Largest Micronutrient Survey ever conducted: CNNS 2016-

112,316
Children and adolescents interviewed

51,029
Blood, stool and urine samples collected

360
Anthropometric measurers

30
Microscopists
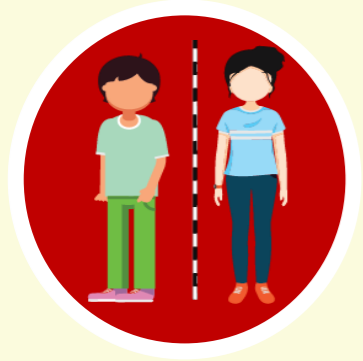
2500
Survey personnel in 30 states

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
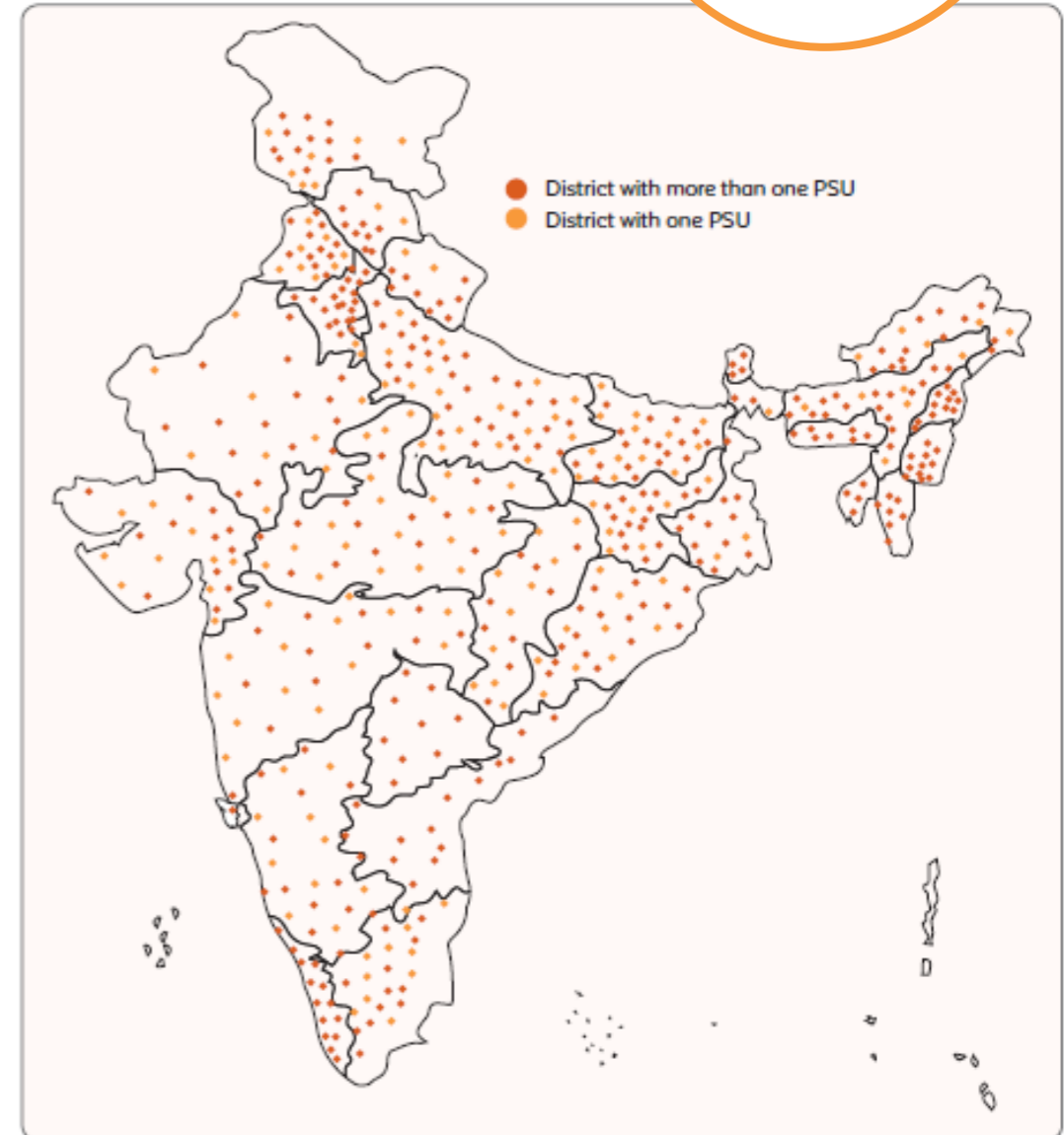
CiNNS
Birth to Adolescence

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:
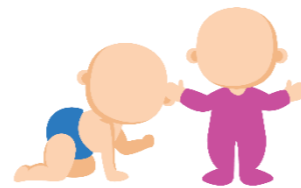- 160 Districts- one PSU
- 356 Districts- two or more PSUs

District with more than one PSU
District with one PSU

Birth to Adolescence

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

-- **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**

CiNNS

Birth to Adolescence

7
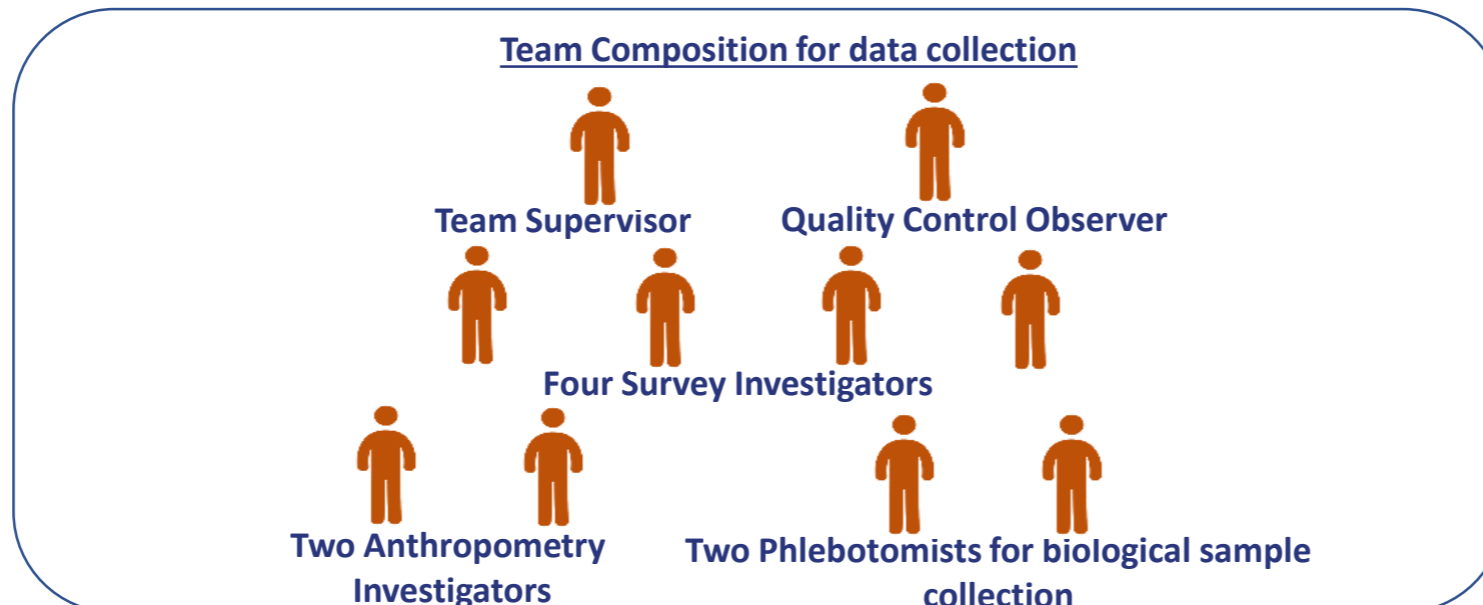
Quality Assurance Measures for Data Quality

Evaluation of Interviewers
prior to employment

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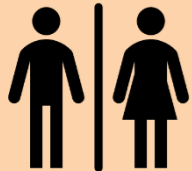- Written and oral test
- Mock interview
- Ethics test

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 Jharkhand

CNNS covered 65 PSUs for data collection in Jharkhand

Achieved following sample size by age groups:

	0-4 years	5-9 years	10-19 years	Total
Household and anthropometry data	1,226	1,230	1,093	**3,549**
Biological sample	681	590	518	**1,789**

Birth to Adolescence

Period of data collection in Jharkhand

CNNS data collection period: March 3, 2017 to July 4, 2017

- CNNS collected data during the spring season through monsoon season of 2017

- NFHS collected data during the summer season through winter season of 2016.

