Largest Micronutrient Survey ever conducted: CNNS 2016-

112,316
Children and adolescents interviewed
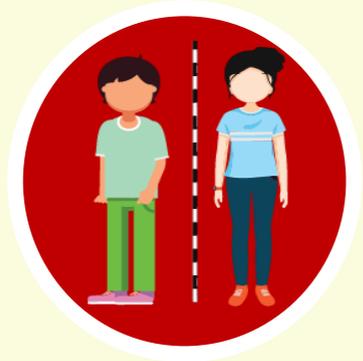
51,029
Blood, stool and urine samples collected

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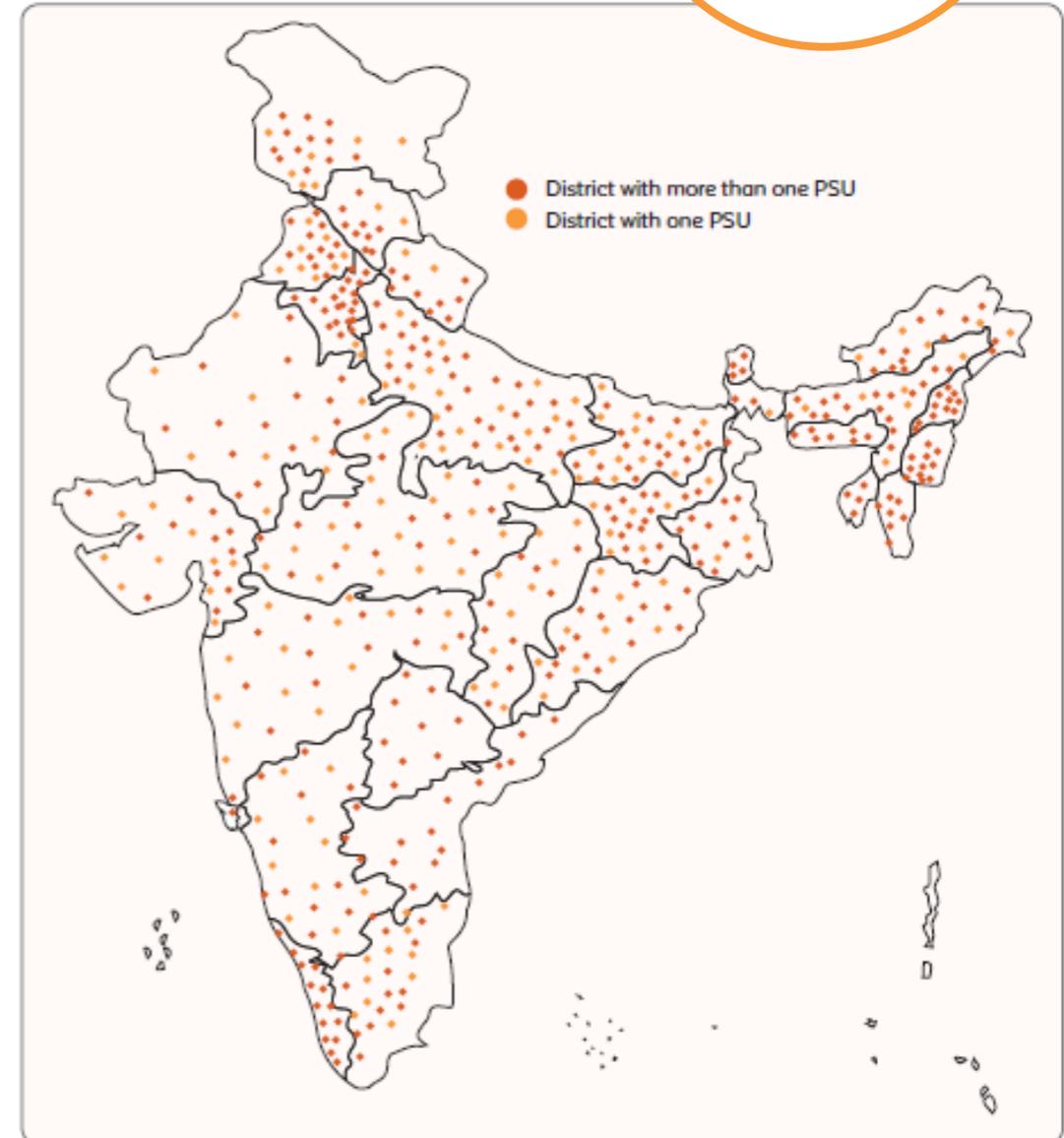
Anthropometric measurements	Pre-school children (0-4 years)	School-age children (5-9 years)	Adolescents (10-19 years)
	• Height • Weight • Mid-upper arm circumference (MUAC) • Triceps skinfold • Subscapular skinfold (1-4 years)		
		• Waist circumference	
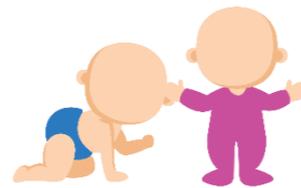
Birth to Adolescence

Biochemical indicators - micronutrient deficiencies and NCDs

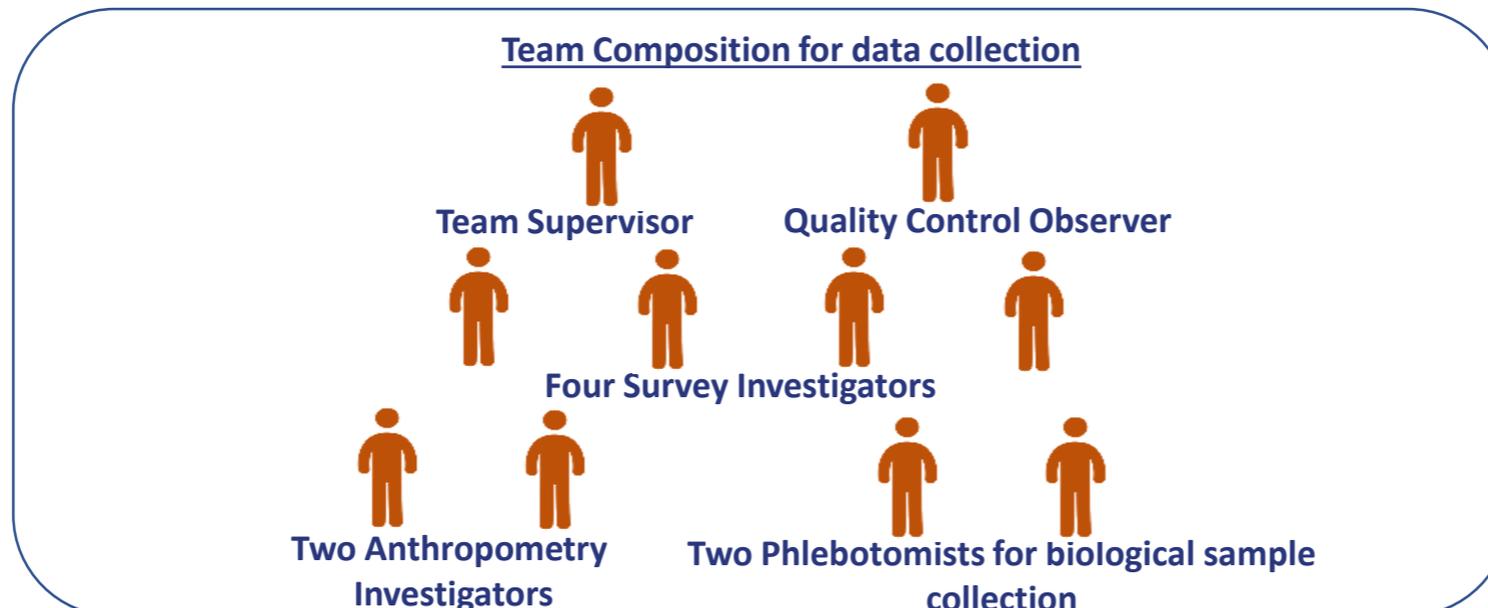| Indicator Group			
Anaemia and haemoglobinopathies	• Haemoglobin • Variant haemoglobins		
Inflammatory biomarkers	• C-reactive protein		
Protein	• Serum protein and albumin		
Micronutrients	• Iron: Serum ferritin, serum transferrin receptor • Vitamin A: Serum retinol • Zinc: Serum zinc • B-vitamins: 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

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

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

- 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**

CNNS
Birth to Adolescence

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

CNNS
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 West

CNNS covered 110 PSUs for data collection in West Bengal

Achieved following sample size by age groups:

	0-4 years	5-9 years	10-19 years	Total
Household and anthropometry data	1,777	1,808	1,472	**5,057**
Biological sample	1,047	929	756	**2,732**

Birth to Adolescence

Period of data collection in West Bengal

CNNS data collection period: June 1, 2018 to October 24, 2018
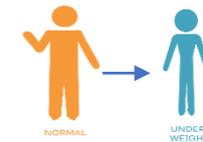
- CNNS collected data during the rainy season through early autumn season of 2018

- NFHS-4 collected data during the spring season through rainy season of 2015.

