Largest Micronutrient Survey ever conducted: CNNS 2016-

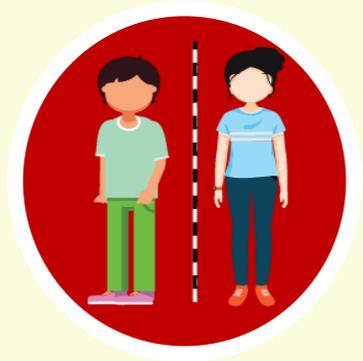**112,316**
Children and adolescents interviewed

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

200
Trainers and coordinators

900
Interviewers

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

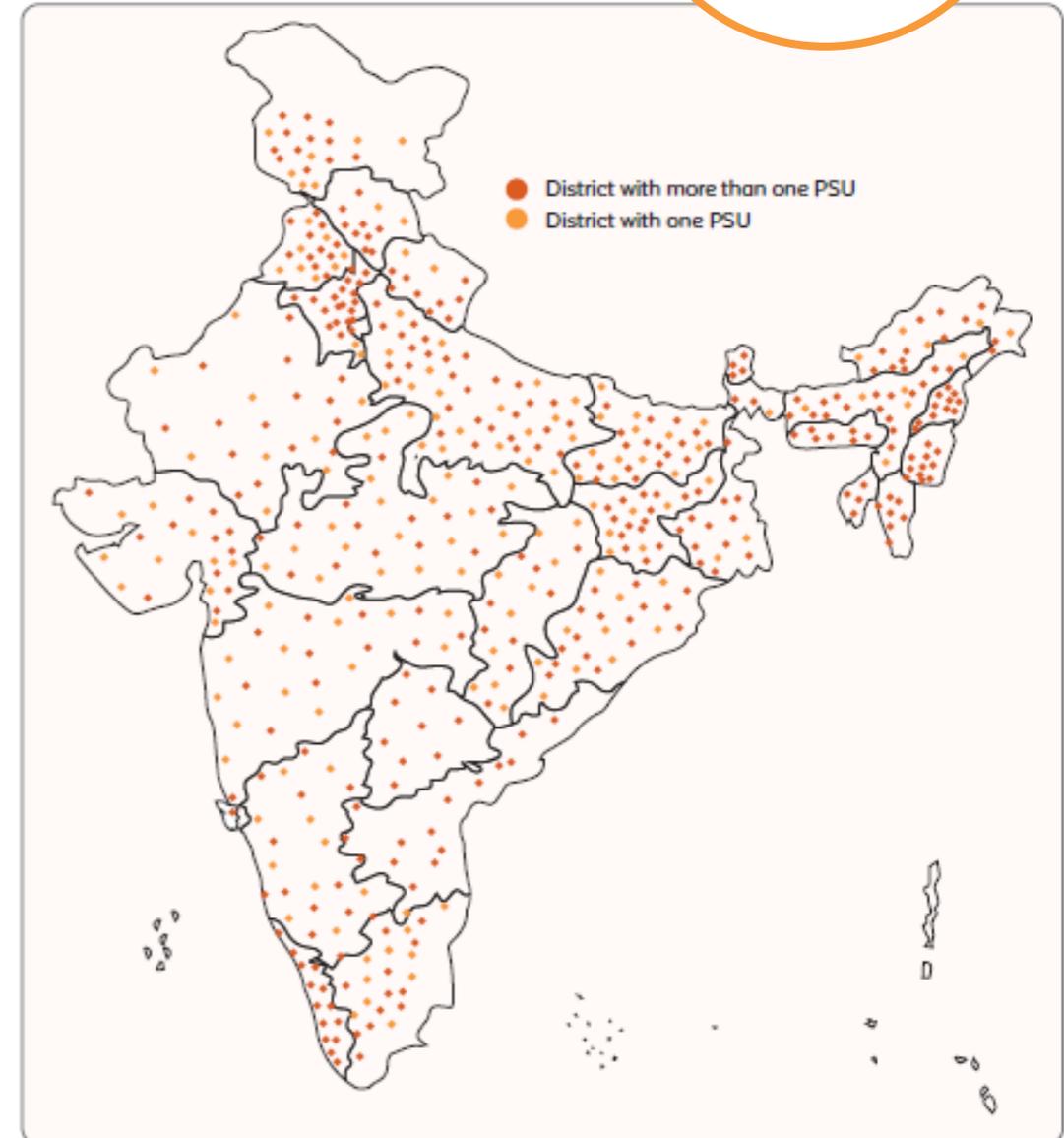# Survey Design

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

CNNS
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	
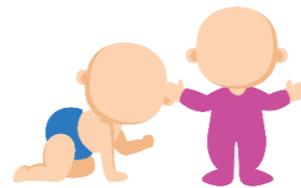
Birth to Adolescence

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**

CNNS

Birth to Adolescence

7
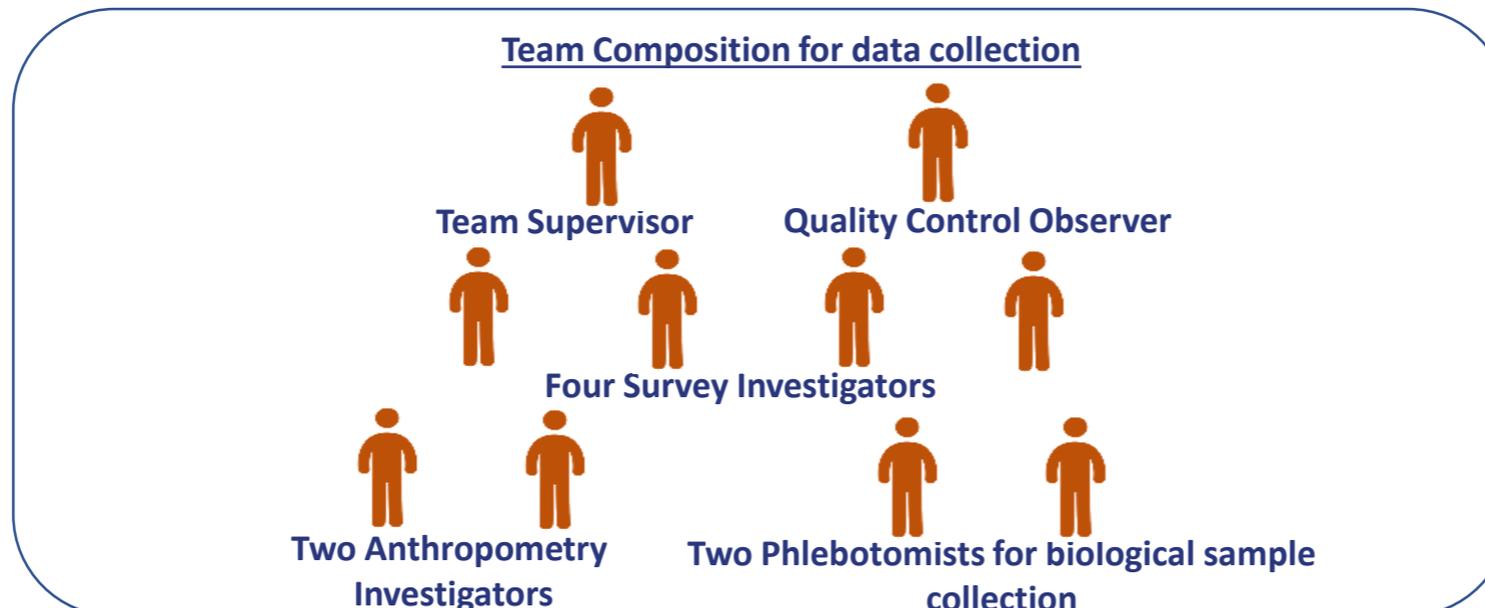
Quality Assurance Measures for Data Quality

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

CiNNS
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 Punjab

CNNS covered 55 PSUs for data collection in Punjab

Achieved following sample size by age groups:

	0-4 years	5-9 years	10-19 years	Total
Household and anthropometry data	1,004	1,048	996	**3,048**
Biological sample	571	538	534	**1,643**

Birth to Adolescence

Period of data collection in Punjab

CNNS data collection period: September 20, 2017 to March 4, 2018

- CNNS collected data during the autumn of 2017 through winter of 2018

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

Survey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CNNS 2017-18	March, 2018								September, 2017 to			
NFHS 4 2016	January, 2016 to June, 2016											

CNNS
Birth to Adolescence

No change in stunting and underweight but wasting declined in children under 5 years

NFHS **CNNS**

- Stunting (Low height for age): NFHS 25.7%, CNNS 24.3%
- Wasting (Low weight for height): NFHS 15.6%, CNNS 6.7%
- Underweight (Low weight for age): NFHS 21.6%, CNNS 19.7%

Stunting (Low height for age)   **Wasting (Low weight for height)**   **Underweight (Low weight for age)**

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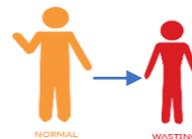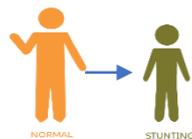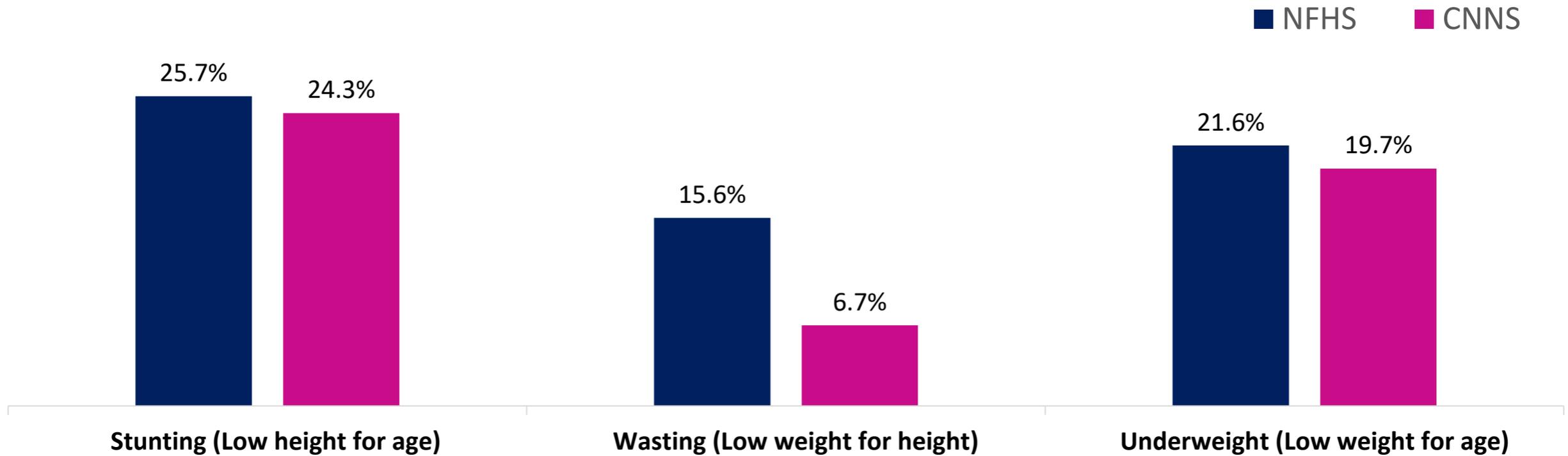
1/5 of adolescents aged 10-19 years was thin for their age (BMI-Age <-2SD)

1/8 children aged 5-9 years was stunted. The school age period does not provide an opportunity for catch up growth in height.