Survey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CNNS 2017			March to July 2017									
NFHS 4 2016				April to December, 2016								

Jharkhand key findings: Anthropometry (1/2)

Decline in stunting and underweight was observed while wasting remained unchanged in children under 5 years

■ NFHS-4   ■ CNNS

	Stunting (Low height for age)	Wasting (Low weight for height)	Underweight (Low weight for age)
NFHS-4	45.3%	29.0%	47.8%
CNNS	36.2%	29.1%	42.9%

CNNS
Birth to Adolescence
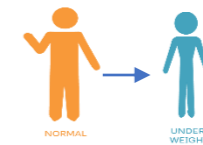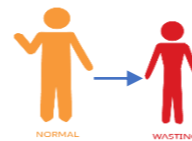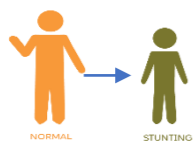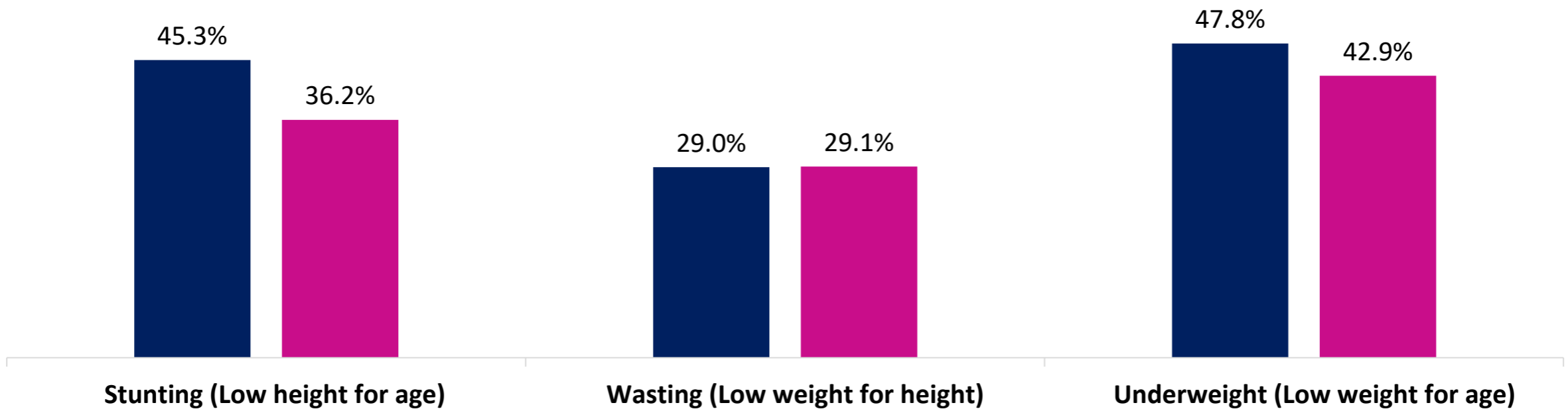
Jharkhand key findings: Anthropometry (2/2)

3/10 adolescents aged 10-19 years were thin for their age (BMI-Age <-2SD)

1/4 children aged 5-9 years was stunted. The school age period does not provide an opportunity for catch up growth in height.

2% of adolescents aged 10-19 years were overweight or obese.

2.4%

Overweight (high BMI for age)

NORMAL

OVERWEIGHT/
OBESITY

Birth to Adolescence
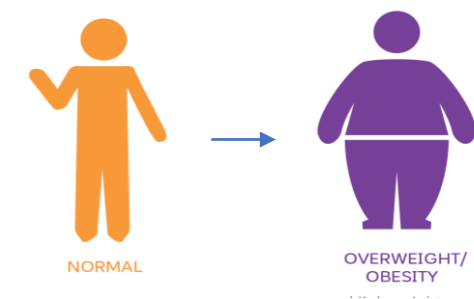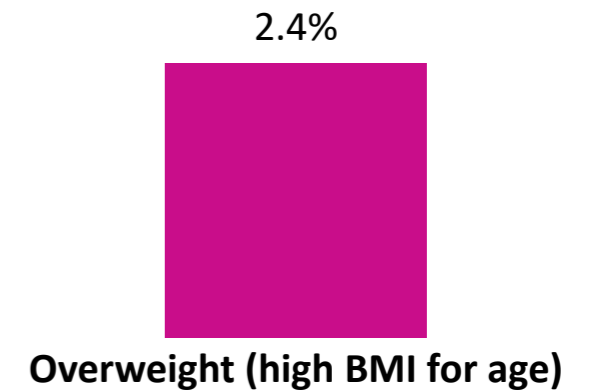
Stunting declined among children under five

Lower prevalence of stunting was observed in CNNS compared to NFHS-4 – **36%** vs **45%** in Jharkhand

In eastern region states decline in stunting was observed in all states except Odisha

■ NFHS-4   ■ CNNS

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

CNNS
Birth to Adolescence
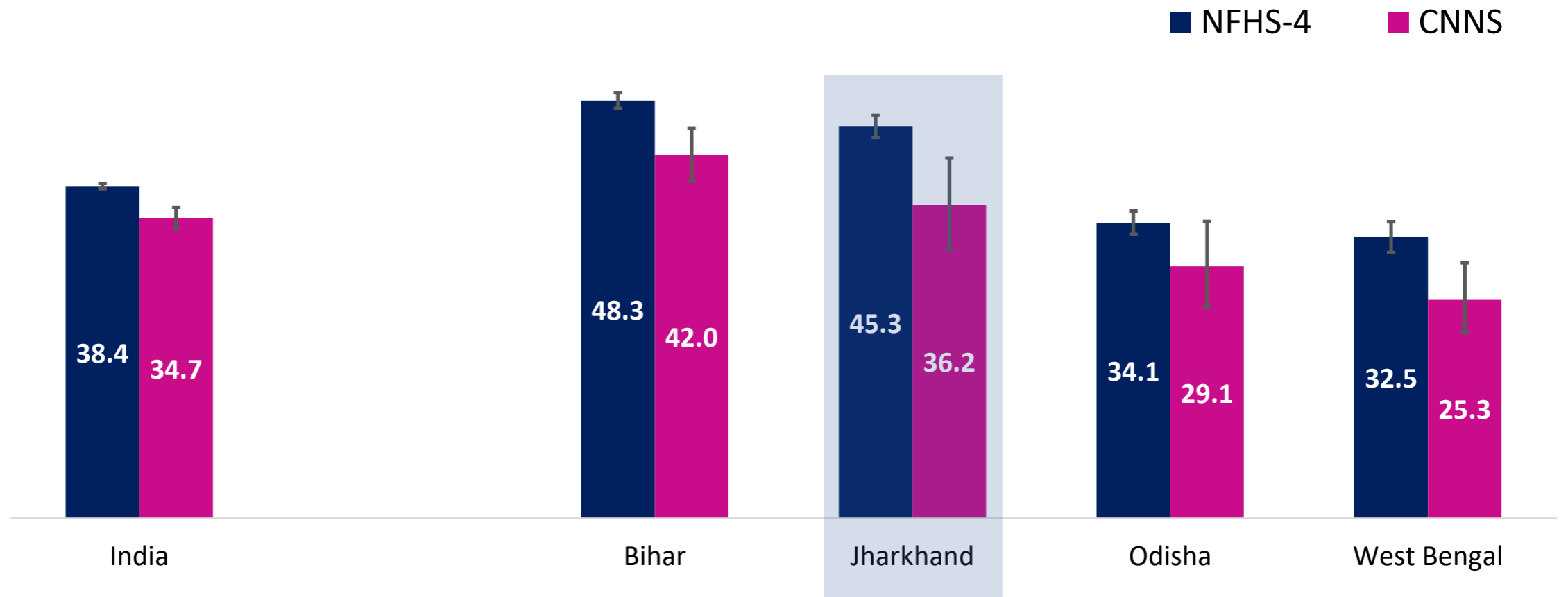
Wasting among children under five did not change
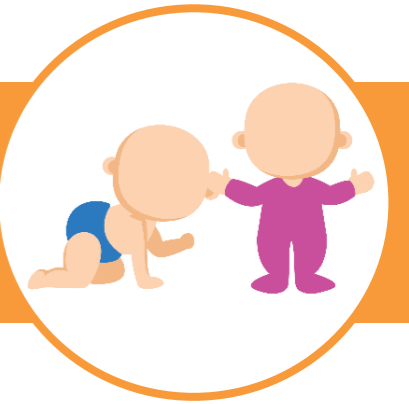
Prevalence of wasting unchanged in Jharkhand between NFHS-4 and CNNS – **29%**

