6	10.0	8.6	10.2	7.6	898	0.105
Madhya Pradesh	8.8	8.0	6.9	8.4	8.1	7.7	8.4	9.8	9.3	9.2	7.3	8.1	1152	0.475
Maharashtra	7.7	6.9	7.4	8.7	8.3	8.3	8.0	7.5	8.8	10.2	9.8	8.3	1921	0.015
Manipur	8.6	9.2	8.1	8.1	7.4	6.5	7.4	8.6	8.5	9.5	9.8	8.3	1206	0.217
Meghalaya	9.4	9.0	9.8	8.9	7.0	8.1	5.9	8.1	8.3	8.3	8.4	8.9	1114	0.137
Mizoram	9.2	8.5	7.8	9.5	7.2	7.2	7.0	8.3	9.1	8.1	9.8	8.0	1009	0.402
Nagaland	9.8	9.8	8.3	6.1	5.8	7.3	6.8	8.3	11.7	9.0	8.2	8.8	1199	0.000
NCT of Delhi	8.5	8.7	7.5	6.9	6.5	8.2	8.1	9.2	9.2	10.4	8.2	8.7	1735	0.008

Odisha	8.6	6.8	9.0	8.1	9.4	9.0	7.2	8.3	7.0	7.5	9.8	9.3	1313	0.084
Punjab	9.2	8.1	6.5	4.5	8.1	6.9	7.9	10.9	9.5	11.0	9.6	8.2	1004	0.000
Rajasthan	9.1	7.0	7.1	6.1	5.7	6.8	9.4	10.6	9.7	10.4	10.6	7.6	1221	0.000
Sikkim	7.4	9.4	7.9	7.7	7.3	7.1	8.1	8.5	9.8	8.1	10.0	8.7	1121	0.242
Tamil Nadu	6.9	6.7	6.7	8.4	7.7	8.7	7.7	9.5	8.4	10.7	9.2	9.3	1906	0.000
Telangana	9.5	8.3	7.3	7.5	6.6	8.5	7.3	9.3	9.0	9.3	8.8	8.7	1037	0.353
Tripura	8.0	11.5	6.4	9.5	7.6	7.0	6.4	8.0	8.9	9.5	9.4	7.8	1133	0.000
Uttar Pradesh	8.5	8.3	7.5	7.7	7.6	7.2	10.1	10.4	9.7	8.5	6.8	7.6	1965	0.000
Uttarakhand	7.5	8.4	8.3	7.3	7.2	6.7	7.9	8.5	10.1	11.3	8.6	8.3	1134	0.013
West Bengal	8.8	7.7	5.8	7.8	6.7	7.8	7.1	8.6	10.2	9.7	10.1	9.9	1777	0.000

Note: Chi-square test has been conducted under the null hypothesis that the distribution of month of birth is uniform. Sampling weights have not been used in the analysis. Flagged data are included.

Observation: Distribution of month of birth is not uniform across most of the states except a few states. Similarly, reported month of birth has an unequal distribution at the national level. Histogram for the all the children (Figure 2) indicates that a higher proportion of children are reported to be born during August to December. This unequal distribution is likely to be driven by cultural practices.

Figure A3: Mean height-for-age z-score (HAZ) by month in addition to age in completed years, India, CNNS 2016–18

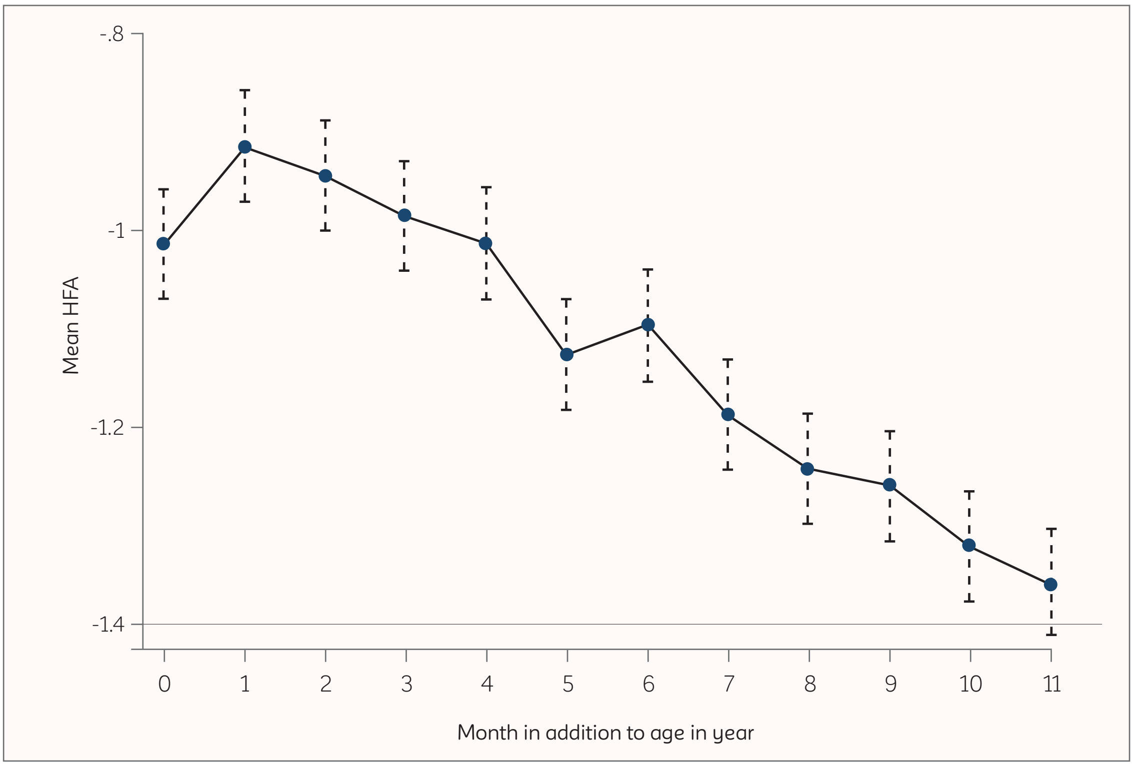
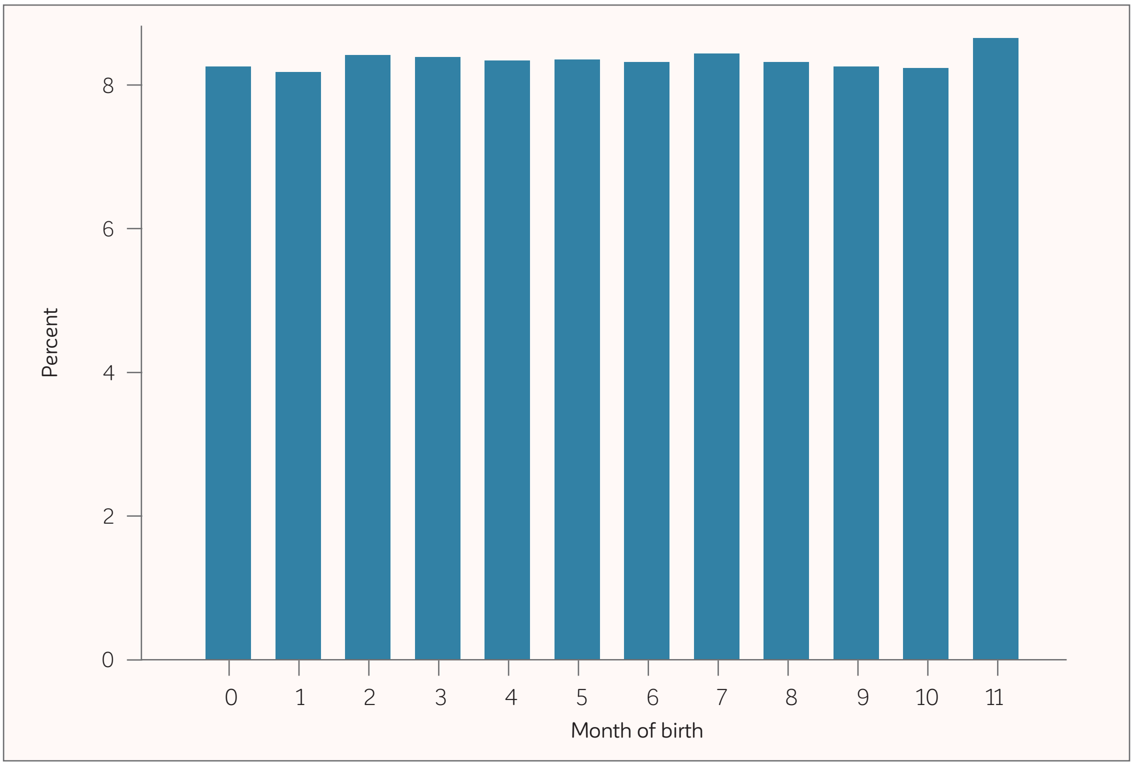


Figure A4: Distribution of reported number of months following completed years of the children under 5 years, India, CNNS 2016–18



Notes: Sampling weights have not been used in this analysis.

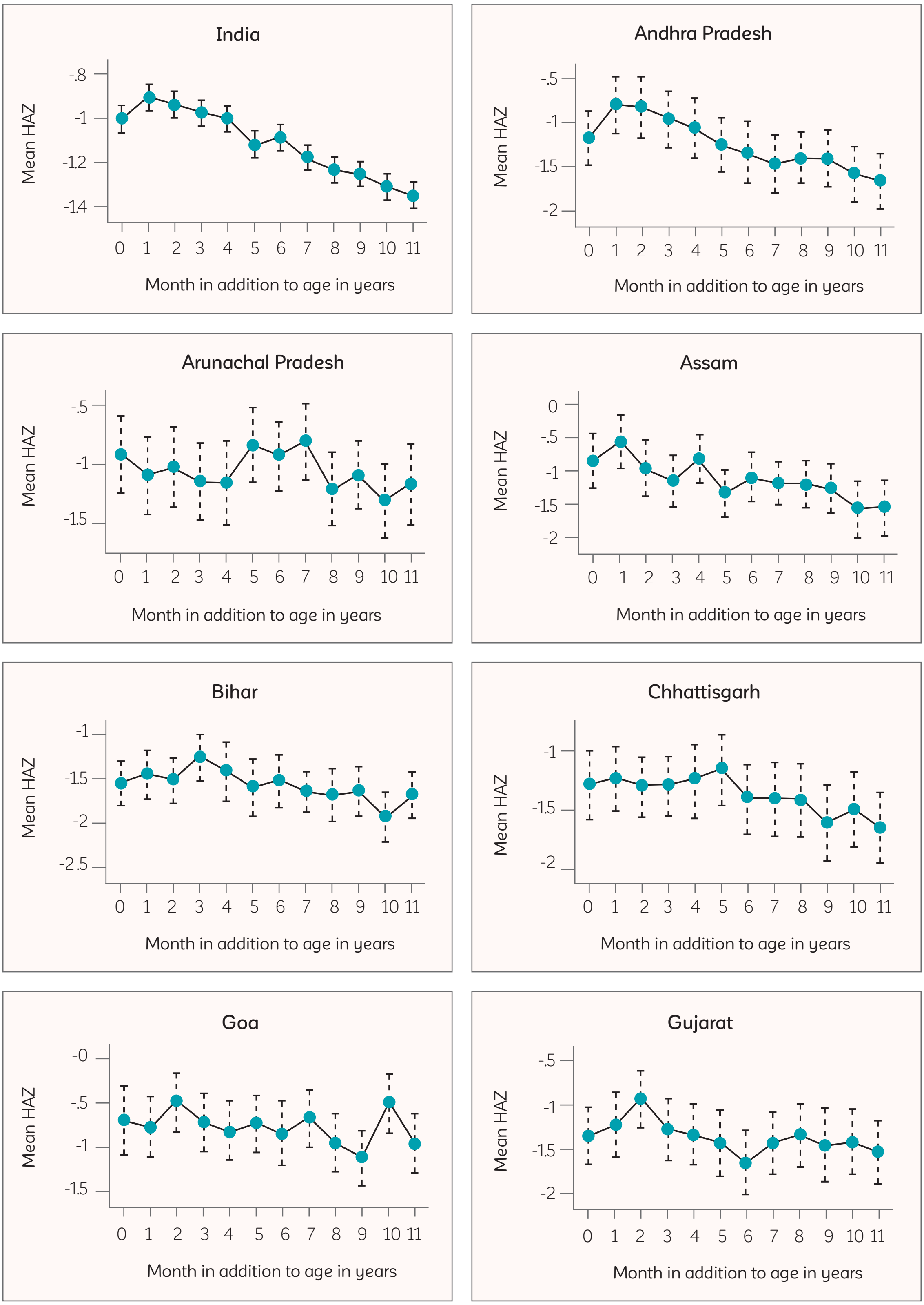
Table A10: Distribution of the number of month of following completed years of children under 5 years old by state, India, CNNS 2016–18

