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Noncommunicable risk factor prevalence among 15-17-year-old adolescents – Findings from National Noncommunicable Disease Monitoring Survey (NNMS) of India.

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Title page

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Abstract

Objective To generate national-level estimates of key NCD indicators for adolescents aged 15-17 years identified in the national NCD monitoring framework.

Design and setting A community-based, national level cross-sectional survey conducted during 2017-18. The survey was co-ordinated by ICMR-NCDIR with 10 implementing research institutes across India.

Participants A multistage sampling design was adopted covering ages between 15-69 years, which included adolescents (15-17 years) and adults (18-69 years) from a sample of 12,000 households from 600 primary sampling units (PSUs). The PSUs were equally distributed in urban and rural areas which were nationally representative. To estimate key NCD risk factors for adolescents, a separate computed sample size, study tools, data weighting and analysis was undertaken. All available adolescents (15-17 years) from the selected households were included for the survey.

Main outcomes measures Key NCD risk factors for adolescents between 15-17 years and school-based information adapted from WHO-STEPwise approach to NCD risk factor surveillance, IDSP-NCD risk factor survey, WHO-Global School Student Health Survey and WHO-Global Adult Tobacco Survey were estimated.

Results A total of 1402 households and 1531 adolescents completed the survey. Prevalence of current use of tobacco in any form daily was 3.1% (95% CI: 2.0-4.7), 25.2% (95% CI: 22.2-28.5) adolescents showed insufficient levels of physical activity, 6.2% (95% CI: 4.9-7.9) were overweight and 1.8% (95% CI: 1.0-2.9) were obese. Two-thirds reported being imparted health education on NCD risk factors in their schools/colleges.

Conclusion The survey showed high prevalence of NCD related key risk factors, knowledge and attitudes towards selected risk factors among 15-17 years. This national level data fills the information gaps for this age group and helps to assess India's progress towards NCD targets set for 2025 and 2030 comprehensively. It offers national evidence to stakeholders for re-visiting and framing new policies, strategies for prevention and control of NCDs.

Key words Adolescents; India; Noncommunicable diseases; Public Health Surveillance; Risk Factors.

Summary box

Strengths and limitations of this study

- NNMS is first national level comprehensive NCD risk factor survey conducted In India. It provides reliable national estimates of prevalence of noncommunicable disease (NCD) risk factors among adolescents (15-17 years), adults (18-69 years). Furthermore, the survey includes data on health system response to NCDs in the country.
- NNMS overcomes all the challenges of multiple vertical surveys. It uses standard, validated methodology and operational definitions to arrive at National level estimates on NCD risk factors in India. To the authors' knowledge, no other study on NCD risk factors in India has been done on a national level representative sample.
- The survey has been designed to suit the National NCD monitoring framework. Data from survey contributes to framing policies and cost-effective strategies to prevent and control NCDs in India.
- This paper presents the NNMS essential national data on prevalence of behavioural and metabolic risk factors among adolescents (15-17 years). This has been undertaken through use of validated questionnaires, standard equipment and methods to measure height and weight. NNMS results further provide information on dietary practices, physical activity related, health promotion and education information taught in their schools/colleges to prevent and control NCD risk factors.
- NNMS is a national level cross-sectional community household level survey. The study limits adolescents of only 15-17 years. This was decided, as surveying children of 10-14 years require different approach (perhaps a school-based approach). Furthermore, to maximize ethical and operational logistics.

Main text

INTRODUCTION

Adolescents constitute 21% of India's total population, ranking it to be the largest in the world (1.5 billion adolescents).[1-3] The health status during this phase has an important bearing on the overall health during her/his adulthood.[4] Their ongoing transitional state of neural, psychological and physical development makes them susceptible to the behavioural risk factors (tobacco use, alcohol consumption, unhealthy diet and insufficient physical activity) for noncommunicable diseases (NCDs).[4,5] However, initiation of these unhealthy behaviours often transforms into lifelong adoption, thereby increasing risk for developing NCDs like cancers, cardiovascular diseases, respiratory diseases, diabetes, hypertension and mental disorders in their early adulthood.[4,5] Adolescence also presents an opportunity to prevent, reduce risk factors and fast-track modifications in behaviours.

Studies have shown that the use of tobacco amongst adolescent boys and girls in India is 29% and 4% respectively.[6,7] While 11% boys and 1% girls between 15-19 years were engaged in alcohol use, 3% of them were consuming it daily.[6,7] Nearly about 1.7% adolescent boys and 2.4% adolescent girls were overweight contributing to rise in proportion with pre-diabetes in this age group. Insufficient physical activity and adopting unhealthy dietary habits have major roles in adding to the NCD risk as they enter adulthood. [8]

In response to the World Health Organizations (WHO) Global Voluntary NCD Targets to be achieved by 2025, the Government of India has framed the National NCD Monitoring framework and Action Plan, which includes 10 targets and 21 indicators. This includes three (out of twenty-one) indicators on NCD risk factors for adolescents [9] (*Table 1*). Furthermore, the Sustainable Development Goals (SDGs) 2030 includes ambitious targets related to NCDs and eleven out of eighteen SDGs and nineteen out of fifty-three health-associated SDG indicators address child and adolescent health. [10] The spectrum of 17 SDGs and 169 targets are interconnected, like health and education together supports all SDGs.[10] National Health Policy 2017 emphasises on health education and promotion as part of the curriculum in schools.[11,12]

Table 1 National NCD Monitoring framework [9] for adolescents			
Framework element	Targets for 2025	No.	Indicators
	Outcomes		
NCD Risk factors			
Obesity	Halt the rise in obesity	1	Prevalence of obesity in adolescents (defined as two standard deviations BMI for age and sex overweight according to the WHO Growth Reference).