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

■ 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

15
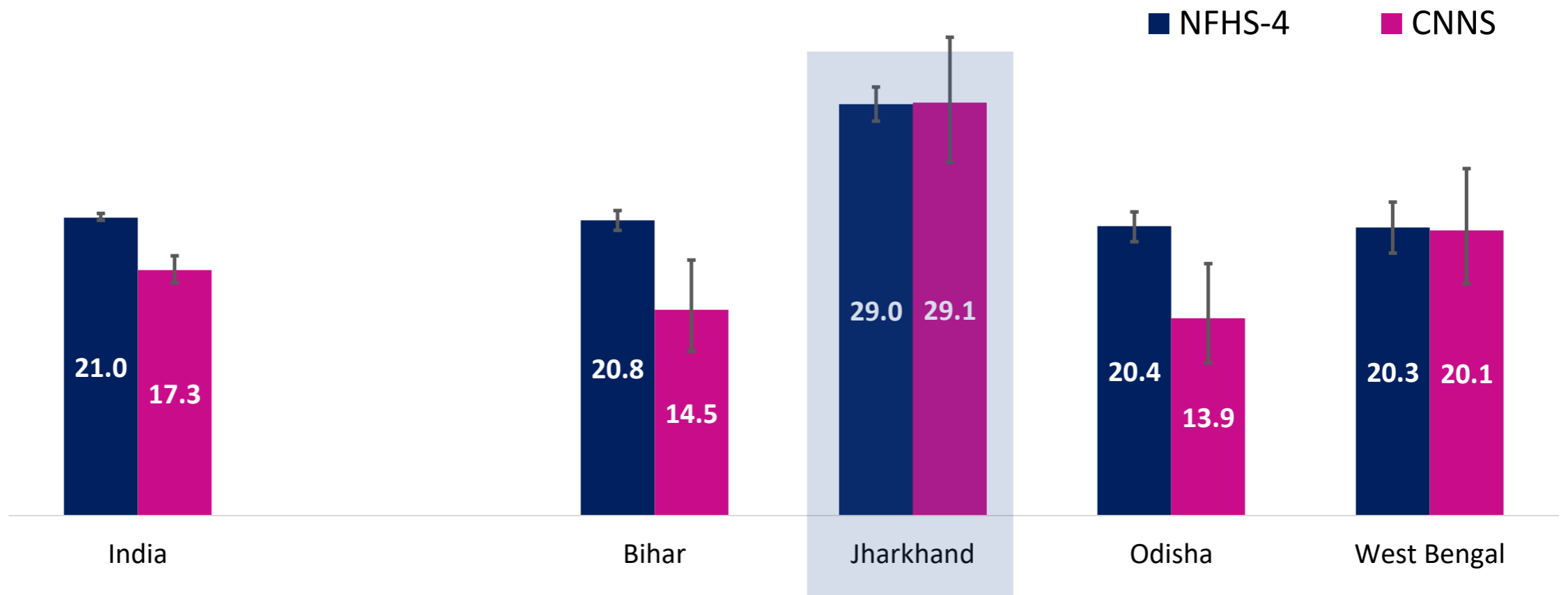
Prevalence of underweight among children under five declined

Underweight is a composite measure of chronic and acute malnutrition

The prevalence of underweight did not decline significantly between NFHS-4 and CNNS

Among eastern states, underweight declined only in Bihar

Legend: ■ 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

16
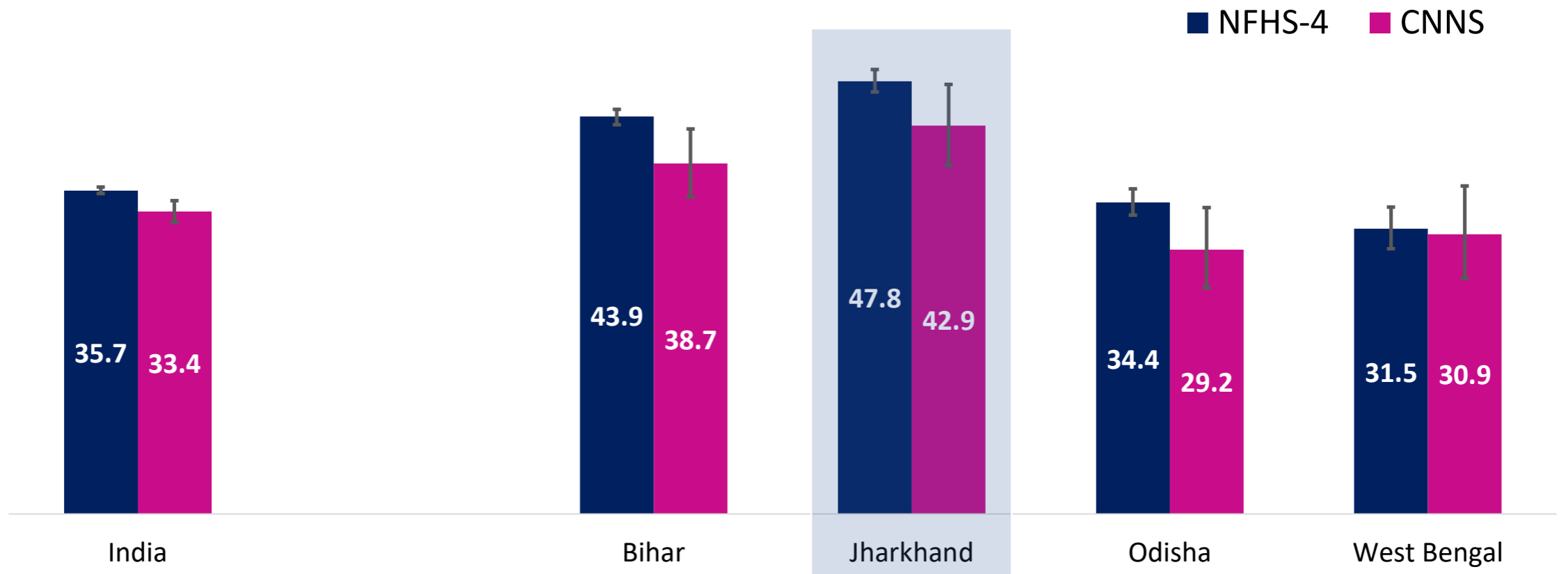
Triceps Skinfold Thickness (TSFT) for children under five
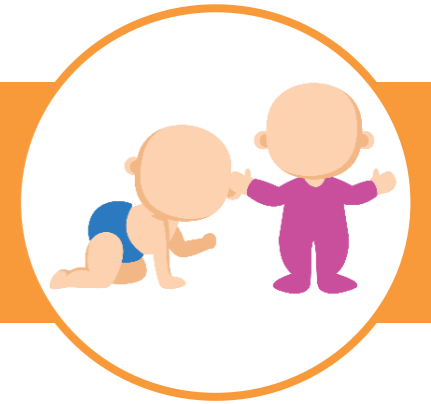
Low fat mass as reported by TSFT in Jharkhand was similar to national average; but higher than two other eastern states and lower than Odisha

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

State	TSFT (-3SD to -2SD) total	TSFT (< -3SD)
India	9.7	2.4
Bihar	5.6	1.1
Jharkhand	9.9	1.1
Odisha	12.3	2.0
West Bengal	6.9	1.6

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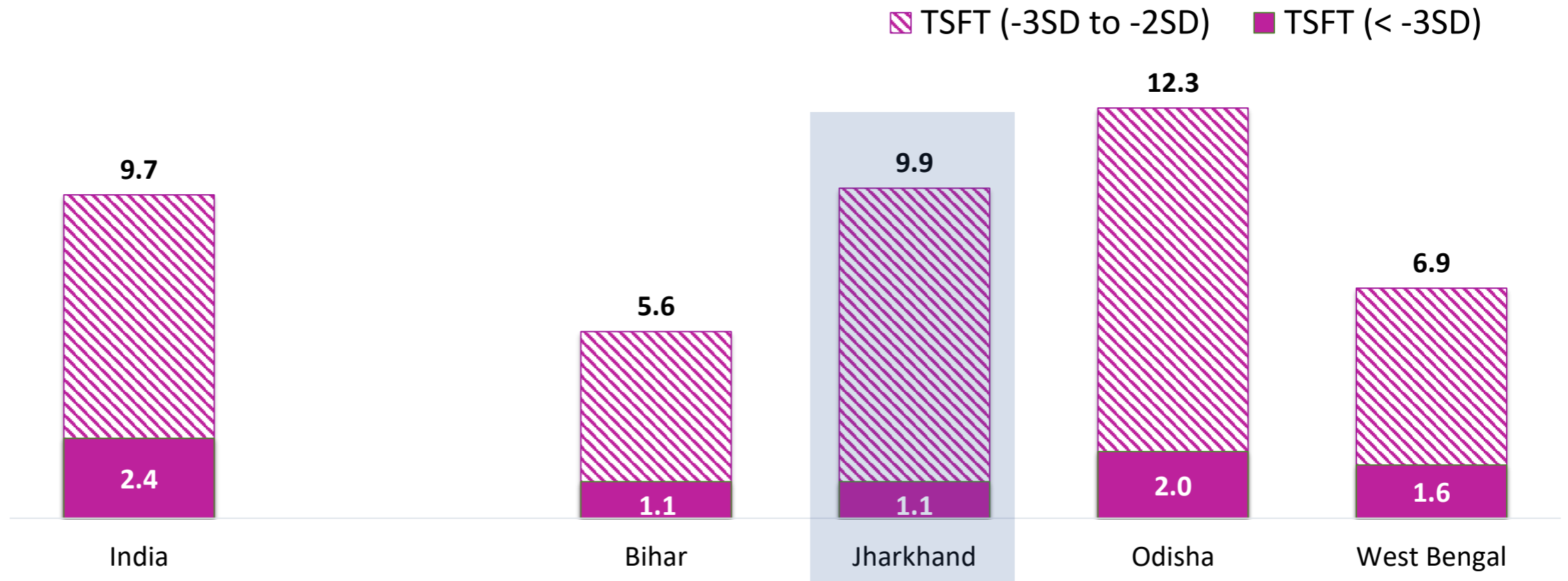
Subscapular Skinfold Thickness (SSFT) for children aged 1-4 years

Thinness as reported by SSFT in Jharkhand was significantly higher than Bihar, West Bengal and national average; but lower than Odisha