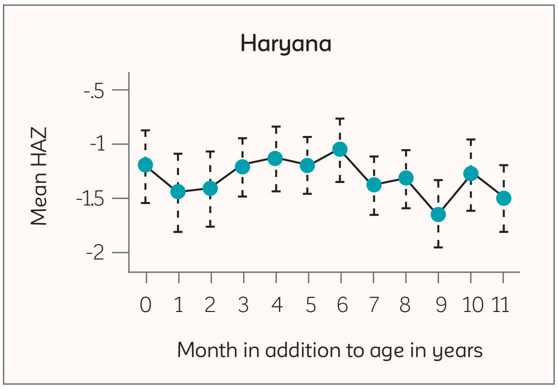
State	Number of month of following completed years												Unweighted Number (0–4 years)	P-value
	0	1	2	3	4	5	6	7	8	9	10	11		
India	**8.3**	**8.2**	**8.4**	**8.4**	**8.3**	**8.3**	**8.3**	**8.4**	**8.3**	**8.2**	**8.3**	**8.6**	**38,061**	**0.830**
Andhra Pradesh	9.2	8.8	7.2	8.3	7.6	9.5	7.3	8.0	7.8	8.2	9.5	8.8	1173	0.530
Arunachal Pradesh	7.8	7.3	7.2	8.3	6.8	8.7	10.4	8.2	9.3	10.3	8.8	7.0	1268	0.009
Assam	7.3	7.6	6.7	7.7	9.4	9.8	9.0	10.7	9.2	8.5	6.9	7.3	1452	0.001
Bihar	11.8	9.1	9.9	9.0	6.0	6.1	7.2	8.1	7.1	8.0	8.5	9.2	1407	0.000
Chhattisgarh	8.8	9.6	10.7	8.3	7.4	8.3	8.5	7.4	7.6	7.4	7.8	8.2	1200	0.162
Goa	6.3	8.0	8.5	8.6	8.3	8.7	6.8	9.5	8.8	9.4	8.8	8.5	1037	0.378
Gujarat	7.4	8.1	10.2	8.6	9.6	8.1	7.7	9.0	8.3	6.3	8.3	8.3	1066	0.213
Haryana	7.2	6.0	6.4	10.3	8.4	10.4	8.2	10.4	10.1	7.9	6.8	8.0	1090	0.000
Himachal Pradesh	8.0	7.9	8.0	6.5	9.8	6.1	9.3	8.1	8.6	9.5	10.0	8.3	1192	0.017
Jammu and Kashmir	10.4	9.3	9.9	8.1	8.6	9.2	8.1	7.7	6.9	8.0	6.6	7.3	1156	0.037
Jharkhand	7.5	6.9	7.5	8.2	8.2	7.4	9.8	9.7	8.6	8.6	8.3	9.3	1226	0.227
Karnataka	6.5	9.5	8.1	9.0	8.9	7.9	7.7	7.5	9.0	8.2	9.2	8.6	949	0.635
Kerala	6.9	7.3	7.9	9.7	8.7	9.4	8.5	8.2	7.8	9.2	7.6	8.8	898	0.644
Madhya Pradesh	8.7	7.1	8.9	10.6	7.9	9.1	8.4	6.8	8.6	6.9	7.6	9.3	1152	0.062
Maharashtra	6.7	7.7	7.4	8.4	9.2	9.4	9.0	8.2	8.4	8.3	8.3	9.1	1921	0.140
Manipur	7.8	9.4	9.3	8.7	9.2	8.0	7.0	6.8	8.0	7.0	8.9	10.0	1206	0.074
Meghalaya	7.3	6.6	7.7	8.0	8.3	9.0	8.9	9.3	8.5	9.2	10.6	6.6	1114	0.047
Mizoram	7.8	8.5	8.9	8.1	9.4	7.8	8.5	9.4	9.3	6.5	7.1	8.4	1009	0.459
Nagaland	7.8	9.4	10.1	10.3	9.8	8.4	8.2	8.2	7.3	7.3	6.2	7.0	1199	0.005
NCT of Delhi	8.5	7.9	8.4	6.8	8.4	7.8	8.8	9.0	8.9	8.6	8.9	8.1	1735	0.637
Odisha	8.3	10.2	9.1	7.8	6.7	6.9	8.5	9.6	8.1	9.0	7.8	7.9	1313	0.076
Punjab	7.3	8.6	7.6	10.1	10.0	9.5	8.6	8.2	7.1	7.2	7.9	8.3	1004	0.214
Rajasthan	7.9	10.6	10.2	10.8	9.3	8.2	7.3	5.5	6.8	6.6	7.5	9.3	1221	0.000
Sikkim	8.6	6.2	8.2	7.4	7.1	8.7	8.4	7.8	8.7	8.7	8.6	11.6	1121	0.011
Tamil Nadu	7.9	7.8	8.4	7.6	7.3	7.3	7.5	8.9	9.5	9.8	8.8	9.1	1906	0.049
Telangana	6.6	6.5	9.9	7.3	9.6	10.2	7.5	9.4	7.2	9.1	8.1	8.6	1037	0.014
Tripura	7.1	10.2	8.3	8.3	9.4	8.2	8.6	7.4	7.9	8.2	7.9	8.6	1133	0.511
Uttar Pradesh	12.7	7.6	7.7	7.6	7.5	7.3	9.2	7.9	7.6	7.0	8.2	9.8	1965	0.000
Uttarakhand	8.9	9.2	9.7	9.3	9.3	7.8	7.1	8.3	7.3	6.9	7.8	8.3	1134	0.270
West Bengal	8.7	7.3	6.1	7.2	7.1	8.3	7.8	9.1	9.5	9.9	9.5	9.6	1777	0.000

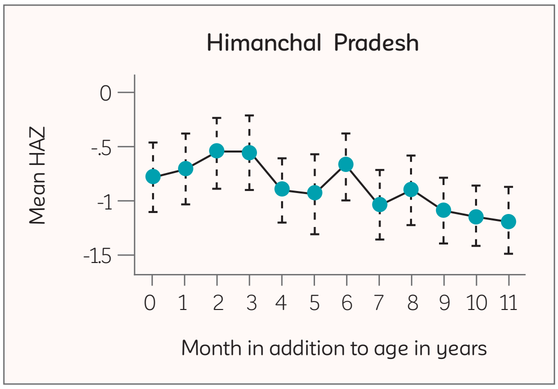
Notes: Chi-square test has been conducted under the null hypothesis that the distribution of reported number of month following completed years of the children is uniform. Sampling weights have not been used in this analysis. Flagged data are included.

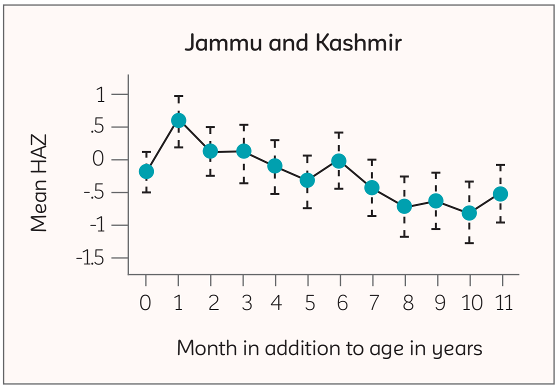
Observation: Distribution of number of month following completed years is uniform across most of the states except a few states. Similarly, reported number of month following completed years has an equal distribution at the national level. Histogram for the all the children (Figure 3) indicates a uniform distribution.

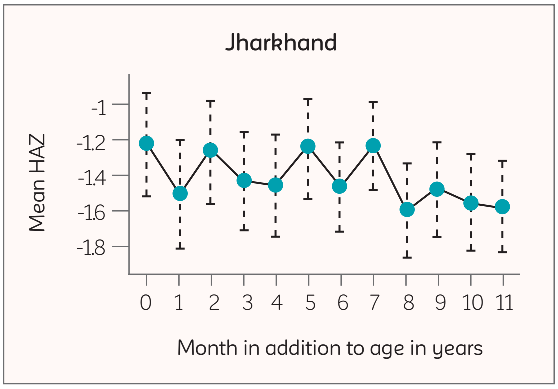
Figure A5: Mean height-for-age z-score (HAZ) by number of months following completed years of children under 5 years old by state, India, CNNS 2016–18

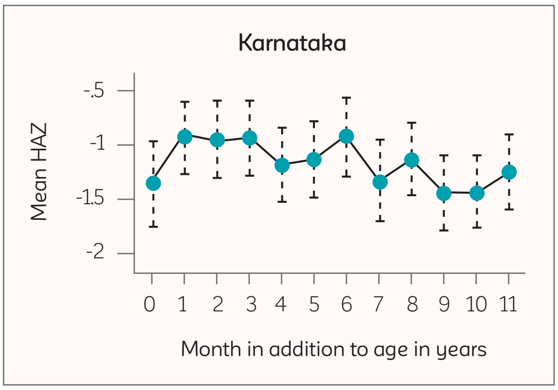


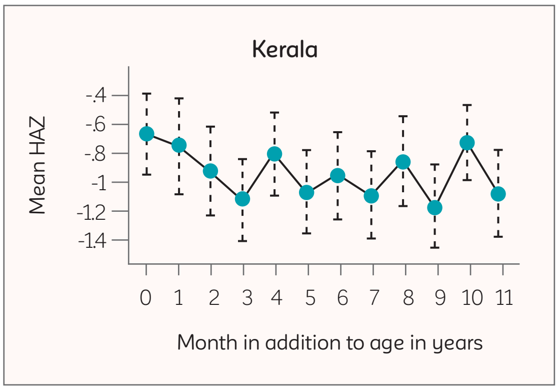

Haryana
Mean HAZ
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

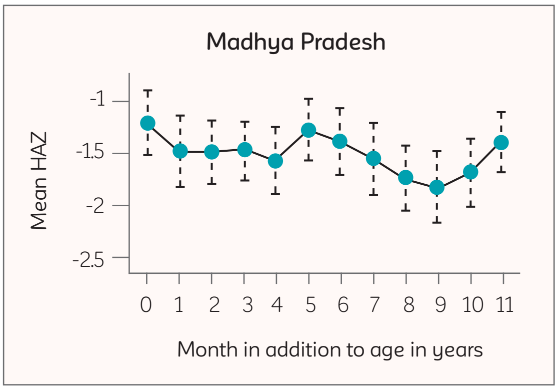

Himanchal Pradesh
Mean HAZ
0
-.5
-1
-1.5
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

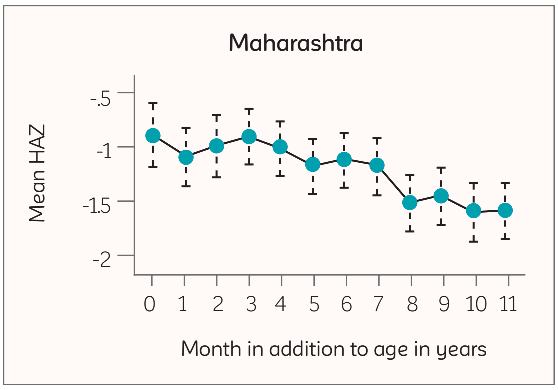

Jammu and Kashmir
Mean HAZ
1
.5
0
-.5
-1
-1.5
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

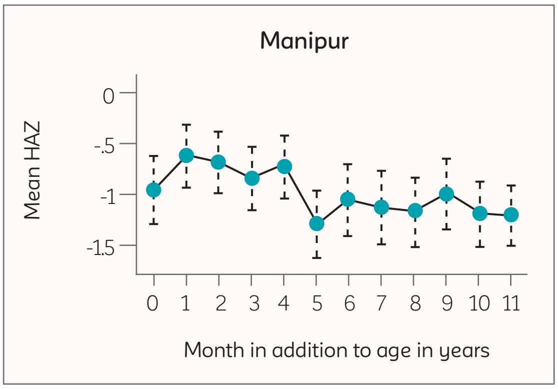

Jharkhand
Mean HAZ
-1
-1.2
-1.4
-1.6
-1.8
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