Survey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CNNS 2018						June 1 to October 24, 2018						
NFHS 4 2015		February to July, 2015										

CNNS
Birth to Adolescence

Significant decline in stunting but no change in wasting and underweight in children under 5 years

Legend: ■ NFHS-4   ■ CNNS

- Stunting (Low height for age): NFHS-4 32.5%, CNNS 25.3%
- Wasting (Low weight for height): NFHS-4 20.3%, CNNS 20.1%
- Underweight (Low weight for age): NFHS-4 31.5%, CNNS 30.9%

CNNS
Birth to Adolescence
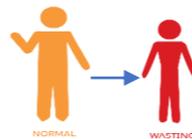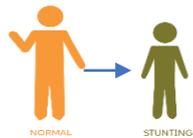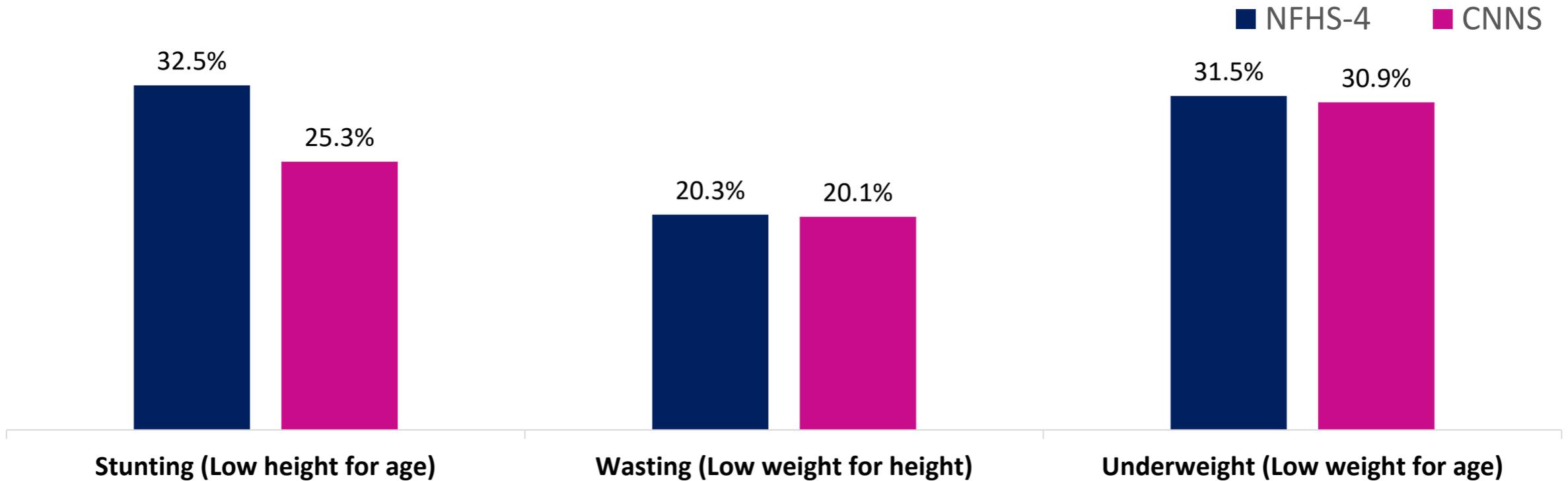
1/4 adolescents aged 10-19 years was thin for their age (BMI-Age <-2SD)

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

8% of adolescents aged 10-19 years were overweight or obese.

7.7%

Overweight (high BMI for age)

NORMAL

OVERWEIGHT/
OBESITY

Birth to Adolescence
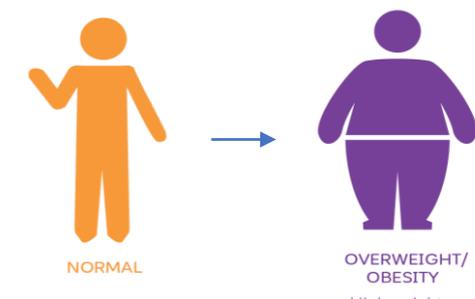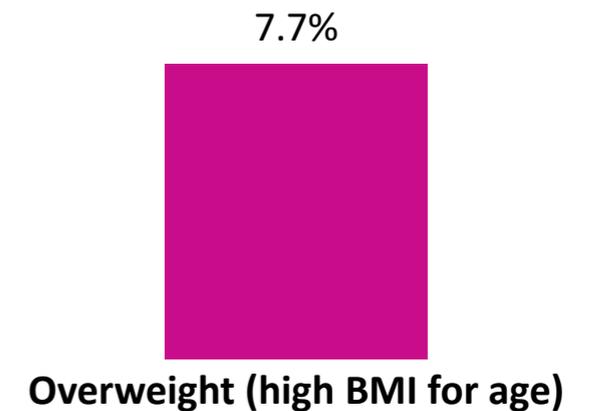
Stunting declined among children under five
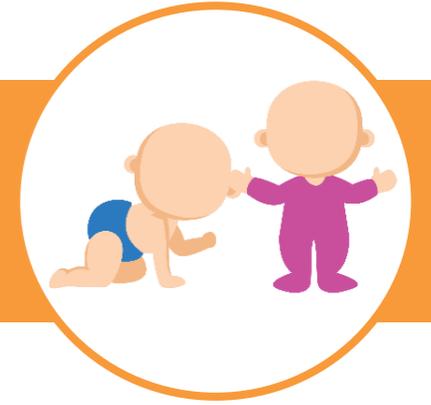
Decline in stunting was observed in West Bengal in CNNS compared to NFHS-4 – **25%** vs **33%**

Significant decline in stunting was observed in all eastern region states, except Odisha

Legend: ■ NFHS-4   ■ CNNS

	NFHS-4	CNNS
India	38.4	34.7
Bihar	48.3	42.0
Jharkhand	45.3	36.2
Odisha	34.1	29.1
West Bengal	32.5	25.3

CNNS
Birth to Adolescence
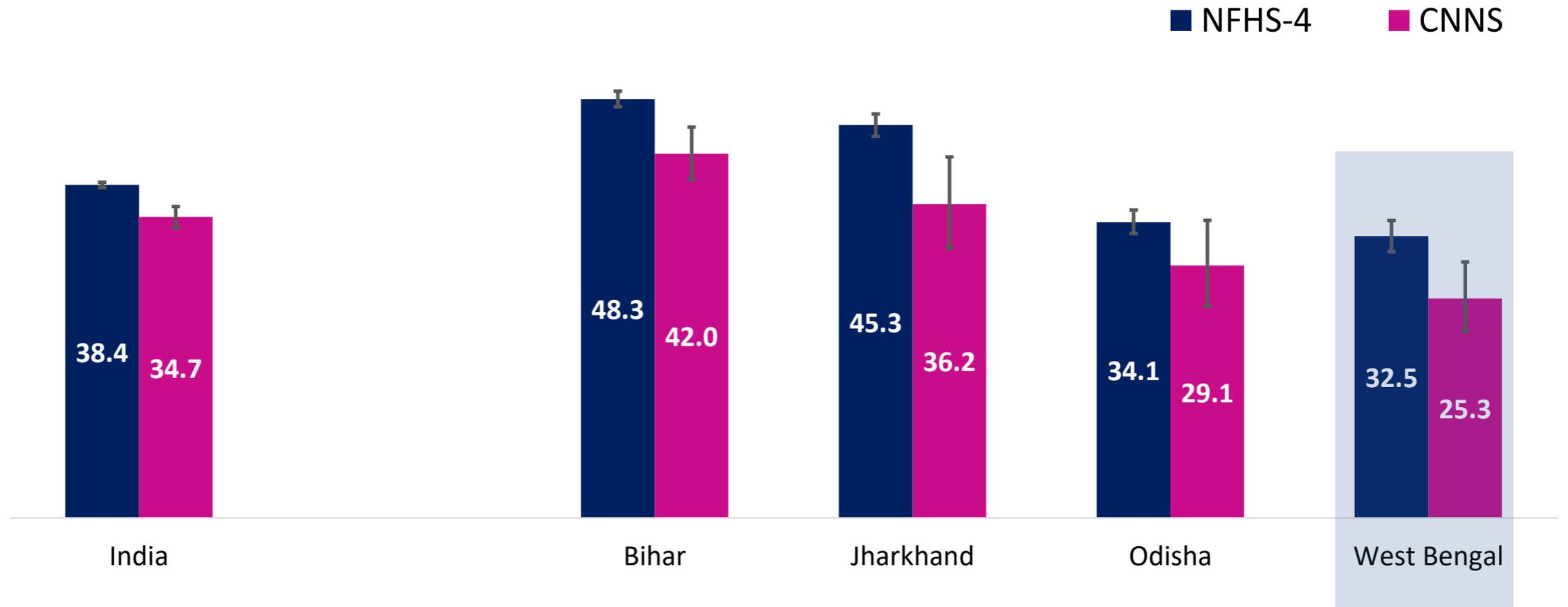
Wasting among children under five did not change
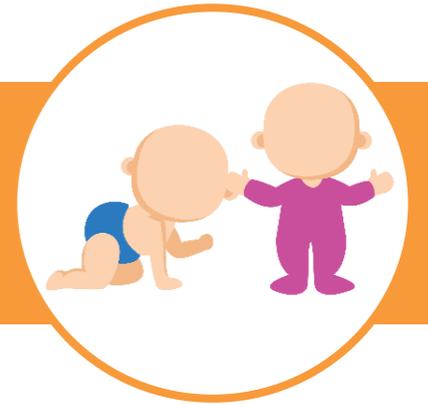
Prevalence of wasting was unchanged in West Bengal between NFHS-4 and CNNS – **20%**

Among all eastern states wasting declined significantly in Bihar and Odisha, and no change in West Bengal and Jharkhand

Legend: ■ NFHS-4 ■ CNNS

	India	Bihar	Jharkhand	Odisha	West Bengal
NFHS-4	21.0	20.8	29.0	20.4	20.3
CNNS	17.3	14.5	29.1	13.9	20.1