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

State	SSFT (-3SD to -2SD) total	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
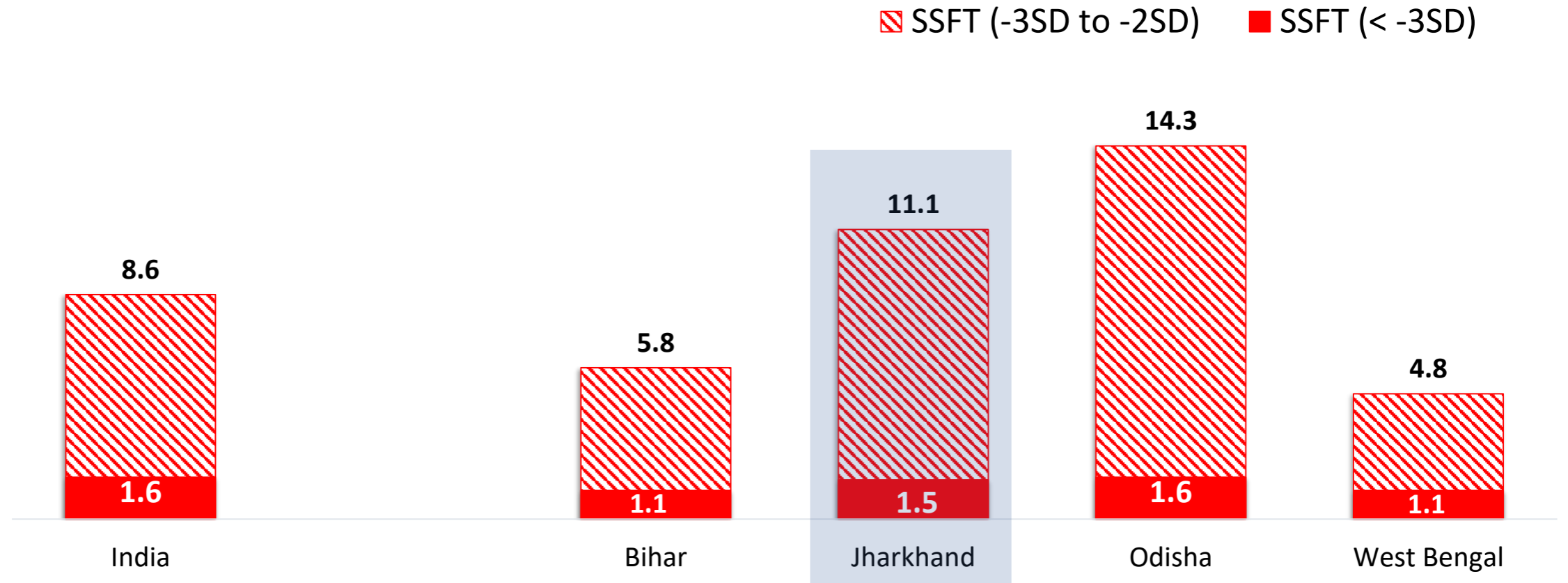
Mid Upper Arm Circumference (MUAC) for children aged 6-59 months
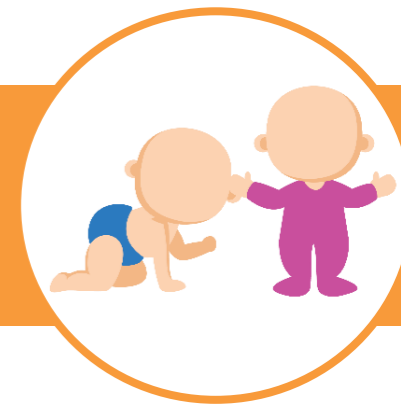
About **6%** children in Jharkhand had low MUAC

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

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

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

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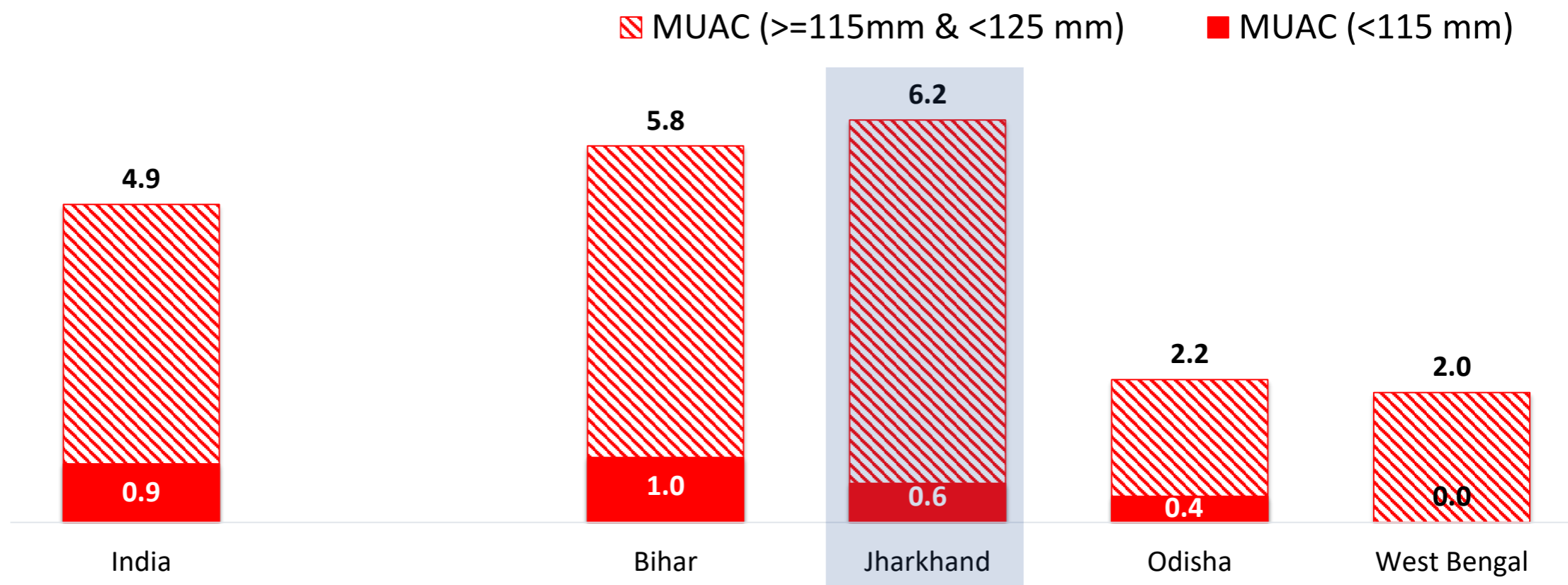
Stunting among school-age children (5-9 years)

1/4 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

Among the eastern states, Jharkhand had higher prevalence of stunting than Odisha and West Bengal; but lower than Bihar

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

	India	Bihar	Jharkhand	Odisha	West Bengal
Moderately stunted (top)	21.9	28.5	24.9	21.4	19.0
Severely stunted (bottom)	5.5	9.0	8.5	4.7	4.2

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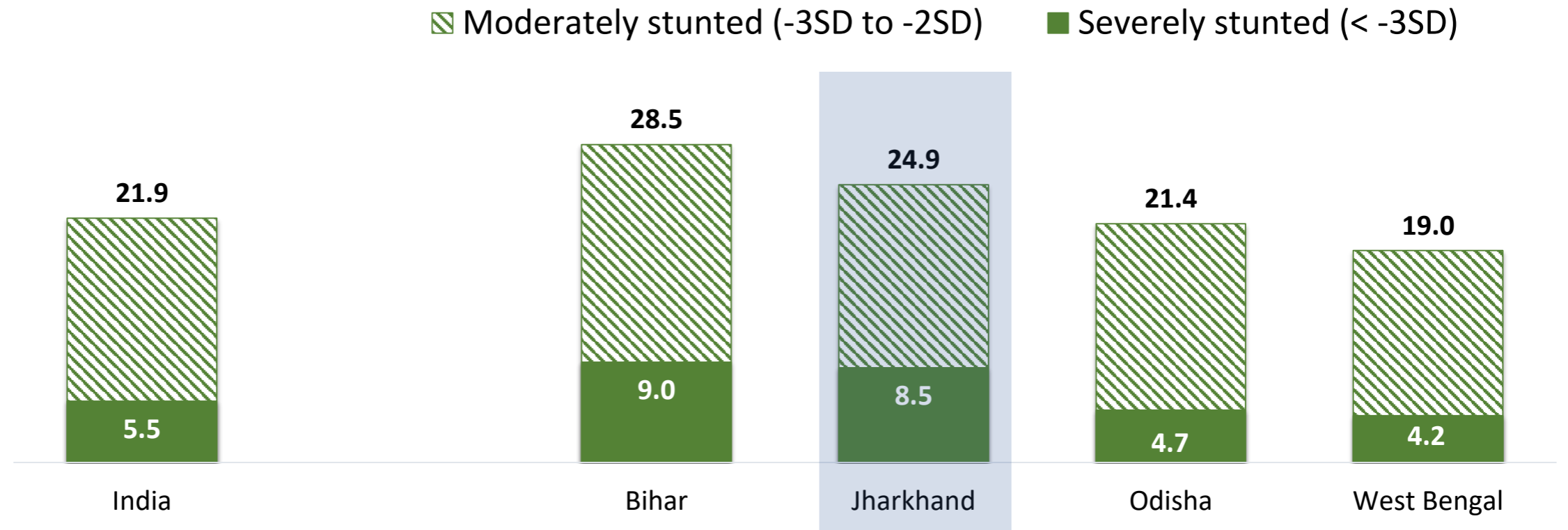
Thinness among school-age children (5-9 years)

Nearly 3/10 children aged 5-9 years were thin

Prevalence of thinness in Jharkhand (**28%**) and West Bengal (**28%**) 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