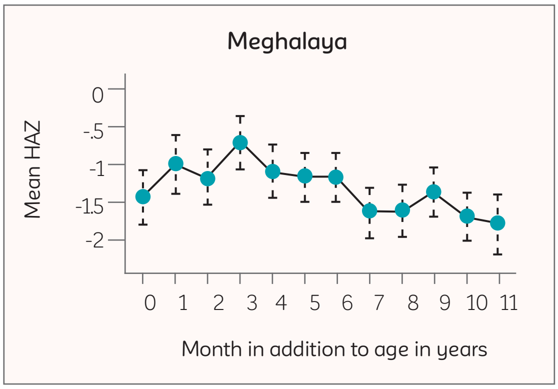

Karnataka
Mean HAZ
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

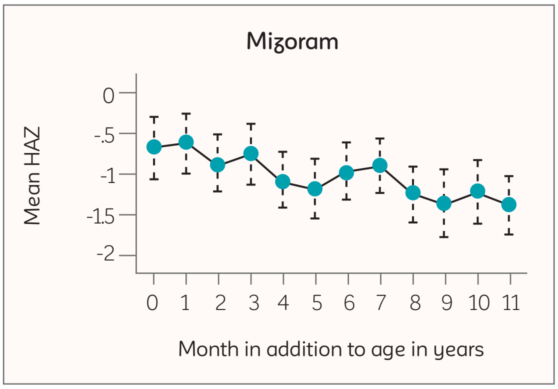

Kerala
Mean HAZ
-.4
-.6
-.8
-1
-1.2
-1.4
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

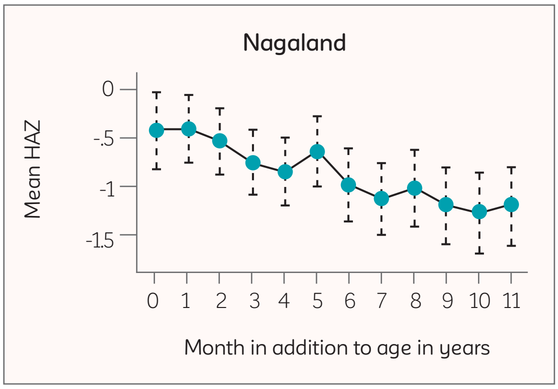

Madhya Pradesh
Mean HAZ
-1
-1.5
-2
-2.5
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

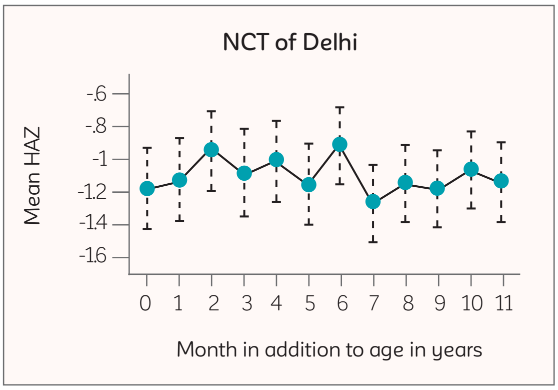

Maharashtra
Mean HAZ
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

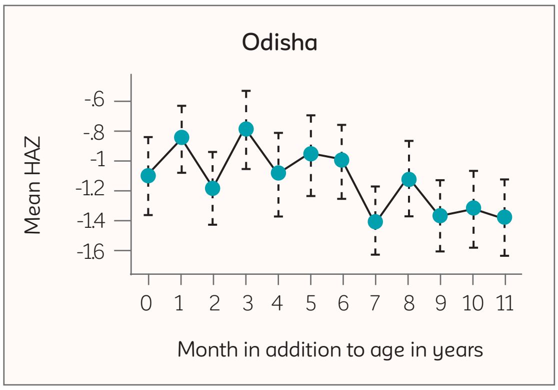

Manipur
Mean HAZ
0
-.5
-1
-1.5
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

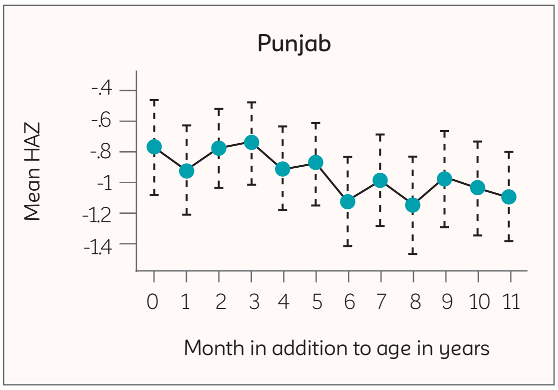

Meghalaya
Mean HAZ
0
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

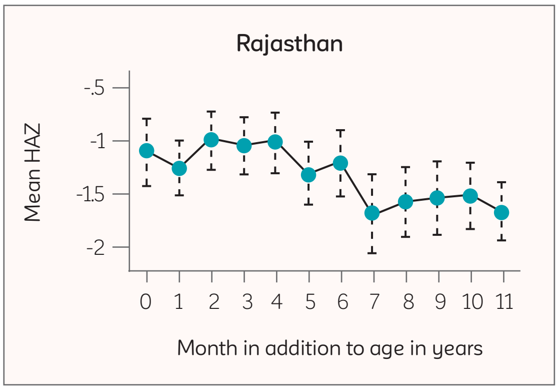

Mizoram
Mean HAZ
0
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

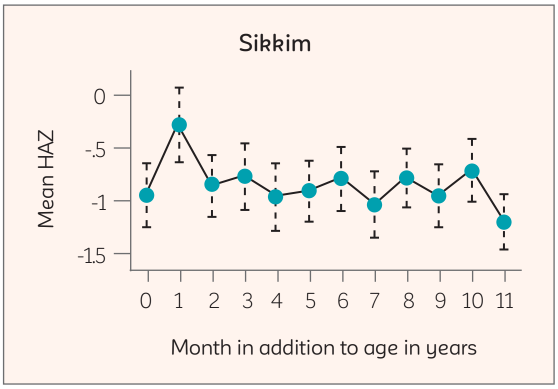

Nagaland
Mean HAZ
0
-.5
-1
-1.5
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

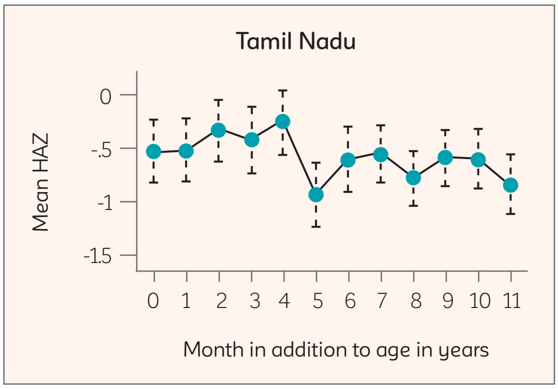

NCT of Delhi
Mean HAZ
-.6
-.8
-1
-1.2
-1.4
-1.6
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

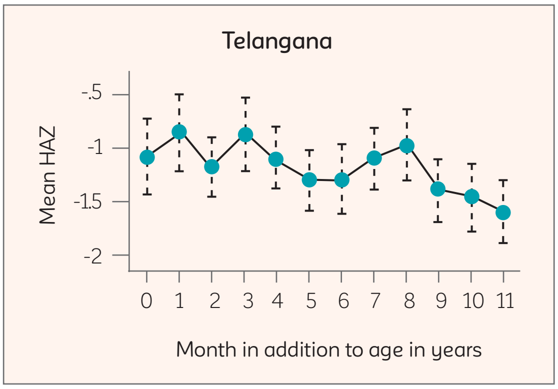

Odisha
Mean HAZ
-.6
-.8
-1
-1.2
-1.4
-1.6
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

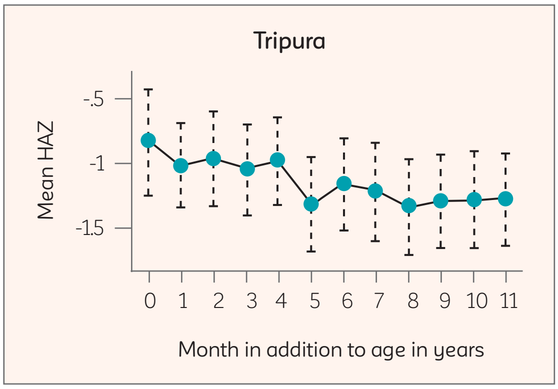

Punjab
Mean HAZ
-.4
-.6
-.8
-1
-1.2
-1.4
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

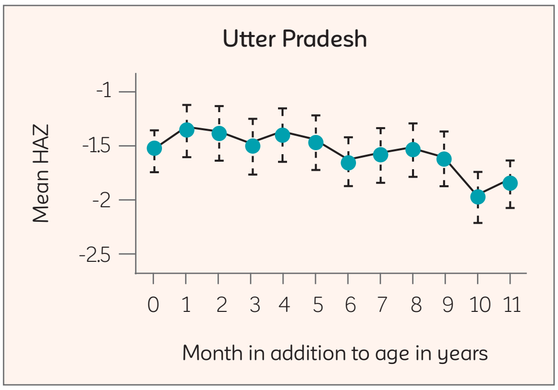

Rajasthan
Mean HAZ
-.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10 11
Month in addition to age in years

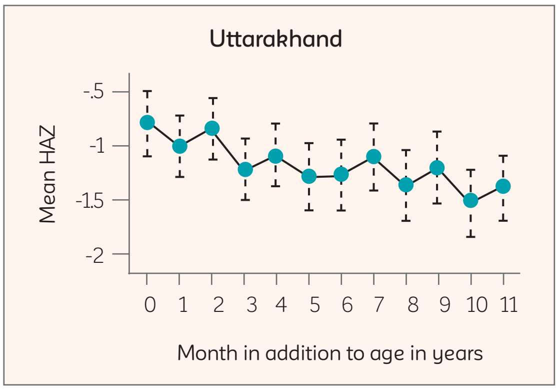


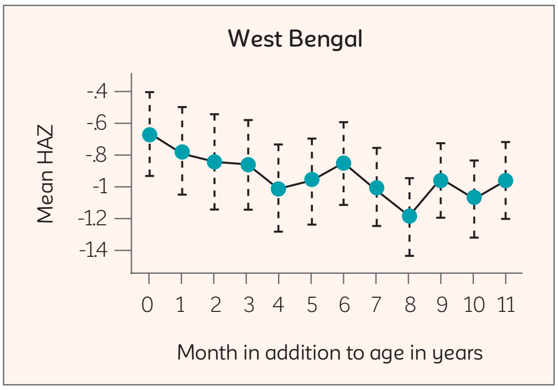












Notes: Sampling weights have not been used in this analysis. Flagged data are excluded.

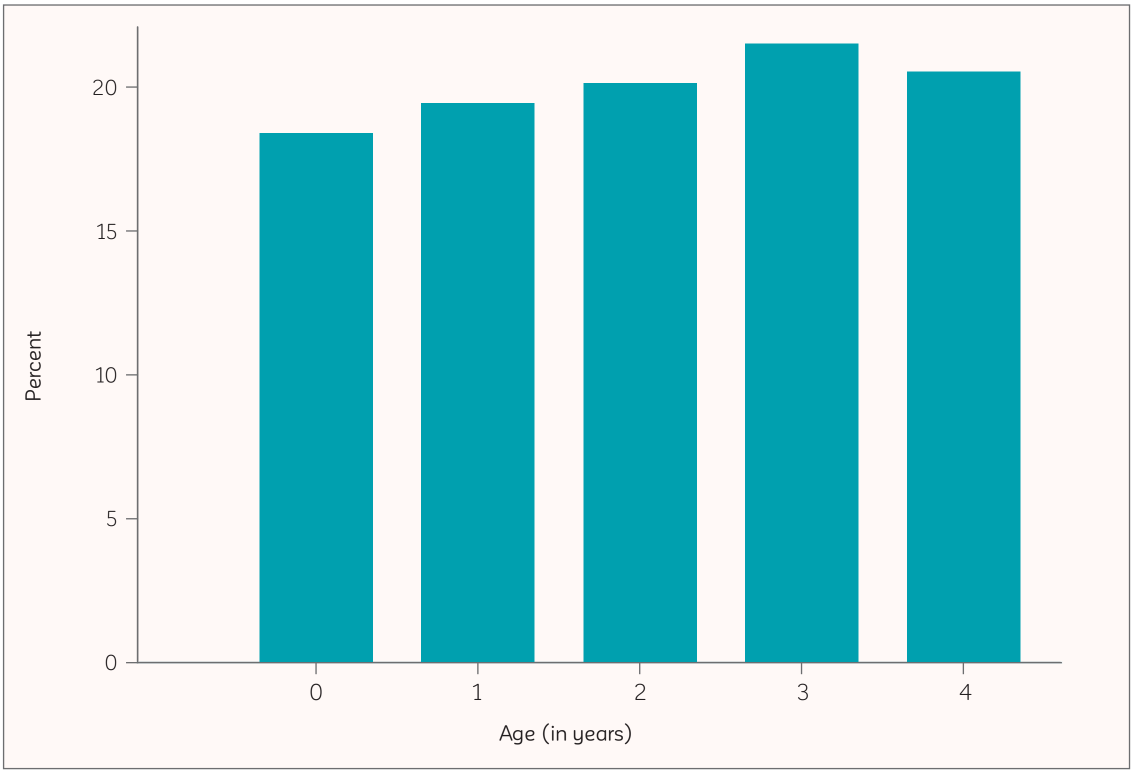
Table A11: Distribution of the sample by age in completed years of children under 5 years old by state, India, CNNS 2016–18

