Largest Micronutrient Survey ever conducted: CNNS 2016-

112,316
Children and adolescents
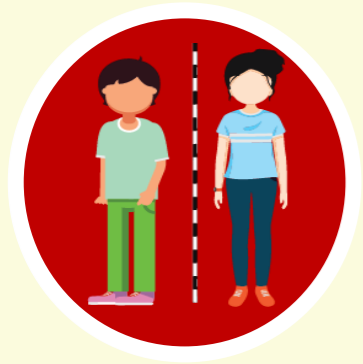interviewed

51,029
Blood, stool and urine
samples collected

360
Anthropometric
measurers

2500
Survey personnel
in 30 states

30
Microscopists

100
Data Quality
assurance monitors

200
Lab technicians

900
Interviewers

200
Trainers and
coordinators

360
Phlebotomists

Justification and Objectives

- To assess the prevalence of malnutrition in both children and adolescents with special focus on assessment of micronutrient deficiencies through biochemical measures.

- To identify determinants and associations of various risk factors for anaemia in both children and adolescents.

- To assess biomarkers for hypertension, diabetes, cholesterol and kidney function and their associations with various risk factors for Non-Communicable Diseases (NCDs).

Malnutrition is responsible for 68% of total under five mortality in India*

*Soumya Swaminathan, et al. (2019), The burden of child and maternal malnutrition and trends in its indicators in the states of India: the Global Burden of Disease Study 1990–2017. https://doi.org/10.1016/S2352-4642(19)30273-1

Birth to Adolescence

Survey Design

CNNS is a cross-sectional, household survey using a multi-stage sampling design.

CNNS covered **2035 Primary Sampling Units (PSUs)** from more than **82%** of all districts from the Census 2011 (516 out of 628 districts) across 30 states:
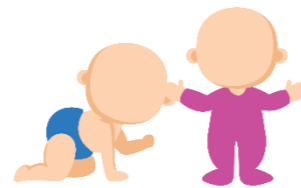
- 160 Districts- one PSU
- 356 Districts- two or more PSUs

● District with more than one PSU
● District with one PSU

Anthropometry data
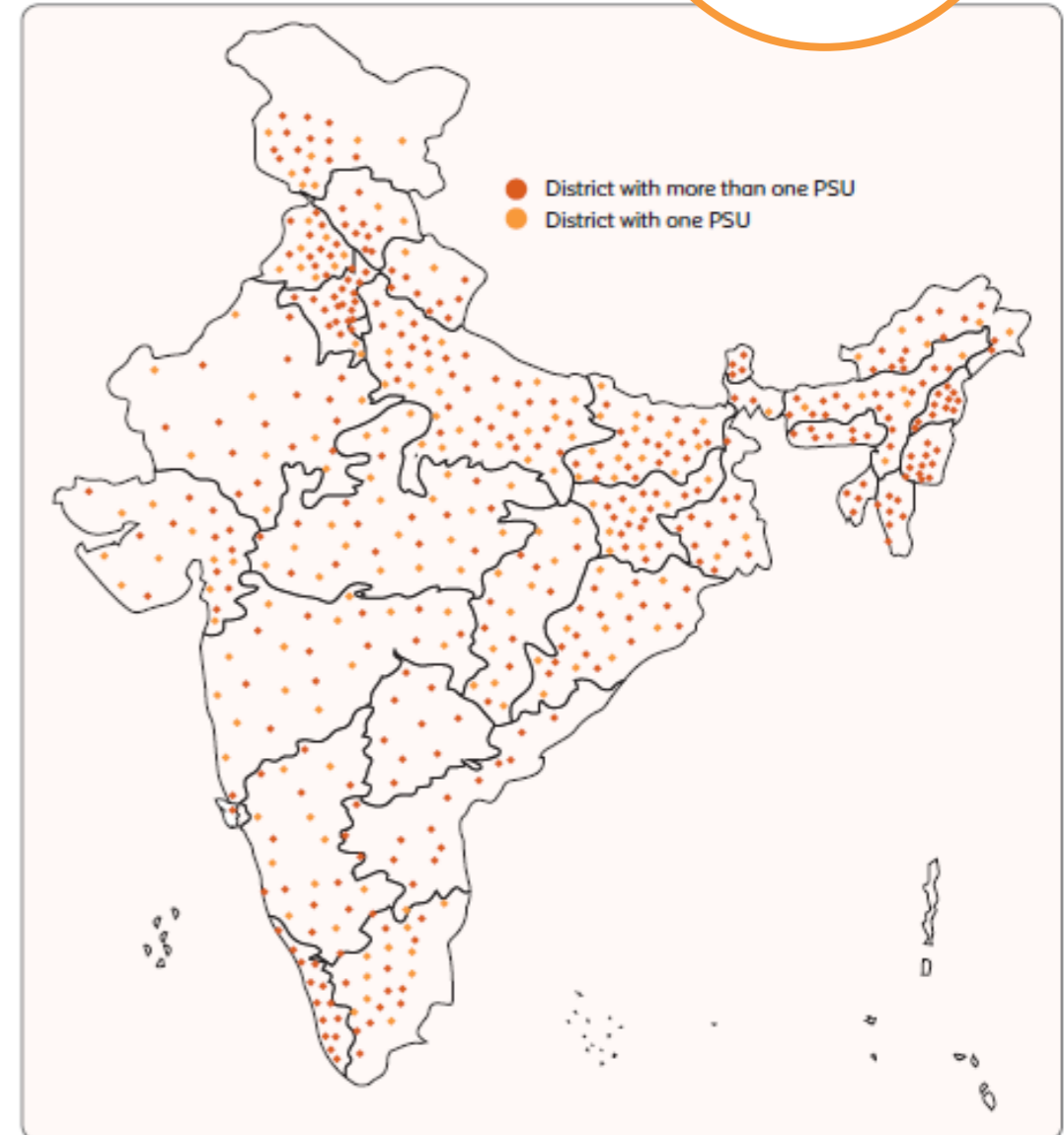
Anthropometric measurements	Pre-school children (0-4 years)	School-age children (5-9 years)	Adolescents (10-19 years)
	• Height • Weight • Mid-upper arm circumference (MUAC) • Triceps skinfold • Subscapular skinfold (1-4 years)		
		• Waist circumference	

CINS
Birth to Adolescence

Biochemical indicators - micronutrient deficiencies and NCDs

Indicator Group			
Anaemia and haemoglobinopathies	• Haemoglobin • Variant haemoglobins		
Inflammatory biomarkers	• C-reactive protein		
Protein	• Serum protein and albumin		
Micronutrients	• 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		
Non-communicable diseases		• Blood Pressure • Blood glucose, HbA1c • Lipid profile: Serum cholesterol, LDL, HDL, and triglycerides • Renal function: Serum creatinine, urinary protein creatinine ratio	

Monitoring and Supervision

Three-tiers of Data Quality Assurance

--- **Third Level**

- Field work/protocol/training monitoring: by quality control team
- Biological sample quality control : by AIIMS, NIN and US CDC

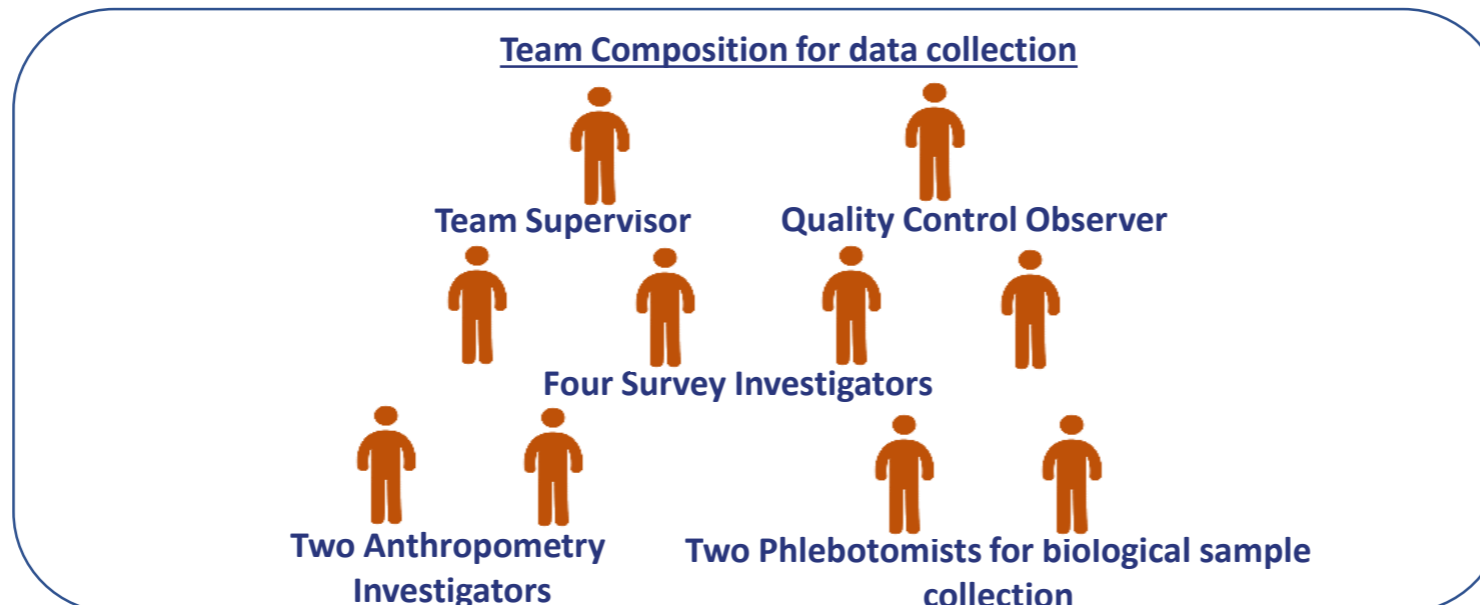--- **Second Level**

- 3-member Data Quality Assurance (DQA) team for re-interviews & observations
- Concurrent monitoring of biological sample collection, storage and transportation by CDSA

--- **First Level**

- Internal monitoring by the Quality Control Observer
- Daily supervision of the field work by Team Supervisor

Team Composition for data collection

Team Supervisor   **Quality Control Observer**

Four Survey Investigators

Two Anthropometry Investigators   **Two Phlebotomists for biological sample collection**

7

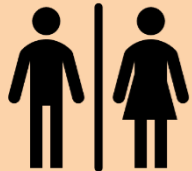# Quality Assurance Measures for Data Quality

Evaluation of Interviewers
prior to employment

Survey team
- Written and oral test
- Mock interview
- Ethics test

Anthropometry team
- Standardisation
- Selection based of demonstrated capacity measured by technical error of measurements (TEM)

Quality Assurance Measures

	DQA team conducted consistency checks, and provided feedback on real time basis
	No more than 4 interviews allowed in a day by an interviewer
	Daily SMS based monitoring/ alerts system for biological sample (from PSUs, collection points and reference labs).
	Sample transportation in thermal insulation bags maintaining temperature at 2-8° Celsius for up to 16 hours
	Time and temperature monitoring of samples by digital data loggers