CNNS
Birth to Adolescence
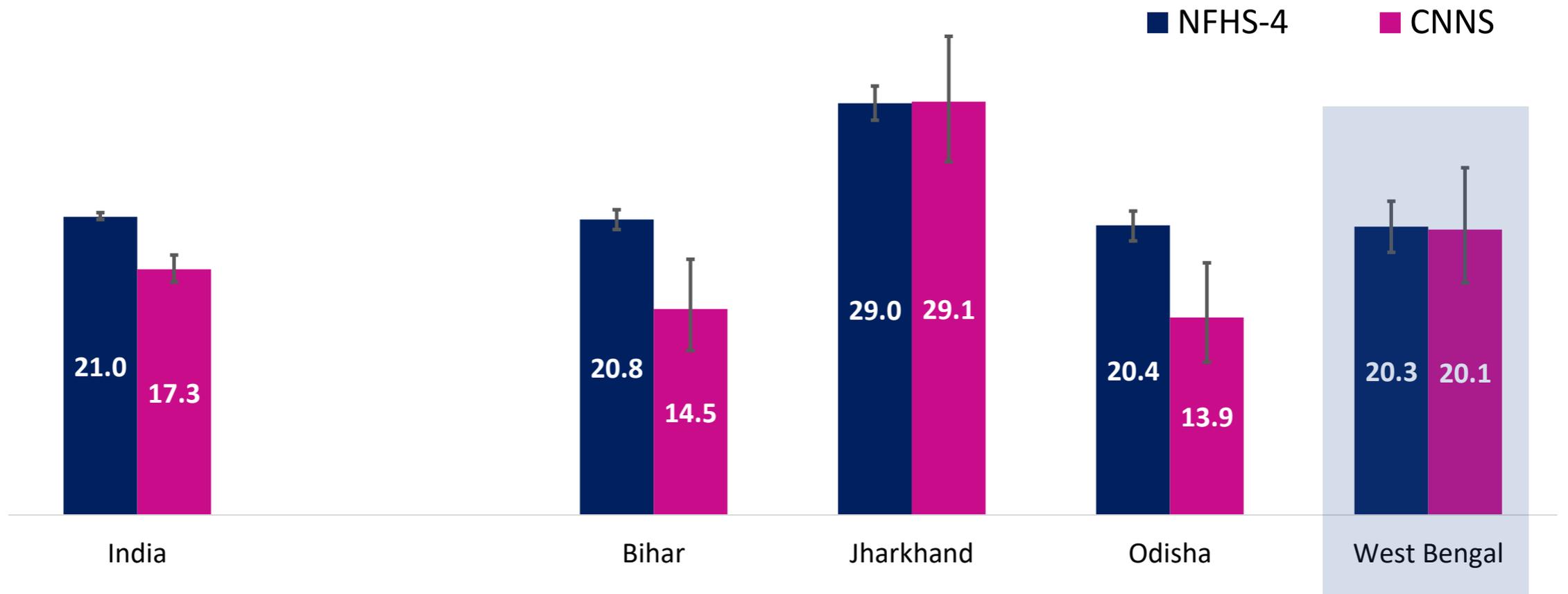
Prevalence of underweight unchanged among children under five

Underweight is a composite measure of chronic and acute malnutrition

The prevalence of underweight remained unchanged between NFHS-4 and CNNS – **32%** Vs **31%**

Among eastern states, prevalence of underweight declined only in Bihar

■ NFHS-4 ■ CNNS

	India	Bihar	Jharkhand	Odisha	West Bengal
NFHS-4	35.7	43.9	47.8	34.4	31.5
CNNS	33.4	38.7	42.9	29.2	30.9

CNNS
Birth to Adolescence

Triceps Skinfold Thickness (TSFT) for children under five
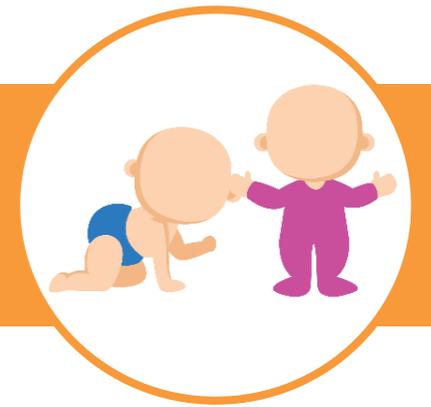
Low fat mass as reported by TSFT in West Bengal (**7%**) was lower than national average (**10%**) and high than other eastern states except Bihar

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

State	India	Bihar	Jharkhand	Odisha	West Bengal
Total	9.7	5.6	9.9	12.3	6.9
TSFT (< -3SD)	2.4	1.1	1.1	2.0	1.6

17
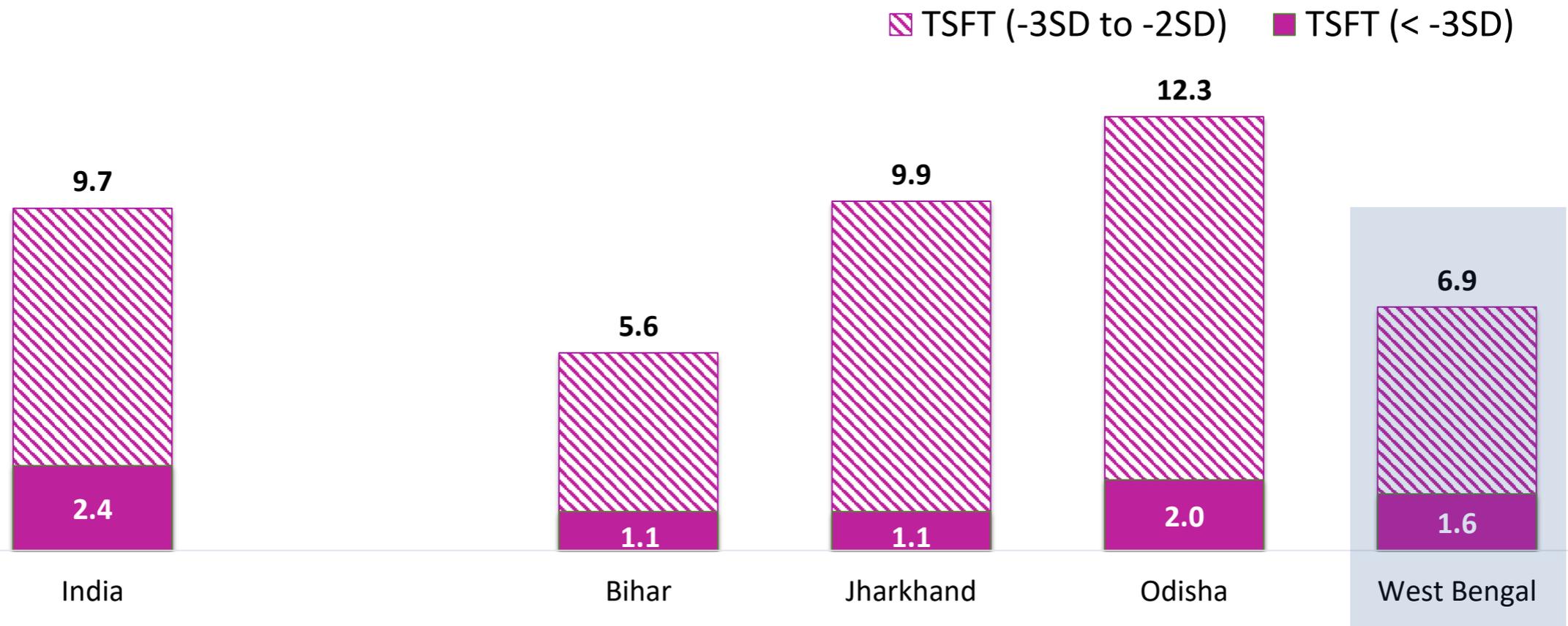
Subscapular Skinfold Thickness (SSFT) for children aged 1-4 years

Thinness as reported by SSFT in West Bengal (**5%**) was lowest among eastern states and nearly half of national average (**9**%)

| | SSFT (-3SD to -2SD) | SSFT (< -3SD) |

Region	SSFT (-3SD to -2SD)	SSFT (< -3SD)
India	8.6	1.6
Bihar	5.8	1.1
Jharkhand	11.1	1.5
Odisha	14.3	1.6
West Bengal	4.8	1.1

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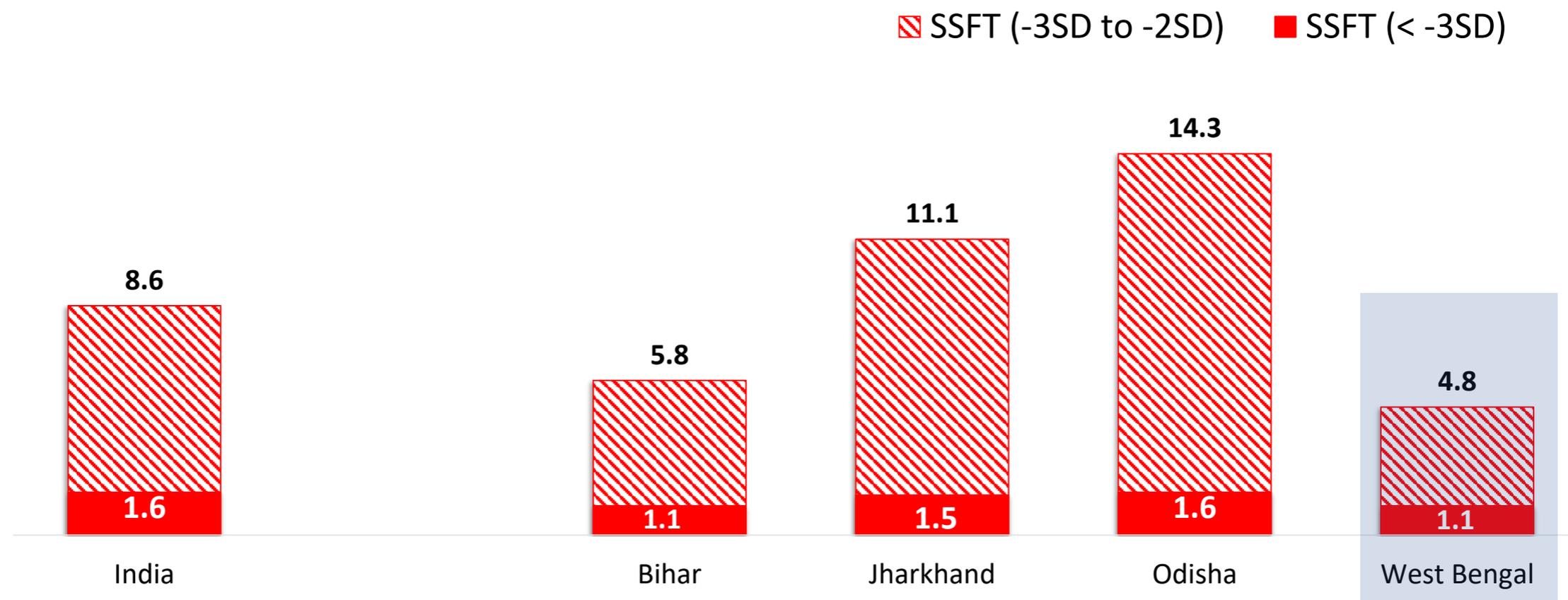
Mid Upper Arm Circumference (MUAC) for children aged 6-59 months

About **2%** children in West Bengal had low MUAC, much lower than India as a whole (5%)

Prevalence of low MUAC ranged between **2%** and **6%** across the eastern states

Legend: ▨ MUAC (>=115mm & <125 mm)　■ MUAC (<115 mm)