9% of adolescents aged 10-19 years were overweight or obese.

9.1%

Overweight (high BMI for age)

Birth to Adolescence

NORMAL

OVERWEIGHT/ OBESITY
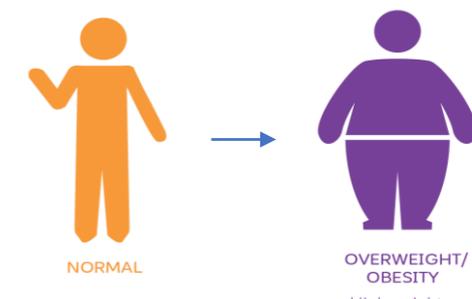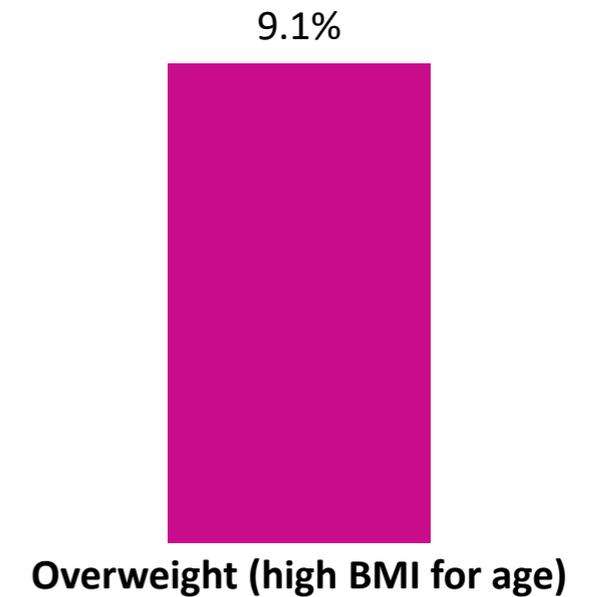
Stunting unchanged among children under five
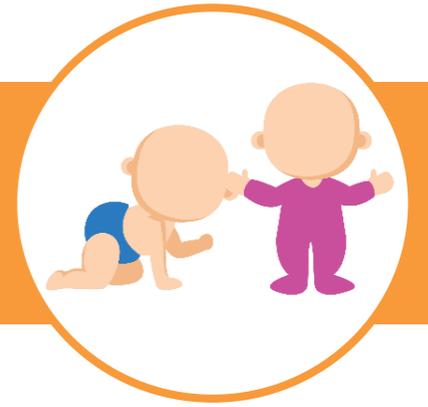
Prevalence of stunting remained unchanged in CNNS compared to NFHS-4 – **24%** vs **26%**

In most of the northern states, stunting did not change, except in Jammu and Kashmir, where it declined

Legend: ■ NFHS-4 ■ CNNS

State	NFHS-4	CNNS
India	38.4	34.7
Delhi	31.9	28.8
Haryana	34.0	34.9
Himachal Pradesh	26.3	28.4
Jammu and Kashmir	27.4	15.5
Punjab	25.7	24.3
Rajasthan	39.1	36.8
Uttarakhand	33.5	29.9

CNNS
Birth to Adolescence
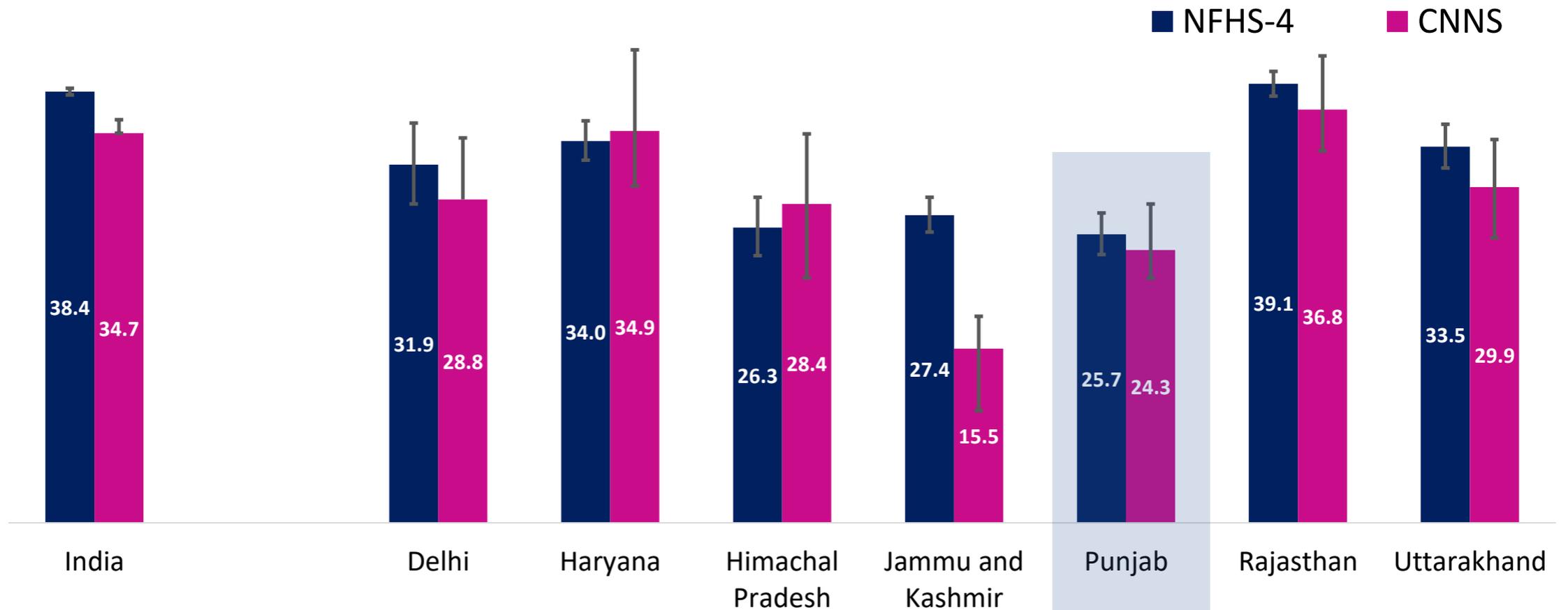
Wasting declined among children under five
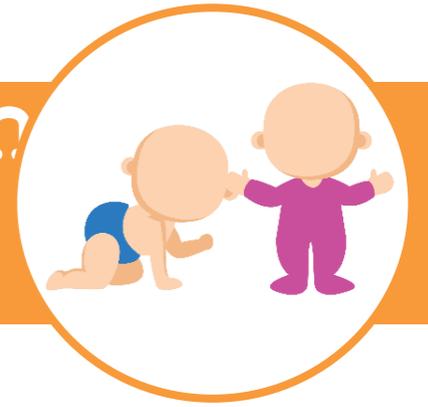
Prevalence of wasting declined significantly in Punjab between NFHS-4 and CNNS – **16%** vs **7%**

In 4/7 northern states, wasting declined; except in Jammu and Kashmir, Himachal Pradesh and Delhi

■ NFHS-4   ■ CNNS

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
NFHS-4	21.0	15.9	21.2	13.7	12.1	15.6	23.0	19.5
CNNS	17.3	14.8	11.7	11.0	14.9	6.7	14.3	5.9

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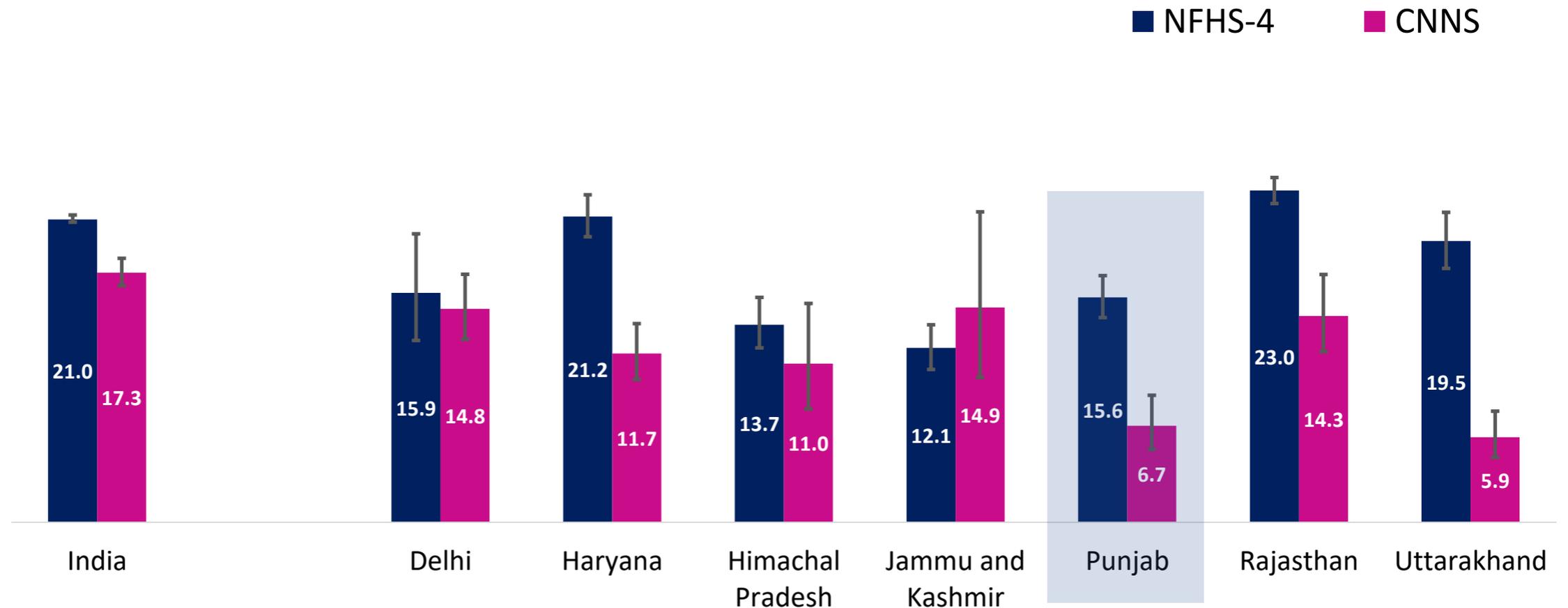
Prevalence of underweight among children under five unchanged
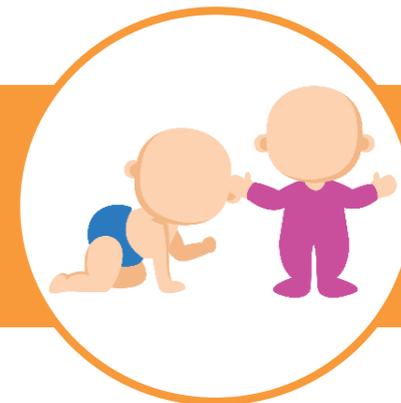
Underweight is a composite measure of chronic and acute malnutrition