Birth to Adolescence

Agencies engaged in the implementation of CNNS

Survey Implementation by MoHFW, Government of India and supported by UNICEF

Technical support:
US Centre for Disease Control
and UNICEF

Regular review and technical
guidance: Technical advisory group
constituted by MoHFW

Quality assurance and external
monitoring: AIIMS, PGIMER, NIN,
KSCH and CDSA

Overall field coordination, training, quality monitoring,
data management and analysis:
Population Council

Biological sample collection,
transportation & analysis:
SRL Limited

Survey and anthropometric data
collection: IIHMR, Kantar Public,
Gfk Mode and Sigma Consulting

Sample size in Uttar Pradesh

CNNS covered 105 PSUs for data collection in Uttar Pradesh

Achieved following sample size by age groups:

	0-4 years	5-9 years	10-19 years	Total
Household and anthropometry data	1,965	1,996	1,798	**5,759**
Biological sample	557	698	579	**1,834**

CNNS
Birth to Adolescence

Period of data collection in Uttar Pradesh

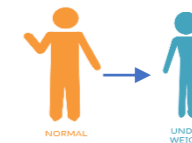**CNNS data collection period: April 6, 2016 to September 27, 2016**

- CNNS collected data during the summer through monsoon season of 2016

- NFHS collected data throughout the year of 2015 and followed to the next year, ended in the end of monsoon season of 2016

Survey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CNNS 2016				April to September, 2016								
NFHS 4 2015-16	January, 2015 to September, 2016											

CNNS
Birth to Adolescence

Some significant reduction in stunting, but no change in wasting and underweight in children under 5 years.

Legend: ■ NFHS ■ CNNS

	Stunting (Low height for age)	Wasting (Low weight for height)	Underweight (Low weight for age)
NFHS	46.2%	17.9%	39.5%
CNNS	38.8%	18.5%	36.8%

CNNS
Birth to Adolescence
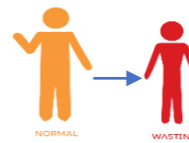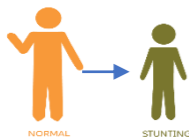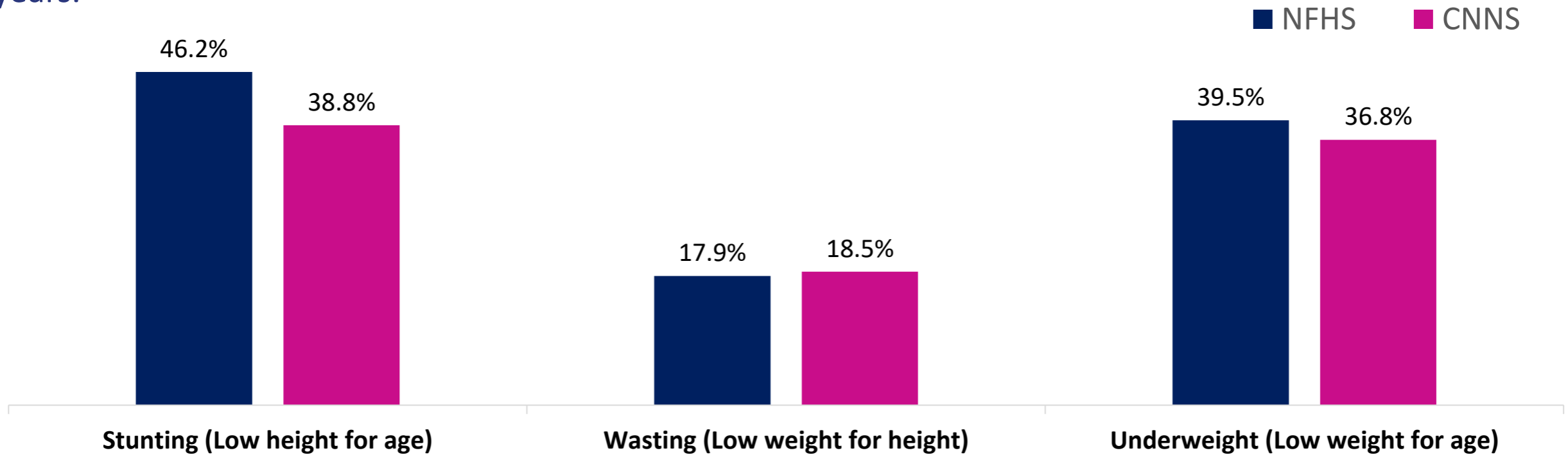
1/5 adolescents aged 10-19 years were thin for their age (BMI-Age <-2SD)

1/5 children aged 5-9 years were stunted. The school age period does not provide an opportunity for catch up growth in height.

2% of adolescents aged 15-19 years were overweight or obese.

2.3%

Overweight (high BMI for age)

NORMAL

OVERWEIGHT/ OBESITY

CNNS
Birth to Adolescence
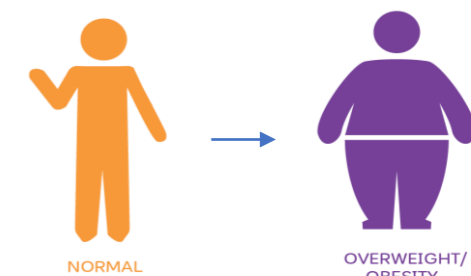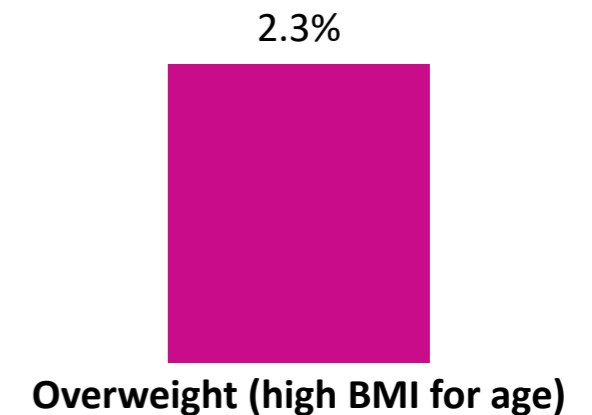
Stunting declined among children under five

Lower prevalence of stunting was observed in CNNS compared to NFHS-4 – **39%** vs **46%** in Uttar Pradesh

Stunting did not decline significantly in other central region states

Legend: ■ NFHS-4 ■ CNNS

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
NFHS-4	38.4	37.6	42.0	46.2
CNNS	34.7	35.4	39.5	38.8
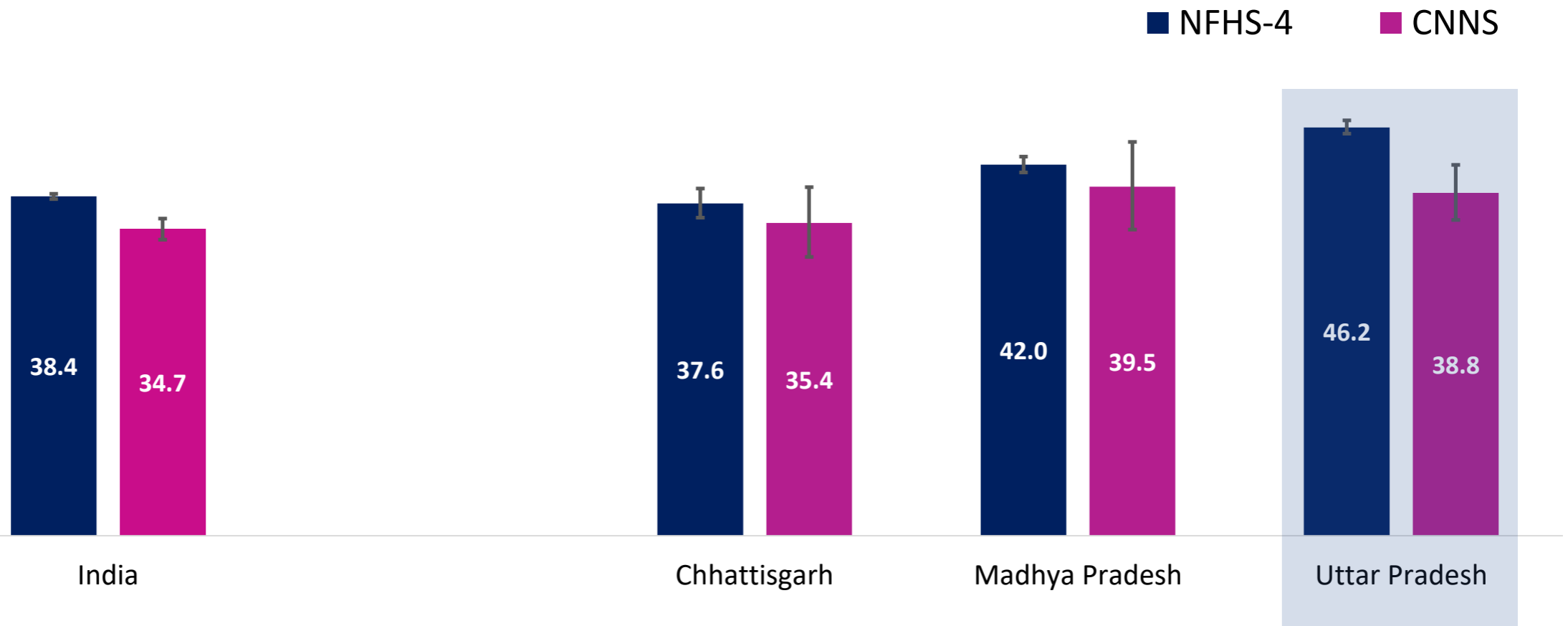
Wasting among children under five did not change

Prevalence of wasting unchanged in Uttar Pradesh between NFHS-4 and CNNS – **18%** vs **19%**

However, wasting declined significantly in Madhya Pradesh

■ NFHS-4 ■ CNNS

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
NFHS-4	21.0	23.1	25.8	17.9
CNNS	17.3	19.3	19.6	18.5