State	MUAC (>=115mm & <125 mm)	MUAC (<115 mm)
India	4.9	0.9
Bihar	5.8	1.0
Jharkhand	6.2	0.6
Odisha	2.2	0.4
West Bengal	2.0	0.0

CNNS
Birth to Adolescence

19
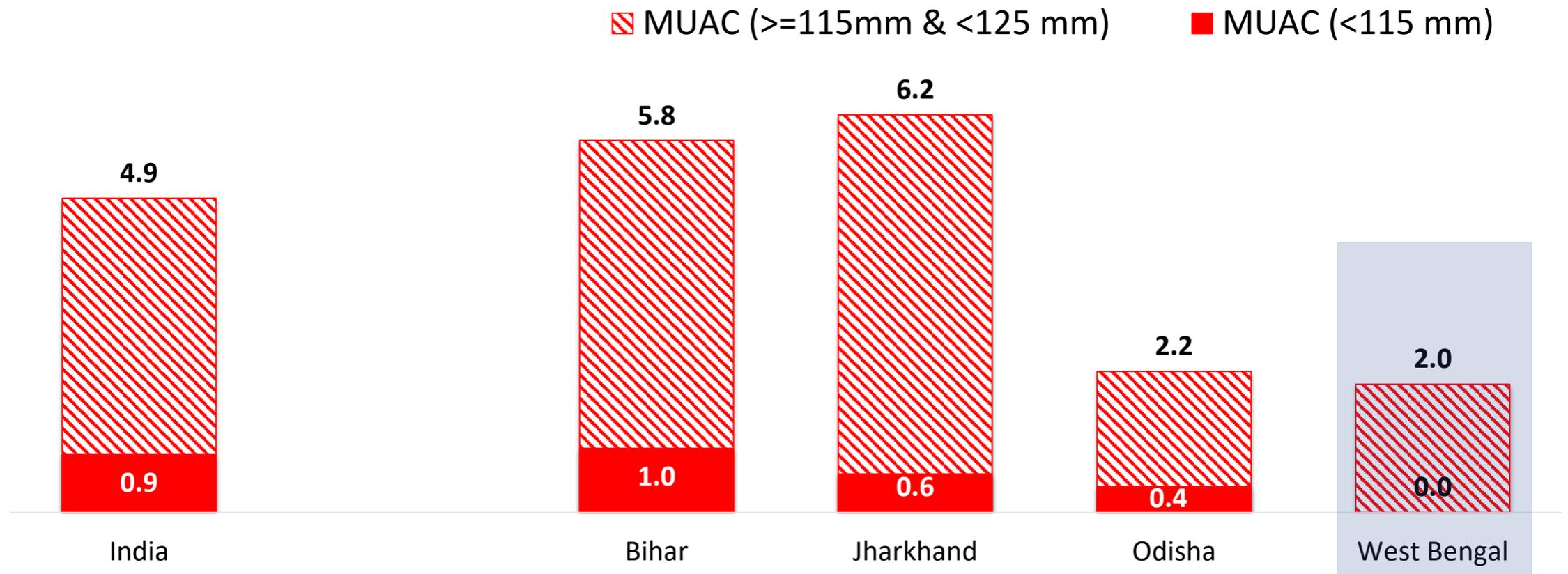
Stunting among school-age children (5-9 years)

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

West Bengal had the lowest prevalence of stunting among eastern states and national average

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

	India	Bihar	Jharkhand	Odisha	West Bengal
Total	21.9	28.5	24.9	21.4	19.0
Severely stunted	5.5	9.0	8.5	4.7	4.2

Birth to Adolescence
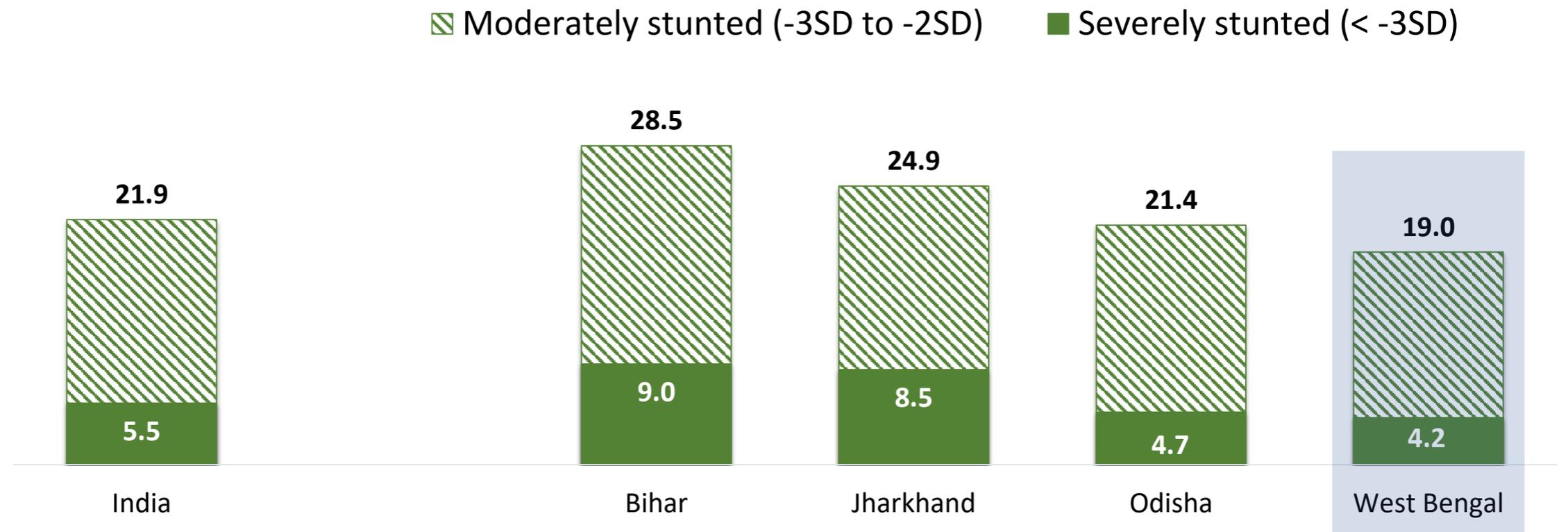
Thinness among school-age children (5-9 years)

28% of children aged 5-9 years were thin in West Bengal

Prevalence of thinness in West Bengal and Jharkhand was higher than other eastern states and national average

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

	India	Bihar	Jharkhand	Odisha	West Bengal
Total	23.0	21.4	27.9	18.8	28.3
Severe thinness	4.9	4.2	4.9	3.8	7.3

Birth to Adolescence
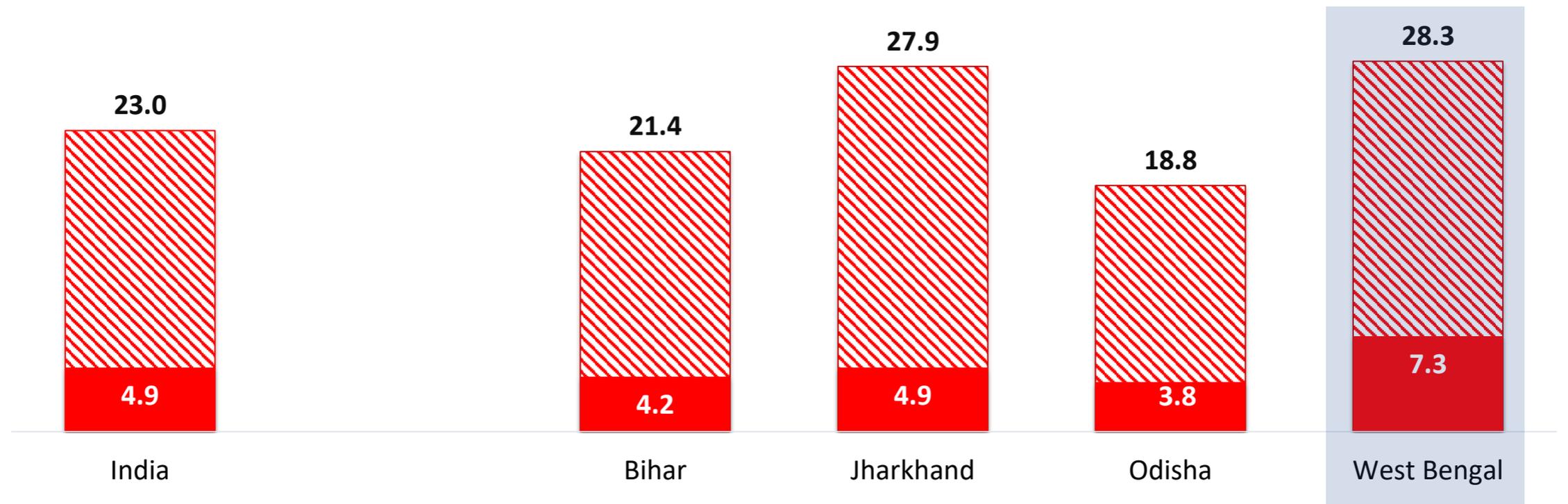
Overweight and obesity among school-age children (5-9 years)

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

Prevalence of overweight in West Bengal was slightly higher than national average and other eastern states except Odisha (8%)

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

State	Obese (BMI > +2SD)	Total (Overweight + Obese)
India	1.3	3.7
Bihar	0.2	0.8
Jharkhand	0.3	0.5
Odisha	2.9	7.8
West Bengal	1.8	4.4