The prevalence of underweight did not change between NFHS-4 and CNNS – **22%** Vs **20%**

Prevalence remained unchanged in most of the northern states; except in Uttarakhand

■ NFHS-4   ■ CNNS

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
NFHS-4	35.7	27.0	29.4	21.2	16.6	21.6	36.7	26.6
CNNS	33.4	28.1	28.8	22.6	13.1	19.7	31.5	18.7

16
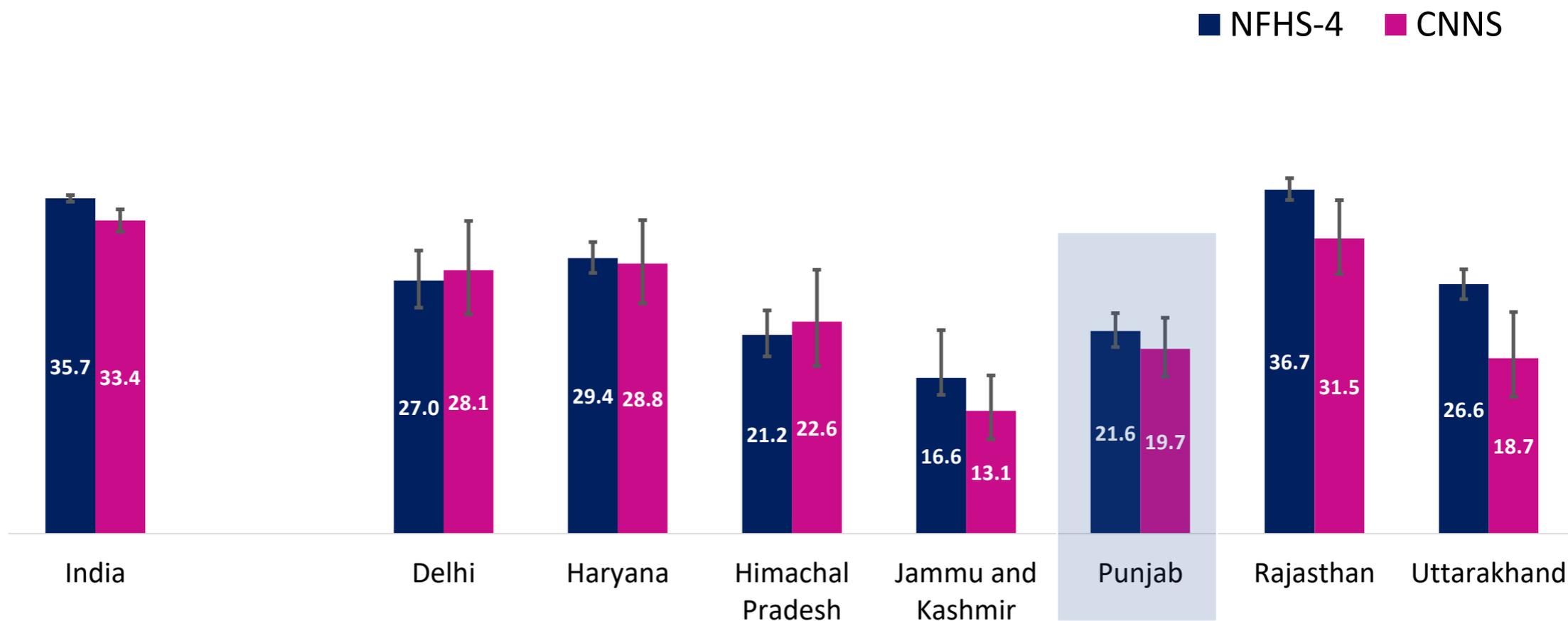
Triceps Skinfold Thickness (TSFT) for children under five

Low fat mass as reported by TSFT in Punjab (**7%**) was lower than national average (**10%**); highest in Jammu & Kashmir (**21%**) among the northern states

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

State	Total	TSFT (< -3SD)
India	9.7	2.4
Delhi	5.0	0.6
Haryana	7.2	2.0
Himachal Pradesh	10.7	0.9
Jammu and Kashmir	21.1	6.0
Punjab	7.3	0.9
Rajasthan	7.0	0.9
Uttarakhand	5.0	1.7

CNNS
Birth to Adolescence
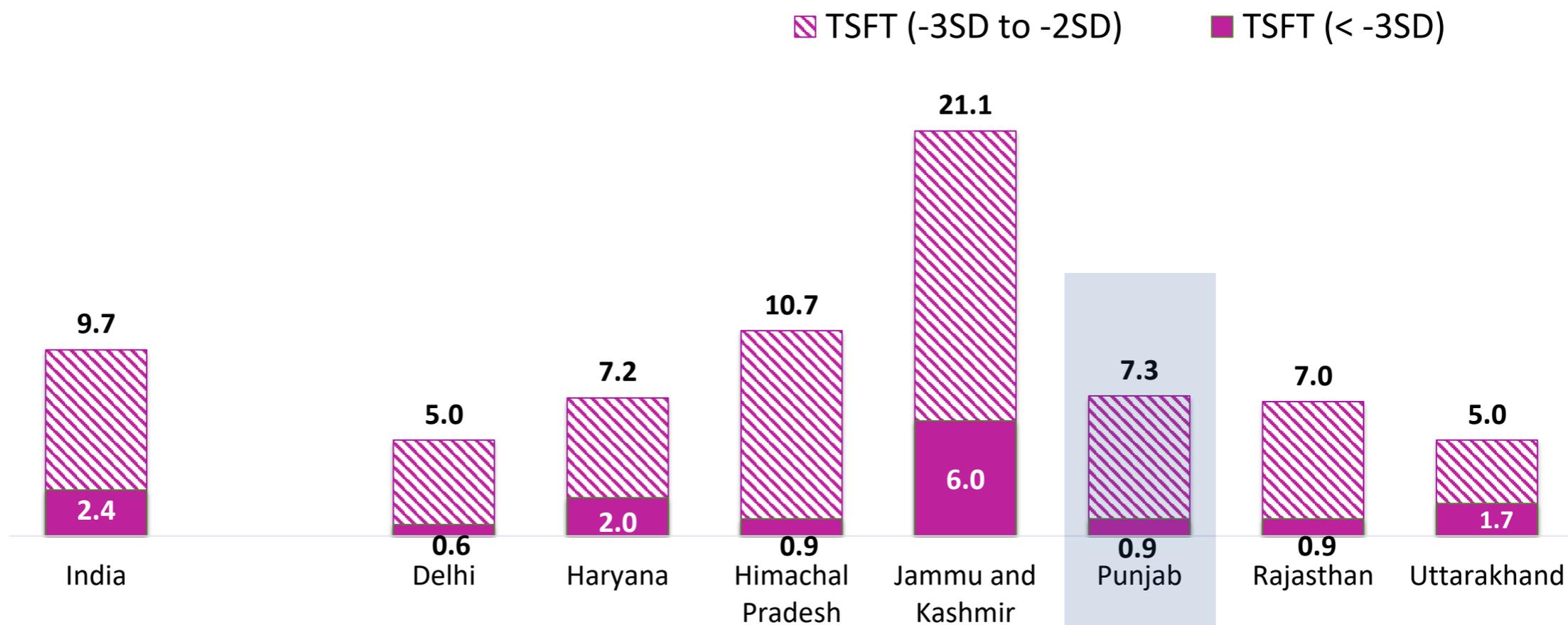
Subscapular Skinfold Thickness (SSFT) for children aged 1-4 years
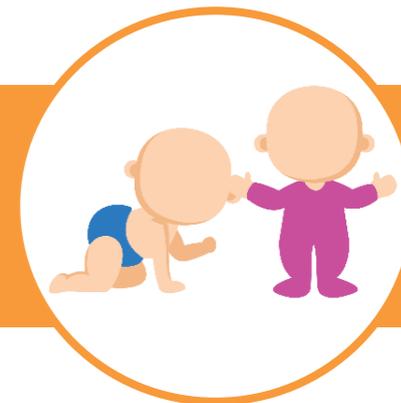
Thinness as reported by SSFT in Punjab (**5%**) was lower than national average (**9%**) and most of the northern states except Delhi (**5%**)

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

State	SSFT (-3SD to -2SD)	SSFT (< -3SD)
India	8.6	1.6
Delhi	4.9	1.2
Haryana	8.3	2.2
Himachal Pradesh	10.1	0.9
Jammu and Kashmir	16.1	1.6
Punjab	4.9	1.1
Rajasthan	8.0	1.1
Uttarakhand	6.6	1.7