CNNS
Birth to Adolescence
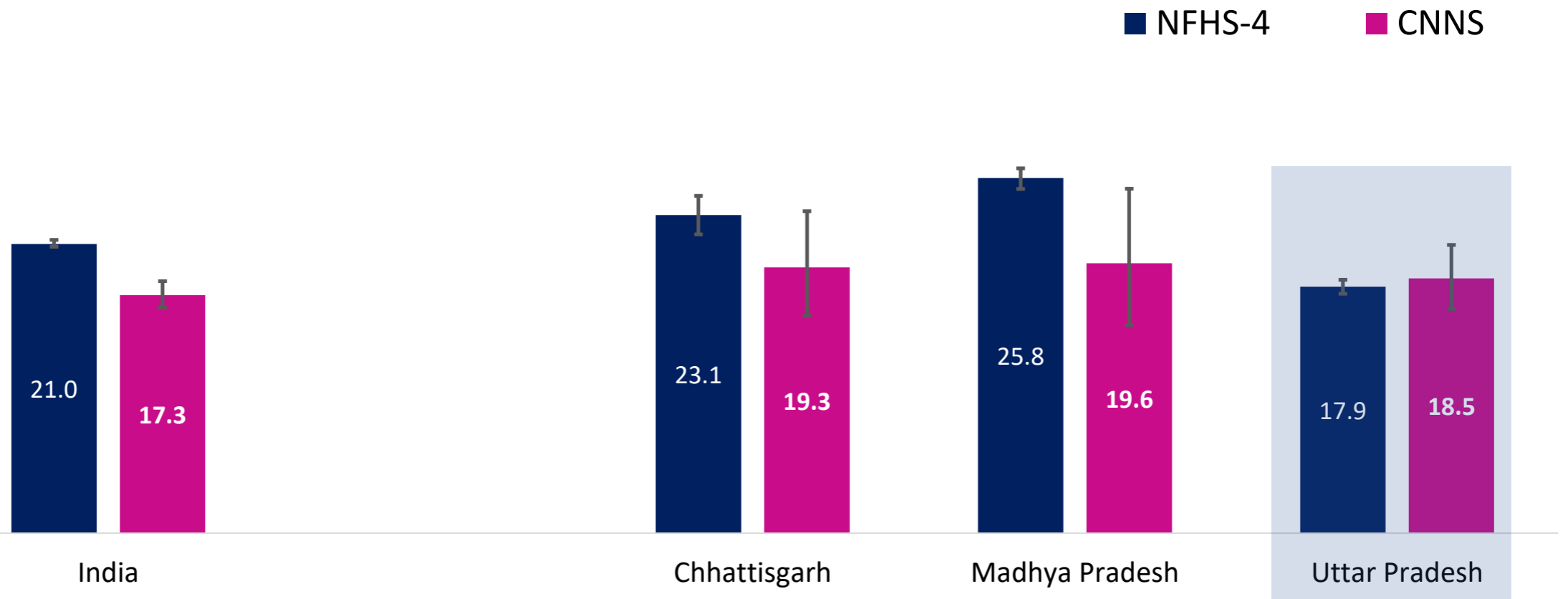
Underweight nearly unchanged among children under five
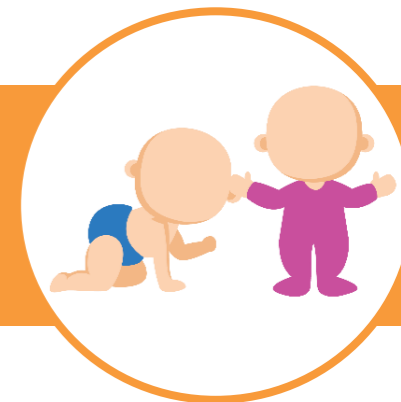
Underweight is a composite measure of chronic and acute malnutrition

The prevalence of underweight did not decline significantly between NFHS-4 and CNNS – **40% vs 37%**

Prevalence of underweight did not decline significantly in other central region states

■ NFHS-4 ■ CNNS

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
NFHS-4	35.7	37.7	42.8	39.5
CNNS	33.4	40.0	38.7	36.8

CNNS
Birth to Adolescence
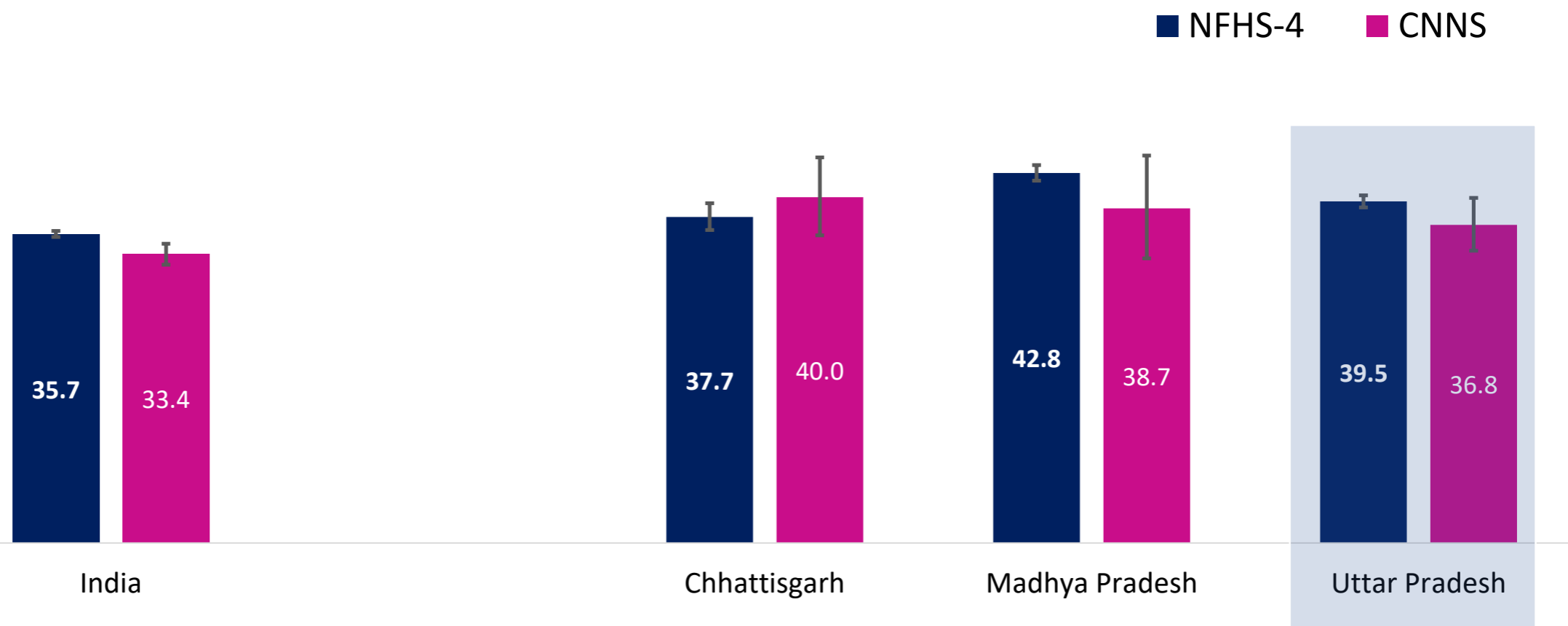
Triceps Skinfold Thickness (TSFT) for children under five

Low fat mass as reported by TSFT in Uttar Pradesh (**14%**) was significantly higher than national level and Madhya Pradesh (**10%**) but lower than Chhattisgarh (**16%**)

Legend: ▨ TSFT (-3SD to -2SD)   ■ TSFT (< -3SD)

Region	TSFT (-3SD to -2SD) total	TSFT (< -3SD)
India	9.7	2.4
Chhattisgarh	15.8	3.4
Madhya Pradesh	9.5	3.1
Uttar Pradesh	13.9	3.3

CNNS Birth to Adolescence
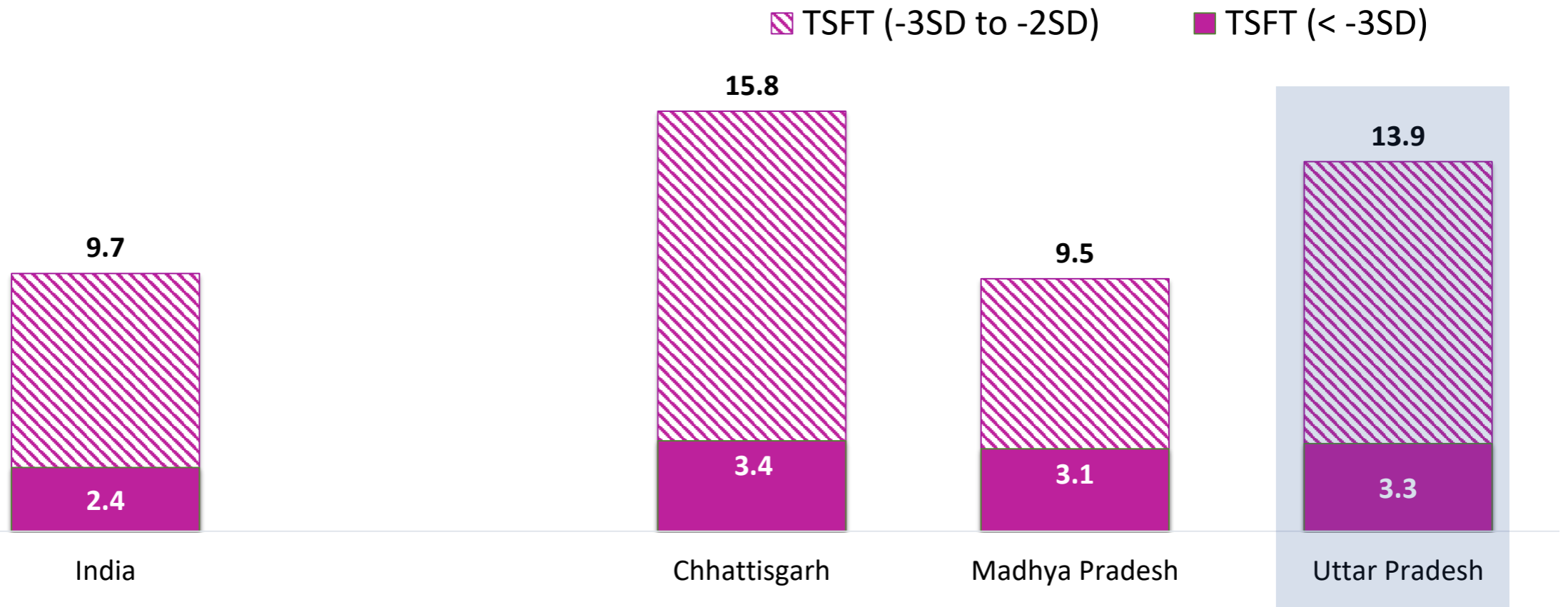
Subscapular Skinfold Thickness (SSFT) for children aged 1-4 years

Thinness as reported by SSFT in Uttar Pradesh (**10%**) was at about national level (**9%**) and lower than other central region states

Legend: ▨ SSFT (-3SD to -2SD)   ■ SSFT (< -3SD)

Region	SSFT (< -3SD)	Total
India	1.6	8.6
Chhattisgarh	1.9	11.6
Madhya Pradesh	3.8	13.5
Uttar Pradesh	2.1	10.2