Physical inactivity	10% Relative reduction in prevalence of insufficient physical activity	2	Prevalence of insufficiently active adolescents (defined as less than 60 minutes per day of physical activity).
Tobacco use	30% Relative reduction in prevalence of current tobacco use	3	Prevalence of current tobacco use (smoking and smokeless) among adolescents.

Due to differences in objectives, inclusion of the NCD indicators, sample size, methodology, age groups, and operational definitions across various studies, it makes it difficult to generalize it to the whole country.[13-17] Recognizing these constraints, challenges and the need for evaluation and monitoring of NCD risk factors, the Indian Council of Medical Research (ICMR) was recognized as a nodal agency for monitoring, evaluation and surveillance under the national NCD monitoring framework. The National NCD Monitoring Survey (NNMS) was undertaken to monitor progress of actions taken and generate evidence for policy and strategies to prevent and control NCDs. The primary objective of the survey was to generate national level estimates of key NCD indicators identified in the national NCD monitoring framework. This paper discusses the adolescent risk factors for NCDs with an added component on school-based information detailing health education and promotion activities.

METHODS

Study setting

The National NCD Monitoring Survey (NNMS) was a community-based cross-sectional survey conducted in 2017-18. It covered age groups from 15-69 years, which included adolescent population aged 15-17 years as a sub-set. The survey was co-ordinated by the Central Coordinating Unit (CCU), the ICMR-NCDIR, Bengaluru and included primary sampling units (PSUs) from twenty-five states of India and was implemented through a network of ten implementing research institutes / agencies of repute across the country.

Sampling and study participants

The survey used stratified multistage sampling design. Sample size was calculated based on previous estimates of prevalence of obesity (6%),[18] relative precision as half of prevalence,[19] design effect of 1.5 and non-response rate of 15%. Total estimated sample size for adolescents (15-17 years) was 1700. The PSUs were villages for rural areas and wards for urban areas. One Census Enumeration Block (CEB) from each ward was selected by random selection. Sampling frame was constituted for adults and adolescents together that was divided into four subgroups/strata urban/rural and men/women (2 x 2). The number

of households to be covered was calculated as 12000 for adults keeping the prevalence of obesity among adults as 9%, relative precision of 15% and non-response rate of 15%. From each PSU, twenty households were selected through circular systematic sampling. Based on the proportion of adolescents as 10 to 15% from the Census 2011 and assuming 12% adolescents were available in the 12000 selected households for adults, the sample size for adolescents was expected to be 1440, if one adolescent was selected from each household. However, we covered all the available adolescents at the selected household to reach the required sample size.

Patient and public involvement

In the selected PSUs, the survey teams engaged with the local authorities, people's representatives and local population to explain the purpose and details of the survey prior to data collection. We plan to disseminate the results from this survey to policymakers at national, sub-national levels and the public.

Study tools and data collection

The study tools were adapted from the WHO-STEP wise approach to Surveillance (STEPs),^[20] Integrated Disease Surveillance Project (IDSP) - NCD risk factor survey,¹⁸ WHO-Global School Student Health Survey (GSHS) [21] and the WHO-Global Adult Tobacco Survey (GATS).^[22] All tools were translated to eleven Indian regional languages and validated with back-translation. The data were collected using an open-source android-based application, open data kit (ODK) [23,24] in portable handheld devices, with built-in quality checks. Structured interview schedules used for collection of information on demographic characteristics, behavioural risk factors (tobacco, alcohol use, diet, physical activity) and metabolic risk factors (overweight and obesity). Anthropometric measurements of height and weight were measured using standard procedures to estimate the prevalence of metabolic risk factors. Survey also collected school/college related information from adolescents who reported going to school in the last 12 months. Data on availability of shops selling tobacco nearby school vicinity, time spent by adolescents in physical activity in schools and type of food available in canteen. Information on health promotion and education materials and as a structured school curriculum at schools/colleges were also collected.

Ethical clearance and permissions

ICMR-NCDIR and all implementing agencies obtained ethical clearances from their respective institutional ethics committees. All participants identified with risk factors were referred to the nearest public health system facility for further evaluation and management. State and local health departments cooperated for facilitation of the survey.

Quality assurance

The CCU monitored overall survey implementation and provided technical and scientific support to its partners and collaborators to ensure data quality.