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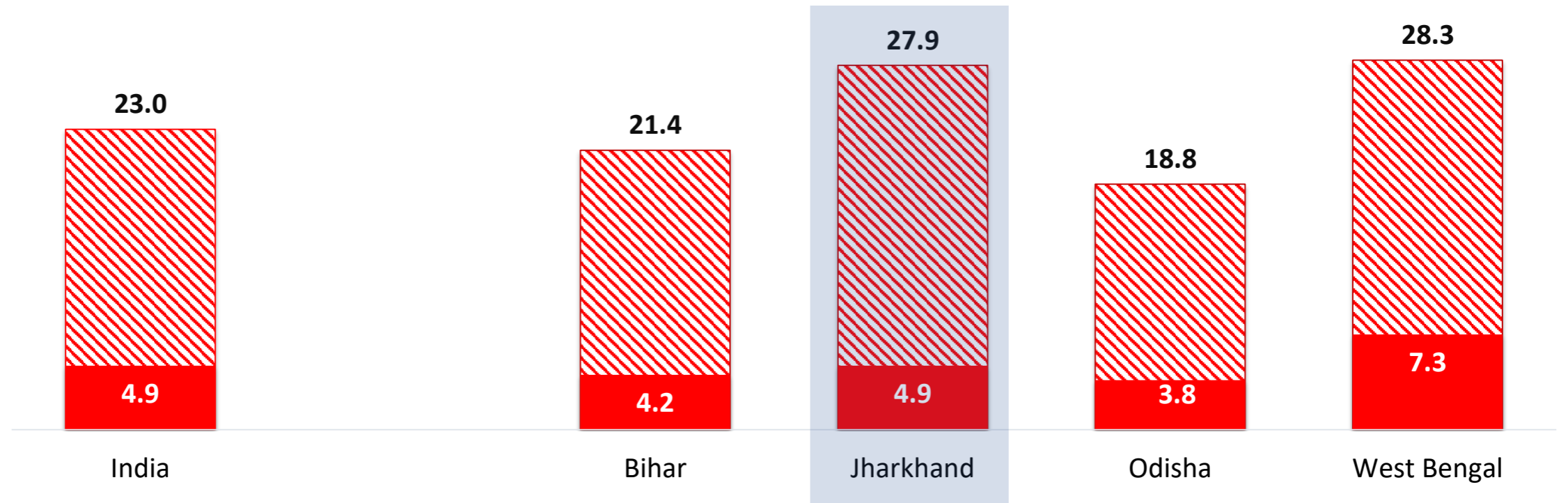
Overweight and obesity among school-age children (5-9 years)

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

Prevalence of overweight in Jharkhand was the lowest in the eastern region and the national average

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

State	Total	Obese
India	3.7	1.3
Bihar	0.8	0.2
Jharkhand	0.5	0.3
Odisha	7.8	2.9
West Bengal	4.4	1.8

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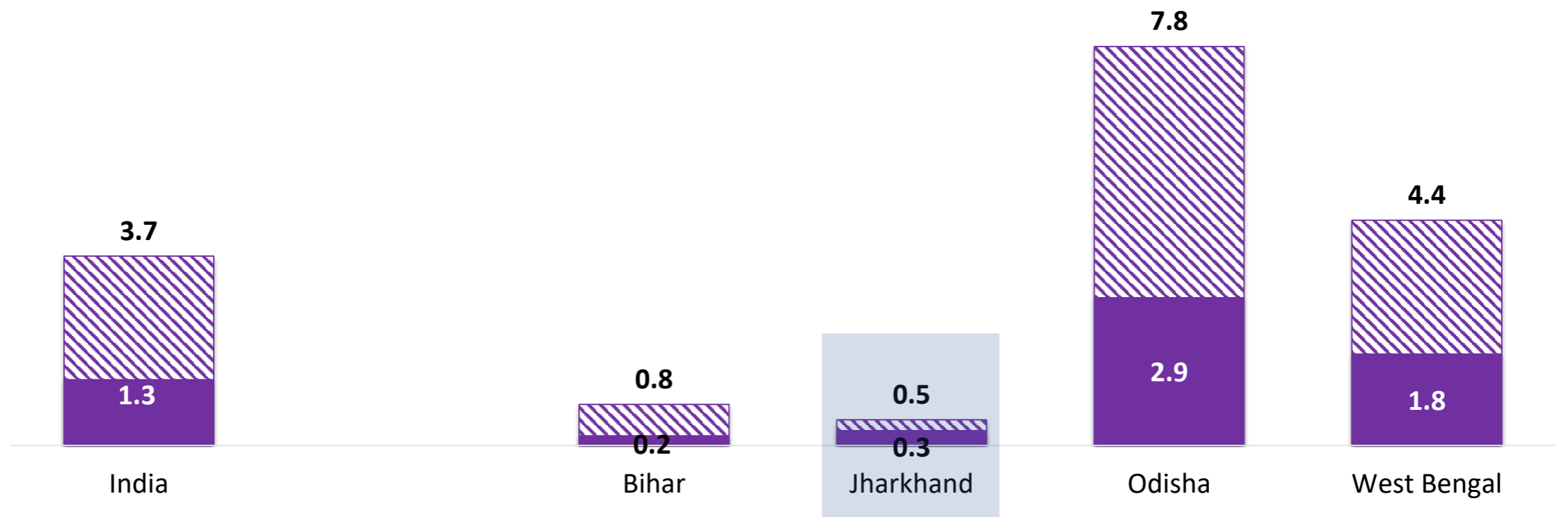
Thinness among adolescents aged 10-19 years substantially high

Nearly 3/10 adolescents aged 10-19 years were thin in Jharkhand

Among the eastern states, Jharkhand (**29%**) had the highest and Odisha (**18%**) had the lowest prevalence of thinness

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

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

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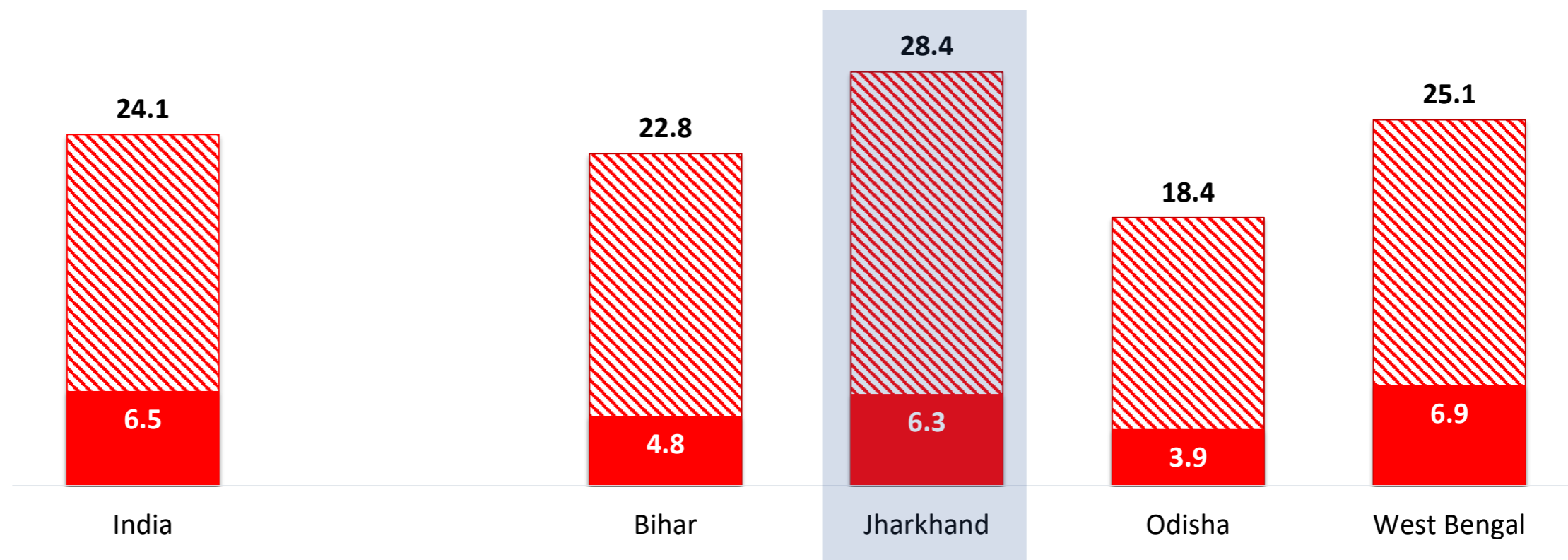
Prevalence of overweight among adolescents aged 10-19 years high

2% adolescents were overweight in Jharkhand, less than half of the national average (**5%**)