CNNS
Birth to Adolescence
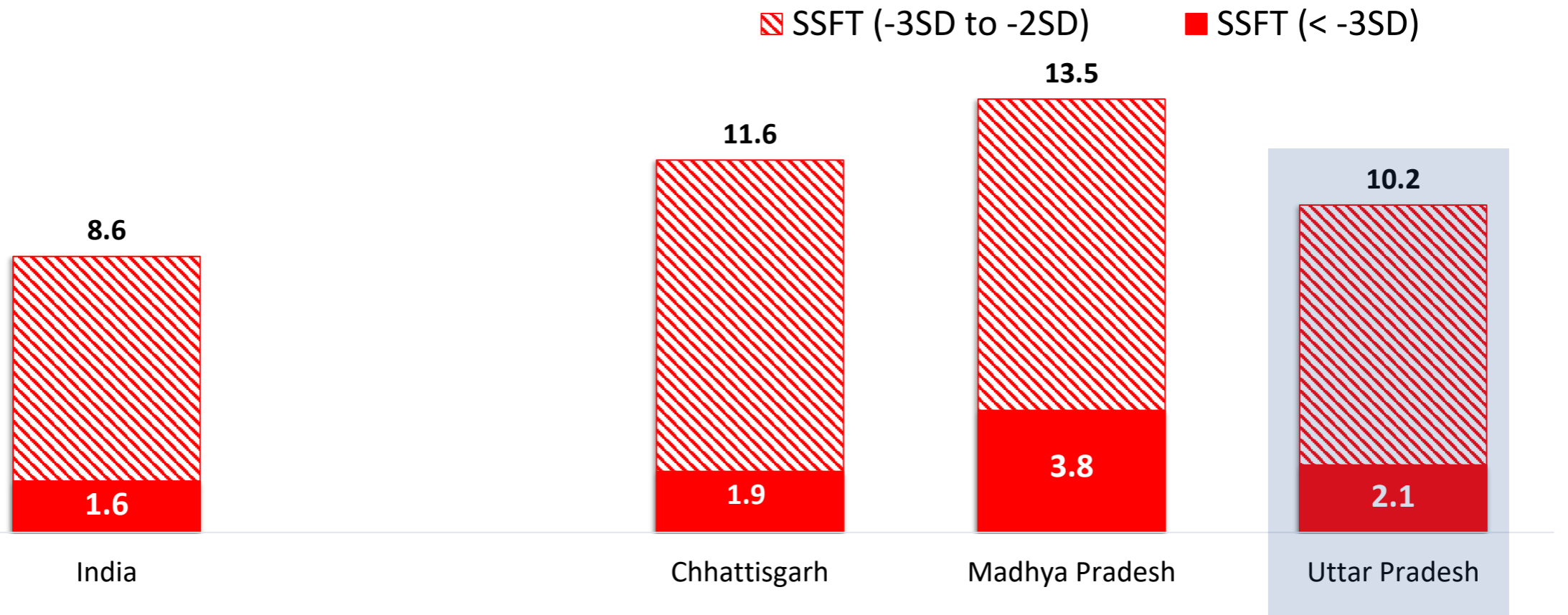
Mid Upper Arm Circumference (MUAC) for children aged 6-59 months

About **7%** children in Uttar Pradesh had low MUAC which is higher than national level (**5%**) and other central region states

Prevalence of low MUAC ranged between **4%** and **7%** across the central region states

⬚ MUAC (>=115mm & <125 mm)   ■ MUAC (<115 mm)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Total	4.9	3.8	5.9	6.7
MUAC (<115 mm)	0.9	0.2	1.3	0.9
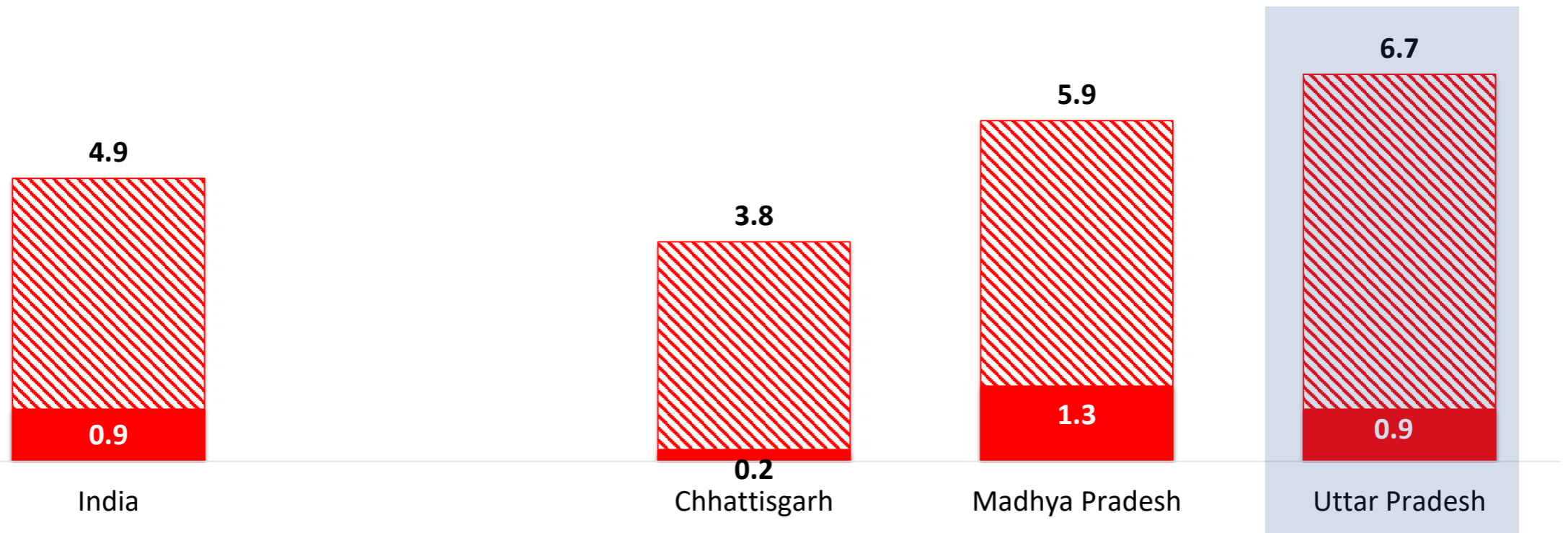
Stunting among school-age children (5-9 years)

1/5 of children aged 5-9 years was stunted; significant proportion of children who were stunted in childhood remained stunted into their schooling age reducing their potential capacity for education

Prevalence of stunting across the central region states and India were at similar level (**22%**)

Legend: ▨ Moderately stunted (-3SD to -2SD)   ■ Severely stunted (< -3SD)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Moderately stunted (top label)	21.9	21.0	21.1	21.2
Severely stunted	5.5	5.2	5.3	5.6

Birth to Adolescence
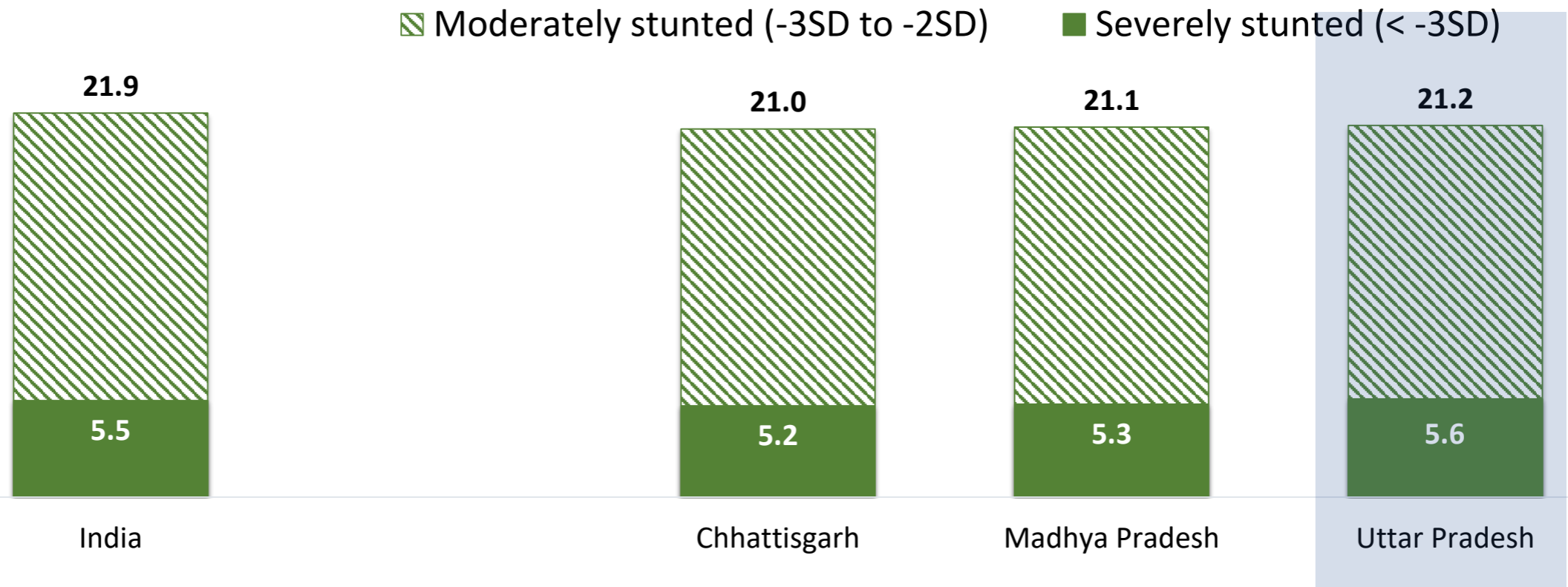
1/4 children aged 5-9 years was thin in Uttar Pradesh

Prevalence of thinness in Uttar Pradesh was slightly higher than national average and other central region states

Moderate thinness (-3SD to -2SD)   ■ Severe thinness (< -3SD)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Total	23.0	23.7	21.8	25.9
Severe thinness	4.9	5.9	5.3	4.8

Birth to Adolescence
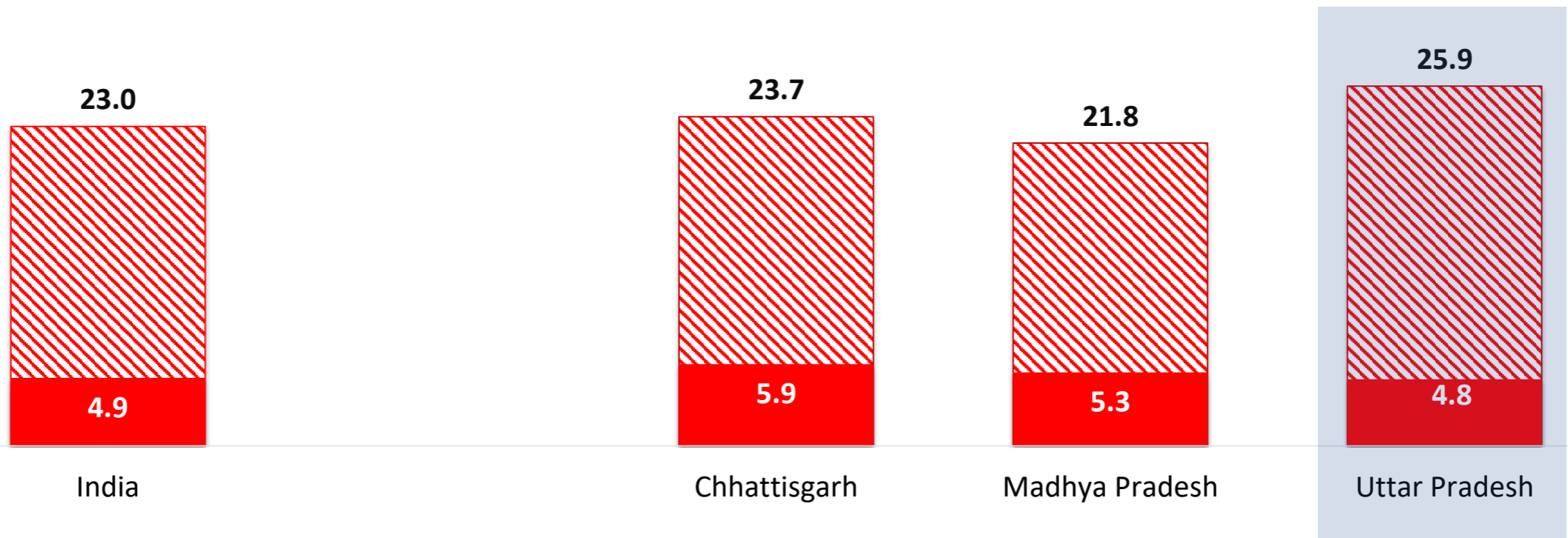
Overweight and obesity among school-age children (5- years) increasing