National and regional level workshops were undertaken to impart training in field operations, consenting procedures and interviewing techniques for adolescents, data collection in handheld devices, maintaining privacy and confidentiality. A mock field survey was undertaken in two non-selected PSUs in all the survey sites and re-trainings were given to refresh survey procedures and clarify issues confronted in the field. Standard operational definitions²⁵ were used for estimating behavioural and metabolic risk factors (tobacco use, alcohol use, diet, physical activity, BMI).

Statistical analysis

The data were imported from ODK platform to IBM SPSS Version 22.0 (IBM Corp, Armonk, NY, USA). It was cleaned and weighted to provide prevalence estimates at the level of the population, households, area of residence (urban and rural) and gender. Data were analysed in STATA 14.1 (StataCorp LP, College Station, Texas, USA) by complex survey analysis and the results presented in descriptive statistics with mean and proportion with 95% confidence interval (CI).

RESULTS

A total of 1819 adolescents were available in 1402 participated households. Among them, 1643 participated (176 did not participate as the household was locked) in the survey. A total of 1531 adolescents completed the survey (112 adolescents refused after initial acceptance or refused mid-way) with an overall response rate of 93.2%. Majority (95.0%) of adolescents had completed formal schooling (*Figure 1 and 2*). It was observed that a total of 86.8% adolescents from urban and 74.0% from rural areas reported attending school/college in the last 12 months. (*Table 2*)

Table 2: Reported School / college related information in the last 12 months (Percentage with 95% CI)

15 - 17 years	Urban	Rural	Boys	Girls	Overall
Percentage who attended school/college in the last 12 months	86.8 (81.3-90.8)	74.0 (69.6-78.0)	84.0 (80.2-87.2)	71.5 (66.6-76.0)	78.0 (74.6-81.2)
Noticed any poster/wall painting/ signboard/ display on the following topics					
Harmful effects of tobacco	41.4 (34.3-48.8)	40.5 (34.8-46.5)	42.7 (36.7-48.9)	38.4 (32.7-44.6)	40.8 (36.3-45.5)
No smoking sign	45.7 (38.9-52.7)	43.1 (37.3-49.2)	46.4 (40.5-52.4)	41.0 (35.1-47.3)	44.0 (39.5-48.7)
Harmful effects of alcohol	35.3 (28.7-42.5)	26.3 (21.3-32.0)	31.8 (26.1-38.1)	26.4 (21.7-31.8)	29.4 (25.3-33.9)
Promotion material on healthy diet	43.6 (37.0-50.5)	31.6 (26.3-37.5)	35.9 (30.4-41.8)	35.8 (30.1-41.9)	35.8 (31.6-40.4)
Promotion material on physical activity	40.8 (34.3-47.7)	30.4 (24.8-36.7)	33.4 (27.8-39.6)	34.9 (29.2-41.1)	34.1 (29.7-38.8)
Percentage who reported being taught in school about					
Ill effects of tobacco	67.0 (59.3-73.8)	66.5 (61.3-71.4)	67.3 (61.3-72.7)	65.9 (59.6-71.6)	66.7 (62.4-70.7)
Ill effects of alcohol	65.0 (57.6-71.7)	66.6 (61.8-71.1)	67.2 (61.7-72.7)	64.6 (58.4-70.3)	66.0 (62.0-69.8)
Benefits of healthy diet	69.0 (62.2-75.1)	65.2 (59.9-70.2)	67.7 (62.1-72.9)	65.1 (58.9-70.8)	66.6 (62.4-70.5)
Benefits of physical activity	63.2 (57.1-68.9)	64.8 (59.7-69.6)	63.1 (57.8-68.2)	65.6 (60.2-70.7)	64.2 (60.3-68.0)
Tobacco related information					
Noticed teacher/staff smoke in school/college premises in last 12 months	16.2 (11.5-22.5)	18.1 (14.4-22.5)	20.4 (16.3-25.3)	13.7 (10.0-18.4)	17.5 (14.4-20.9)
Any shop within 100 metres of school /college selling tobacco	48.2 (41.1-55.4)	42.9 (37.3-48.6)	48.5 (42.8-54.4)	39.8 (33.9-46.0)	44.7 (40.3-49.2)
School/college canteen related information					
Presence of canteen	34.7 (27.8-42.2)	21.4 (16.4-27.4)	24.7 (19.7-30.5)	27.7 (22.0-34.3)	26.0 (21.9-30.6)
Reported availability of High fat, Salt and sugar and fat (HFSS) foods items in school/college canteen	94.0 (88.3-97.0)	83.0 (69.8-91.2)	86.1 (74.1-93.0)	90.6 (88.3-94.9)	88.2 (80.8-93.0)