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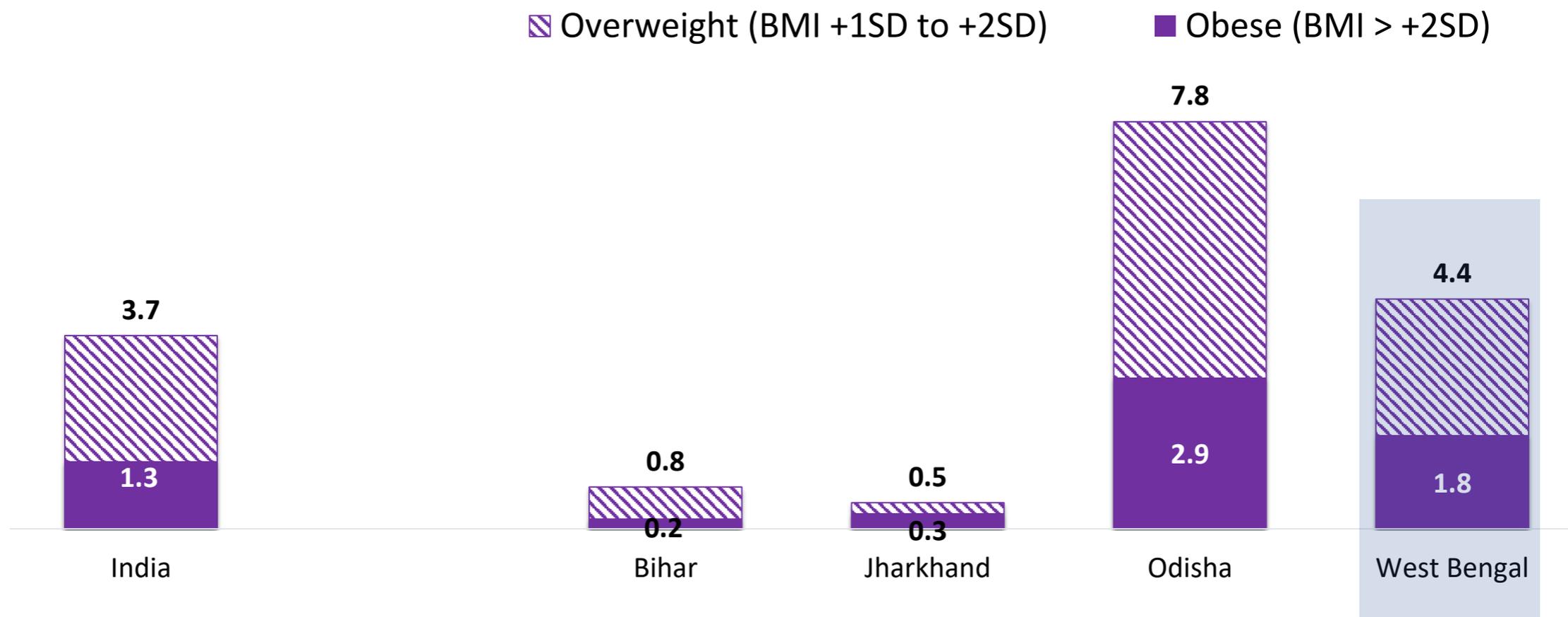
Thinness among adolescents aged 10-19 years substantially high

1/4 adolescents aged 10-19 years was thin in West Bengal

Among the eastern states, Jharkhand (**28%**) had the highest prevalence of thinness

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

State	Total	Severe thinness
India	24.1	6.5
Bihar	22.8	4.8
Jharkhand	28.4	6.3
Odisha	18.4	3.9
West Bengal	25.1	6.9

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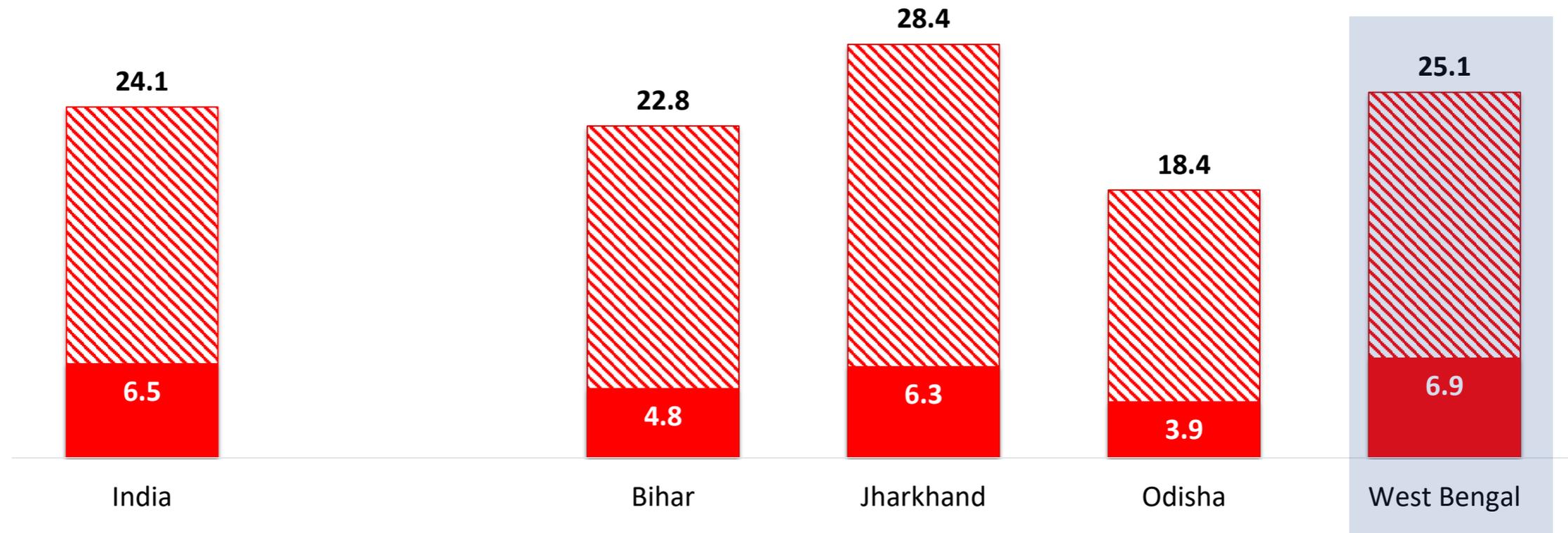
Prevalence of overweight among adolescents aged 10-19 years high

8% of adolescents were overweight in West Bengal, higher than national average (**5%**)

West Bengal had significantly higher prevalence than Bihar and Jharkhand and at similar level with Odisha in the eastern region

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

	India	Bihar	Jharkhand	Odisha	West Bengal
Overweight	4.8	1.9	2.4	7.8	7.7
Obese	1.1	0.1	0.2	1.8	2.0

CNNS
Birth to Adolescence
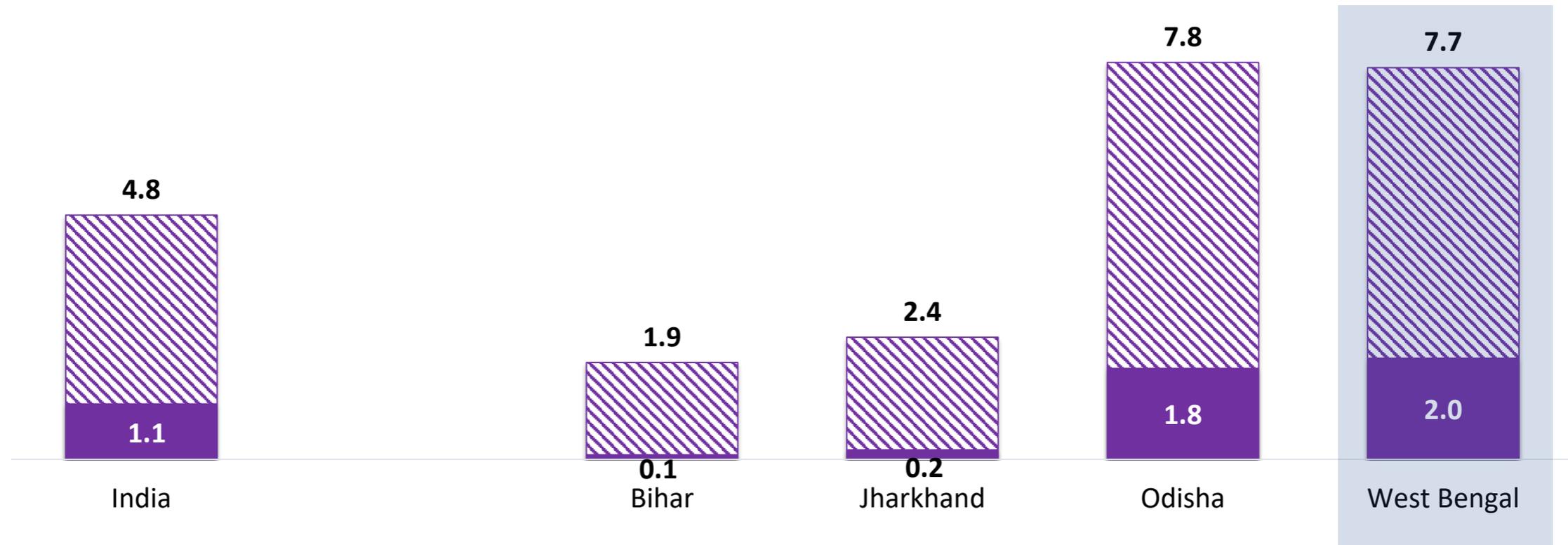
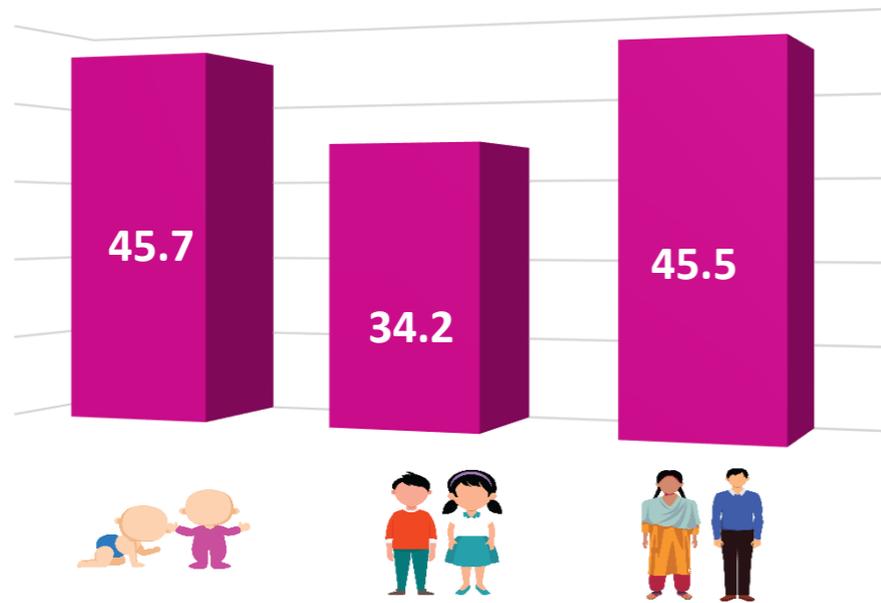# West Bengal key findings: Anaemia and iron deficiency