State	<1 Year	1 Year	2 Years	3 Years	4 Years	Unweighted Number (<5 years)	P-value
India	**18.4**	**19.4**	**20.1**	**21.5**	**20.5**	**38063**	
Andhra Pradesh	14.5	19.3	18.2	25.0	23.0	1173	0.000
Arunachal Pradesh	21.5	19.9	18.1	21.5	19.0	1268	0.026
Assam	16.7	18.4	21.4	22.2	21.2	1452	0.296
Bihar	19.2	19.5	20.0	20.3	21.0	1407	0.790
Chhattisgarh	16.8	18.9	21.9	21.3	21.0	1200	0.431
Goa	16.4	19.5	17.5	23.6	23.0	1037	0.023
Gujarat	17.3	19.8	20.5	21.1	21.3	1066	0.863
Haryana	19.9	21.5	18.0	22.7	18.0	1090	0.036
Himachal Pradesh	17.8	20.7	21.5	20.2	19.8	1192	0.471
Jammu and Kashmir	26.7	16.9	19.0	20.0	17.4	1156	0.000
Jharkhand	17.0	21.0	20.9	22.0	19.2	1226	0.352
Karnataka	16.6	19.9	21.2	21.1	21.2	949	0.648
Kerala	15.9	21.5	20.5	20.6	21.5	898	0.221
Madhya Pradesh	18.3	17.9	22.0	20.5	21.4	1152	0.365
Maharashtra	18.6	17.3	20.7	21.0	22.4	1921	0.087
Manipur	16.0	18.4	24.1	22.1	19.3	1206	0.004
Meghalaya	19.7	18.5	21.5	20.6	19.7	1114	0.494
Mizoram	16.7	20.2	19.2	23.6	20.3	1009	0.349
Nagaland	19.5	17.8	17.7	25.6	19.4	1199	0.003
NCT of Delhi	17.2	20.6	19.5	21.4	21.3	1736	0.468
Odisha	17.0	18.9	19.4	21.6	23.2	1313	0.174
Punjab	17.6	20.3	21.4	20.0	20.6	1004	0.631
Rajasthan	20.0	17.8	18.6	21.8	21.9	1222	0.192
Sikkim	17.6	20.2	22.4	21.1	18.7	1121	0.249
Tamil Nadu	20.7	18.9	19.5	21.6	19.4	1906	0.121
Telangana	17.2	21.4	17.6	19.5	24.3	1037	0.004
Tripura	21.2	20.2	19.3	20.7	18.5	1133	0.092
Uttar Pradesh	19.1	20.5	20.3	20.3	19.8	1965	0.460
Uttarakhand	18.9	19.1	21.2	21.1	19.8	1134	0.873
West Bengal	18.0	20.1	20.6	21.7	19.6	1777	0.800

Notes: Chi-square test has been conducted under the null hypothesis that the state level distribution of age in completed years is same as national level distribution. Every cell gives the percentage of children belonging to a particular age out of the total sample of children in the state. Sampling weights have not been used to construct this table. Flagged data are included.

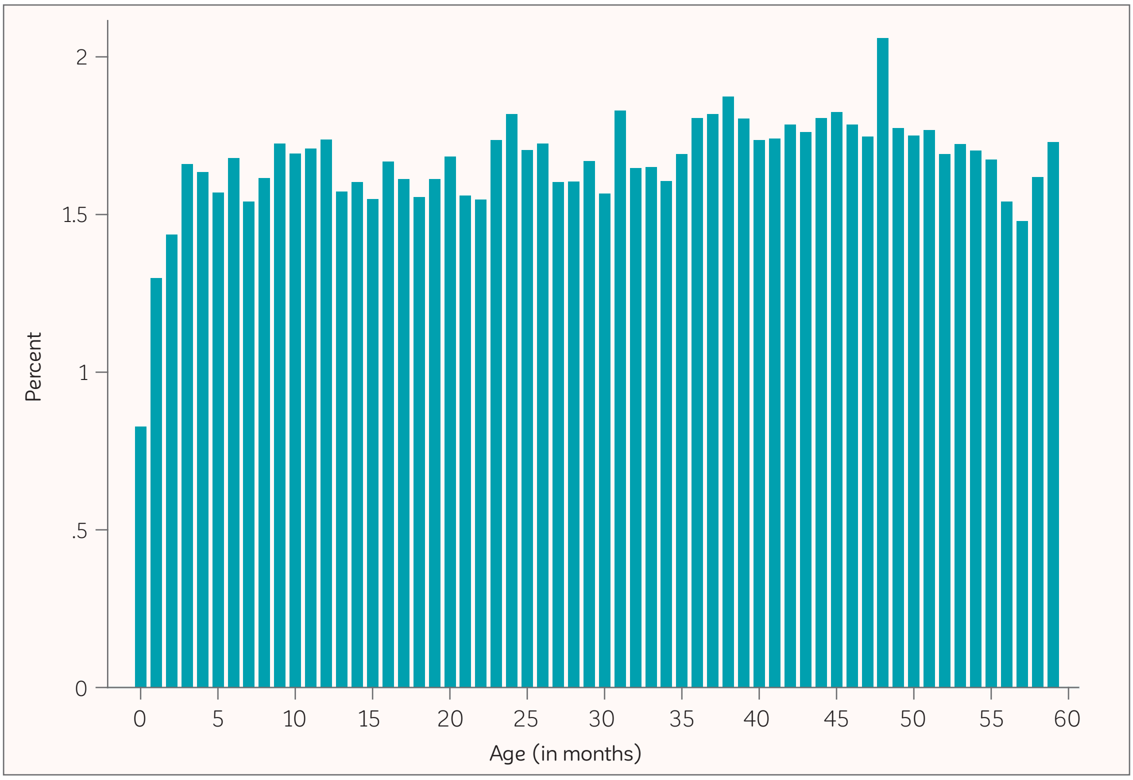
Observation:
In comparison to the national level distribution of sample by age in completed years, most of the states except Jammu and Kashmir, Haryana, Arunachal Pradesh, Nagaland, Manipur, Tripura, Andhra Pradesh, Goa and Telangana have a similar distribution of age. Histogram at the national level (Figure 4) indicates an unequal age distribution in terms of completed years. Chi-square test also indicates that the national level distribution of age is not uniform (chi-square value - 103.5327 and p- value – 0.000).

Figure A6: Distribution of age in completed years of children under 5 years, India, CNNS 2016–18



Note: Sampling weights have not been used in the analysis. Flagged data are included.

Figure A7: Age (in months) distribution of children under 5 years, India, CNNS 2016–18



Note: Sampling weights have not been used to construct this figure.

Table A12: Digit preference score (DPS) of the anthropometric measures of children under 5 years old by state, India, CNNS 2016–18

State	Weight		Height		MUAC		TSFT		SSFT	
	DPS	N	DPS	N	DPS	N	DPS	N	DPS	N
India	**3.4**	**37053**	**7.9**	**73606**	**6.1**	**72865**	**7.7**	**73021**	**6.8**	**59495**
Andhra Pradesh	3.5	1164	8.4	2328	6.4	2326	8.0	2316	8.7	1857
Arunachal Pradesh	8.6	1248	16.9	2482	19.2	2460	14.1	2463	11.2	1930
Assam	12.7	1450	16.7	2869	13.8	2836	9.0	2840	9.7	2380
Bihar	2.4	1367	10.1	2728	9.7	2722	13.0	2723	8.2	2223
Chhattisgarh	4.0	1180	8.2	2333	6.0	2304	10.5	2321	9.3	1931
Goa	4.8	1032	10.7	2016	8.3	1985	12.0	1989	12.1	1683
Gujarat	2.6	1038	10.2	2073	6.6	2046	8.3	2030	14.8	1682
Haryana	3.6	1069	7.6	2135	6.7	2123	7.2	2128	5.7	1698
Himachal Pradesh	7.3	1173	10.8	2344	9.4	2342	6.3	2327	9.0	1917
Jammu and Kashmir	7.9	1148	9.8	2294	11.5	2282	10.7	2278	13.9	1672
Jharkhand	2.0	1185	7.2	2359	6.6	2348	6.8	2358	3.8	1956
Karnataka	3.5	908	12.3	1816	6.7	1802	4.6	1788	10.8	1474
Kerala	4.1	879	5.1	1724	5.3	1676	6.1	1702	8.0	1421
Madhya Pradesh	3.9	1143	8.0	2270	5.6	2262	13.1	2262	11.7	1852
Maharashtra	3.4	1909	7.8	3812	4.5	3794	11.4	3785	8.6	3088
Manipur	5.1	1201	7.4	2357	7.0	2286	5.9	2321	4.5	1966
Meghalaya	5.7	1075	14.2	2099	8.4	2004	11.8	2053	11.5	1637
Mizoram	6.5	1009	14.7	2003	17.4	1984	6.9	2000	6.4	1668
Nagaland	8.4	1175	9.4	2325	10.2	2297	10.4	2308	7.3	1857
NCT of Delhi	2.3	1634	7.0	3262	6.1	3218	3.9	3222	5.4	2682
Odisha	3.0	1297	4.3	2576	3.7	2558	7.2	2560	6.9	2127
Punjab	4.0	998	8.3	1988	8.4	1980	9.5	1981	12.0	1633
Rajasthan	2.6	1176	10.0	2351	10.4	2336	5.2	2335	3.7	1868
Sikkim	7.2	1103	16.2	2184	7.1	2157	10.7	2151	8.3	1785
Tamil Nadu	4.6	1850	7.3	3684	4.7	3652	4.8	3661	3.1	2921
Telangana	5.5	1029	6.7	2049	5.6	2026	6.0	2021	6.4	1620
Tripura	8.8	1119	11.7	2202	6.9	2167	8.8	2194	6.3	1727
Uttar Pradesh	2.6	1939	10.0	3856	6.3	3826	10.6	3830	10.2	3113
Uttarakhand	2.4	1093	8.2	2183	5.5	2174	10.7	2173	5.1	1766
West Bengal	3.5	1462	10.3	2904	10.0	2892	10.2	2901	8.5	2361

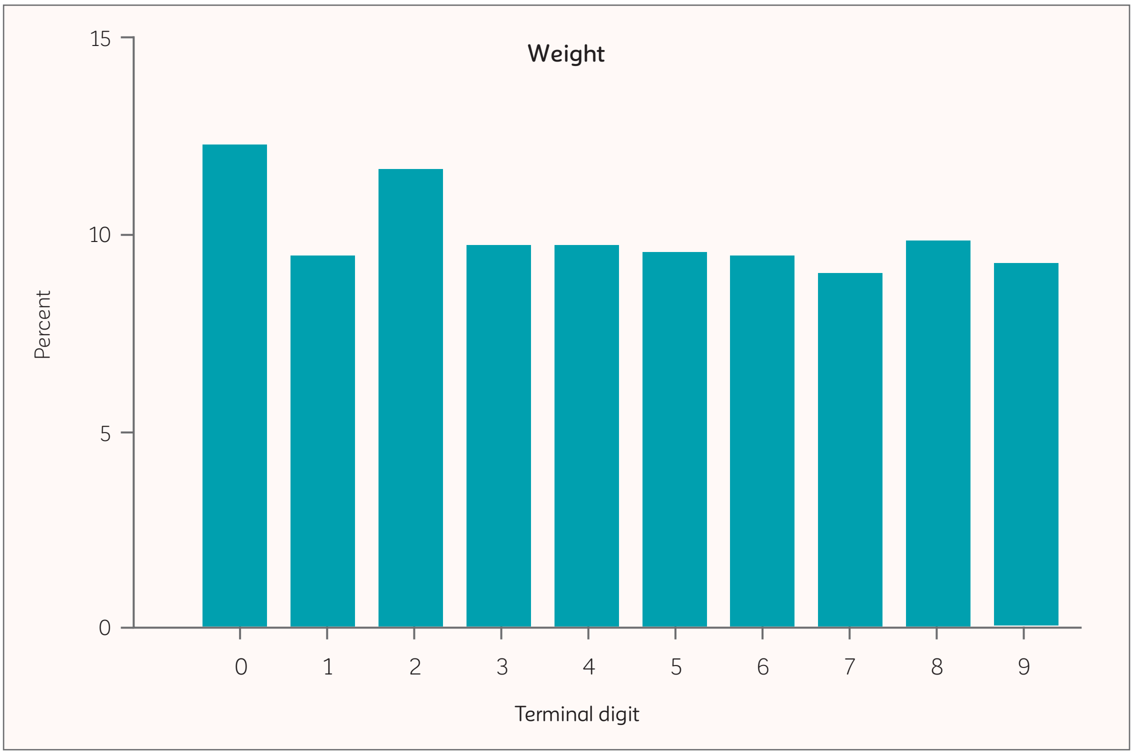
Note: The DPS* is categorized as:
0–8=Excellent,
8–13 = Good,
13–20= Acceptable
> 20 = Problematic