Birth to Adolescence
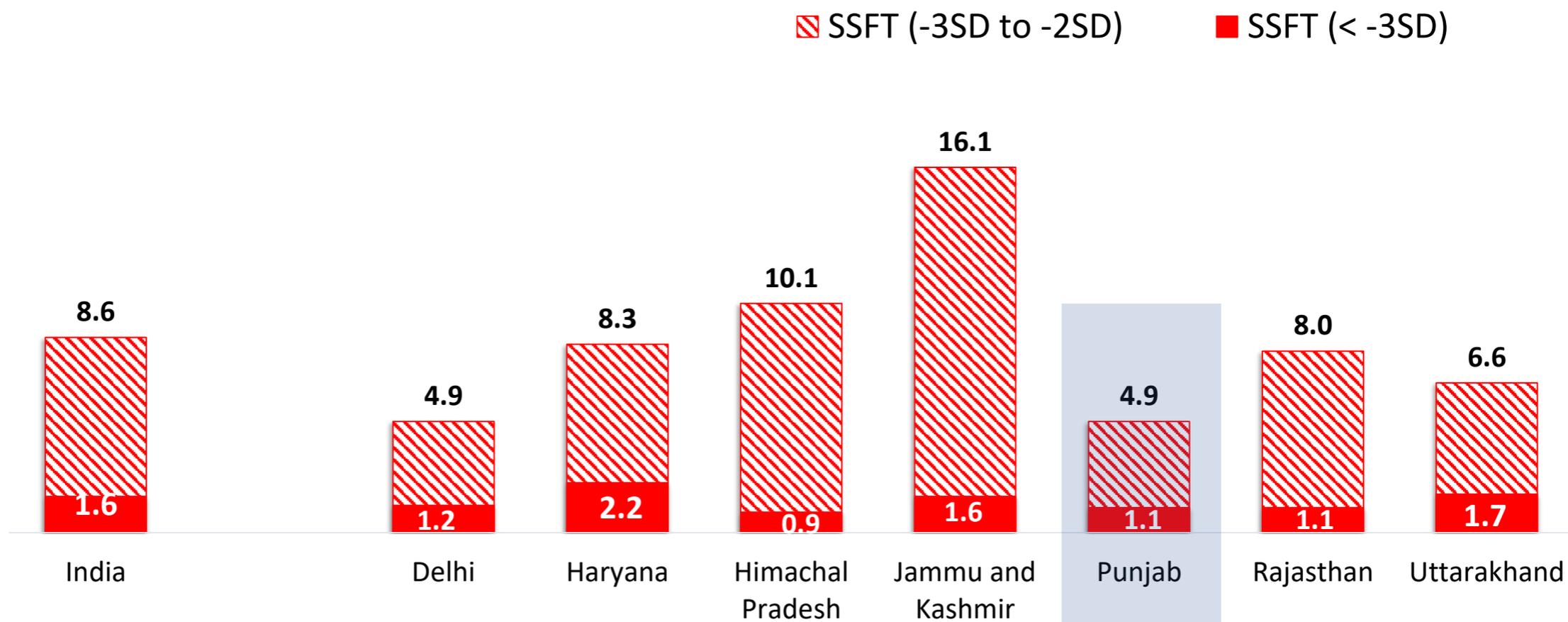
Mid Upper Arm Circumference (MUAC) for children aged 6-59 months
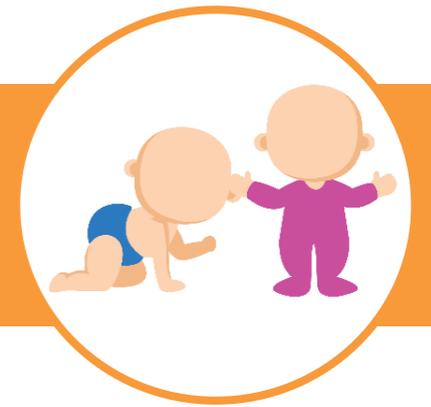
About **4%** children in Punjab had low MUAC

Prevalence of low MUAC ranged between **1%** and **6%** across the northern states

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

State	MUAC (<115 mm)	Total
India	0.9	4.9
Delhi	0.3	2.4
Haryana	0.7	4.7
Himachal Pradesh	0.6	2.4
Jammu and Kashmir	2.5	6.0
Punjab	1.1	3.7
Rajasthan	1.0	5.2
Uttarakhand	0.1	0.8

CNNS
Birth to Adolescence

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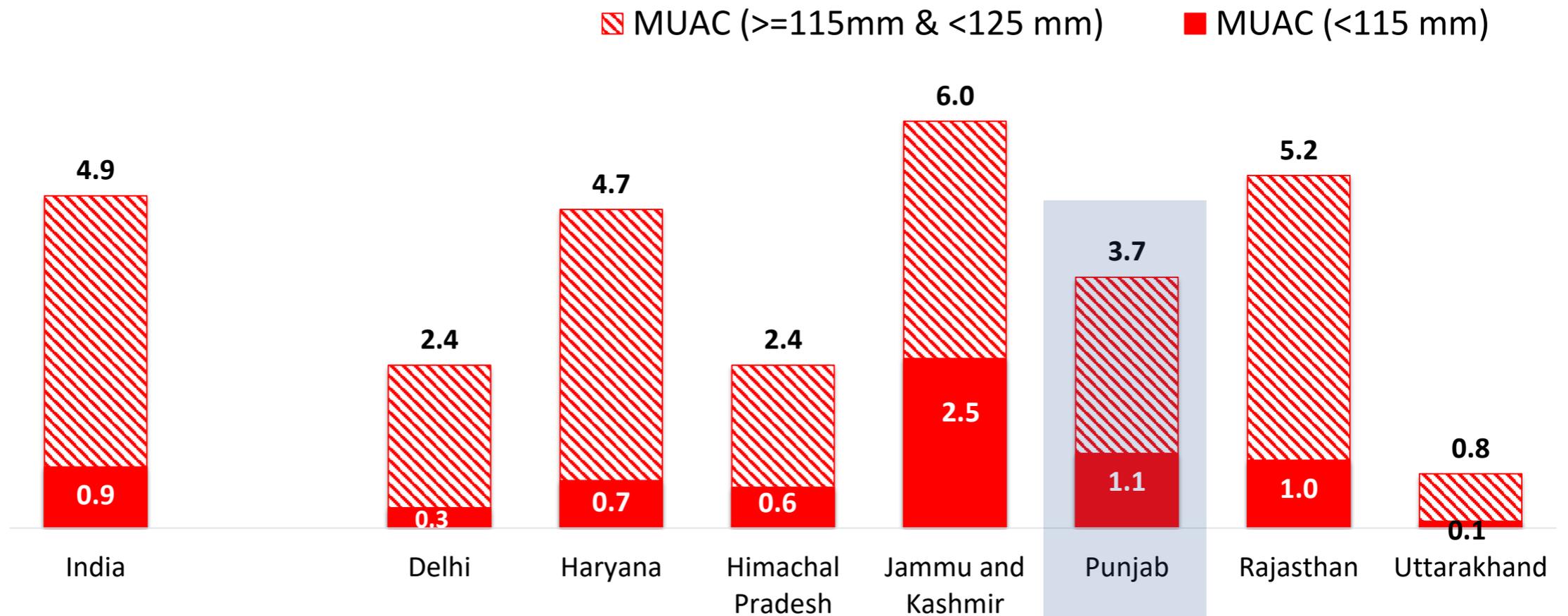
Stunting among school-age children (5-9 years)

Nearly **1/8** of children aged 5-9 years was stunted in Punjab; significant proportion of children who were stunted in childhood remained stunted into their schooling age reducing their potential capacity for education

Among northern states, Punjab had lowest prevalence of stunting

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

State	Moderately stunted	Severely stunted
India	21.9	5.5
Delhi	21.0	5.5
Haryana	16.4	3.0
Himachal Pradesh	20.3	3.1
Jammu and Kashmir	13.3	4.8
Punjab	12.3	2.5
Rajasthan	23.9	6.1
Uttarakhand	20.4	4.1

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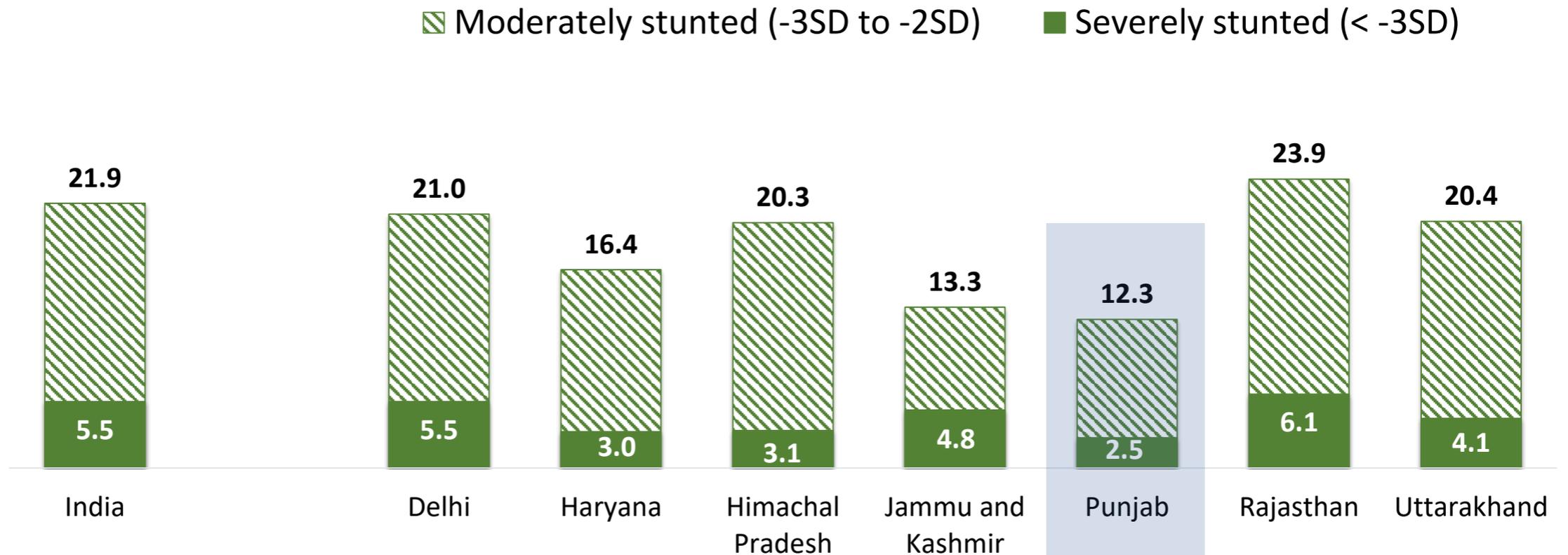
Thinness among school-age children (5-9 years)

Nearly **1/8** children aged 5-9 years was thin in Punjab

Prevalence of thinness in Punjab (**12%**) was the lowest among northern states and also significantly lower than national average (**23%**)

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

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
Total	23.0	18.5	20.4	22.2	16.6	11.9	22.1	14.2
Severe	4.9	3.1	3.4	4.6	6.7	2.2	3.9	3.7

CNNS
Birth to Adolescence
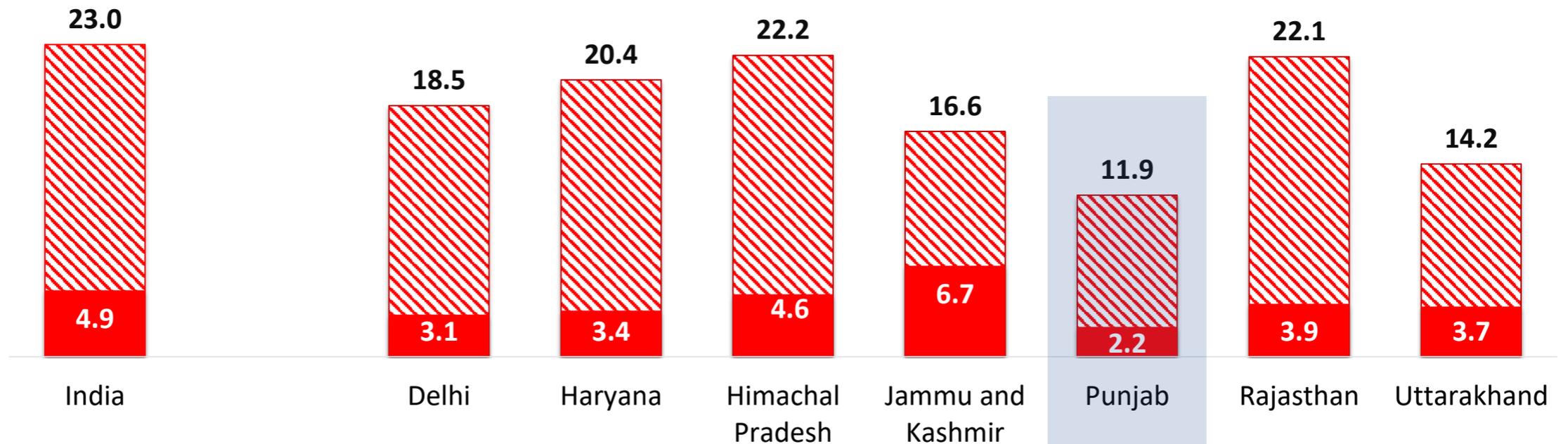
Overweight and obesity are on rise even among children aged 5-9 years