Anaemia

45.7	34.2	45.5
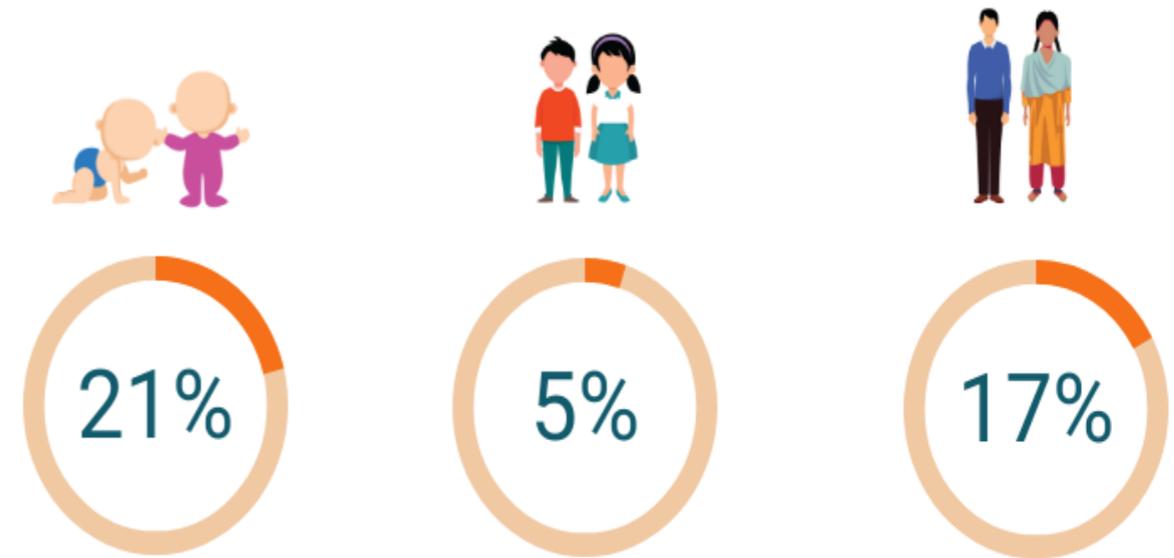
In West Bengal, like in most states, anaemia was significantly higher among children aged 1-4 years compared to children aged 5-9 years, however, adolescents aged 10-19 years had similar level

Iron deficiency

21%   5%   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

Nearly **1/2** children aged 1-4 years were anaemic in West Bengal (**46%**), higher than national level (**41%**)

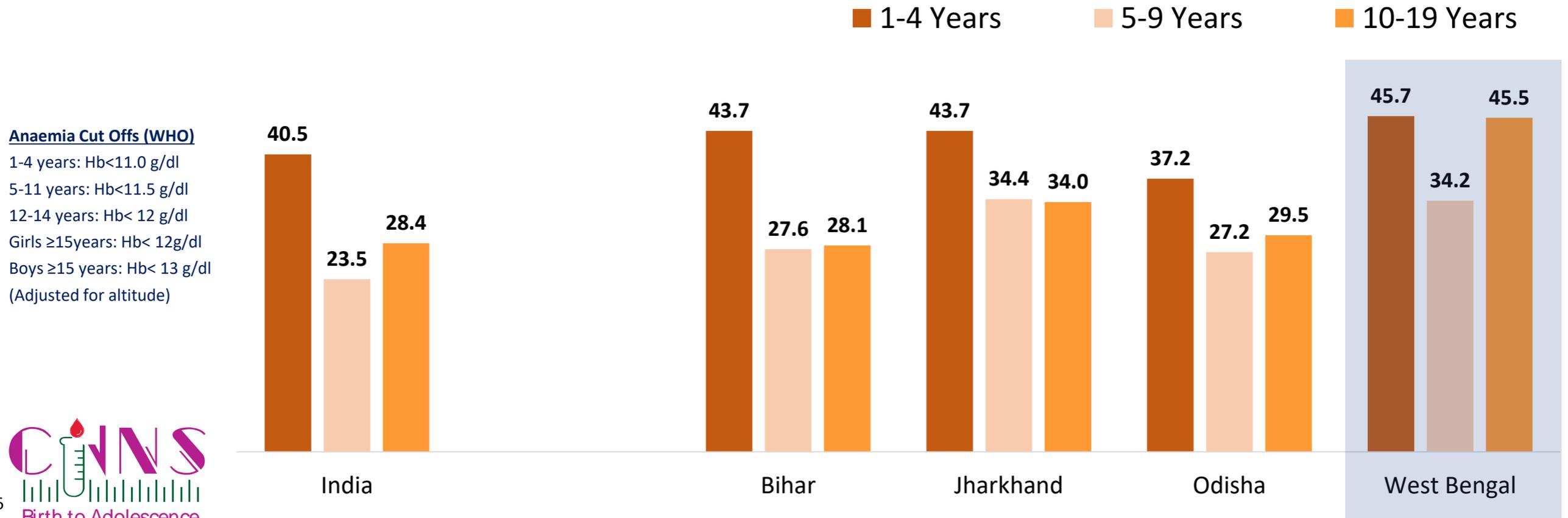Prevalence of anaemia was similar among children aged 1-4 years and adolescents aged 10-19 years

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)

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

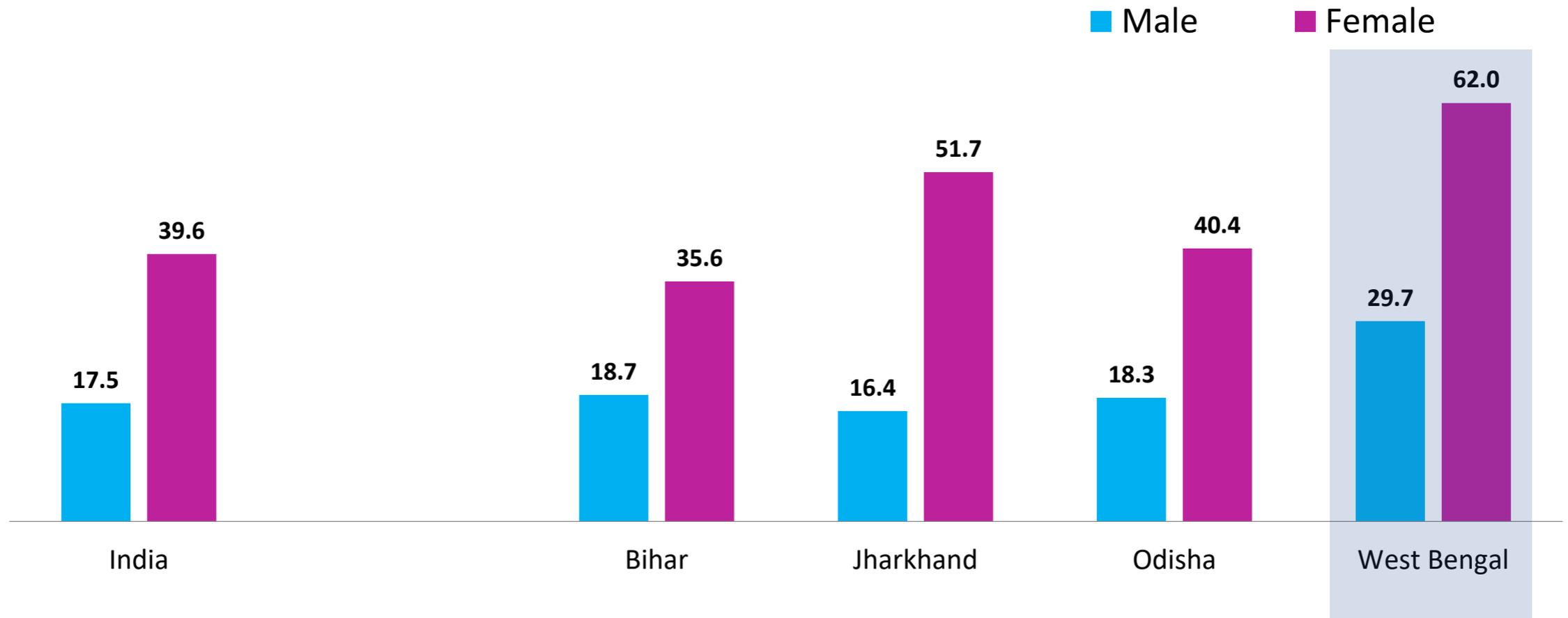|	1-4 Years	5-9 Years	10-19 Years
India	40.5	23.5	28.4
Bihar	43.7	27.6	28.1
Jharkhand	43.7	34.4	34.0
Odisha	37.2	27.2	29.5
West Bengal	45.7	34.2	45.5