*DPS was developed by WHO MONICA project for assessment of the data quality of terminal digits and calculated as:

*DPS = 100 * (X^2 / (df * N))$^{1/2}$; where, N is the number of observations, X^2* is the chi¬-square ¬statistic for the test of homogeneity of the terminal digits, and df are the respective degrees of freedom. (Kuulasmaa et al, 1998)

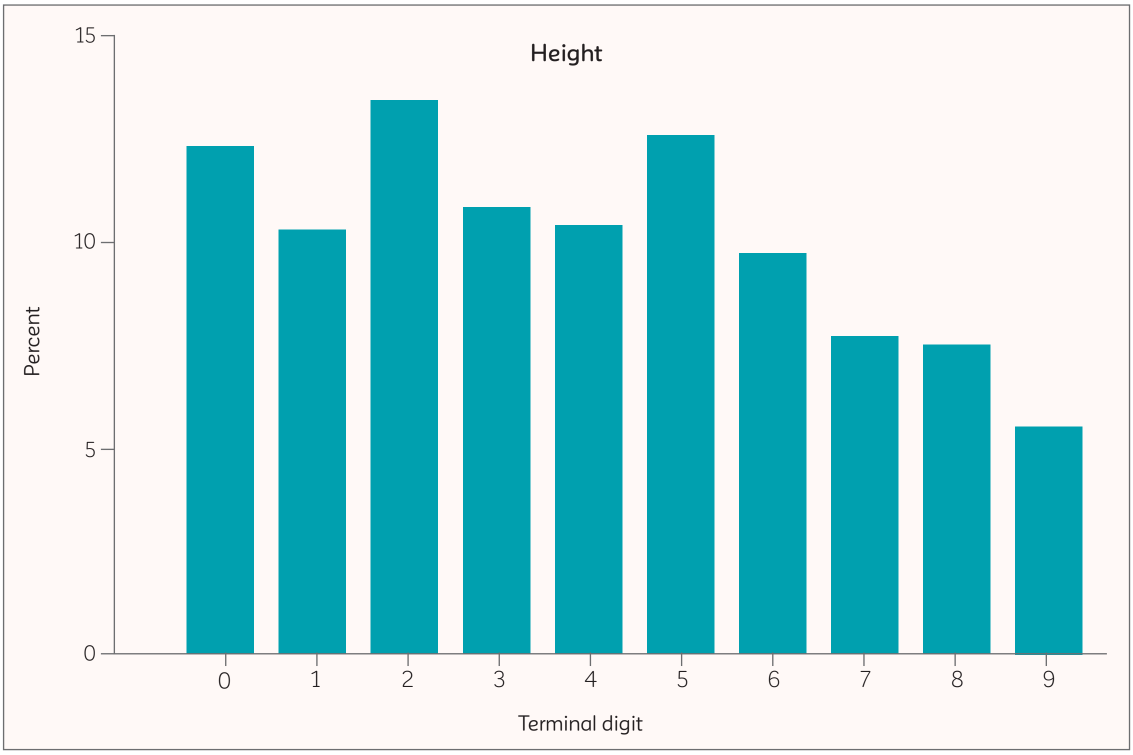
All the anthropometric outcomes except 'Weight' are measured twice and the duplicate measures are included in this analysis. Sampling weights have not been used in this analysis. Flagged data are included.

Figure A8: Distribution of terminal digit of weight of children under 5 years, India, CNNS 2016–18



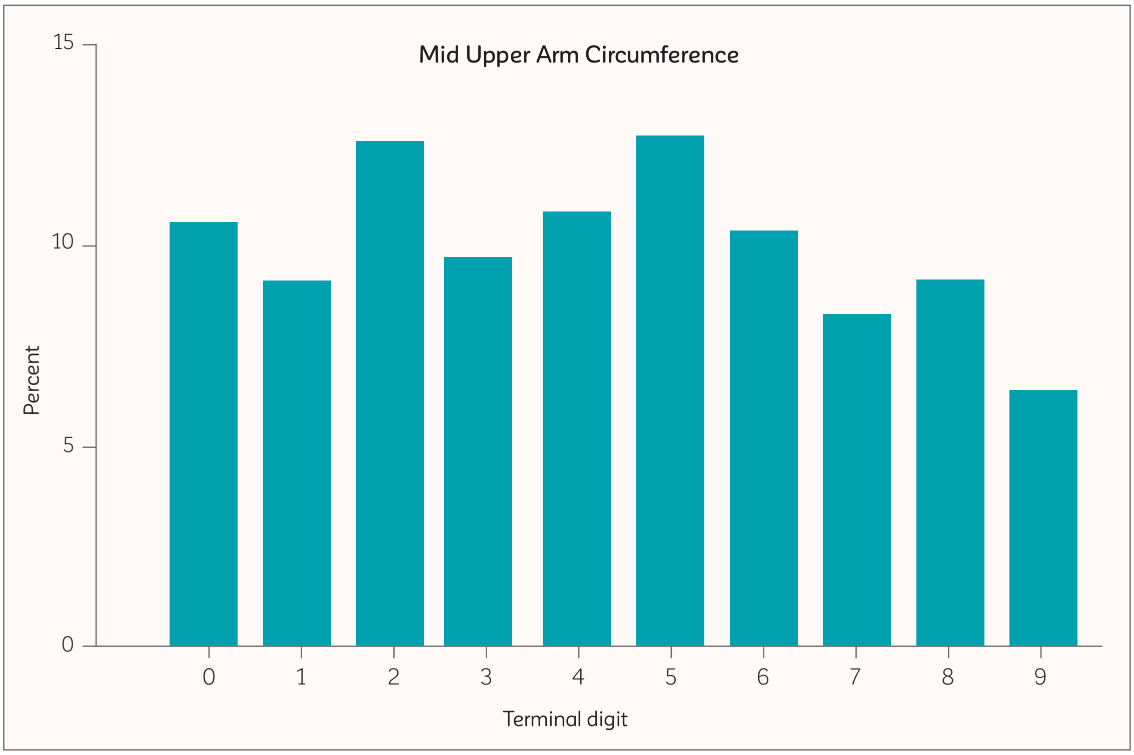
Notes: Sampling weights have not been used in this analysis.

Figure A9: Distribution of terminal digit of height of children under 5 years, India, CNNS 2016–18



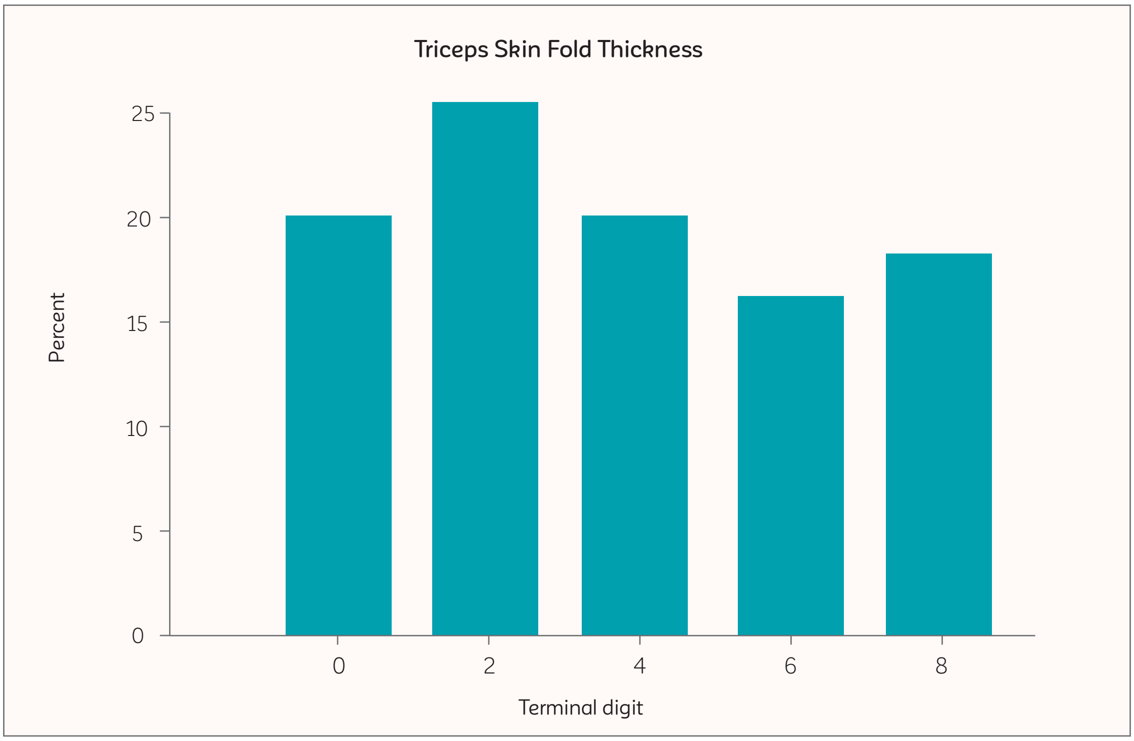
This distribution is based on the both the readings recorded by the evaluator. Sampling weights have not been used in this analysis.

Figure A10: Distribution of terminal digit of mid upper arm circumference of children under 5 years, India, CNNS 2016–18



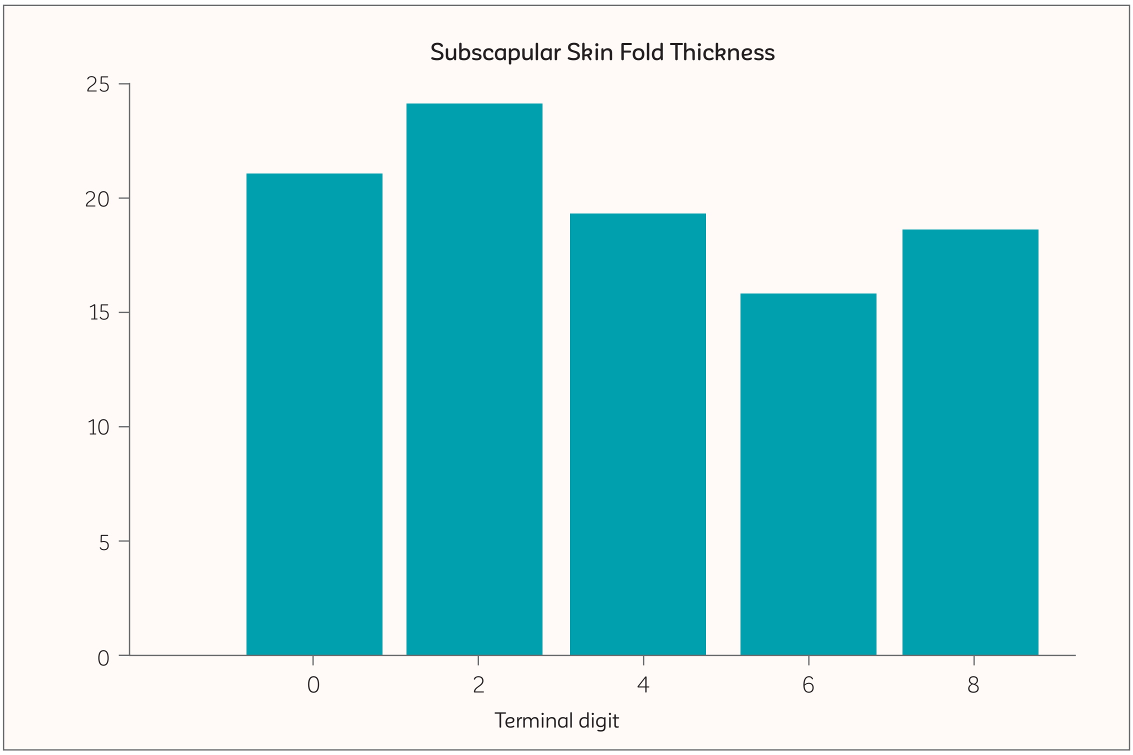
This distribution is based on the both the readings recorded by the evaluator. Sampling weights have not been used in this analysis.