Tobacco and alcohol use

Only 3.1% (95% CI: 2.0-4.7) of adolescents were currently using any form of tobacco daily in last 12 months preceding the survey. The proportion was higher in rural areas [3.6% (95% CI: 2.3-5.8)] and among boys [5.5% (95% CI: 3.5-8.6)]. Nearly double the proportion [7.0% (95% CI: 5.4-9.1)] reported to have experimented using smoking or smokeless tobacco. Prevalence of smokeless tobacco use [2.9% (95% CI: 1.9-4.5)] was higher than use of smoking tobacco [0.3% (95% CI: 0.1-0.9)]. Findings showed that smokeless tobacco use was higher in rural [3.4% (95% CI: 2.1-5.6)] than urban areas [1.9% (95% CI: 0.8-4.5)] and among boys [5.2% (95% CI: 3.3-8.2)] than girls [0.4% (95% CI: 0.1-1.3)]. (Table 3)

Table 3: Prevalence of NCD risk factors in adolescents of 15-17 years (Percentage) and (Mean) with 95% CI					
15 – 17 years	Urban	Rural	Boys	Girls	Overall
Tobacco use (%)					
Ever use/ experimented any form of tobacco	5.6 (3.6-8.8)	7.7 (5.5-1.06)	11.9 (9.0-15.6)	1.7 (0.6-4.3)	7.0 (5.4-9.1)
Current use*					
Any form of tobacco	1.9 (0.8-4.5)	3.6 (2.3-5.8)	5.5 (3.5-8.6)	0.4 (0.1-1.3)	3.1 (2.0-4.7)
Smoked tobacco	0.1 (0.0-0.6)	0.4 (0.1-1.3)	0.4 (0.1-1.5)	0.2 (0.0-1.2)	0.3 (0.1-0.9)
Smokeless tobacco	1.9 (0.8-4.5)	3.4 (2.1-5.6)	5.2 (3.3-8.2)	0.4 (0.1-1.3)	2.9 (1.9-4.5)
Both Smoked and smokeless	0.1 (0.0-0.7)	0.2 (0.0-0.8)	0.2 (0.0-0.6)	0.2 (0.0-1.2)	0.2 (0.0-0.5)
Thoughts about harm from second hand tobacco smoke					
Thought that inhaling smoke from other people's tobacco smoking can cause harm	86.9 (82.3-90.4)	84.4 (80.1-88.0)	86.6 (82.1-90.2)	83.6 (79.3-87.2)	85.2 (82.0-88.0)
Alcohol use (%)					
Ever consumed	3.2 (1.5-6.6)	3.6 (2.1-6.1)	5.4 (3.3-8.6)	1.4 (0.6-3.1)	3.5 (2.2-5.4)
Consumed in last 12 months	1.1 (0.4-2.6)	1.4 (0.7-2.8)	1.8 (1.0-3.4)	0.7 (0.2-2.0)	1.3 (0.7-2.3)
Consumed in last 30 days	0.9 (0.3-2.5)	0.4 (0.1-1.2)	0.8 (0.3-2.0)	0.3 (0.1-1.0)	0.5 (0.2-12.0)
Binge drinking**	0.2 (0.02-0.6)	0.1 (0.01-0.6)	0.2 (0.1-0.7)	0.0 (0.0-0.0)	0.1 (0.03-0.4)
Physical activity					
Insufficient physical activity [†] (%)	38.0 (31.9-44.4)	19.3 (16.2-22.9)	21.5 (17.3-26.3)	29.3 (25.1-33.9)	25.2 (22.2-28.5)

Minutes being sedentary in a day (Mean)	361.4 (314.9-407.9)	331.2 (297.2-365.2)	331.1 (298.5-363.7)	351.2 (318.8-383.7)	340.7 (313.2-368.2)
Doing physical activity in school/college (%)	68.0 (60.1-75.0)	62.3 (56.4-67.8)	69.1 (63.3-74.3)	58.2 (52.1-63.9)	64.3 (59.6-68.7)
Minutes spent in physical activity per day at school (Mean)	18.0 (14.7-21.3)	15.3 (12.8-17.7)	20.0 (17.1-23.0)	11.8 (9.6-14.0)	16.1 (14.1-18.1)
Metabolic risk factors^{††}					
Mean BMI (Kg/m ²)	19.5 (19.0-19.9)	18.4 (18.2-18.7)	18.5 (18.1-18.8)	19.1 (18.8-19.4)	18.8 (18.5-19.0)
Overweight (including obesity) (%)	11.9 (9.0-15.7)	3.6 (2.4-5.3)	6.4 (4.5-8.9)	6.1 (4.3-8.7)	6.2 (4.9-7.9)
Obesity (%)	3.5 (1.9-6.5)	0.9 (0.4-2.3)	2.6 (1.4-4.7)	0.8 (0.3-2.3)	1.8 (1.0-2.9)
* Defined as use of any form of tobacco (smoke and/or smokeless) daily in last 12 months preceding the survey.					
** Defined as those engaged in five or more standard drinks of alcohol for boys and four or more for girls in a single drinking occasion in the past 30 days.					
† Insufficient physical activity in adolescents was percentage doing less than 60 minutes of moderate to vigorous intensity physical activity daily, which is equivalent to <1680 MET minutes per week and calculated as [60 minutes * 4 MET * 7 days].					
†† The BMI (as per WHO)** was used to categorise the respondents into overweight and obesity. Overweight was ≥ 1SD BMI for age and sex (equivalent to BMI 25Kg/m ² at 19 years) and obesity was ≥ 2SD BMI for age and sex (equivalent to BMI 30Kg/m ² at 19 years), as per WHO.					