CNNS
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 West Bengal, like in most of the states, adolescent girls were twice more likely than adolescent boys to be anaemic
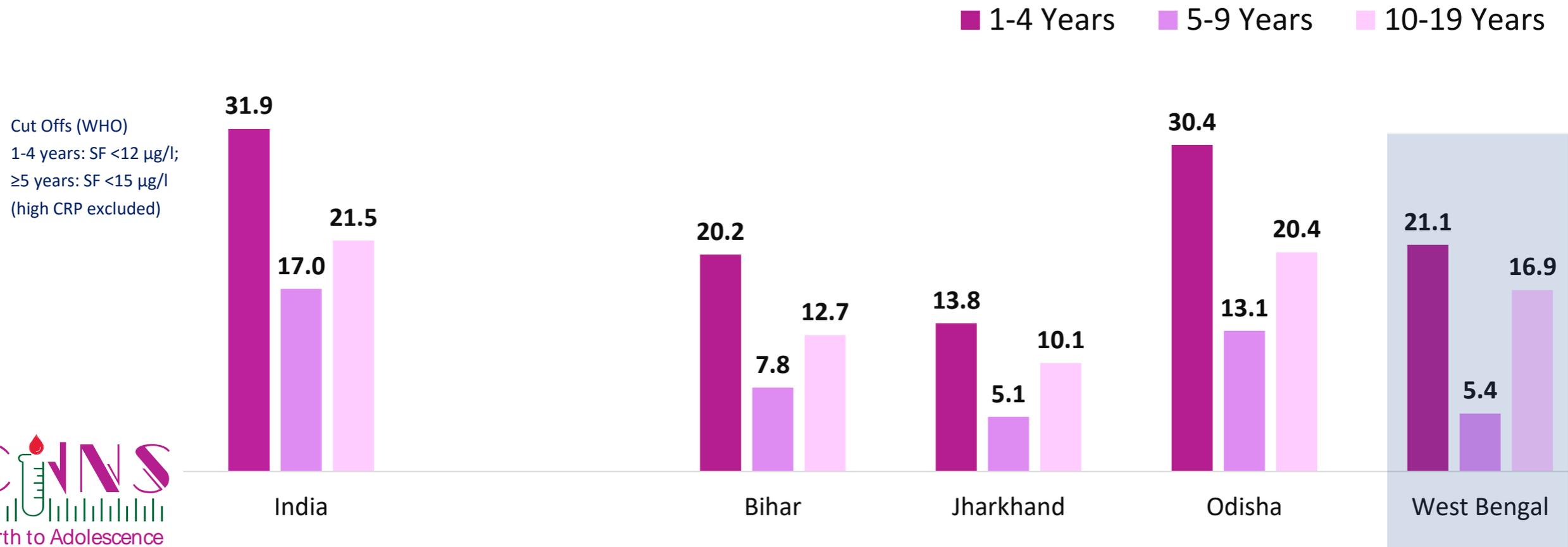

- Male
- Female

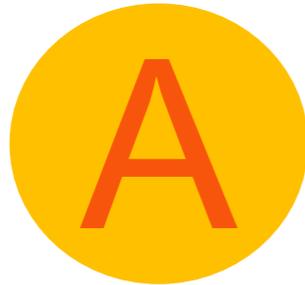|	India	Bihar	Jharkhand	Odisha	West Bengal
Male	17.5	18.7	16.4	18.3	29.7
Female	39.6	35.6	51.7	40.4	62.0

CINNS
Birth to Adolescence

West Bengal had low prevalence of iron deficiency among school-aged children (5%) compared to children aged 1-4 years (21%) and adolescents (17%), alike many other states and India as a whole

Among eastern states, children and adolescents from Odisha had highest prevalence of iron deficiency

■ 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	Bihar	Jharkhand	Odisha	West Bengal
1-4 Years	31.9	20.2	13.8	30.4	21.1
5-9 Years	17.0	7.8	5.1	13.1	5.4
10-19 Years	21.5	12.7	10.1	20.4	16.9

CNNS
Birth to Adolescence

A

Vitamin A deficiency was at similar level among children and adolescents aged 1-19 years, much lower than the national average

D
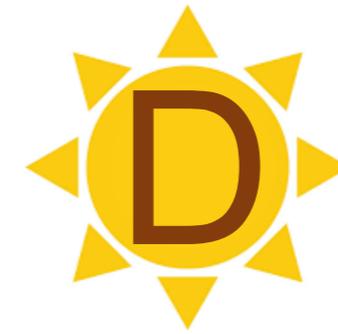
Vitamin D deficiency ranged from 7% to 20% in 1-19 years age group as per cut off by expert panel of IOM.

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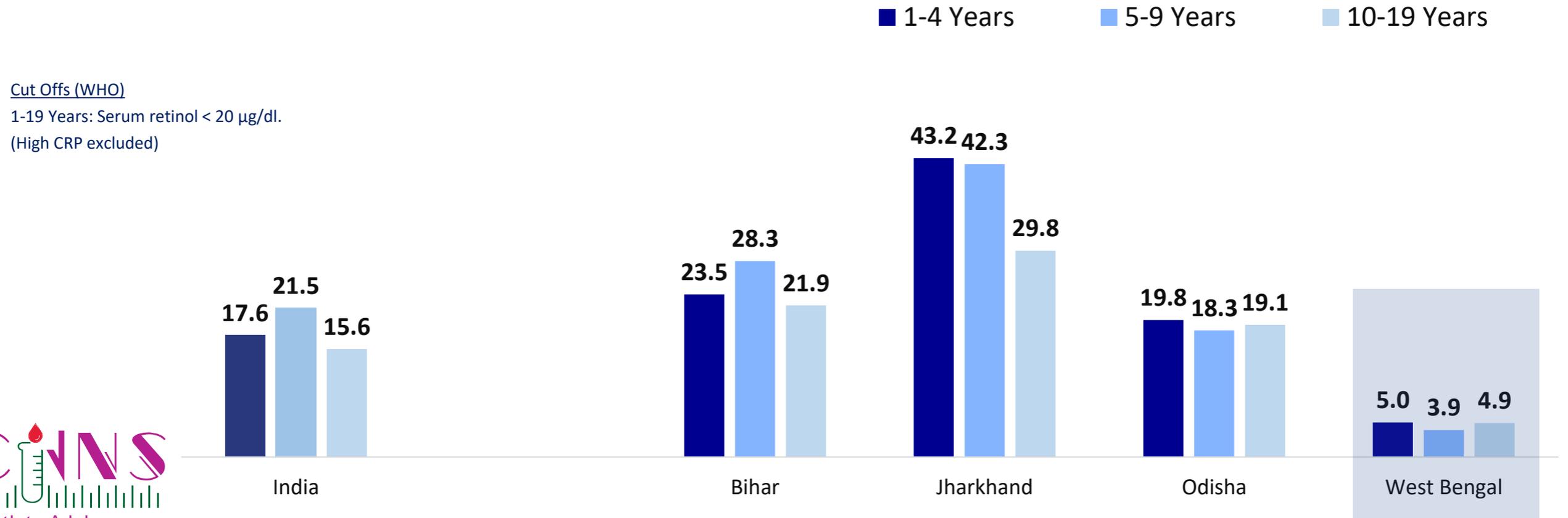
CNNS
Birth to Adolescence

Vitamin A deficiency among children and adolescents

Children and adolescents had Vitamin A deficiency at similar level in West Bengal (**4-5%**), significantly lower than national average (**18-22%**)

Among eastern states, West Bengal had lowest prevalence of Vitamin A deficiency

■ 1-4 Years ■ 5-9 Years ■ 10-19 Years

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

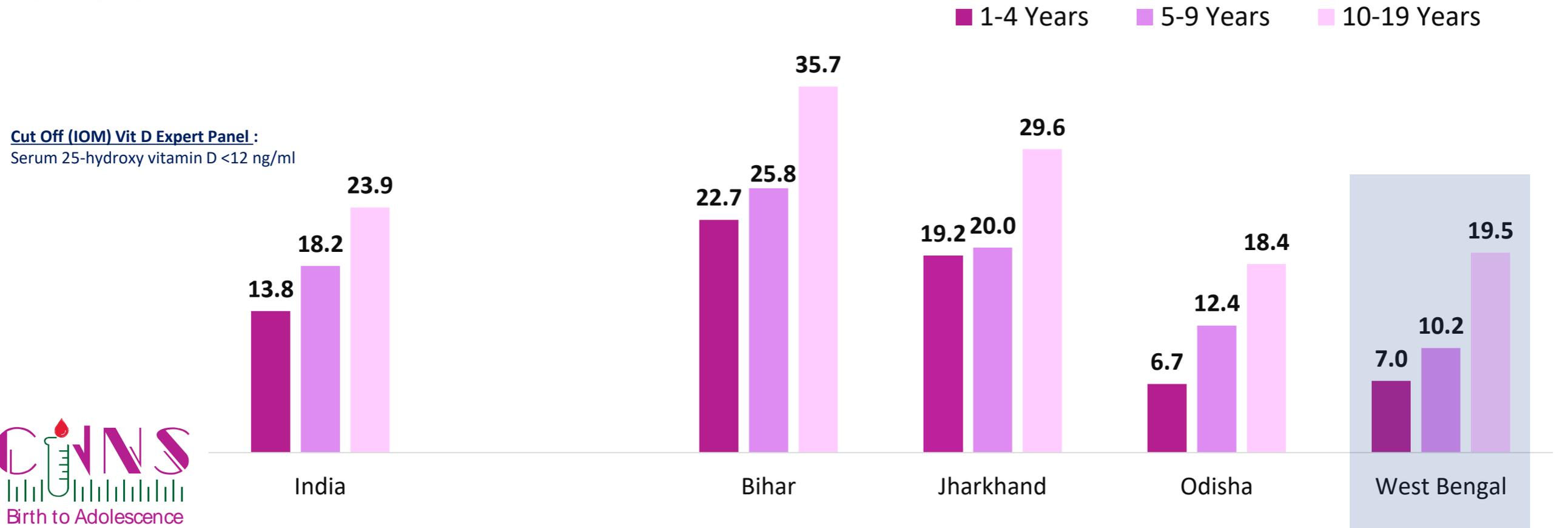|	1-4 Years	5-9 Years	10-19 Years
India	17.6	21.5	15.6
Bihar	23.5	28.3	21.9
Jharkhand	43.2	42.3	29.8
Odisha	19.8	18.3	19.1
West Bengal	5.0	3.9	4.9

CNNS
Birth to Adolescence

30

Vitamin D deficiency increases with age

7-20% of children and adolescents had Vitamin D deficiency in West Bengal, which is significantly lower than the national average (**14-24%**); Vitamin D deficiency increased with age.