Among the eastern states, Jharkhand and Bihar had low prevalence of overweight

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

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

CNNS
Birth to Adolescence

Jharkhand key findings: Anaemia and iron deficiency

Anaemia

43.7

34.4

34.0
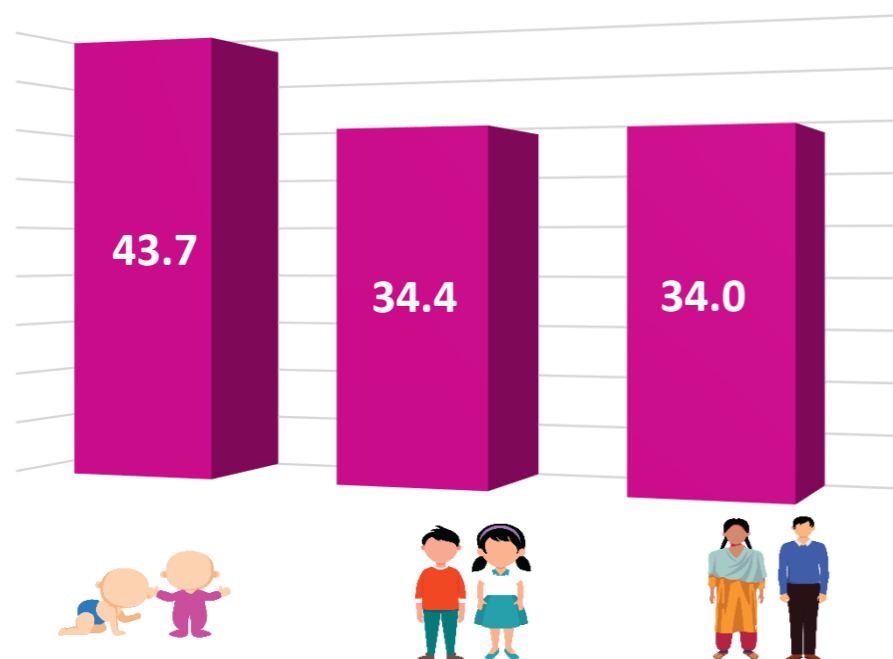
In Jharkhand, like in most states, anaemia was significantly higher among children aged 1-4 years compared to children aged 5-9 years and adolescents aged 10-19 years

Iron deficiency

14%

5%

10%
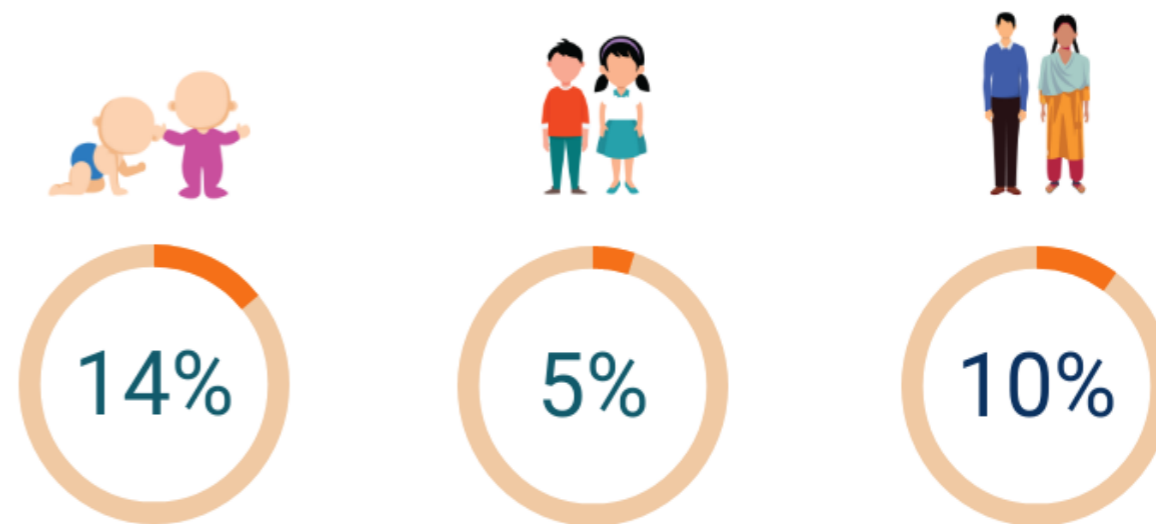
Findings indicate that children aged 1-4 years had higher iron deficiency (measured by serum ferritin) than other children or adolescents

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Birth to Adolescence

Prevalence of Anaemia among children and adolescents

Over 2/5 children aged 1-4 years were anaemic in Jharkhand (**44%**), higher than national level (**41%**)

Prevalence of anaemia was highest among children aged 1-4 years

Legend: ■ 1-4 Years ■ 5-9 Years ■ 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)

Region	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
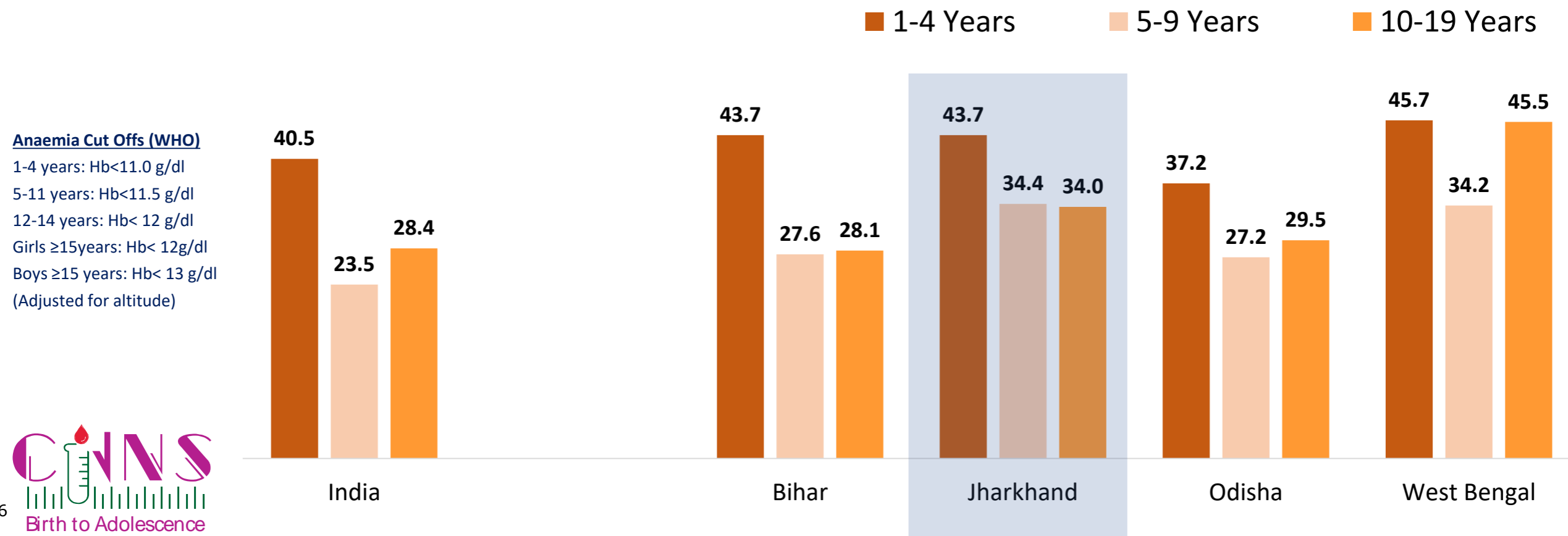
Prevalence of Anaemia among adolescents (10-19 years)

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

In Jharkhand, adolescent girls were three times 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

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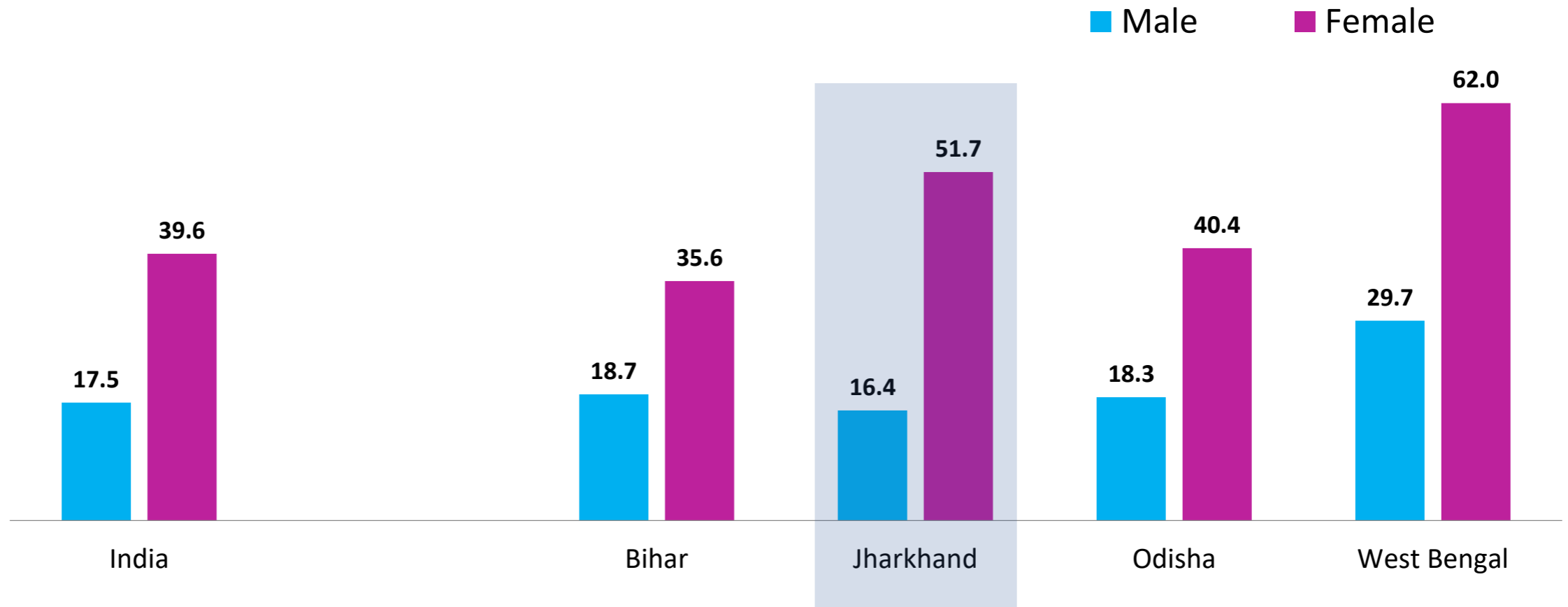
Iron deficiency measured by serum ferritin among children and adolescents