Overweight and obesity are on rise even among children aged 5-9 years

Prevalence of overweight in Uttar Pradesh (**2%**) was half of national level (**4%**)

Among central region states, prevalence of overweight in this age group falls in similar region (**1-2%**)

▨ Overweight (BMI +1SD to +2SD)   ■ Obese (BMI > +2SD)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Total	3.7	1.8	1.4	1.6
Obese	1.3	0.3	0.7	0.5

CNNS
Birth to Adolescence
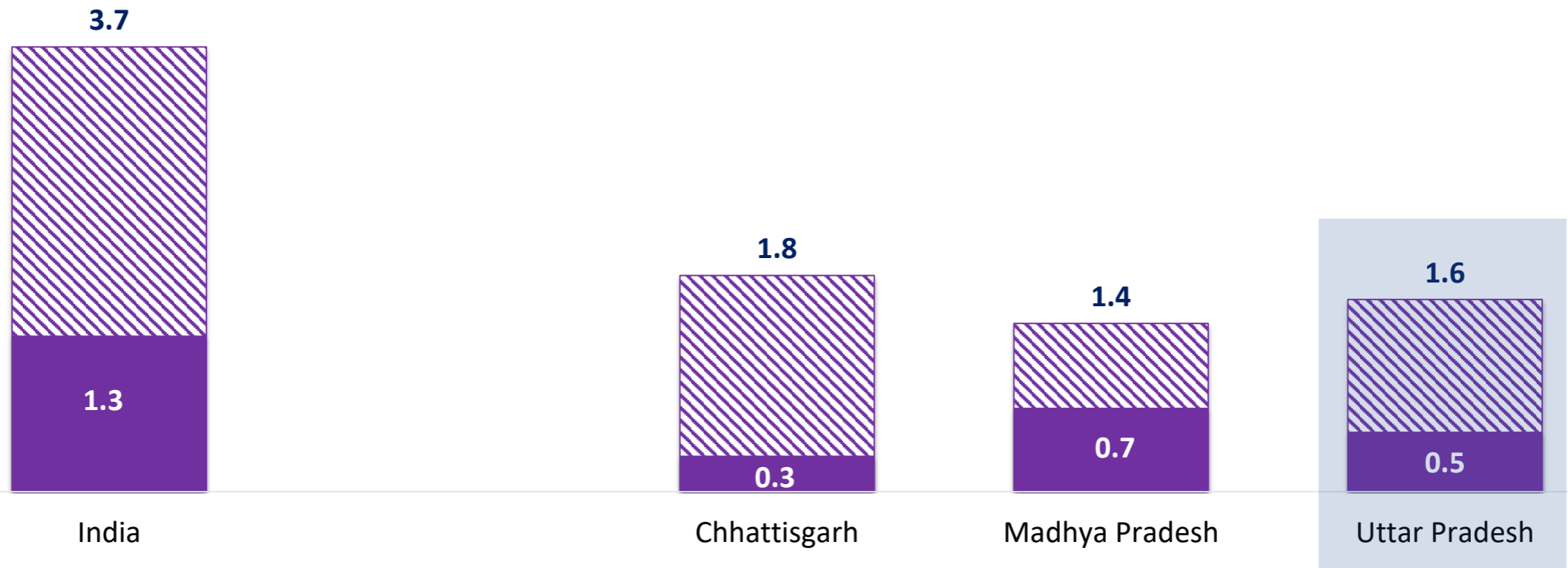
Thinness among adolescents aged 10-19 years substantially high

1/5 adolescents aged 10-19 years was thin in Uttar Pradesh (**22%**), slightly less than national average (**24%**)

Among the central states, Madhya Pradesh (**32%**) had very high prevalence of thinness

⬚ Moderate thinness (-3SD to -2SD)   ■ Severe thinness (< -3SD)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Total	24.1	18.3	31.9	22.4
Severe thinness	6.5	5.4	8.3	5.9

CNNS
Birth to Adolescence
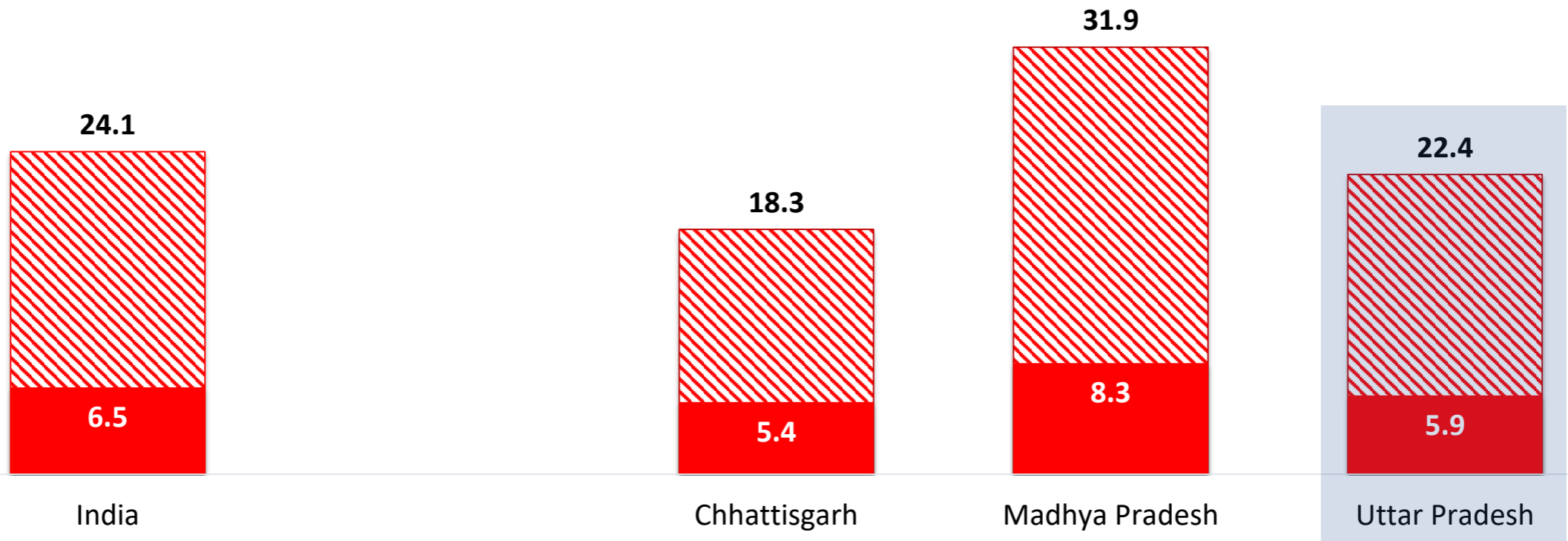
Prevalence of overweight among adolescents aged 10-19 years high

2% adolescents was overweight in Uttar Pradesh as compared to the national average of **5%**

Among the central region states, prevalence of overweight in Uttar Pradesh and Madhya Pradesh (**2%**) were at similar level and had highest prevalence in Chhattisgarh (**4%**)

Overweight (BMI +1SD to +2SD)　　Obese (BMI > +2SD)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Total	4.8	4.2	2.3	2.3
Obese	1.1	0.9	0.3	0.5

Birth to Adolescence
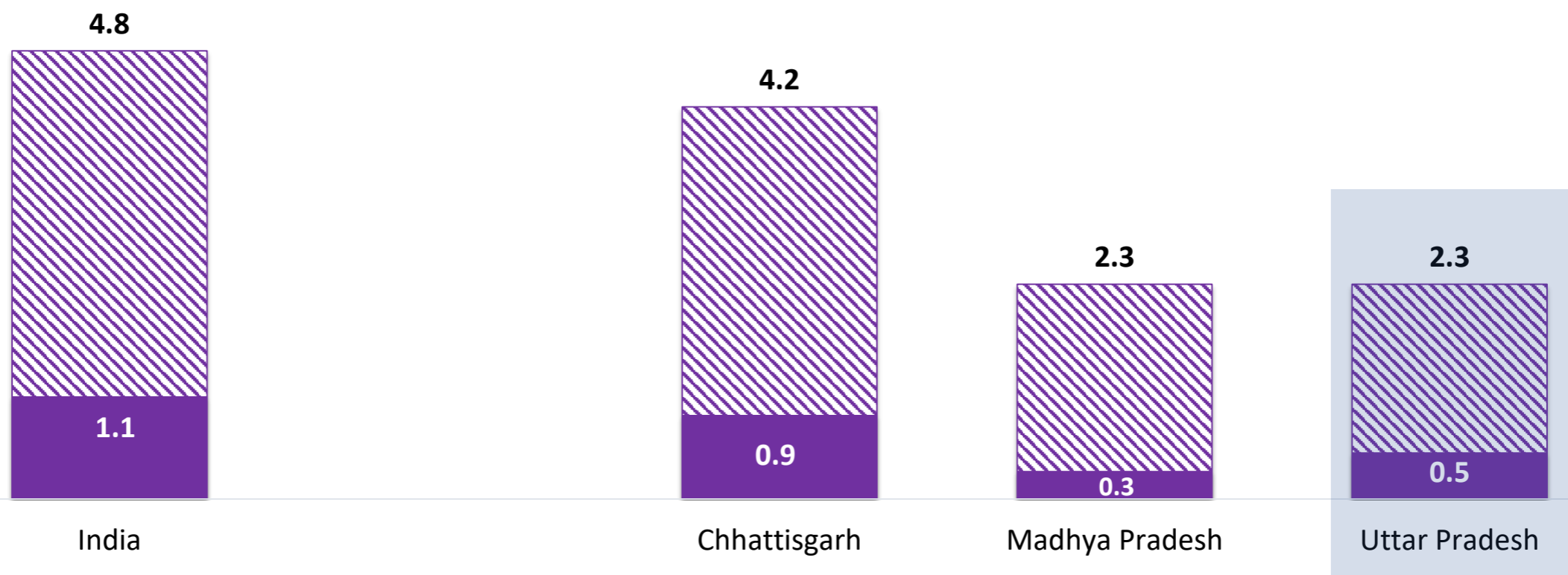
Uttar Pradesh key findings: Anaemia and iron deficiency