More than three-fourth of adolescents [85.2% (95% CI: 82.0-88.0)] thought that inhaling smoke from other people's tobacco smoking (second hand smoke) was harmful. This was slightly higher in urban areas [86.9% (95% CI: 82.3-90.4)] and among boys [86.6 (95% CI: 82.1-90.2)] (*Table 3*).

More than two-fifth [44.7% (95% CI: 40.3-49.2)] of adolescents going to school or college in last one year reported presence of shop selling tobacco within 100 metres of school/college. Nearly one-fifth [17.5% (95% CI: 14.4-20.9)] adolescents reported noticing teacher/school staff smoking within the premises (*Table 2*).

It was observed that of the 3.5% (95% CI: 2.2-5.4) adolescents, 5.4% (95% CI: 3.3-8.6) boys and 1.4% (95% CI: 0.6-3.1) girls reported consuming alcohol ever in their life. In the last 12 months, 1.3% (95% CI: 0.7-2.3) and 0.5% (95% CI: 0.2-12.0) adolescents in the past 30 days reported drinking alcohol. While 0.1% (95% CI: 0.03-0.4) were engaged in binge drinking. (*Table 3*).

Diet and physical activity

Nearly one-half adolescents reported consuming chips/namkeen [52.1% (95% CI: 48.1-56.0)] and fried items [49.3% (95% CI: 45.2-53.3)] at least once a week. One-third [33.9% (95% CI: 30.0-38.1)] reported consuming fresh fruits/fresh juices at least once a week. These findings were reported higher by adolescents in urban areas and boys (Table 4).

Table 4: Prevalence of Dietary NCD risk factors in adolescents of 15-17 years (Percentage) and (Mean) with 95% CI

15 – 17 years	Urban	Rural	Boys	Girls	Overall
Diet					
Usually consumed any of the food items at least once in a week					
Fried items	52.9 (46.1-59.6)	47.6 (42.6-52.6)	55.3 (49.9-60.5)	42.7 (37.7-47.9)	49.3 (45.2-53.3)
Chips / Namkeen	58.3 (52.4-63.9)	49.2 (44.1-54.3)	49.9 (44.1-55.7)	54.4 (49.5-59.1)	52.1 (48.1-56)
Pizza / Burger	10.1 (6.0-16.5)	4.7 (3.3-6.8)	7.3 (5.0-10.4)	5.5 (3.4-8.7)	6.4 (4.7-8.8)
Instant noodles	31.8 (24.9-39.7)	13.1 (10.1-16.7)	16.1 (12.6-20.3)	22.1 (17.4-27.7)	19.0 (15.7-22.7)
Cold or other aerated drinks	23.2 (18.3-28.9)	15.9 (12.6-19.9)	24.5 (20.4-29.1)	11.4 (8.3-15.4)	18.2 (15.4-21.5)
Fresh fruits / Fresh juices	49.0 (42.4-55.5)	27.0 (22.3-32.3)	37.2 (31.8-43)	30.3 (25.6-35.5)	33.9 (30.0-38.1)
Energy drinks	11.6 (7.4-17.7)	4.2 (2.1-8.2)	6.6 (3.8-11.3)	6.4 (3.9-10.4)	6.5 (4.4-9.6)
Breakfast related information					
Skipping breakfast on all 30 days (%)	4.6 (1.8-11.4)	3.7 (2.2-6.0)	3.8 (1.9-7.3)	4.1 (2.6-6.5)	4.0 (2.5-6.3)
Skipping breakfast on any one day in last 30 days (%)	48.7 (42.3-55.1)	48.1 (43.3-52.9)	45.8 (40.6-51.2)	50.9 (45.8-56.1)	48.3 (44.4-52.2)
Number of days breakfast was skipped (Mean)	9.5 (7.2-11.8)	9.7 (8.1-11.2)	9.2 (7.4-11.0)	10.0 (8.6-11.3)	9.6 (8.3-10.9)

In last 30 days, 48.3% reported skipping breakfast on at least one day (50.9% girls and 45.8% boys) and 4.0% skipped breakfast on all 30 days. Breakfast was reportedly skipped on an average for 10 days [9.6 days (95% CI: 8.3-10.9)], which was similar across all strata (Table 4).