Prevalence of overweight in Punjab (**8%**) was double the national average (**4%**)

Among northern states, Jammu & Kashmir and Punjab had the highest prevalence of overweight in this age group (**8-9%**)

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

State	Total	Obese
India	3.7	1.3
Delhi	6.0	2.0
Haryana	3.7	1.2
Himachal Pradesh	3.8	1.2
Jammu and Kashmir	9.0	3.4
Punjab	7.9	2.8
Rajasthan	1.6	0.4
Uttarakhand	6.1	1.9

22
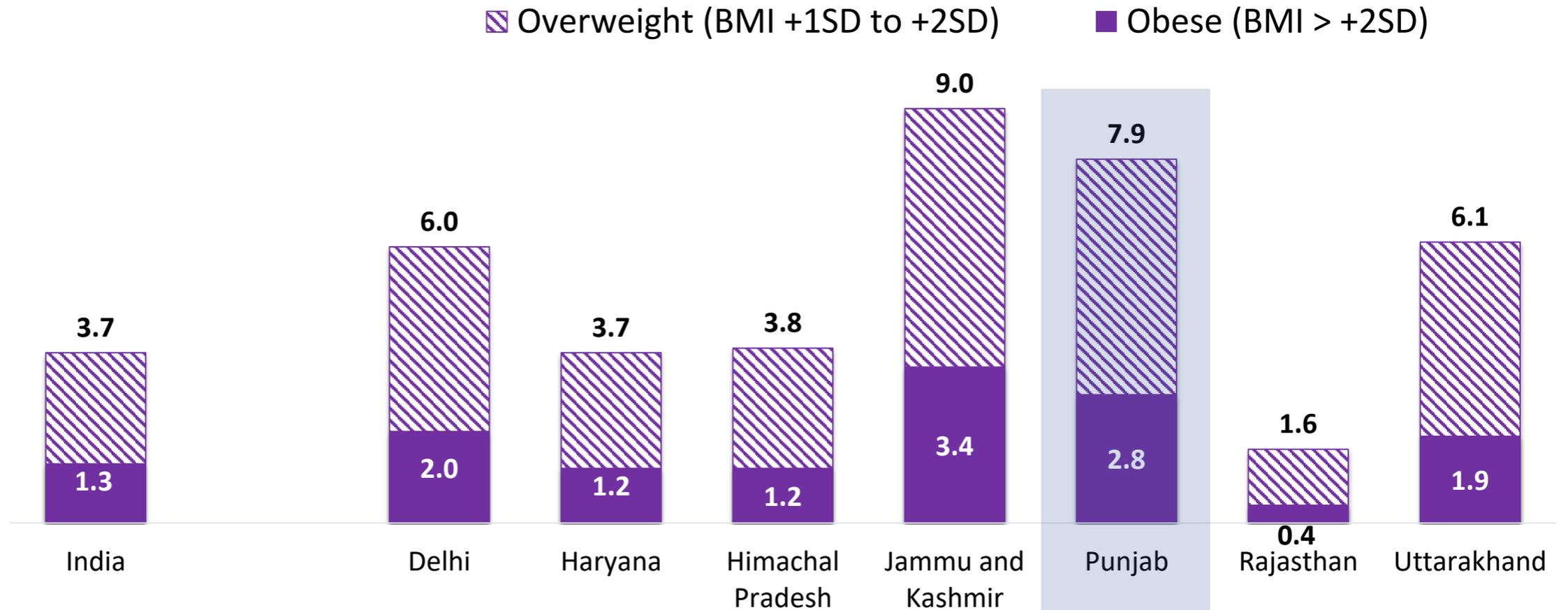
Thinness among adolescents aged 10-19 years substantially high

18% of adolescents aged 10-19 years were thin in Punjab, lower than national average (**24%**)

Among the northern states, Himachal Pradesh (**31%**) and Rajasthan (**29%**) had high prevalence of thinness

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

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
Total	24.1	21.3	20.6	31.2	13.3	17.8	29.3	15.2
Severe thinness	6.5	4.9	5.6	9.9	4.0	2.9	7.4	2.2

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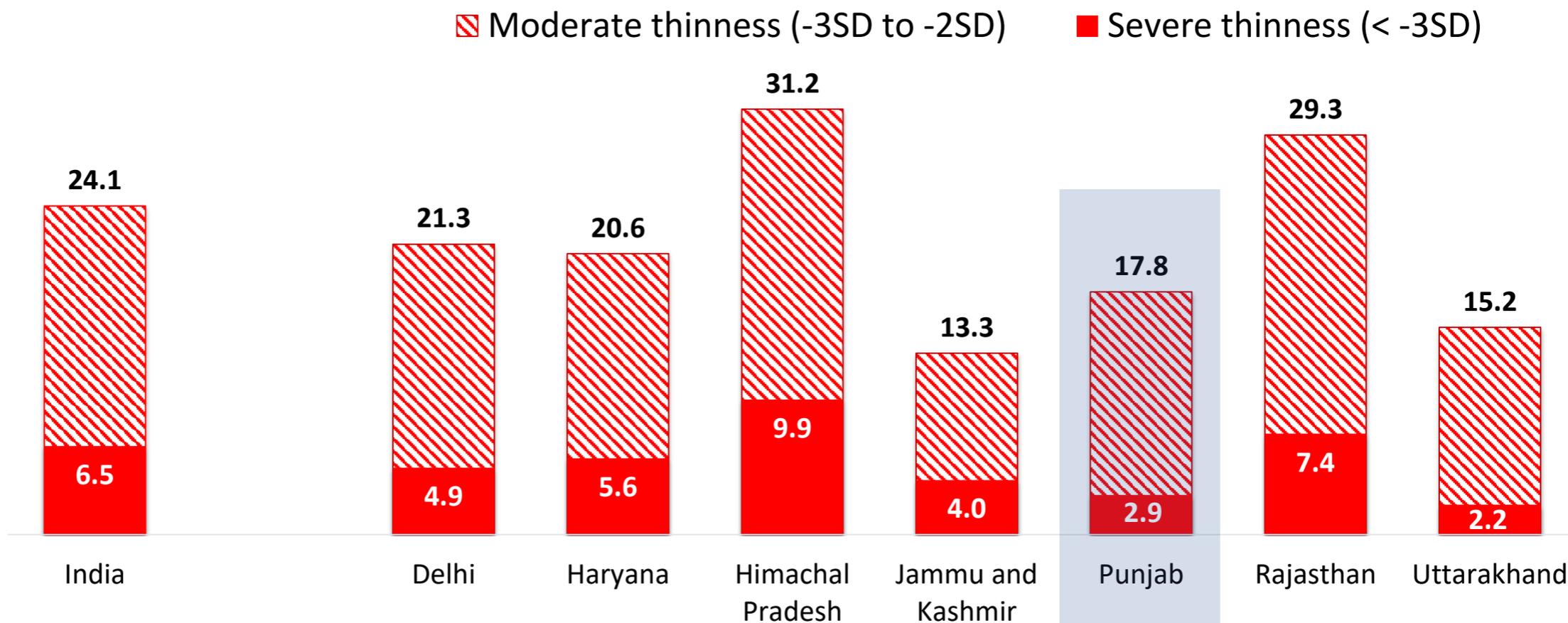
Prevalence of overweight among adolescents aged 10-19 years high

1/10 adolescents was overweight in Punjab (**9**%), was higher than the national average (**5%**)

Among the northern states, Delhi (**12%**)had highest prevalence, also high in Jammu and Kashmir (**9%**) and Punjab (**9%**)
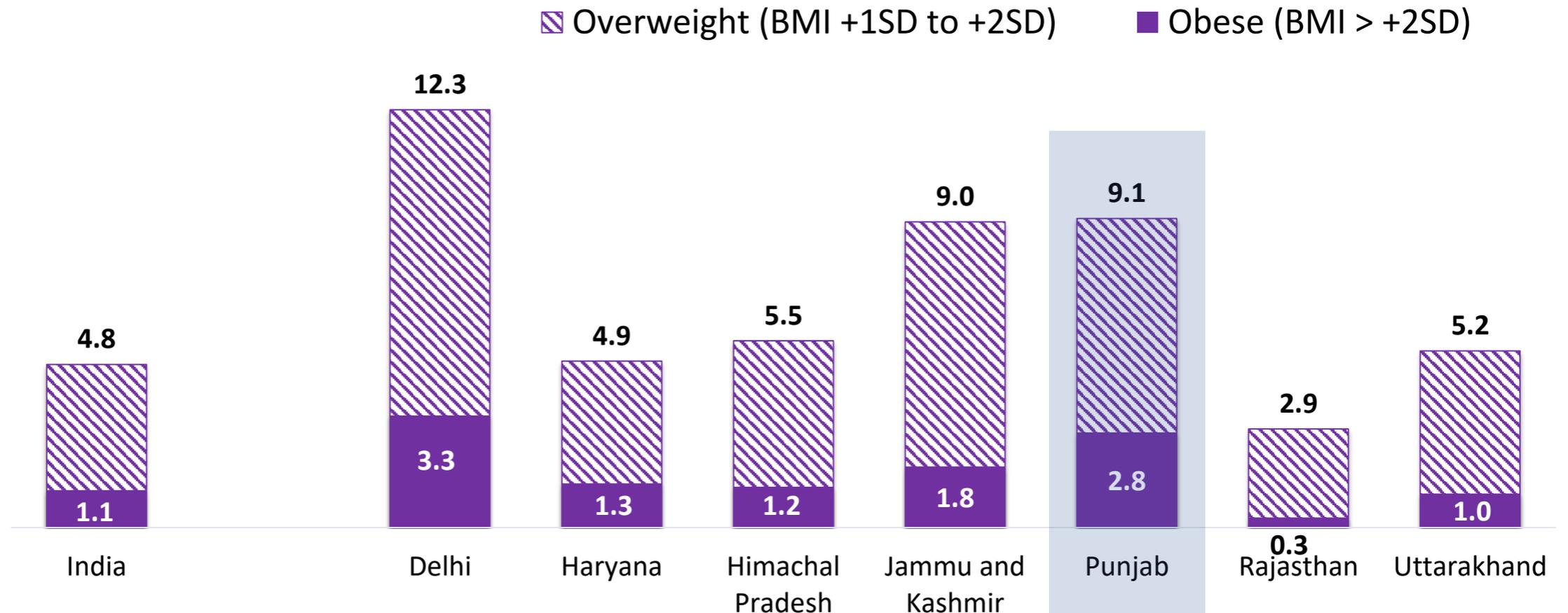