In eastern states, Bihar had highest Vitamin D deficiency among children and adolescents, followed by Jharkhand

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

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

	1-4 Years	5-9 Years	10-19 Years
India	13.8	18.2	23.9
Bihar	22.7	25.8	35.7
Jharkhand	19.2	20.0	29.6
Odisha	6.7	12.4	18.4
West Bengal	7.0	10.2	19.5

Birth to Adolescence

West Bengal key findings: Non-communicable diseases

Nearly 6% of school-age children and adolescents were found with high level of glycosylated haemoglobin (HbA1c).
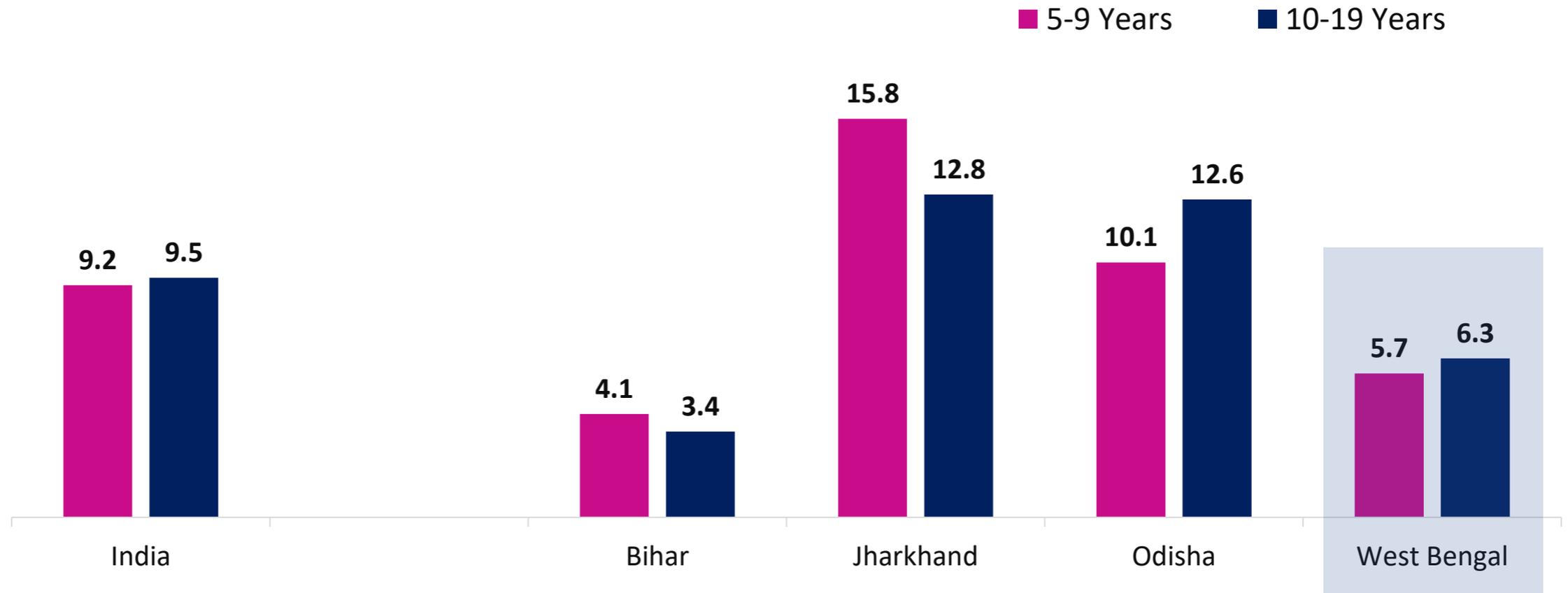
Other indicators of risks of NCDs, such as level of cholesterol, triglycerides, LDL and HDL point to increased risks of NCDs among adolescents.

Birth to Adolescence

Risk of diabetes among school-age children and adolescents

Based on Glycosylated hemoglobin (HbA1c), **6%** of children and adolescents had increased risk of diabetes in West Bengal, which was lower than the country as a whole (**9-10%**)

Among all eastern states, risk of diabetes was the highest in Jharkhand, followed by Odisha

Legend: ■ 5-9 Years ■ 10-19 Years

	India	Bihar	Jharkhand	Odisha	West Bengal
5-9 Years	9.2	4.1	15.8	10.1	5.7
10-19 Years	9.5	3.4	12.8	12.6	6.3

Birth to Adolescence

High total cholesterol and high triglycerides among adolescents

Elevated risk of NCDs in West Bengal among adolescents – **20%** had high level of total cholesterol and **43%** with high level of triglycerides

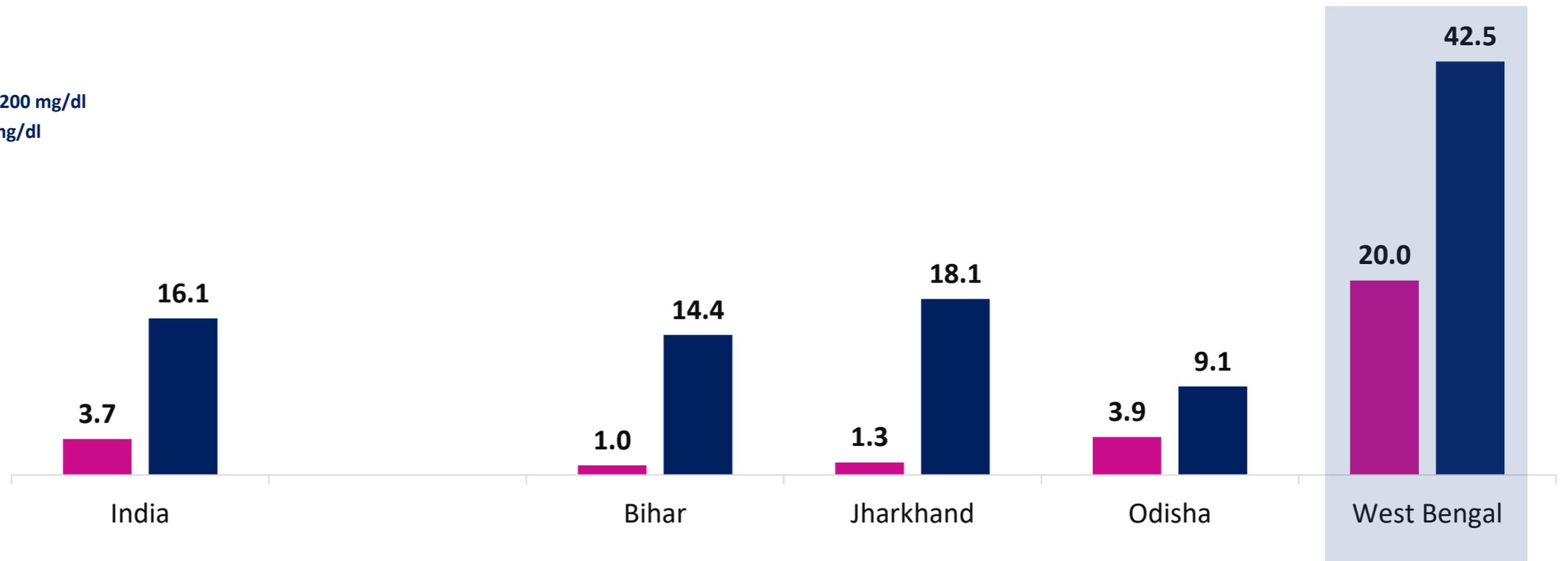In eastern region, West Bengal had the highest prevalence of total cholesterol and high triglycerides

■ High total cholesterol   ■ High triglycerides

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

	India	Bihar	Jharkhand	Odisha	West Bengal
High total cholesterol	3.7	1.0	1.3	3.9	20.0
High triglycerides	16.1	14.4	18.1	9.1	42.5

CNNS
Birth to Adolescence

High LDL and low HDL among adolescents

Risk of NCDs among adolescents in West Bengal was high – **12%** had high level of LDL and **12%** had low level of HDL
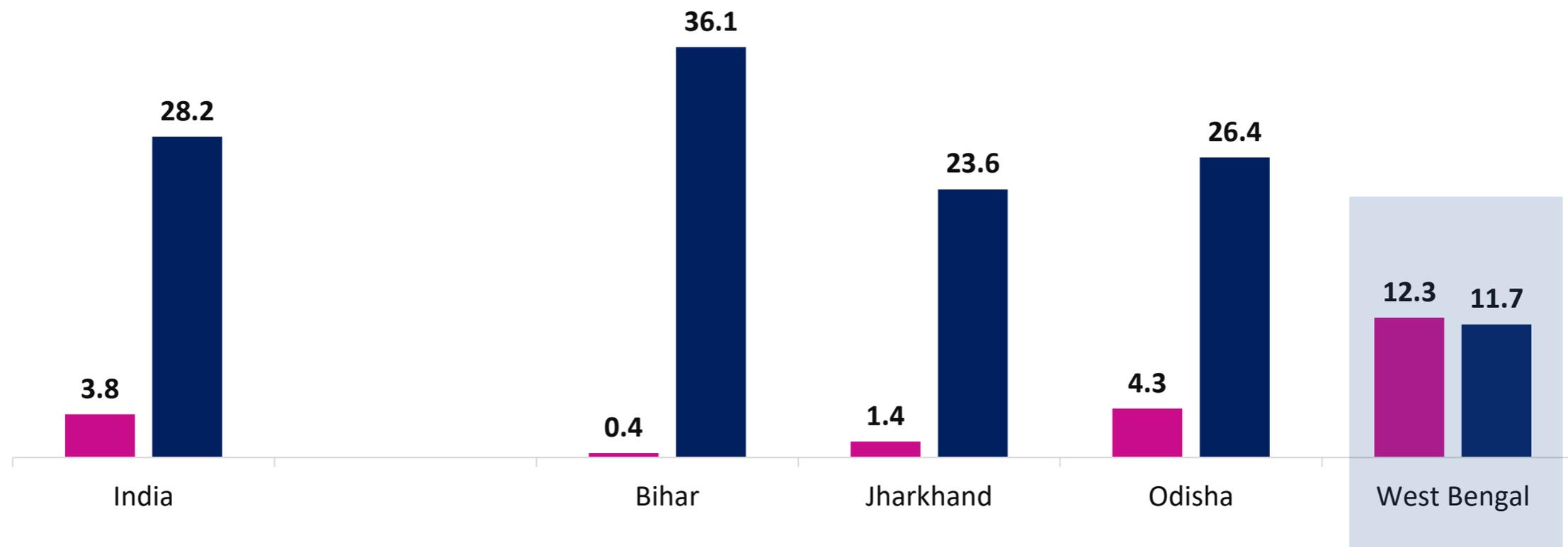
Cut Offs:
LDL >= 130 mg/dl
HDL < 40 mg/dl

■ High LDL   ■ Low HDL

	India	Bihar	Jharkhand	Odisha	West Bengal
High LDL	3.8	0.4	1.4	4.3	12.3
Low HDL	28.2	36.1	23.6	26.4	11.7

CINNS
Birth to Adolescence

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