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2 Among those who have been attending school in the last 1 year, 88.2% (95% CI: 80.8-93.0)
3 reported availability of high fat, salt and sugar (HFSS) food items in their school/college
4 canteen. Higher proportion was reported by adolescents residing in urban areas [94.0%
5 (95% CI: 88.3-97.0)] (Table 2).
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10 One-fourth of adolescents were physically inactive, higher proportion being urban residents
11 [38.0% (95% CI: 31.9-44.4)] and girls [29.3 (95% CI: 25.1-33.9)]. Total of 64.3% (95% CI:
12 59.6-68.7) adolescents reported doing physical activity in school/college and on an average
13 spent 16.1 minutes per day. (Table 3).
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18 **Overweight and Obesity**

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20 Overall, 6.2% (95% CI: 4.9-7.9) of adolescents were overweight and 1.8% (95% CI: 1.0-2.9)
21 were obese. It was observed that higher proportion of adolescents residing in the urban
22 areas were overweight 11.9% (95% CI: 9.0-15.7) or obese 3.5% (95% CI: 1.9-6.5) than
23 those in rural areas. Prevalence of obesity was higher among boys [2.6% (95% CI: 1.4-4.7)]
24 than girls [0.8% (95% CI: 0.3-2.3)] (Table 3).
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30 **Health promotion materials and education provided in schools/colleges**

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32 Nearly one-third of adolescents reported to have noticed health promotion materials (any
33 poster/wall painting/ signboard) displayed in their schools/colleges. Two-thirds of them
34 reported health education being provided in their schools/colleges on benefits of healthy
35 diet, physical activity, ill effects of tobacco and alcohol use. (Table 2).
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41 **DISCUSSION**

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43 The NNMS was a national level comprehensive survey which collected data on seventeen
44 out of twenty-one indicators of the NCD monitoring framework in persons aged between 15-
45 69 years. It exclusively covered adolescents (15-17 years) providing information on
46 behavioural and metabolic risk factors, thus filling the national level data gaps for this age
47 group. In addition, the school-based information component collected data relevant for the
48 government of India initiatives on school-based health promotion interventions.
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55 Several national level surveys have been conducted in the country either as standalone or
56 surveys with some of these risk factors as components. [13-17,26] The Global Youth
57 Tobacco Survey, [26] National Family health Survey (NFHS)-4, [13] GATS 1 and 2, [14]
58 Comprehensive National Nutrition Survey 2016-17 [17] and the recent Magnitude of
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2 substance use in India – 2019 [15] are few to mention. The differences in study objectives,
3 design, methodology, age inclusion criteria and operational definitions does not allow
4 comparisons, and hence this survey is nationally representative.
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8 Observations revealing higher prevalence in use of tobacco in any form and alcohol among
9 boys than girls were similar (NNMS) to those reported in other surveys like GATS-2, NFHS-4
10 and Magnitude of substance use in India-2019.[13-15] Proportion using smokeless tobacco
11 being higher than smoked tobacco was also consistent with that reported in GATS-2. [14]
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14 Current use of tobacco among adolescents aged 15-17 years was observed to be 3.1%,
15 while GATS-2 results show 12.4% among those aged between 15-24 years.[14] The
16 differences in the results can be related to the differences between the study designs.
17 Though, NNMS covered an age range of 15-69 years, separate sample was drawn for 15-
18 17 years and all adolescents in the selected household were included for the study and
19 individual study questionnaires were administered for this age group. In addition, data
20 cleaning, weighting and analysis were exclusive for this study group. It was observed that
21 GATS – 2 selected one household member aged 15+ years and above for individual
22 interview, data was presented as different age groups derived from the same study
23 questionnaire.[14]
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26 NNMS results show that 1.3% adolescents among 15-17 years consumed alcohol in the last
27 12 months, and these were found to be similar to results from Magnitude of substance use
28 in India – 2019 report (1.3%) which covered age group of 10-17 years.[15]
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31 It was observed that nearly 50% of adolescents consumed fried items atleast once in a
32 week, with higher percentage being boys (55.3%), these finding were similar from those
33 reported in NFHS-4 (47.4% among boys aged between 15-19 years).[13]
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36 The mean BMI among boys (18.5 Kg/m²) and girls (19.1 Kg/m²) observed in this study was
37 closer to findings from age-wise split results of NFHS-4 (men: 19.3 Kg/m² and women: 19.4
38 Kg/m² among 15-19 years).[13] The prevalence of overweight among boys (6.4%) and girls
39 (6.1%) from current survey was found to be similar. This finding was nearly similar to NFHS-
40 4 (Men: 4.8% and Women: 4.2% among 15-19 years).[13] Overall 6.2% (95% CI: 4.9-7.9)
41 of adolescents were overweight (including obesity) which was comparable to the findings
42 (5%) from Comprehensive National Nutrition Survey, 2016-17 (among 10-19 years).[17]
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44