Jharkhand had lowest prevalence of iron deficiency compared to other eastern states and lower than national level among children and adolescents

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

Birth to Adolescence
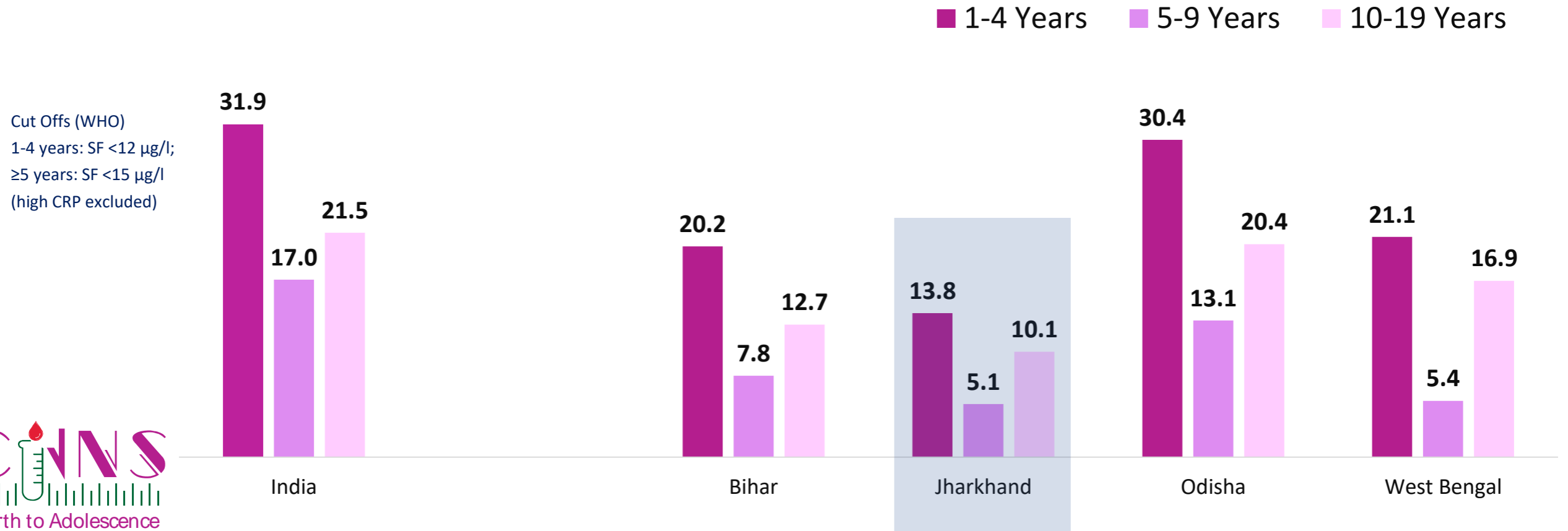
Jharkhand key findings: Vitamin A and Vitamin D deficiency

A

Vitamin A deficiency was high (42-43%) in children 1-9 years

Adolescents were found to have lower levels of Vitamin A deficiency as children aged 1-9 years

D

Vitamin D deficiency ranged from 19% to 30% 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

30-43% children and adolescents had Vitamin A deficiency in Jharkhand, nearly double the national average (**18-22%**)

Among eastern states, Jharkhand had highest 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)

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

CINS
Birth to Adolescence
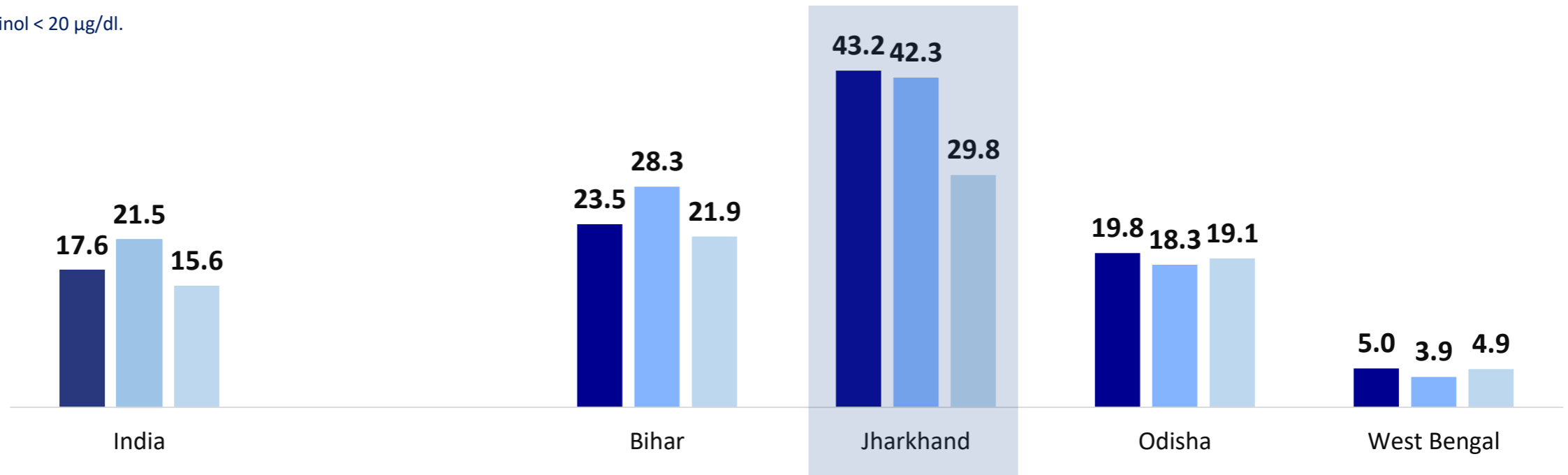
Vitamin D deficiency increases with age

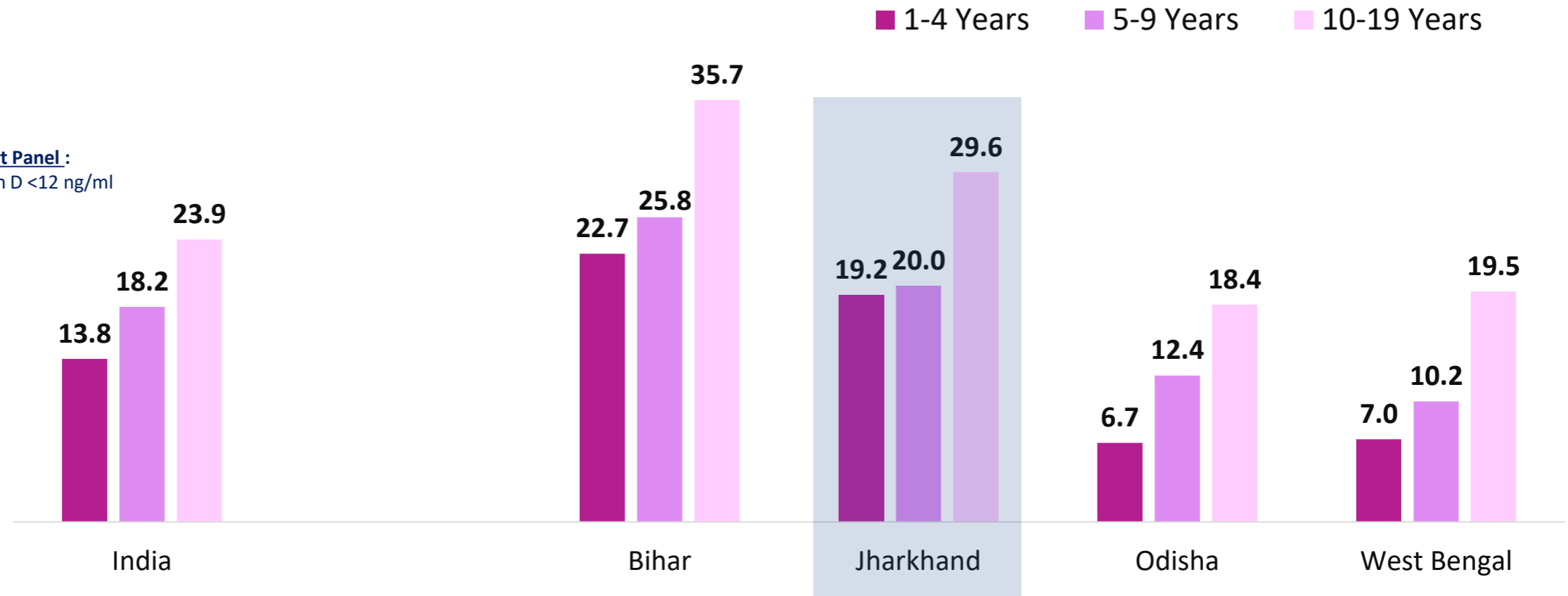**19-30%** children and adolescents had Vitamin D deficiency in Jharkhand, which is higher than the national average (**14-24%**); Vitamin D deficiency increased with age.