Figure A11: Distribution of terminal digit of triceps skin fold thickness of children under 5 years, India, CNNS 2016–18



This distribution is based on the both the readings recorded by the evaluator. Sampling weights have not been used in this analysis.

Figure A12: Distribution of terminal digit of subscapular skin fold thickness of children under 5 years, India, CNNS 2016–18



This distribution is based on the both the readings recorded by the evaluator. Sampling weights have not been used in this analysis.

Table A 13: Standard deviation (SD) of Z-scores of the anthropometric outcomes of children under 5 years old by state, India, CNNS 2016–18

State	Weight-Height Z-score		Height-Age Z-score		Weight-Age Z-score		MUAC-Age Z-score		TSFT-Age Z-score		SSFT-Age Z-score	
	SD	N	SD	N	SD	N	SD	N	SD	N	SD	N
India	**1.34**	**35278**	**1.61**	**35907**	**1.30**	**36336**	**1.10**	**35081**	**1.17**	**35098**	**1.20**	**29475**
Andhra Pradesh	1.27	1130	1.63	1153	1.22	1152	0.99	1131	1.04	1132	1.11	919
Arunachal Pradesh	1.28	1175	1.61	1194	1.25	1226	1.08	1187	1.06	1188	1.19	957
Assam	1.62	1312	2.05	1374	1.46	1421	1.19	1382	1.20	1378	1.18	1177
Bihar	1.18	1346	1.52	1351	1.20	1360	1.00	1307	1.05	1309	1.12	1112
Chhattisgarh	1.20	1107	1.47	1140	1.19	1151	0.98	1096	1.20	1100	1.25	951
Goa	1.45	966	1.53	987	1.37	994	1.15	970	1.08	974	1.19	835
Gujarat	1.30	1007	1.70	1022	1.20	1030	1.01	991	1.41	973	1.17	827
Haryana	1.14	1052	1.39	1059	1.17	1062	1.08	1034	1.16	1035	1.19	848
Himachal Pradesh	1.28	1126	1.55	1151	1.20	1153	1.02	1128	1.05	1134	1.18	962
Jammu and Kashmir	1.63	1042	2.03	1083	1.47	1126	1.47	1070	1.31	1081	1.37	839
Jharkhand	1.13	1167	1.37	1165	1.20	1172	1.00	1134	1.05	1135	1.19	975
Karnataka	1.12	874	1.53	897	1.17	895	1.02	869	1.12	867	1.20	724
Kerala	1.19	828	1.27	839	1.13	845	1.03	825	1.01	819	1.07	685
Madhya Pradesh	1.10	1096	1.52	1111	1.15	1119	0.95	1088	1.13	1088	1.15	922
Maharashtra	1.45	1830	1.68	1861	1.30	1894	0.97	1837	0.97	1834	1.11	1542
Manipur	1.30	1121	1.60	1134	1.17	1174	0.97	1105	1.11	1105	1.12	959
Meghalaya	1.31	980	1.61	1002	1.24	1028	1.07	962	1.11	962	1.17	784
Mizoram	1.28	939	1.64	968	1.30	990	1.00	951	1.08	951	1.03	829
Nagaland	1.51	1063	1.83	1107	1.42	1128	1.32	1075	1.23	1084	1.27	922
NCT of Delhi	1.17	1611	1.42	1617	1.21	1625	1.03	1548	1.08	1552	1.14	1335
Odisha	1.17	1256	1.31	1267	1.21	1278	1.03	1211	1.15	1206	1.22	1049
Punjab	1.19	972	1.34	979	1.16	984	1.14	956	1.13	959	1.11	811
Rajasthan	1.14	1151	1.53	1164	1.22	1162	1.01	1103	1.07	1104	1.17	932
Sikkim	1.29	1017	1.46	1052	1.15	1055	1.09	1041	1.12	1043	1.16	886
Tamil Nadu	1.51	1718	1.78	1763	1.36	1808	1.15	1764	1.11	1763	1.08	1452
Telangana	1.21	996	1.42	1012	1.16	1007	0.99	985	1.01	983	1.06	792
Tripura	1.58	1027	1.72	1051	1.39	1071	1.20	1042	1.42	1045	1.43	849
Uttar Pradesh	1.20	1892	1.50	1902	1.20	1919	1.02	1850	1.14	1853	1.16	1546
Uttarakhand	1.19	1073	1.49	1079	1.14	1089	1.00	1037	1.17	1038	1.30	881
West Bengal	1.35	1404	1.43	1423	1.36	1418	1.13	1402	1.13	1403	1.19	1173

Note: Sampling weights have not been used in this analysis. Flagged data are excluded.

Table A14: Skewness of Z-scores of the anthropometric outcomes of children under 5 years old by state, India, CNNS 2016–18

State	Weight-Height Z-score		Height-Age Z-score		Weight-Age Z-score		MUAC-Age Z-score		TSFT-Age Z-score		SSFT-Age Z-score	
	S	N	S	N	S	N	S	N	S	N	S	N
India	**0.22**	**35278**	**0.56**	**35907**	**0.21**	**36336**	**0.18**	**35081**	**-0.16**	**35098**	**-0.03**	**29475**
Jammu and Kashmir	0.04	1042	0.47	1083	0.07	1126	0.40	1070	-0.15	1081	-0.10	839
Himachal Pradesh	0.03	1126	0.72	1151	0.13	1153	0.19	1128	0.12	1134	-0.12	962
Punjab	0.42	972	0.24	979	-0.11	984	0.12	956	0.03	959	0.03	811
Uttarakhand	0.05	1073	0.24	1079	0.27	1089	0.09	1037	-0.16	1038	-0.15	881
Haryana	0.00	1052	0.21	1059	0.05	1062	0.06	1034	-0.12	1035	-0.21	848
NCT of Delhi	0.43	1611	0.23	1617	0.40	1625	0.25	1548	0.18	1552	0.02	1335
Rajasthan	-0.01	1151	0.42	1164	0.22	1162	0.18	1103	-0.05	1104	-0.03	932
Uttar Pradesh	0.27	1892	0.43	1902	0.23	1919	0.22	1850	-0.17	1853	-0.14	1546
Bihar	0.07	1346	0.39	1351	-0.03	1360	0.00	1307	-0.30	1309	-0.31	1112
Sikkim	0.25	1017	0.37	1052	0.23	1055	-0.28	1041	-0.28	1043	-0.29	886
Arunachal Pradesh	0.35	1175	0.42	1194	0.12	1226	0.42	1187	0.11	1188	0.30	957
Nagaland	-0.03	1063	0.52	1107	0.06	1128	-0.38	1075	-0.58	1084	-0.23	922
Manipur	-0.37	1121	0.70	1134	0.16	1174	0.31	1105	-0.68	1105	-0.13	959
Mizoram	0.40	939	0.87	968	0.80	990	0.22	951	0.09	951	-0.03	829
Tripura	0.14	1027	0.62	1051	0.20	1071	0.36	1042	0.10	1045	0.16	849
Meghalaya	0.14	980	0.51	1002	0.38	1028	0.19	962	-0.07	962	-0.02	784
Assam	0.10	1312	0.65	1374	-0.04	1421	-0.28	1382	-0.05	1378	0.07	1177
West Bengal	0.67	1404	0.40	1423	0.53	1418	0.69	1402	0.22	1403	0.35	1173
Jharkhand	0.14	1167	0.23	1165	0.20	1172	0.24	1134	-0.04	1135	0.09	975
Odisha	0.53	1256	0.46	1267	0.58	1278	0.55	1211	0.24	1206	0.25	1049
Chhattisgarh	0.21	1107	0.51	1140	0.17	1151	0.15	1096	-0.33	1100	-0.12	951
Madhya Pradesh	-0.19	1096	0.48	1111	0.05	1119	-0.17	1088	-0.34	1088	-0.19	922
Gujarat	0.12	1007	1.00	1022	0.14	1030	0.12	991	-0.45	973	-0.11	827
Maharashtra	0.33	1830	0.57	1861	0.07	1894	0.05	1837	-0.18	1834	-0.12	1542
Andhra Pradesh	0.00	1130	0.81	1153	0.07	1152	-0.08	1131	-0.12	1132	-0.12	919
Karnataka	-0.05	874	0.19	897	-0.21	895	0.06	869	0.00	867	-0.17	724
Goa	0.37	966	0.15	987	0.30	994	0.40	970	0.14	974	0.11	835
Kerala	0.11	828	0.30	839	0.35	845	0.19	825	-0.28	819	0.14	685
Tamil Nadu	0.16	1718	0.63	1763	0.03	1808	0.13	1764	-0.13	1763	0.07	1452
Telangana	0.13	996	0.71	1012	0.15	1007	-0.04	985	0.06	983	-0.15	792

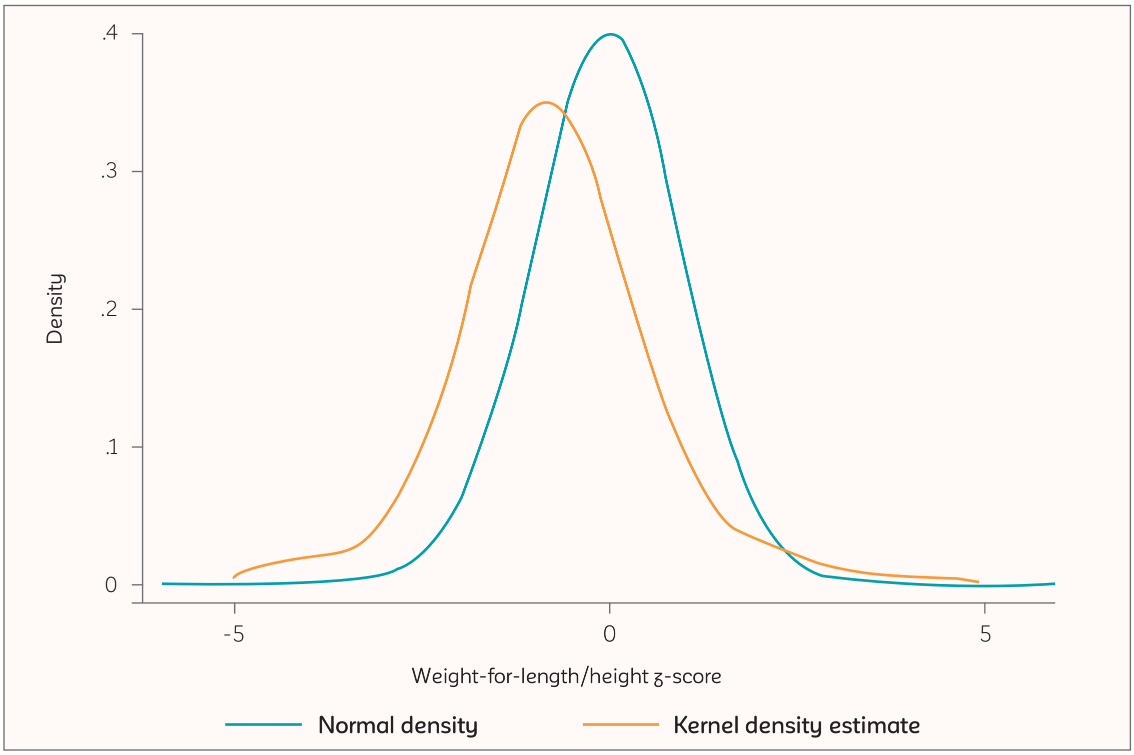
Note: Skewness can be categorized as follows: [-0.2 > S < 0.2] – Excellent, [-0.4 > S <= -0.2] or [0.2 >= S < 0.4] – Good, [-0.6 > S <= -0.4] or [0.4 >= S < 0.6] – Acceptable, and beyond the range of [-0.6 > S < 0.6] – Problematic. Reference: SMART 2019 Sampling weights have not been used in this analysis. Flagged data are excluded.