45 In India, the Cigarette and other Tobacco Products Act (COTPA), [27] 2003 has restrictions
46 on the sale of tobacco products within 100 meters of schools. NNMS findings reveal 44.7%
47 of adolescents reported presence of a shop selling tobacco within 100 metres of school
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2 /college. In addition, use of tobacco (any form), higher proportion of smokeless tobacco
3 indicates the ease in access and availability of these tobacco products to adolescents in
4 their close vicinity. It is evidence from numerous studies [28-30] across different parts of
5 India shows violations of the COTPA act. Improved implementation, monitoring and
6 enforcement of COTPA, in both urban and rural areas is needed.
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11 Similarly, a larger proportion of adolescents (88.2%) reported availability of HFSS food in
12 their school/college canteen, which suggests the ease of access to unhealthy food,
13 supporting the NNMS findings (more than 50% consuming fried foods, chips/namkeen etc.,
14 and proportion with overweight and obesity).
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19 Government of India have prioritized their focus in this age group, to prevent and reduce
20 NCDs. The mid-day meal program implemented across the country encourages students to
21 attend school, promote healthy dietary habits and improve their nutritional status. In addition,
22 the Food Safety and Security Authority of India (FSSAI) has issued regulations on taxation,
23 food advertisements and guidelines for food nutrition labels.[31-33] The Safe and Nutritious
24 food campaign is a nation-wide campaign to help schools to deliver messages and make
25 students inculcate healthy nutritious food habits.[5] Three specific policies addressing
26 adolescent health were brought out in the year 2018. These were namely, (i) National
27 regulations on marketing of all foods and beverages high in sugar, salt and fat to children,
28 (ii) National policies to prohibit sales of tobacco products to minors and (iii) the National
29 regulation on marketing of alcohol to adolescents.[31-34]
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39 Schools form a dynamic setting of opportunity for instituting healthy behaviours and forge
40 linkages with health and education officials, teachers, students, parents, and community.[35]
41 Government of India initiatives through the platforms of schools like the Rashtriya Bal
42 Swasthya Karyakram, in 2013 and Rashtriya Kishor Swasthya Karyakram in 2014 aim
43 deliver health and development requirements to adolescents through a holistic approach.
44 [5,12] Recently, school health programmes were incorporated into the Health and Wellness
45 component of the Ayushman Bharat to strengthen health promotion activities.[12]
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51 In addition, in the year 2018, Government of India adopted the WHO policy of National
52 standards for health promoting schools. With an objective to provide healthy environment
53 through health education and community/ school outreach activities.[34,36-37] The findings
54 from current survey reveal that only one-fourth to two-fifth of adolescents reported having
55 health promotion materials displayed in their schools/colleges. While more than two-thirds
56 reported being educated on healthy habits. School/college-based interventions are highly
57 cost-effective in reducing NCD risk factors, curb NCD epidemic and avoid premature deaths.
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2 It also increases the levels of productivity and improves the overall well-being of forthcoming
3 generations.
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6 Adolescence period forms a key phase in development of NCDs, thus directing and
7 strengthening policies and programmes towards limiting or preventing exposure to NCD
8 risks would yield a triple dividend of benefits – for adolescents today, for their future
9 adulthood, and the next generations.[4]
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13 14 **CONCLUSION**

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17 The comprehensive National NCD Monitoring Survey for the first time documented
18 standardized approach to estimate key adolescent NCD indicators identified in the National
19 NCD monitoring framework. In addition to providing essential data on prevalence of
20 behavioural and metabolic risk factors among adolescents, the study findings emphasize
21 that school-based promotion and education activities offer opportunities to tackle
22 development of NCDs in adulthood. It also recognizes the need to strengthen functioning of
23 school/college health promotion programmes.
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30 Interventions against use of tobacco and alcohol, promoting healthy dietary habits and
31 practicing any form of moderate or vigorous intensity physical activity accumulated for
32 minimum of 60 minutes daily offers solutions to curb or halt the rise of obesity. Advocacy for
33 these policies and emphasizing their benefits to adolescents at national level; and school-
34 based programs offer effective solutions and better investments in tackling the growing
35 burden of NCDs. Large comprehensive surveys including adolescents with good coverage
36 and study designs will be beneficial than vertical single risk factor based surveys to inform
37 policy and program implementation.
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45 **STATEMENTS**

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48 1. **Ethics approval:** The study was approved by the Institutional Ethics Committee of the
49 Co-ordinating Centre, ICMR-NCDIR. Approval no: NCDIR/IEC/2017/4 dated 03
50 February 2017. Every implementing agency obtained their ethics approval from their
51 own Institutional ethics Committee before starting the Survey. All the study participants
52 were enrolled only after obtaining written informed consent.
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54
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56
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59
60 4. **Author Contributions:**

1
2 PM, VK and SL conceptualised this manuscript with contributions from AK. Authors PM,
3
4 VK and SL drafted, modified, and finalized it. All authors provided expertise, with
5
6 contributions in data, or materials, or participation in analysis or reviewed the findings or
7
8 paper (or a combination of these). All authors have agreed to the final version of the
9
10 manuscript.

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12
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18
19 preparation of the manuscript.

20 **7. Data availability Statement:** Data are available upon reasonable request.

21 **8. Transparency statement:** The manuscript is an honest, accurate, and transparent
22
23 account of the study being reported; that no important aspects of the study have been
24
25 omitted; and that any discrepancies from the study as originally planned.