In eastern states, Bihar and Jharkhand had high Vitamin D deficiency among children and adolescents

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

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

Birth to Adolescence

Jharkhand key findings: Non-communicable diseases

Over 10% school-age children and adolescents were found with high level of glycosylated haemoglobin (HbA1c).
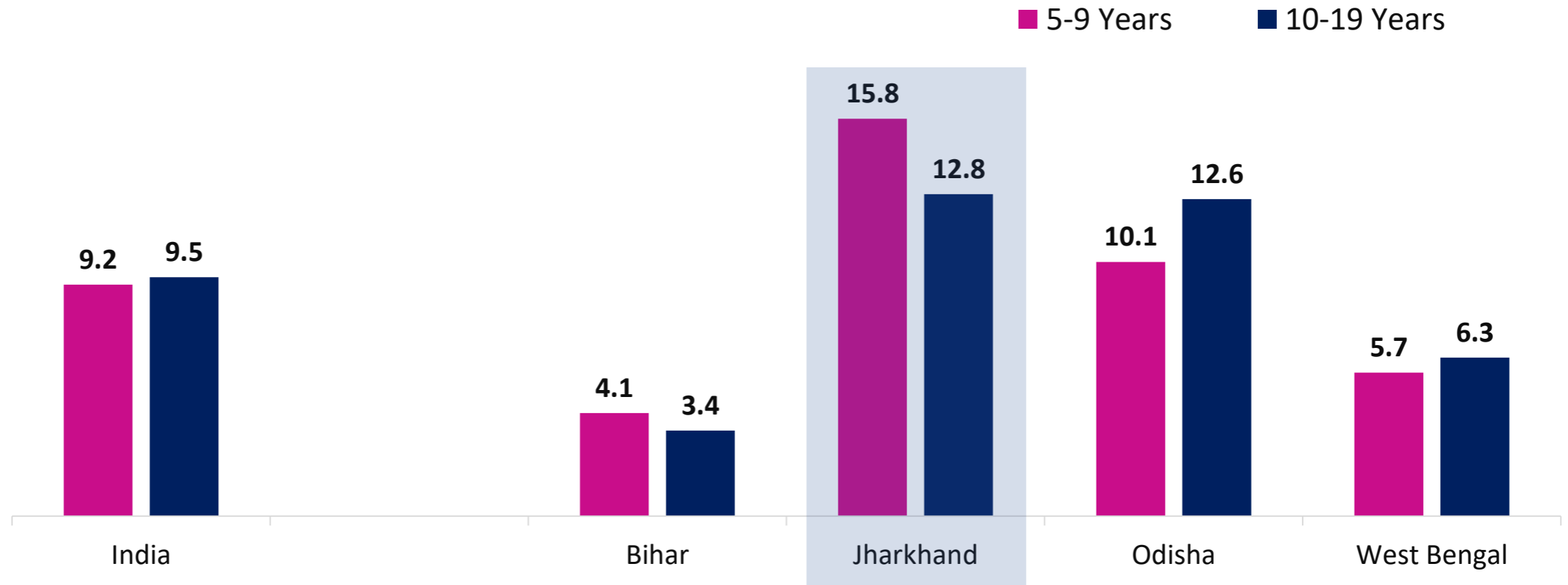
Other indicators of risks of NCDs, such as level of cholesterol, triglycerides, LDL and HDL point to increased risks of NCDs among adolescents.

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Birth to Adolescence

Risk of diabetes among school-age children and adolescents

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

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

Legend: ■ 5-9 Years   ■ 10-19 Years

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

Birth to Adolescence

High total cholesterol and high triglycerides among adolescents

Elevated risk of NCDs in Jharkhand among adolescents – **1%** had high level of total cholesterol and **18%** with high level of triglycerides

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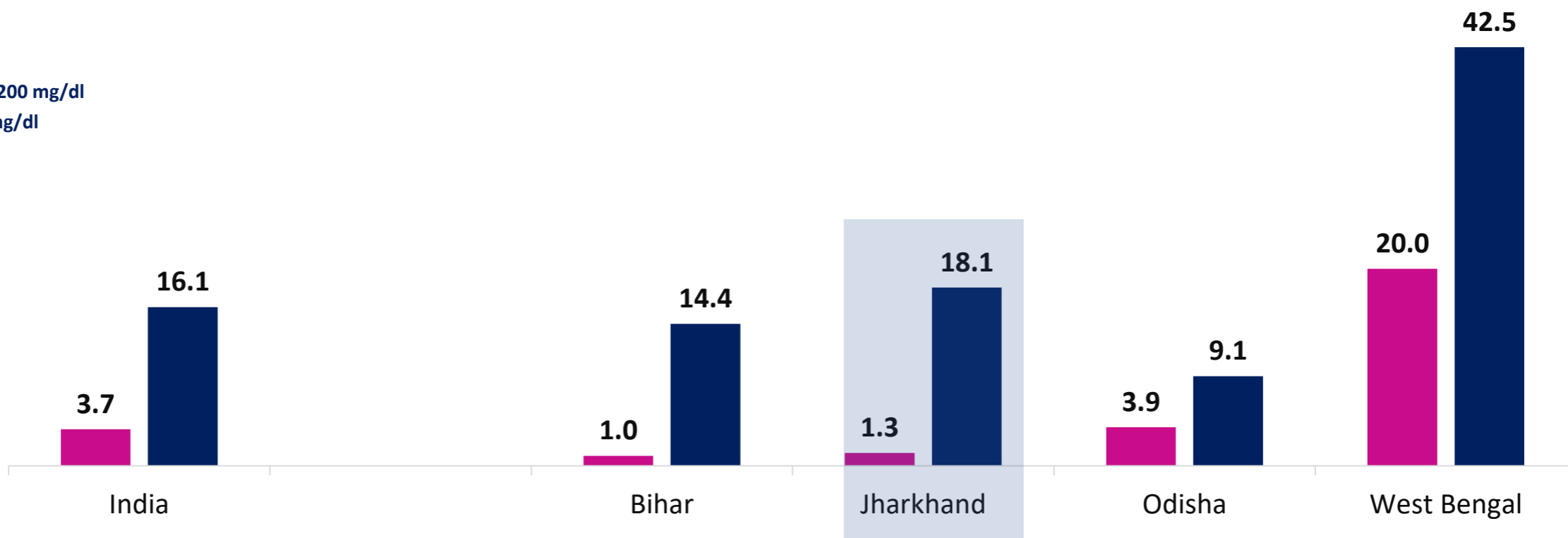
■ High total cholesterol ■ High triglycerides

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

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

CNNS
Birth to Adolescence
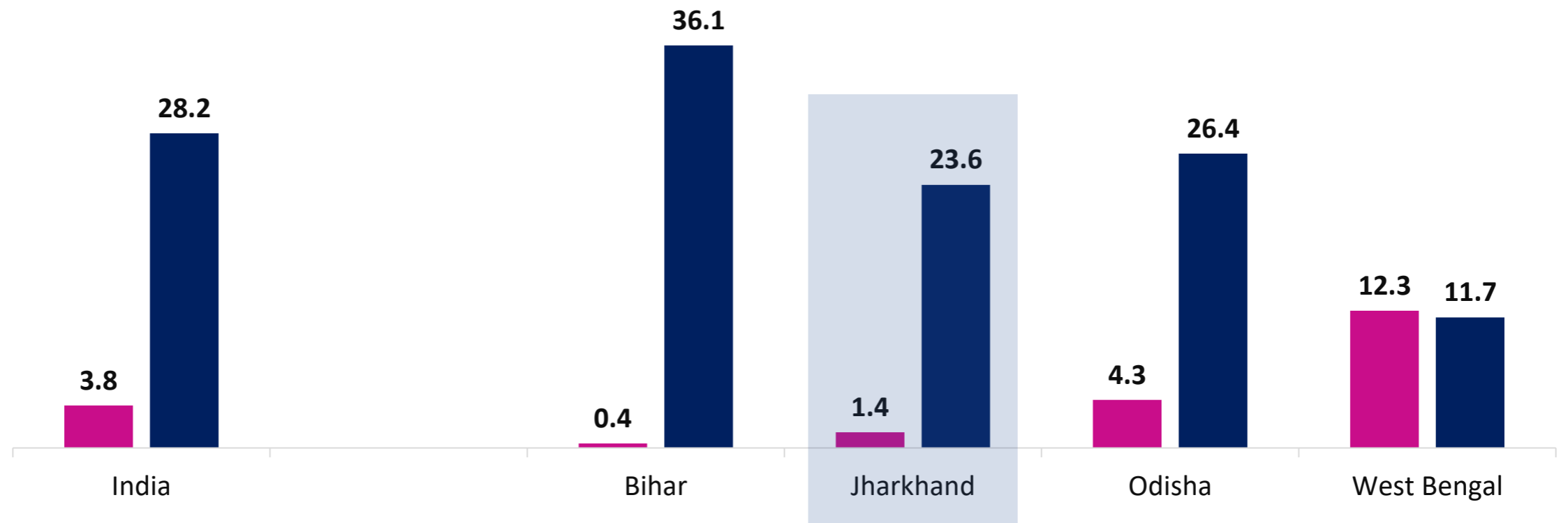
High LDL and low HDL among adolescents

Risk of NCDs among adolescents in Jharkhand was high – **1%** had high level of LDL and **24%** had low level of HDL

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

■ High LDL   ■ Low HDL

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

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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 still high. Along with Vitamin A supplementation, interventions such as dietary diversification and fortification can be taken to scale to address the 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.

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