Anaemia

43.0
21.9
31.6
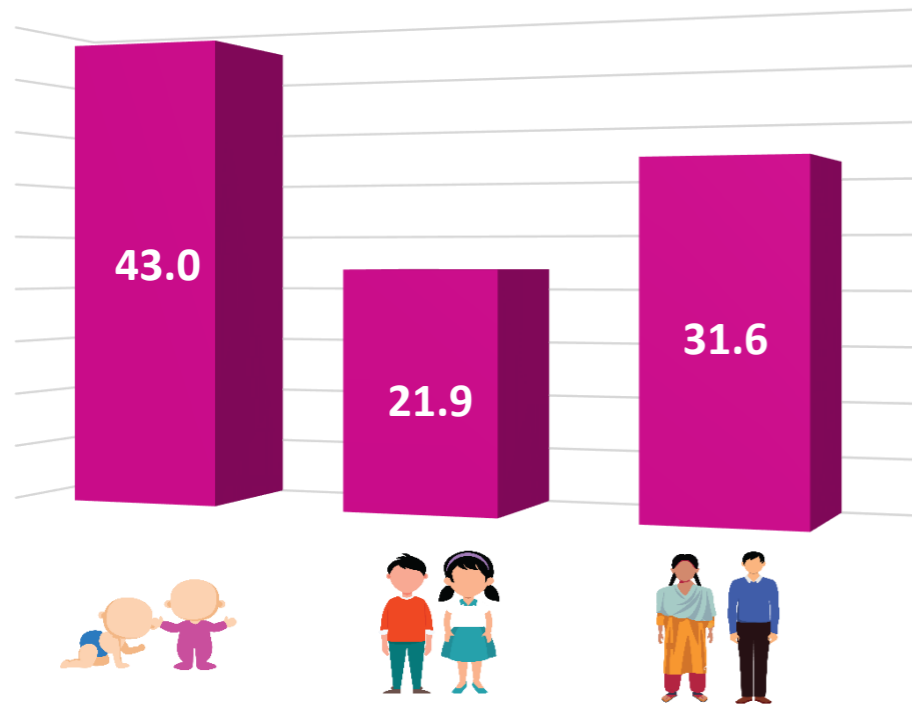
In Uttar Pradesh, like in most states, anaemia was significantly higher among children aged 1-4 years compared to children aged 5-9 years and adolescents aged 10-19 years

Iron deficiency

24%   9%   17%

Findings indicate that children aged 1-4 years had higher iron deficiency (measured by serum ferritin) than other children or adolescents

CNNS
Birth to Adolescence

Prevalence of Anaemia among children and adolescents

More than **2/5** children aged 1-4 years were anaemic in Uttar Pradesh (**43%**), higher than national average (**41%**)
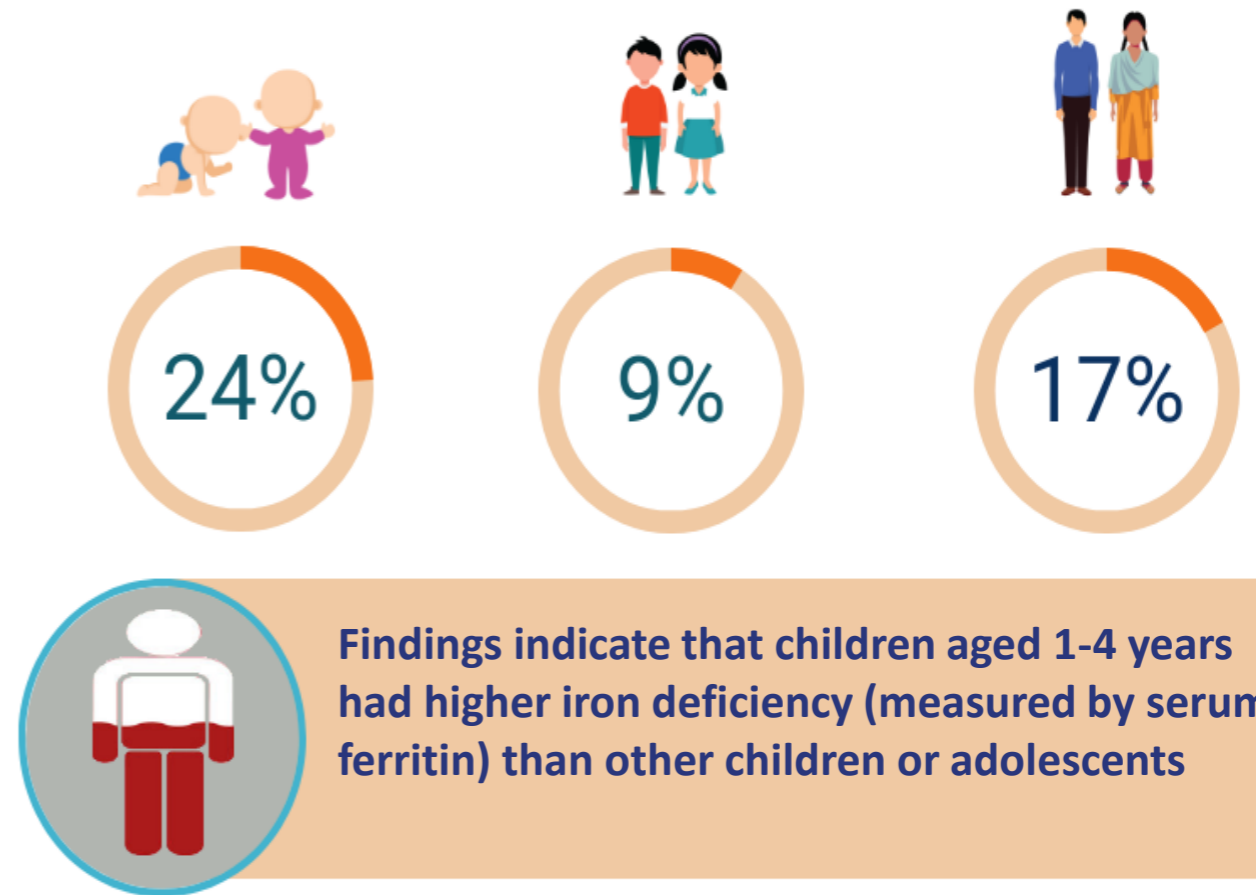
Prevalence of anaemia was highest among children aged 1-4 years, increased again in adolescence

Anaemia Cut Offs (WHO)
1-4 years: Hb<11.0 g/dl
5-11 years: Hb<11.5 g/dl
12-14 years: Hb< 12 g/dl
Girls ≥15years: Hb< 12g/dl
Boys ≥15 years: Hb< 13 g/dl
(Adjusted for altitude)

Legend: ■ 1-4 Years ■ 5-9 Years ■ 10-19 Years

India: 40.5, 23.5, 28.4
Chhattisgarh: 40.8, 28.9, 31.2
Madhya Pradesh: 53.5, 22.0, 21.2
Uttar Pradesh: 43.0, 21.9, 31.6

Birth to Adolescence
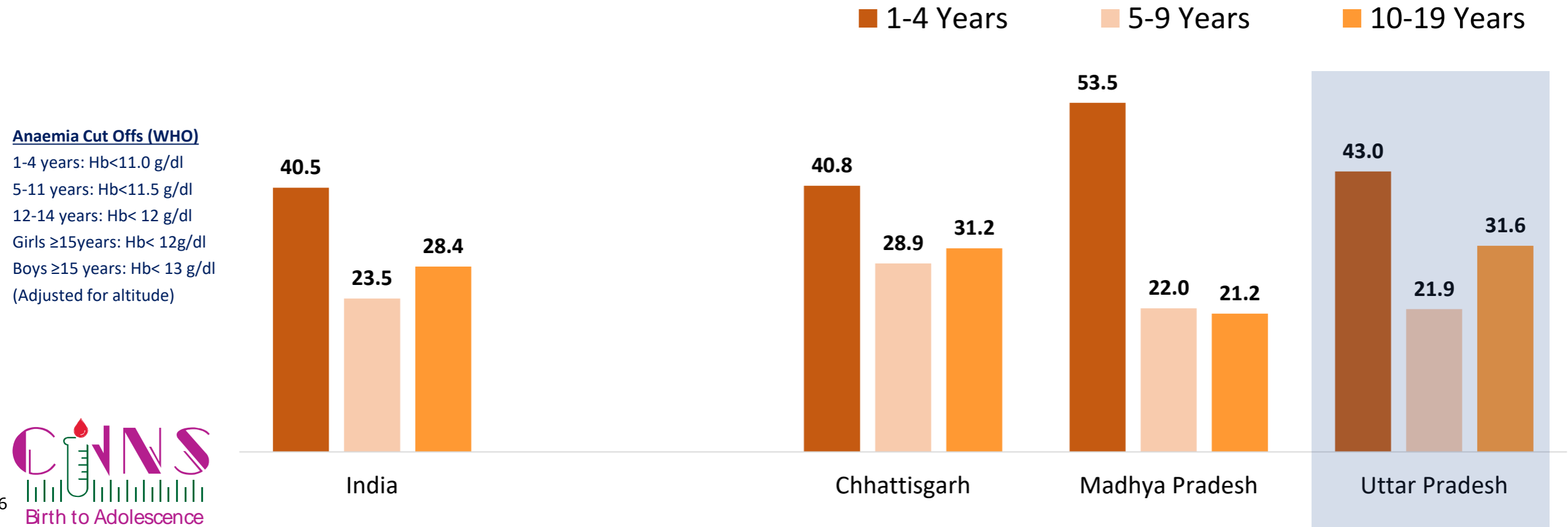
Prevalence of Anaemia among adolescents (10-19 years)

Overall, in the country, anaemia prevalence among adolescent girls (10-19 years) was twice that of adolescent boys

In Uttar Pradesh, as in many other central region states, adolescent girls were substantially higher than adolescent boys to be anaemic

■ Male ■ Female

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
Male	17.5	20.7	15.4	17.3
Female	39.6	41.6	28.7	44.8