Table A15: Kurtosis of Z-scores of the anthropometric outcomes of children under 5 years old by state, India, CNNS 2016–18

State	Weight-Height Z-score		Height-Age Z-score		Weight-Age Z-score		MUAC-Age Z-score		TSFT-Age Z-score		SSFT-Age Z-score	
	K	N	K	N	K	N	K	N	K	N	K	N
India	**1.26**	**35278**	**1.49**	**35907**	**0.91**	**36336**	**1.14**	**35081**	**0.4**	**35098**	**0.16**	**29475**
Andhra Pradesh	1.66	1130	1.96	1153	0.5	1152	0.95	1131	0.08	1132	-0.13	919
Arunachal Pradesh	1.31	1175	1.32	1194	1.26	1226	0.77	1187	0.4	1188	0.56	957
Assam	0.42	1312	0.86	1374	0.67	1421	1.11	1382	0.09	1378	0.35	1177
Bihar	1.47	1346	1.04	1351	0.32	1360	0.42	1307	0.4	1309	0.16	1112
Chhattisgarh	1.02	1107	1.68	1140	0.85	1151	0.39	1096	-0.19	1100	-0.37	951
Goa	1.33	966	1.07	987	0.81	994	0.87	970	0.77	974	0.21	835
Gujarat	1.62	1007	2.36	1022	0.96	1030	0.55	991	-0.27	973	-0.18	827
Haryana	1.09	1052	0.65	1059	0.27	1062	0.71	1034	0.09	1035	0.02	848
Himachal Pradesh	1.31	1126	1.79	1151	0.55	1153	0.51	1128	-0.12	1134	-0.2	962
Jammu and Kashmir	0.77	1042	0.3	1083	0.9	1126	0.97	1070	-0.09	1081	-0.56	839
Jharkhand	1.49	1167	0.7	1165	0.68	1172	0.7	1134	-0.01	1135	0.36	975
Karnataka	0.83	874	0.51	897	1.03	895	1.16	869	0.08	867	0.24	724
Kerala	1.13	828	1.63	839	0.77	845	0.53	825	0.96	819	0.18	685
Madhya Pradesh	0.98	1096	1.86	1111	0.96	1119	0.37	1088	0.29	1088	0.03	922
Maharashtra	1.21	1830	1.76	1861	0.89	1894	0.95	1837	0.62	1834	0.05	1542
Manipur	1.5	1121	1.69	1134	1.22	1174	1.15	1105	1.02	1105	0.37	959
Meghalaya	1.82	980	1.3	1002	1.37	1028	1.53	962	0.26	962	0.27	784
Mizoram	1.66	939	2.06	968	1.42	990	1.29	951	0.71	951	0.08	829
Nagaland	1.19	1063	1.25	1107	1.3	1128	1.13	1075	0.61	1084	0.56	922
NCT of Delhi	1.62	1611	0.75	1617	0.92	1625	0.94	1548	0.67	1552	0.43	1335
Odisha	1.64	1256	0.76	1267	1.02	1278	0.94	1211	0.41	1206	0.3	1049
Punjab	1.91	972	1.19	979	0.64	984	0.92	956	0.24	959	0.32	811
Rajasthan	1.31	1151	0.86	1164	0.5	1162	1	1103	0.22	1104	-0.13	932
Sikkim	1.27	1017	0.79	1052	0.71	1055	1.43	1041	1.49	1043	0.6	886
Tamil Nadu	0.84	1718	1.31	1763	0.85	1808	1.05	1764	0.26	1763	0.03	1452
Telangana	1.22	996	2.46	1012	0.69	1007	0.61	985	0.01	983	0.38	792
Tripura	0.83	1027	1.42	1051	1.26	1071	0.94	1042	0.53	1045	0.32	849
Uttar Pradesh	1.52	1892	1.1	1902	0.88	1919	0.95	1850	0.28	1853	-0.02	1546
Uttarakhand	1.12	1073	1.03	1079	1.17	1089	0.41	1037	0.21	1038	0.03	881
West Bengal	1.60	1404	0.73	1423	0.99	1418	1.31	1402	0.89	1403	0.92	1173

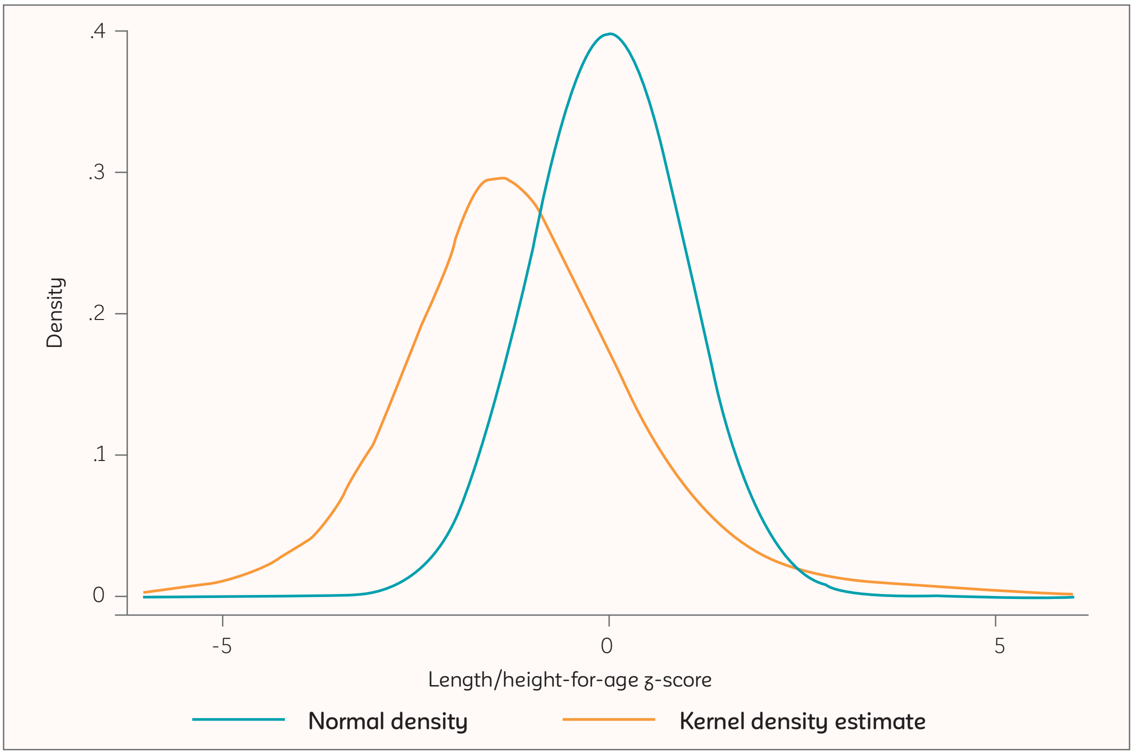
Notes: Kurtosis can be categorized as follows: [-0.2 > K < 0.2] – Excellent, [-0.4 > K <= -0.2] or [0.2 >= K < 0.4] – Good, [-0.6 > K <= -0.4] or [0.4 >= K < 0.6] – Acceptable, and beyond the range of [-0.6 > K < 0.6] - Problematic. Reference: SMART 2019 Sampling weights have not been used to construct this table. Flagged data are excluded.

Figure A13: Kernel density plot of weight-for-height *z*-score of children under 5 years, India, CNNS 2016–18



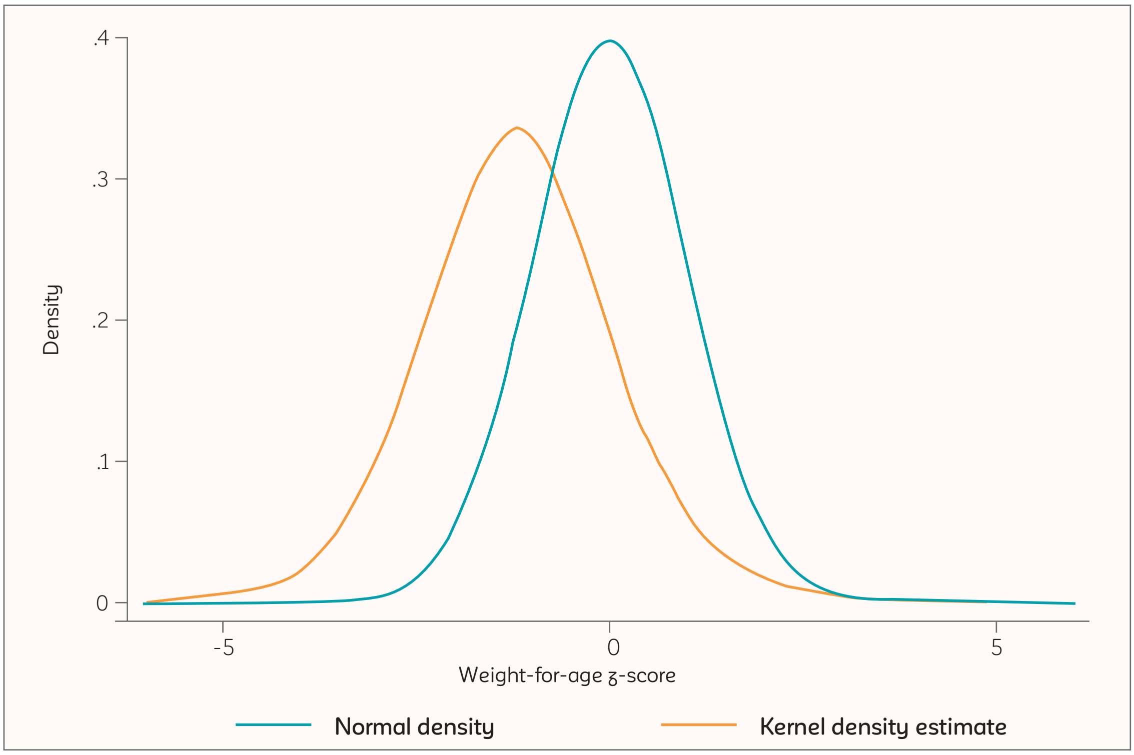
Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Figure A14: Kernel density plot of height-for-age *z*-score of children under 5 years, India, CNNS 2016–18



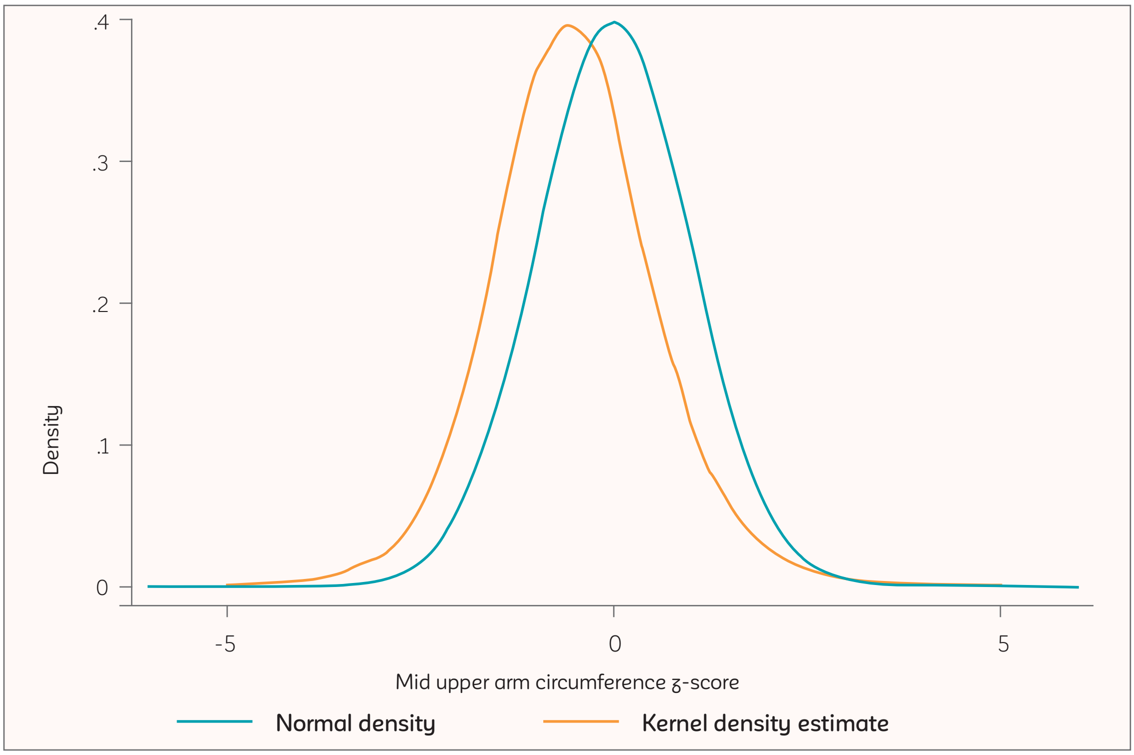
Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Figure A15: Kernel density plot of weight-for-age z-score of children under 5 years, India, CNNS 2016–18