Legend: ▨ Overweight (BMI +1SD to +2SD)　■ Obese (BMI > +2SD)

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
Total	4.8	12.3	4.9	5.5	9.0	9.1	2.9	5.2
Obese	1.1	3.3	1.3	1.2	1.8	2.8	0.3	1.0

Birth to Adolescence

Punjab key findings: Anaemia and iron deficiency

Anaemia

40.0

12.0

26.0
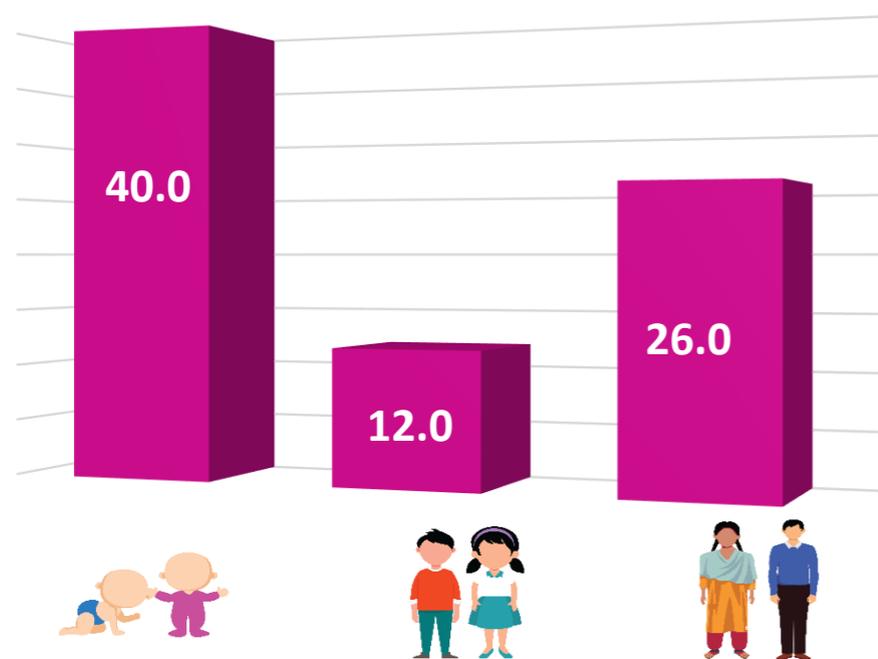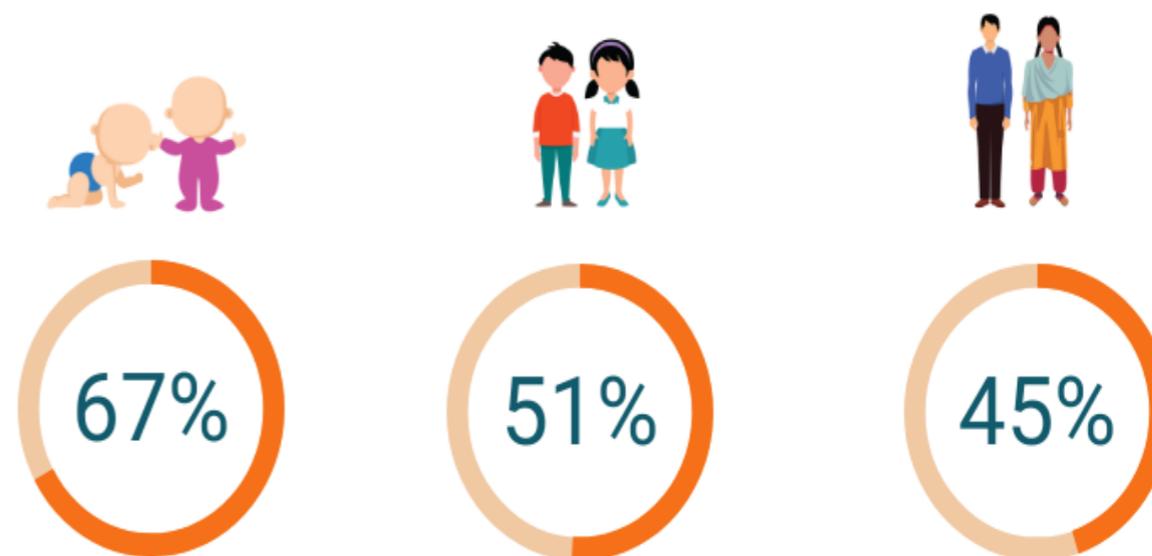
In Punjab, like in most states, anaemia was significantly higher among children aged 1-4 years compared to children aged 5-9 years and adolescents aged 10-19 years

Iron deficiency

67%

51%

45%

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

CINS
Birth to Adolescence

Prevalence of Anaemia among children and adolescents

2/5 children aged 1-4 years were anaemic in Punjab (**40%**), similar to national average (**41%**)
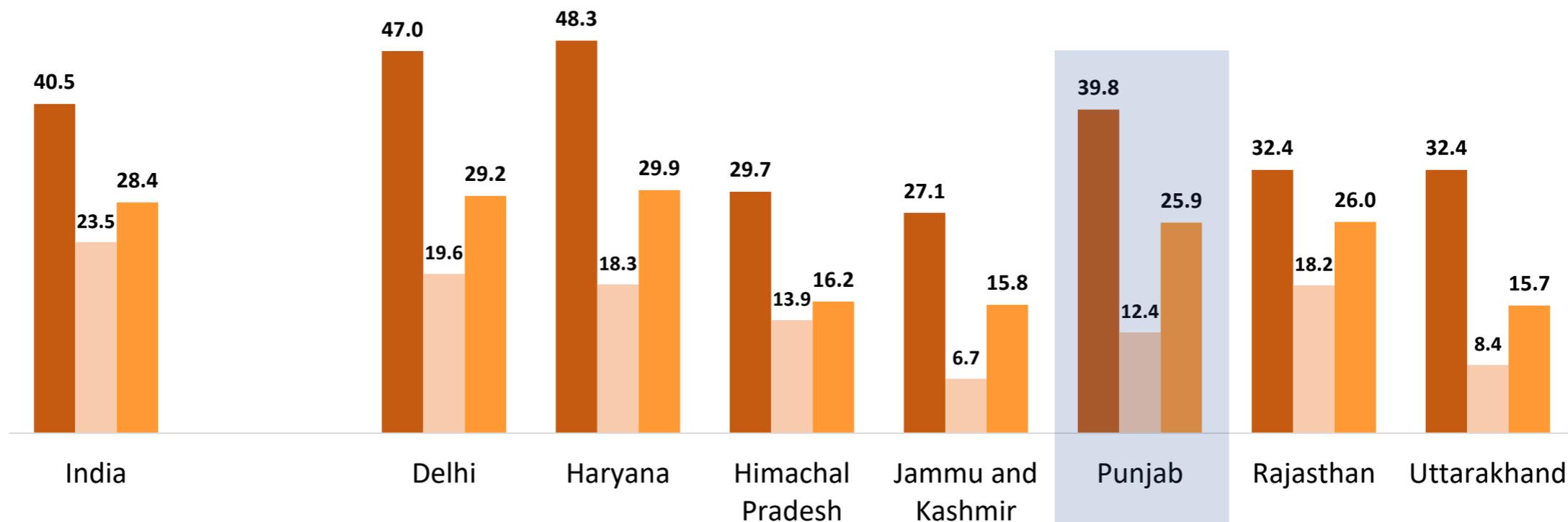
Prevalence of anaemia was highest among children aged 1-4 years, increased again in adolescence

■ 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)

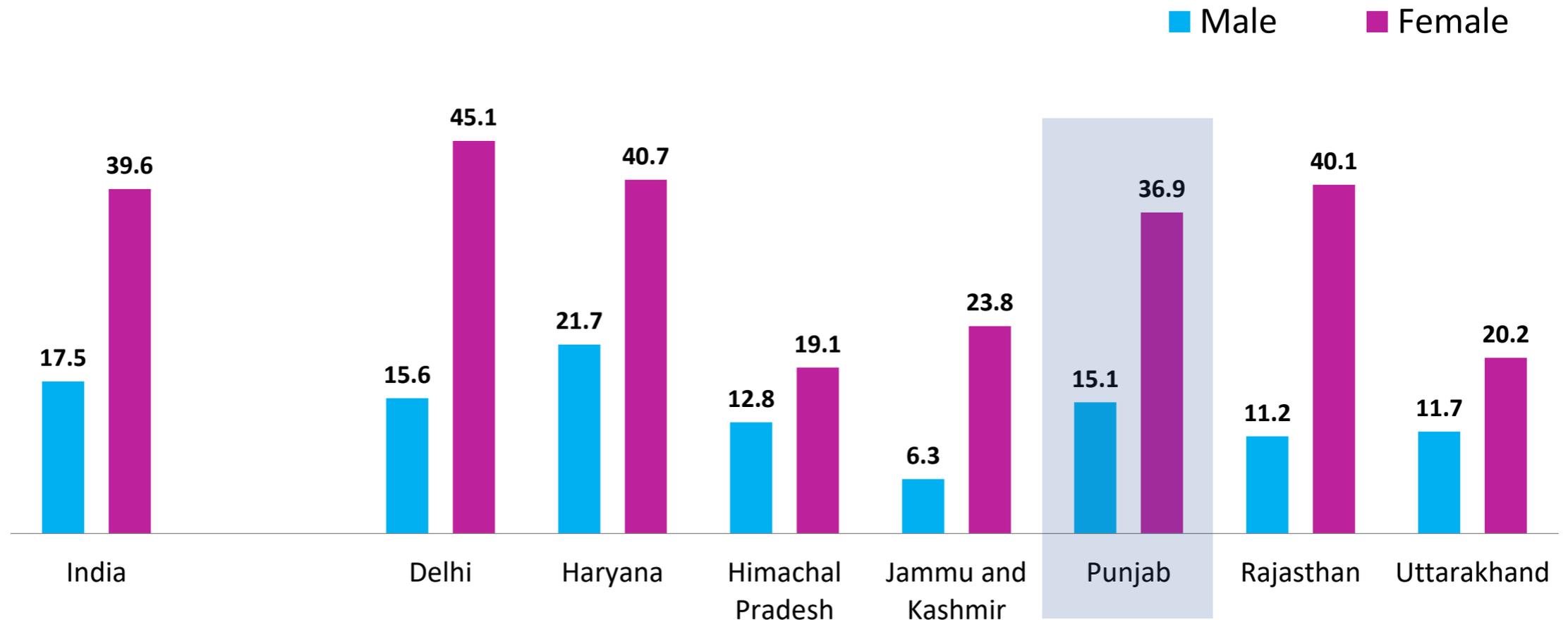| State	1-4 Years	5-9 Years	10-19 Years
India	40.5	23.5	28.4
Delhi	47.0	19.6	29.2
Haryana	48.3	18.3	29.9
Himachal Pradesh	29.7	13.9	16.2
Jammu and Kashmir	27.1	6.7	15.8
Punjab	39.8	12.4	25.9
Rajasthan	32.4	18.2	26.0
Uttarakhand	32.4	8.4	15.7