CNNS
Birth to Adolescence
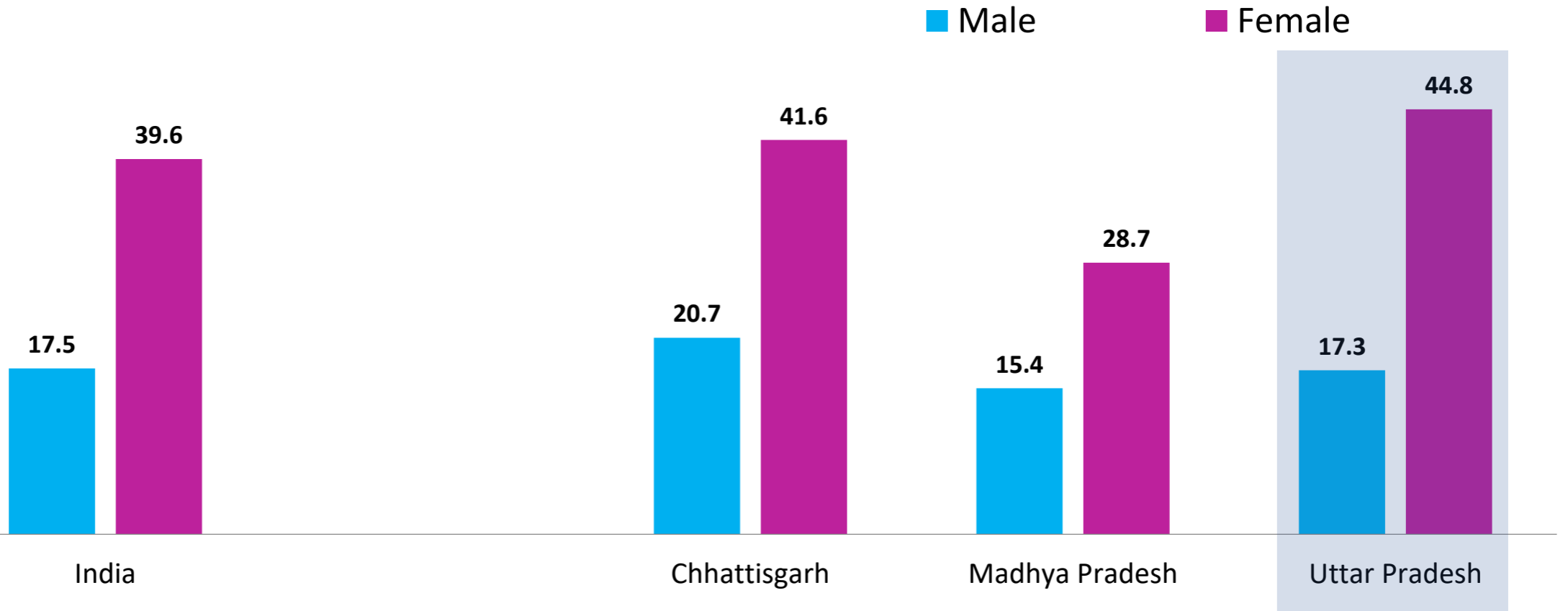
Iron deficiency measured by serum ferritin among children and adolescents

Almost **1/4** children aged 1-4 years had iron deficiency in Uttar Pradesh (**24%**), lower than the national average (**32%**); prevalence was highest among children aged 1-4 years

Among central region states, children and adolescents from Madhya Pradesh had highest prevalence of iron deficiency, followed by Chhattisgarh

■ 1-4 Years ■ 5-9 Years ■ 10-19 Years

Cut Offs (WHO)
1-4 years: SF <12 µg/l;
≥5 years: SF <15 µg/l
(high CRP excluded)

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
1-4 Years	31.9	38.5	45.9	23.9
5-9 Years	17.0	28.4	25.2	9.0
10-19 Years	21.5	31.3	22.1	17.2

Birth to Adolescence

Uttar Pradesh key findings: Vitamin A and Vitamin D deficiency

A

Vitamin A deficiency was higher (29%) in school-age children 5-9 years indicating the need for policy review

Children aged 1-4 years and adolescents were found to have similar levels of Vitamin A deficiency as children aged 5-9 years

D

Vitamin D deficiency ranged from 13% to 19% in 1-19 years age group as per cut off by expert panel of IOM.

Adolescents aged 10-19 years were found to have higher level of Vitamin D deficiency than children aged 1-9 years

CNNS
Birth to Adolescence

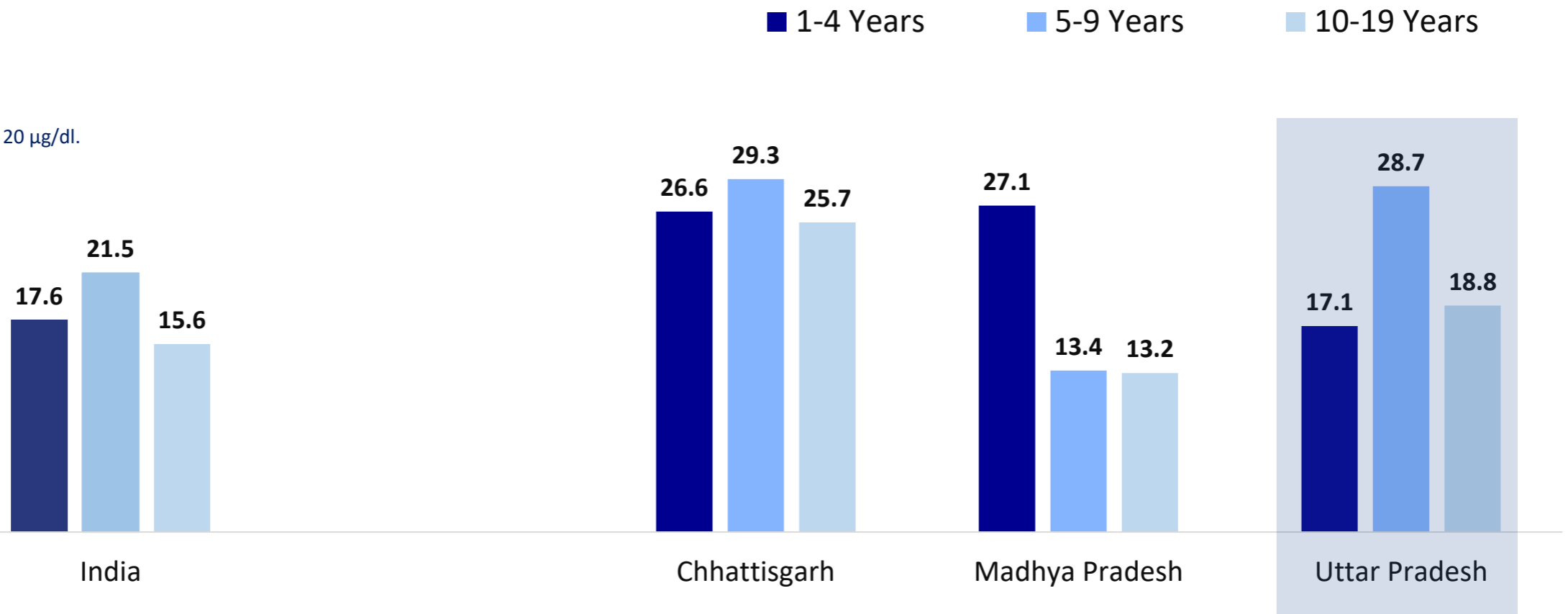# Vitamin A deficiency among children and adolescents

17-29% children and adolescents had Vitamin A deficiency in Uttar Pradesh, slightly higher than national average (**18-22%**)

Among central region states, prevalence of Vitamin A deficiency did not show any particular pattern

■ 1-4 Years ■ 5-9 Years ■ 10-19 Years

Cut Offs (WHO)
1-19 Years: Serum retinol < 20 µg/dl.
(High CRP excluded)

	1-4 Years	5-9 Years	10-19 Years
India	17.6	21.5	15.6
Chhattisgarh	26.6	29.3	25.7
Madhya Pradesh	27.1	13.4	13.2
Uttar Pradesh	17.1	28.7	18.8

Birth to Adolescence
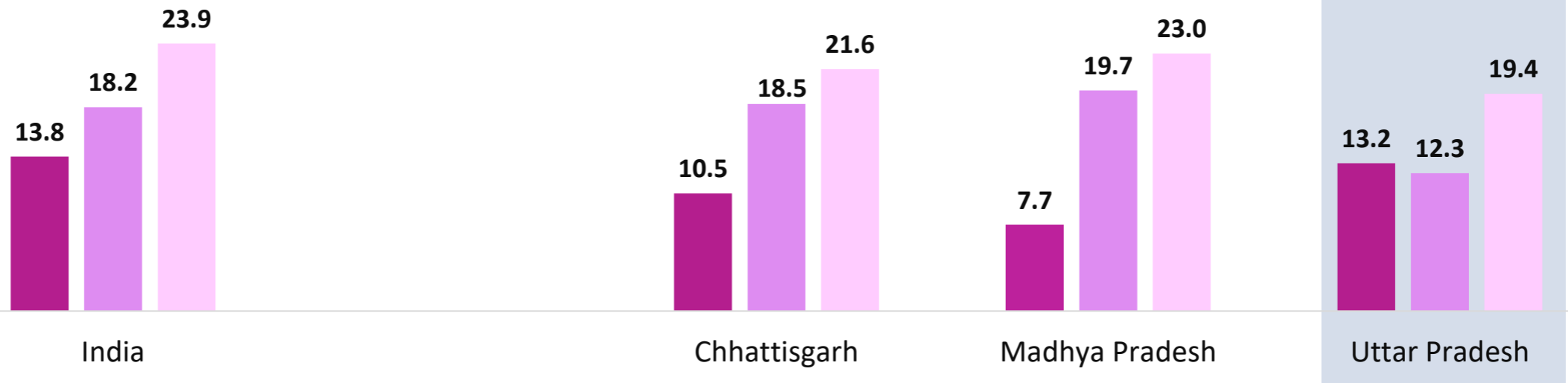
Vitamin D deficiency increases with age

12-19% children and adolescents had Vitamin D deficiency in Uttar Pradesh, lower than the national average (**14-24%**) ; Vitamin D deficiency increased with age

Among central region states, Vitamin D deficiency among children and adolescents shows similar pattern

■ 1-4 Years ■ 5-9 Years ■ 10-19 Years

Cut Off (IOM) Vit D Expert Panel :
Serum 25-hydroxy vitamin D <12 ng/ml

Bar chart:

Region	1-4 Years	5-9 Years	10-19 Years
India	13.8	18.2	23.9
Chhattisgarh	10.5	18.5	21.6
Madhya Pradesh	7.7	19.7	23.0
Uttar Pradesh	13.2	12.3	19.4