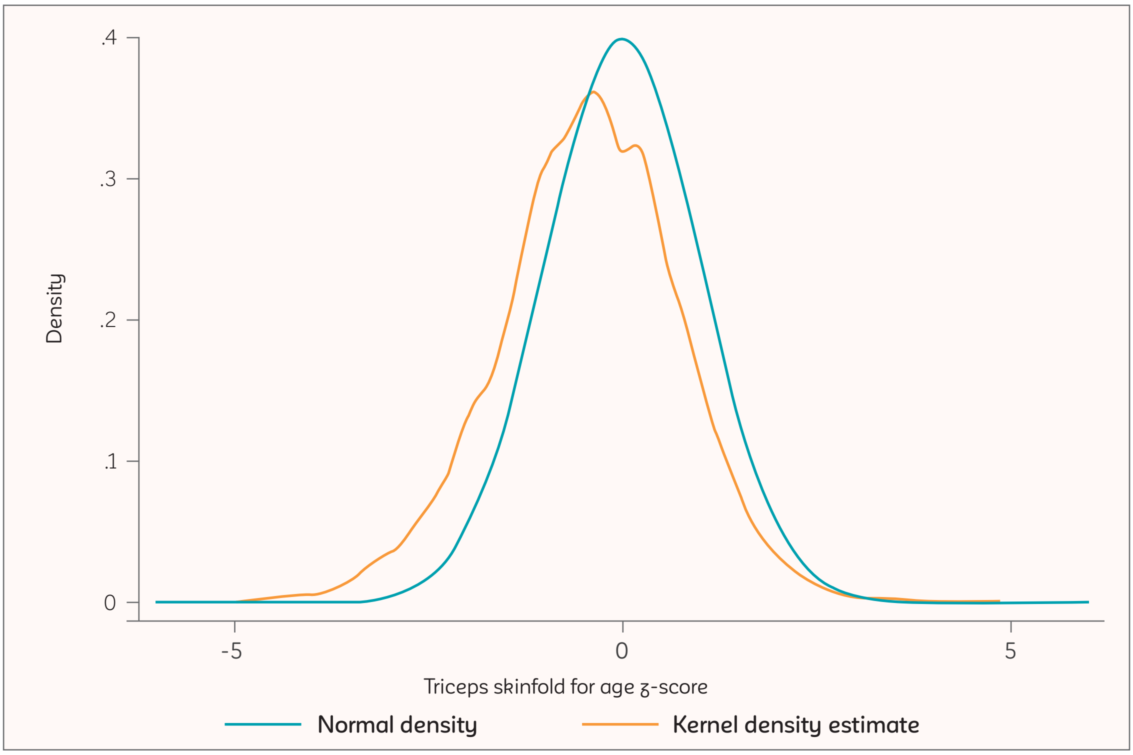
Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Figure A16: Kernel density plot of mid upper arm circumference z-score of children under 5 years, India, CNNS 2016–18



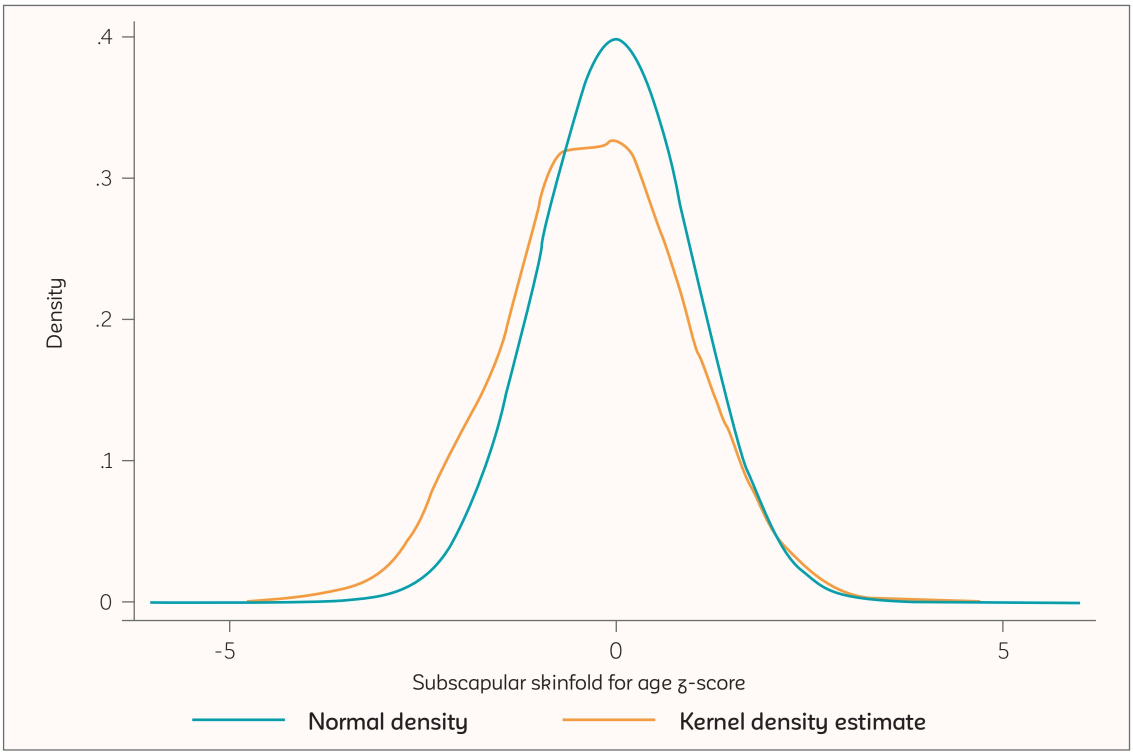
Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Figure A17: Kernel density plot of triceps skinfold for age z-score of children under 5 years, India, CNNS 2016–18



Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Figure A18: Kernel density plot of subscapular skinfold for age z-score of children under 5 years, India, CNNS 2016–18



Notes: Sampling weights have not been used in the analysis. Flagged data are excluded.

Table A16: Number of cases and proportions of mismatches between length/height measurement position and recommended position of children under 5 years old by state, India, CNNS 2016–18

State	Age Group	Expected Position	Total	Observed Mismatch	% Mismatch
India	**Total**		**34,717**	**4666**	**13.4**
India	0–11 months	Lying	6374	431	6.8
India	12–23 months	Lying	6766	3253	48.1
India	24–35 months	Standing	6959	685	9.8
India	36–47 months	Standing	7476	161	2.2
India	48–59 months	Standing	7142	136	1.9
Andhra Pradesh	Total		1164	131	11.3
Arunachal Pradesh	Total		1248	248	19.9
Assam	Total		1450	246	17.0
Bihar	Total		1367	169	12.4
Chhattisgarh	Total		1180	109	9.2
Goa	Total		1030	122	11.8
Gujarat	Total		1038	189	18.2
Haryana	Total		1069	147	13.8
Himachal Pradesh	Total		1171	200	17.1
Jammu and Kashmir	Total		1148	173	15.1
Jharkhand	Total		1184	153	12.9
Karnataka	Total		908	93	10.2
Kerala	Total		879	68	7.7
Madhya Pradesh	Total		1143	173	15.1
Maharashtra	Total		1909	144	7.5
Manipur	Total		1175	–	–
Meghalaya	Total		1075	190	17.7
Mizoram	Total		1009	–	–
Mizoram	Total		1009	163	16.2
Nagaland	Total		1175	170	14.5
NCT of Delhi	Total		1634	270	16.5
Odisha	Total		1297	64	4.9
Punjab	Total		996	99	9.9
Rajasthan	Total		1176	139	11.8
Sikkim	Total		1103	193	17.5
Tamil Nadu	Total		1850	294	15.9
Telangana	Total		1025	104	10.1
Uttar Pradesh	Total		1934	283	14.6
Uttarakhand	Total		1093	92	8.4
West Bengal	Total		1462	240	16.4

Notes: Number of children with missing information on measurement position is 2298. Information on measurement position is not available for Manipur and Tripura.

The total mismatch represents children under 24 months of age who were measured by standing height and children older than 23 months of age who were measured by recumbent length

Annex 2

CNNS Technical Advisory Group (TAG)

Chair:

1. Ms. Vandana Gurnani, IAS, Joint Secretary, MoHFW-GOI, New Delhi

Co-Chairs:

2. Dr. Ajay Khera, MoHFW-GOI, New Delhi
3. Dr. Arvind Pandey, NIMS-ICMR, New Delhi

Members:

Nutrition and Physiology

4. Dr. HPS Sachdev, Sitaram Bhartia Institute of Science and Research, New Delhi
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6. Dr. Umesh Kapil, AIIMS, New Delhi
7. Dr. Anura Kurpad, St. Johns Research Institute, Bangalore

Biochemistry and Laboratory

8. Dr. Lakshmy, AIIMS, New Delhi
9. Dr. Geeta Trilok Kumar, Delhi University, New Delhi
10. Dr. Madhavan Nair, NIN, Hyderabad

Sampling and Survey Methodology

11. Dr. TK Roy, Sampling expert, Former IIPS Director, Mumbai
12. Dr. Praween K. Agrawal, UNICEF, India Country Office, New Delhi
13. Dr. DCS Reddy, Former WHO Epidemiologist, Lucknow
14. Dr. Rajesh Kumar, PGIMER, Chandigarh
15. Shri O. P. Ghos, Director, NSSO, New Delhi

Parasitology

16. Dr. Gagandeep Kang, Christian Medical College, Vellore

Ministry and UNICEF representative

17. Mr. Arjan de Wagt, UNICEF, India Country Office, New Delhi
18. Mr. Robert Johnston, UNICEF, India Country Office, New Delhi
19. Dr. Jee Hyun Rah, UNICEF, India Country Office, New Delhi
20. Dr. Sila Deb, MoHFW, New Delhi
21. Representative from Ministry of Women and Child Development, New Delhi

List of agencies and key members involved in CNNS implementation

Name	Designation	Organization
Overall technical support, coordination and management		
Dr. Jee Hyun Rah	Ex-Nutrition Specialist	UNICEF, India Country Office, New Delhi
Mr. Robert Johnston	Nutrition Specialist	UNICEF, India Country Office, New Delhi
Dr. Praween K. Agrawal	M&E Specialist	UNICEF, India Country Office, New Delhi
Quality assurance and monitoring		
Dr. Donnie Whitehead	Laboratory Scientist	CDC Atlanta, USA
Dr. Pravin Kumar	Paediatrician	Kalawati Saran Hospital, New Delhi
Ms. Shaiphali Goel	Consultant	Kalawati Saran Hospital, New Delhi
Dr Manmeet Kaur	Professor	PGIMER, Chandigarh
Dr. Poonam Khanna	Assistant Professor	PGIMER, Chandigarh
Dr. Puneet Khanduja	Consultant	PGIMER, Chandigarh
Dr. Sucheta Banerjee Kurundkar	Director Training	Clinical Development Services Agency, Faridabad
Dr. Monika Bahl	Director Clinical Portfolio Management	Clinical Development Services Agency, Faridabad
Lead agency		
Dr. Avina Sarna	Ex-Country Director	Population Council
Dr. Niranjan Saggurti	Country Director	Population Council
Dr. Rajib Acharya	Associate	Population Council
Dr. Sowmya Ramesh	Senior Programme Officer	Population Council
Dr. Nizamuddin khan	Senior Programme Officer	Population Council
Dr. Supreet Kaur	Programme Officer	Population Council
Dr. Gopal Agrawal	Programme Officer	Population Council
Dr. Kakoli Borkotoky	Programme Officer	Population Council
Mr. Akash Porwal	Programme Officer	Population Council
Ms. Lopamudra Ray Saraswati,	Programme Officer	Population Council
Mr. Akash Mishra	Assistant Programme Officer	Population Council

Ms. Shefali Gupta	Programme Administrator	Population Council
Ms. Prepsa Saini	Consultant	Population Council
Laboratory		
Dr. Deepti Nariani	Technical Head- Key Accounts	SRL Limited, Gurgaon
Survey agencies		
Dr. R.B. Gupta	Head Social Division	GfK MODE, New Delhi
Dr. Dhirendra Kumar	Professor	IIHMR, Jaipur
Mr. Aariz Quraishi	Head, Operations	TNS Global, New Delhi
Mr. Surya, AV	Head, Operations	Kantar Public, New Delhi

The Comprehensive National Nutrition Survey

(CNNS) is the first ever national nutrition survey covering over 110,000 pre-schoolers, school-age children, and adolescents in rural and urban areas across 30 states of India.

The CNNS provides national and state level representative estimates from biological samples (blood, urine and stool) for micronutrient deficiencies and non-communicable diseases (NCDs) using best practices in training and field and gold standard laboratory methods.

The survey was conducted with generous financial support from

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