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 Punjab, as in many other northern states, adolescent girls were twice more likely than adolescent boys to be anaemic

Legend: ■ Male ■ Female

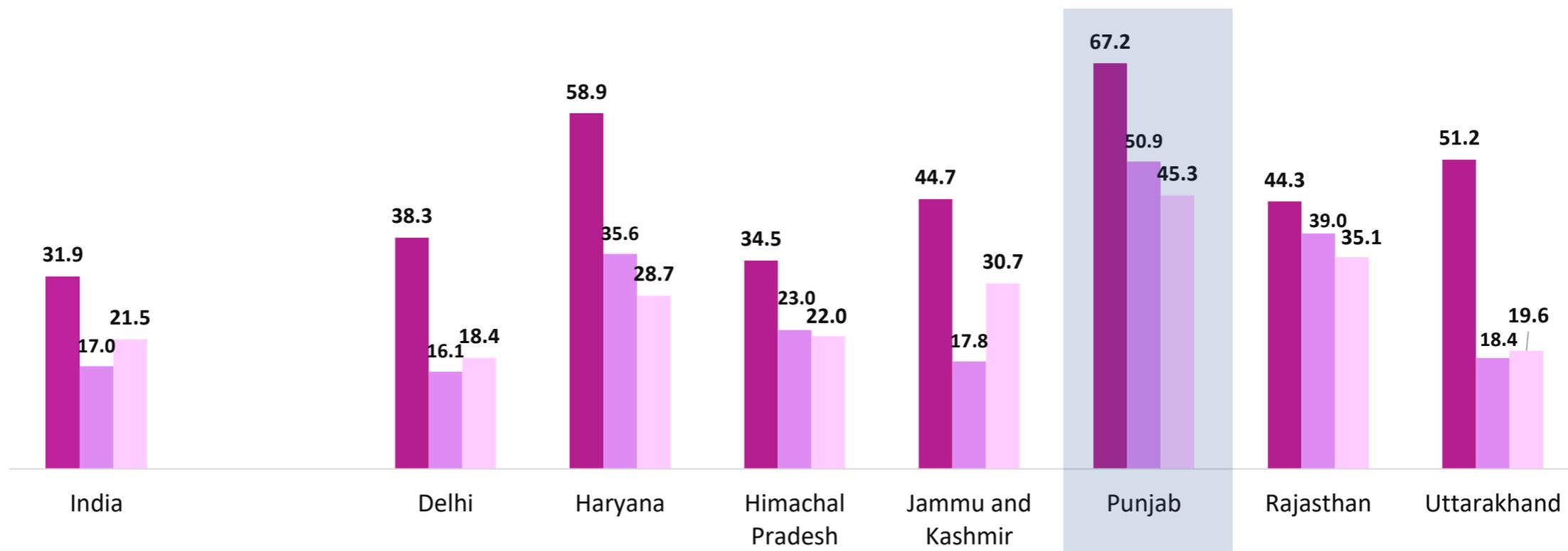| State	Male	Female
India	17.5	39.6
Delhi	15.6	45.1
Haryana	21.7	40.7
Himachal Pradesh	12.8	19.1
Jammu and Kashmir	6.3	23.8
Punjab	15.1	36.9
Rajasthan	11.2	40.1
Uttarakhand	11.7	20.2

Birth to Adolescence

67% of children aged 1-4 years had iron deficiency in Punjab, more than double the national average (**32%**); prevalence was highest among children aged 1-4 years

Among northern states, children and adolescents from Punjab 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)

State	1-4 Years	5-9 Years	10-19 Years
India	31.9	17.0	21.5
Delhi	38.3	16.1	18.4
Haryana	58.9	35.6	28.7
Himachal Pradesh	34.5	23.0	22.0
Jammu and Kashmir	44.7	17.8	30.7
Punjab	67.2	50.9	45.3
Rajasthan	44.3	39.0	35.1
Uttarakhand	51.2	18.4	19.6

CiNNS
Birth to Adolescence

A

Vitamin A deficiency was moderately high (23%) in school-age children 5-9 years indicating the need for policy review

Children aged 1-4 years (17%) and adolescents (13%) were found to have lower levels of Vitamin A deficiency as children aged 5-9 years

D
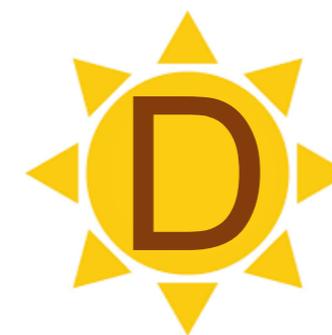
Vitamin D deficiency ranged from 52% to 76% in 1-19 years age group as per cut off by expert panel of IOM.

School-age children were found to have higher level of Vitamin D deficiency than children aged 1-4 years and adolescents

Birth to Adolescence

Vitamin A deficiency among children and adolescents

13-23% children and adolescents had Vitamin A deficiency in Punjab, close to the national average (**16-22%**)
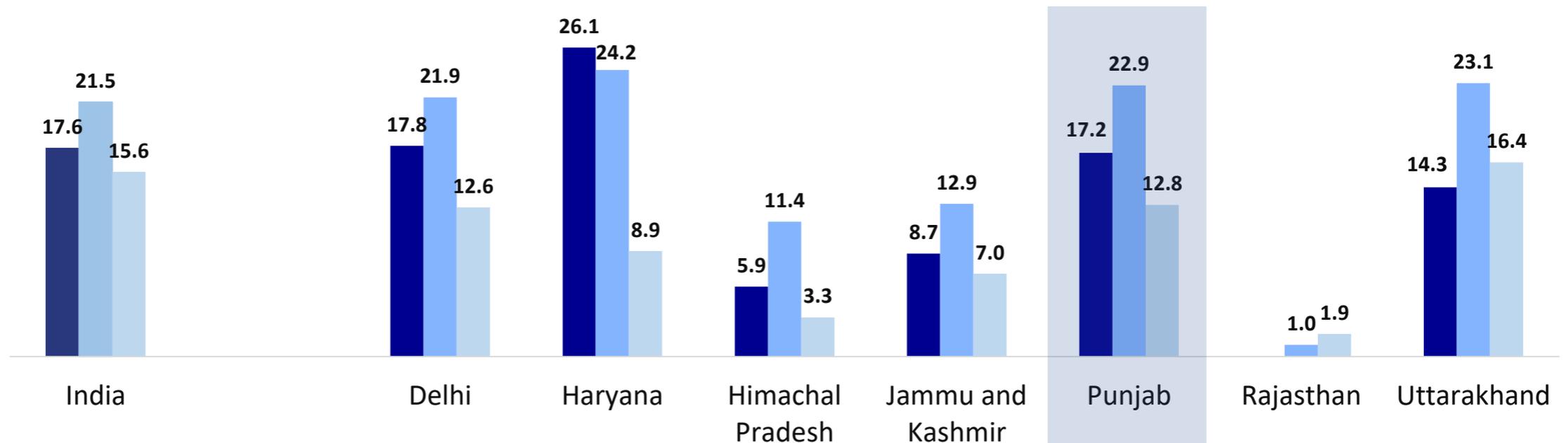
Prevalence of Vitamin A deficiency in all age group did not show any particular pattern among northern states

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

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

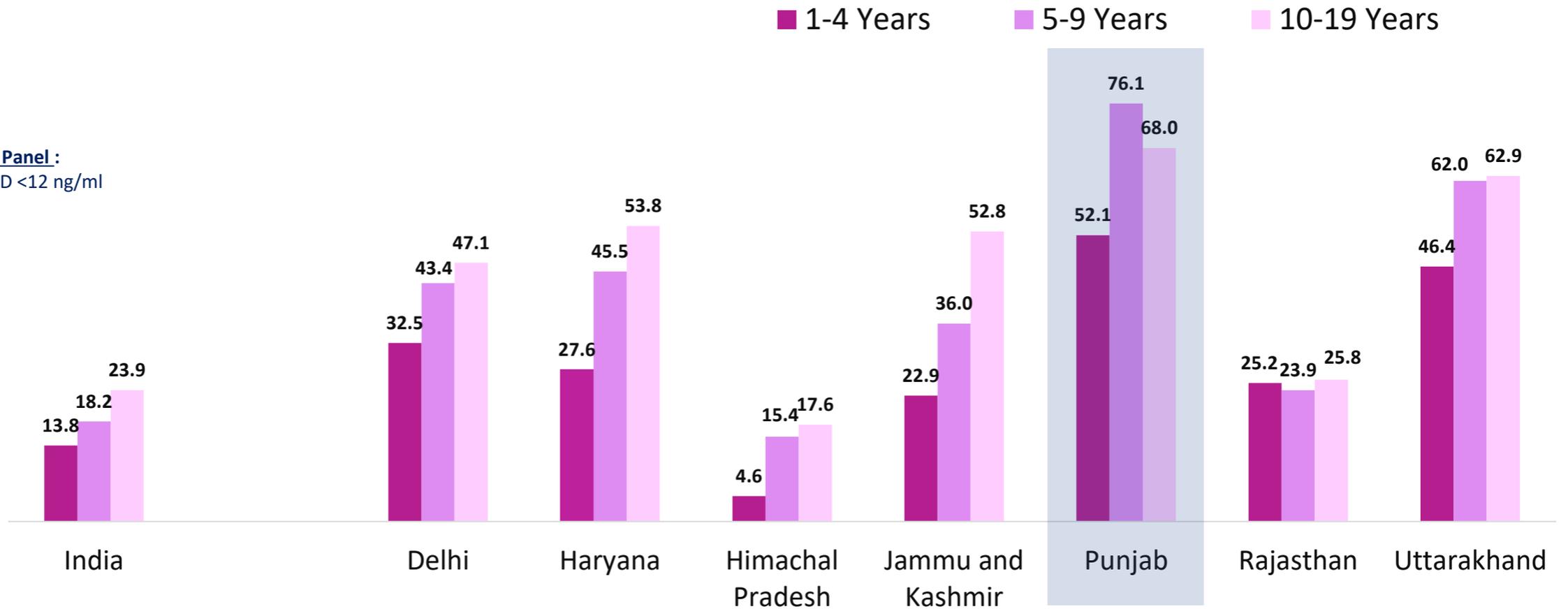|	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
1-4 Years	17.6	17.8	26.1	5.9	8.7	17.2		14.3
5-9 Years	21.5	21.9	24.2	11.4	12.9	22.9	1.0	23.1
10-19 Years	15.6	12.6	8.9	3.3	7.0	12.8	1.9	16.4

CiNNS
Birth to Adolescence

Vitamin D deficiency increases with age

52-76% of children and adolescents had Vitamin D deficiency in Punjab; Vitamin D deficiency increased sharply with age.