CiNNS
Birth to Adolescence

Uttar Pradesh key findings: Non-communicable diseases

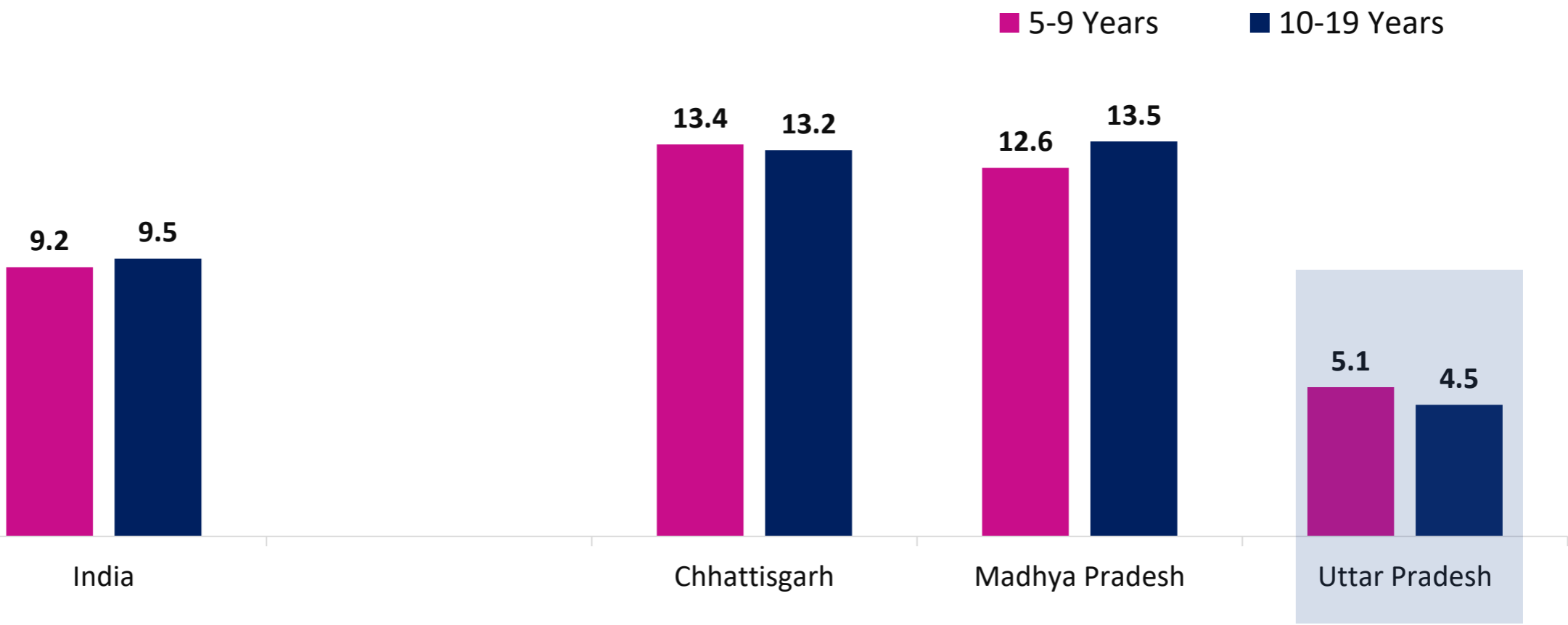**1/20** school-age children and adolescents were found with high level of glycosylated haemoglobin (HbA1c).

Other indicators of risks of NCDs, such as level of cholesterol, triglycerides, LDL and HDL point to increased risks of NCDs among adolescents.

Birth to Adolescence

Risk of diabetes among school-age children and adolescents

Based on Glycosylated hemoglobin (HbA1c), **1/20** children and adolescents had increased risk of diabetes in Uttar Pradesh, half the national average

Among all central region states, risk of diabetes was the lowest in Uttar Pradesh

Legend: ■ 5-9 Years ■ 10-19 Years

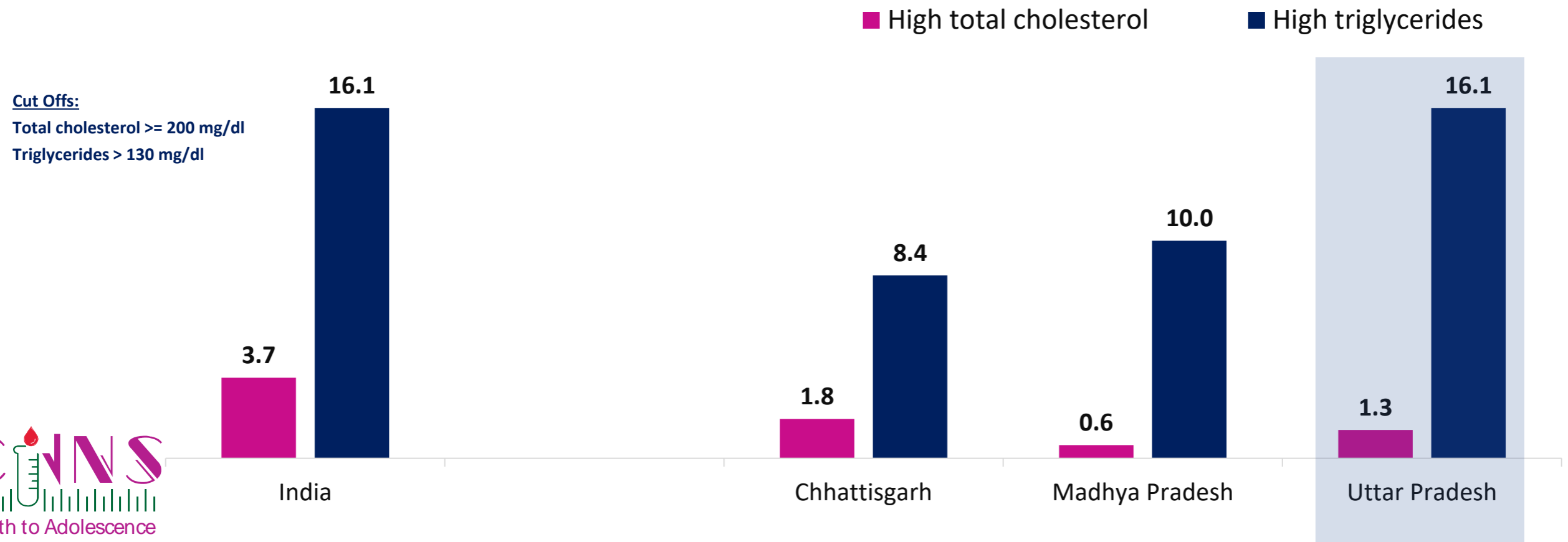|	5-9 Years	10-19 Years
India	9.2	9.5
Chhattisgarh	13.4	13.2
Madhya Pradesh	12.6	13.5
Uttar Pradesh	5.1	4.5

CNNS
Birth to Adolescence

High total cholesterol and high triglycerides among adolescents

Elevated risk of NCDs in Uttar Pradesh among adolescents – **1%** had high level of total cholesterol and **16%** with high level of triglycerides

Prevalence of high total cholesterol were low and that of high triglycerides was high in central region states

■ High total cholesterol ■ High triglycerides

Cut Offs:
Total cholesterol >= 200 mg/dl
Triglycerides > 130 mg/dl

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
High total cholesterol	3.7	1.8	0.6	1.3
High triglycerides	16.1	8.4	10.0	16.1

CNNS
Birth to Adolescence

High LDL and low HDL among adolescents

Risk of NCDs among adolescents in Uttar Pradesh was high – **2%** had high level of LDL and **40%** had low level of HDL

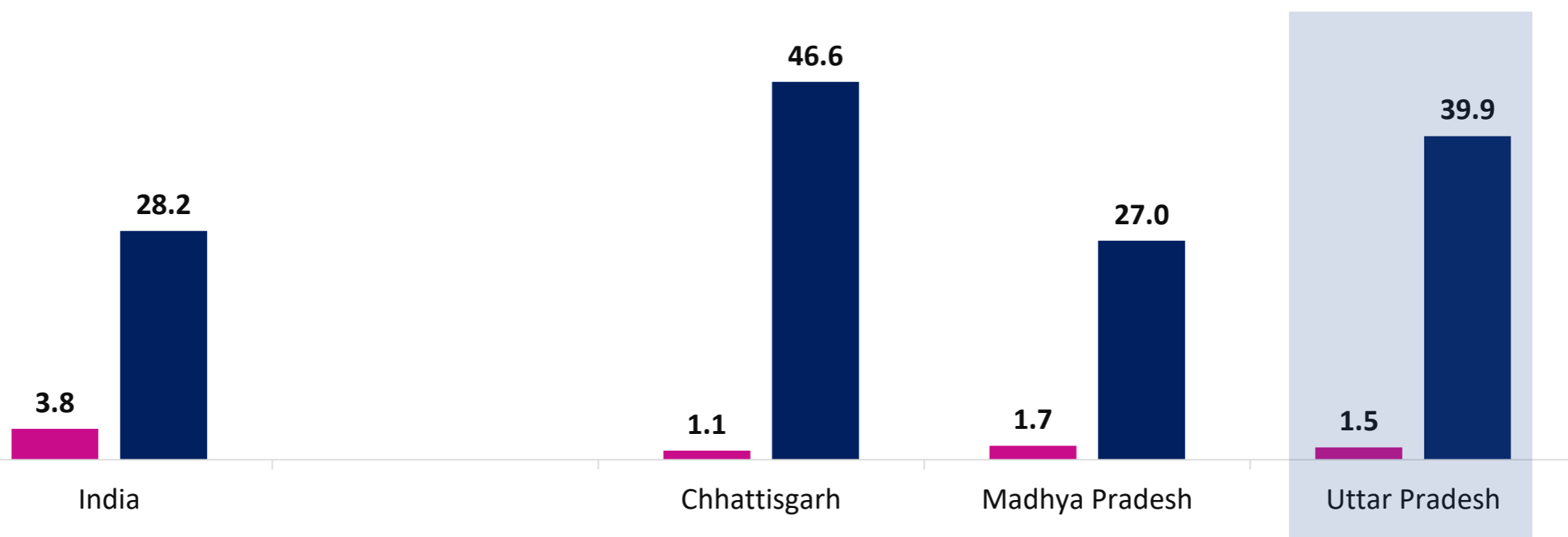Among the central region states, prevalence of low HDL was substantially high

Cut Offs:
LDL >= 130 mg/dl
HDL < 40 mg/dl

Legend: ■ High LDL ■ Low HDL

	India	Chhattisgarh	Madhya Pradesh	Uttar Pradesh
High LDL	3.8	1.1	1.7	1.5
Low HDL	28.2	46.6	27.0	39.9

Preliminary Policy Discussions from CNNS

- Only about half of anaemia is caused by iron deficiency. Programmes must address all causes of anaemia but continue to address iron deficiency in children under five and adolescent girls (population with largest burden).

- Vitamin A deficiency is less prevalent than expected. Policy review is warranted. Interventions such as dietary diversification and fortification can be taken to scale to address the remaining burden.

- Vitamin D deficiency is an emerging public health issue among urban children and adolescents. Scaling up of fortification efforts can be considered. Further research is required to uncover the effects of pollution and other factors to design better programmes.

- Urinary Iodine data need to be examined in conjunction with salt consumption data for the population and level of iodine in salt at the household level.

- Control of NCDs such as diabetes and cardiovascular disease must start in the early ages to instil lifelong healthy habits as adult diseases start in childhood.

CNNS
Birth to Adolescence

The survey was conducted with generous financial support from

Aditya and Megha Mittal

and technical support from