Punjab had the highest prevalence of Vitamin D deficiency among northern states and also in the country.

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

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

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
1-4 Years	13.8	32.5	27.6	4.6	22.9	52.1	25.2	46.4
5-9 Years	18.2	43.4	45.5	15.4	36.0	76.1	23.9	62.0
10-19 Years	23.9	47.1	53.8	17.6	52.8	68.0	25.8	62.9

CiNNS
Birth to Adolescence

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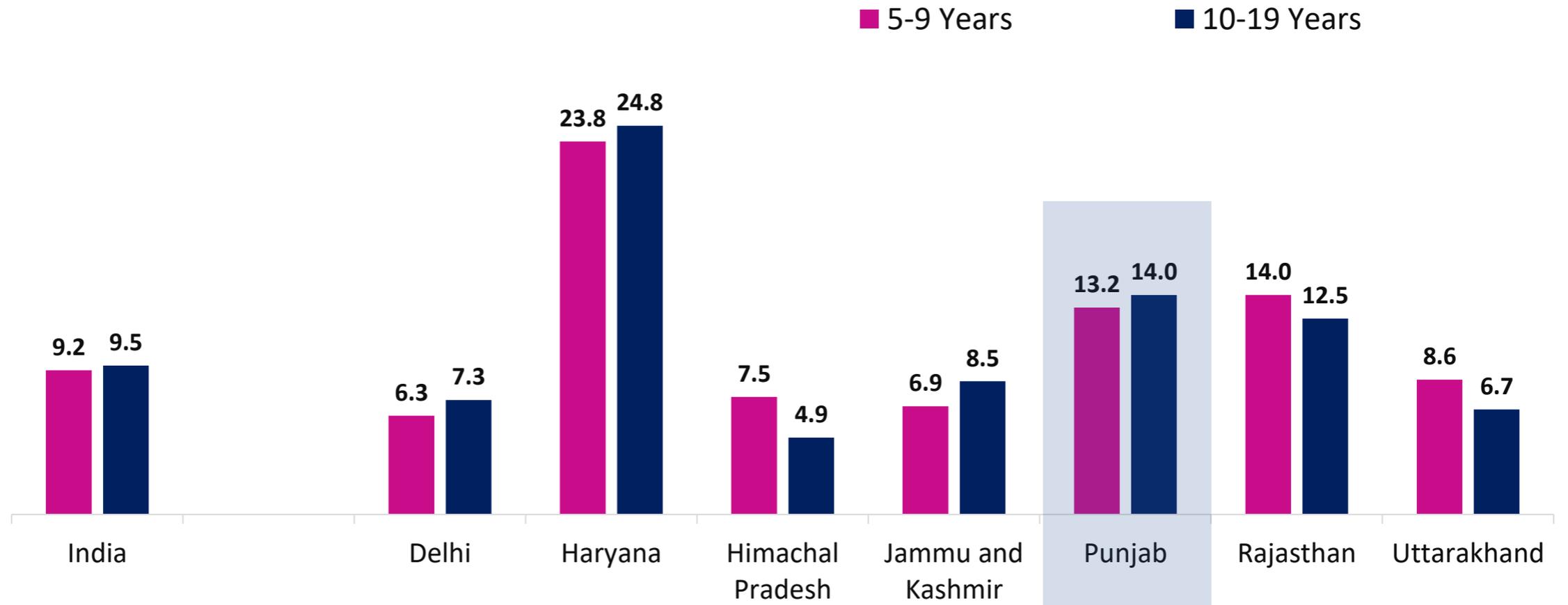# Punjab key findings: Non-communicable diseases

Over 13% 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), over **13%** of children and adolescents had increased risk of diabetes in Punjab; Haryana has the highest prevalence (**24-25%**)

Legend: ■ 5-9 Years ■ 10-19 Years

Region	5-9 Years	10-19 Years
India	9.2	9.5
Delhi	6.3	7.3
Haryana	23.8	24.8
Himachal Pradesh	7.5	4.9
Jammu and Kashmir	6.9	8.5
Punjab	13.2	14.0
Rajasthan	14.0	12.5
Uttarakhand	8.6	6.7

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High total cholesterol and high triglyceride among adolescents

Elevated risk of NCDs in Punjab among adolescents – **4%** had high level of total cholesterol and **10%** with high level of triglycerides

Prevalence of high total cholesterol and high triglycerides were highest in Himachal Pradesh among northern states
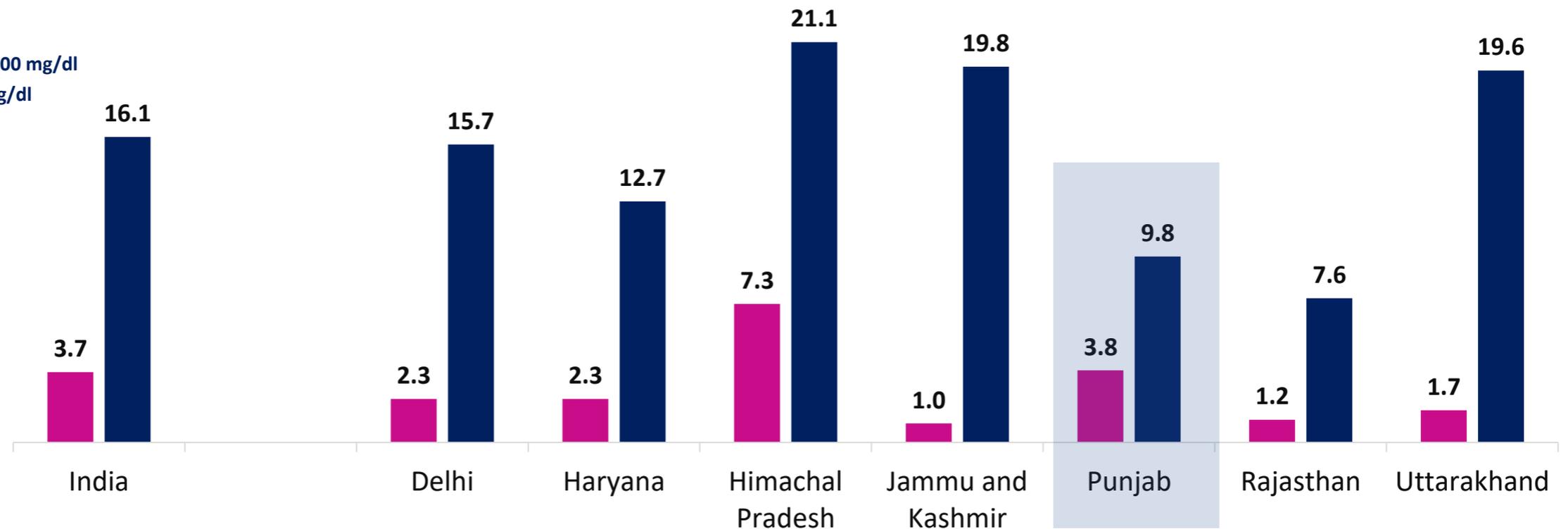
■ High total cholesterol   ■ High triglycerides

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

State	High total cholesterol	High triglycerides
India	3.7	16.1
Delhi	2.3	15.7
Haryana	2.3	12.7
Himachal Pradesh	7.3	21.1
Jammu and Kashmir	1.0	19.8
Punjab	3.8	9.8
Rajasthan	1.2	7.6
Uttarakhand	1.7	19.6

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High LDL and low HDL among adolescents

Risk of NCDs among adolescents in Punjab was high – **3%** had high level of LDL and **12%** had low level of HDL

Among northern states, prevalence of low HDL was highest in Delhi (**40%**)
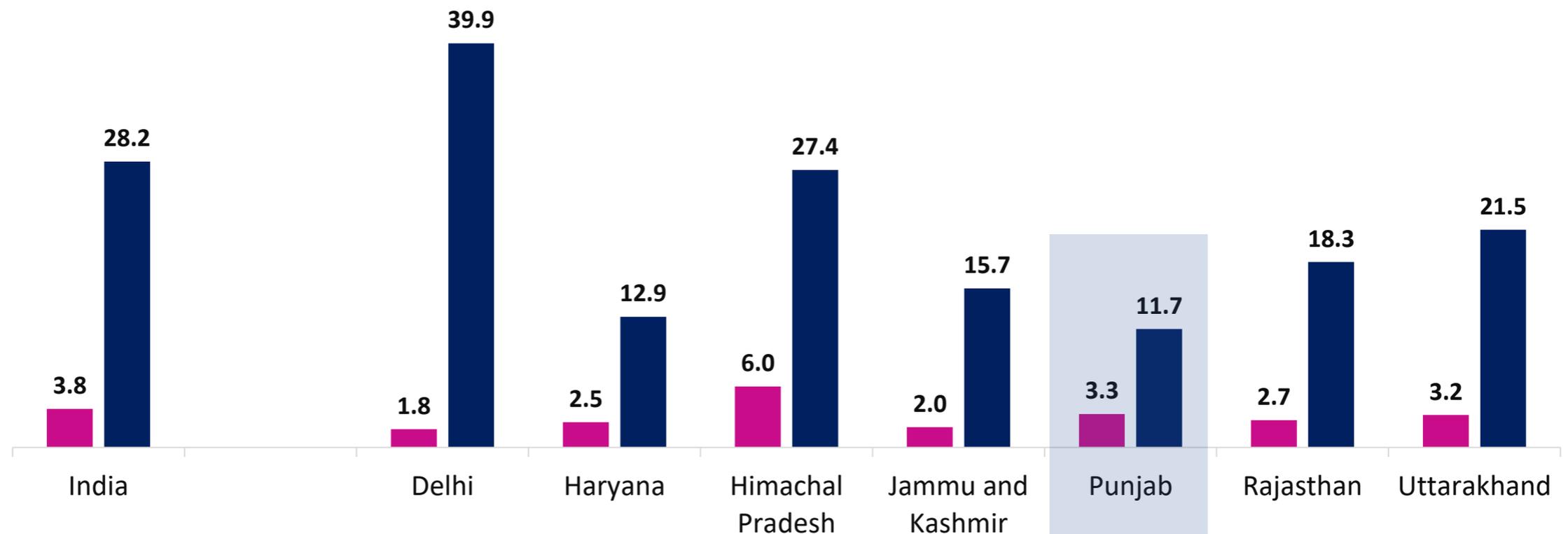
■ High LDL   ■ Low HDL

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

	India	Delhi	Haryana	Himachal Pradesh	Jammu and Kashmir	Punjab	Rajasthan	Uttarakhand
High LDL	3.8	1.8	2.5	6.0	2.0	3.3	2.7	3.2
Low HDL	28.2	39.9	12.9	27.4	15.7	11.7	18.3	21.5

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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 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.

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