26
27 **9. Reproducing figures:** Not applicable

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10 **FIGURE LEGENDS**

- 11
- 12 1. **Figure 1:** Percentage of adolescents (15-17 years) who received formal education by
- 13 area of residence and gender.
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- 15 2. **Figure 2:** Highest educational status among adolescents (15-17 years) by area of
- 16 residence and gender.
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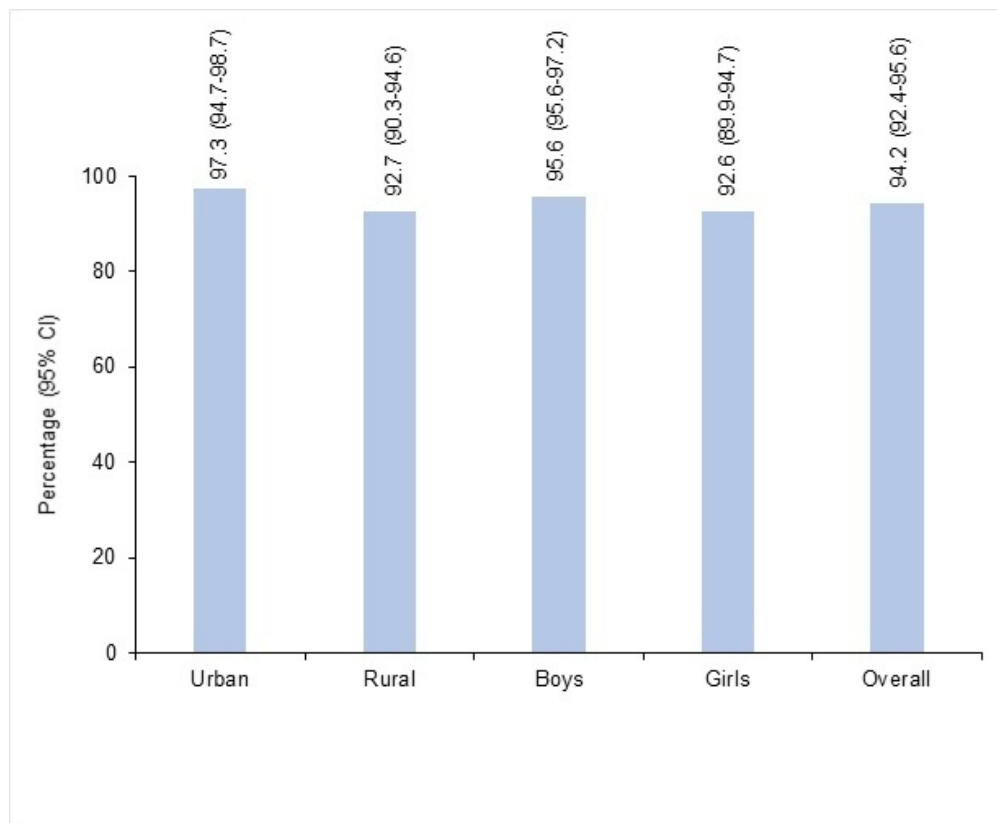


Figure 1: Percentage of adolescents (15-17 years) who received formal education by area of residence and gender.

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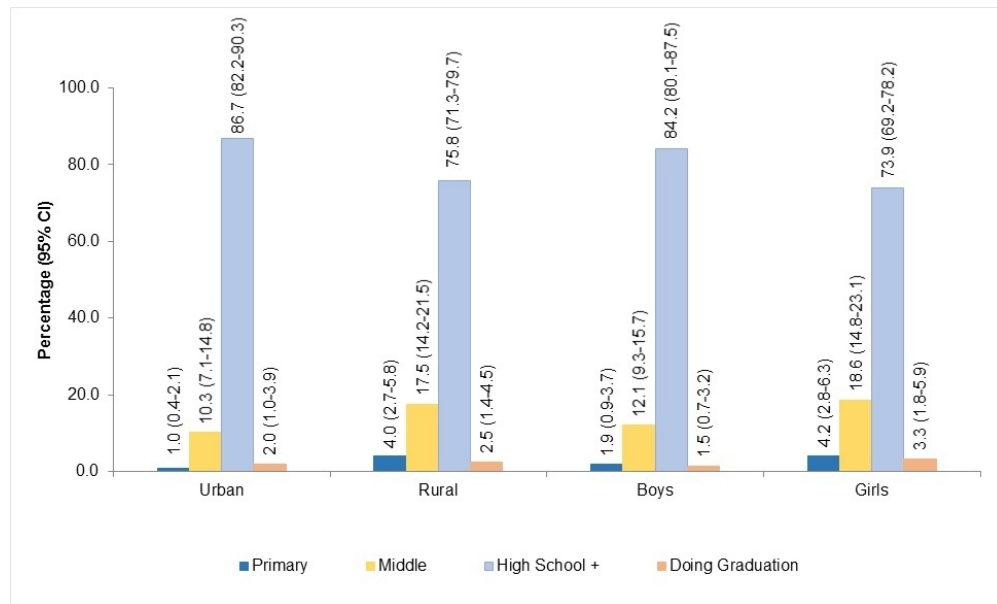


Figure 2: Highest educational status among adolescents (15-17 years) by area of residence and gender.

82x49mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6,7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6,7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-13

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		(b) Report category boundaries when continuous variables were categorized	9-13
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Baseline risk factor prevalence among 15-17-year-old adolescents – Findings from National Noncommunicable Disease Monitoring Survey (NNMS) of India.

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Primary Subject Heading:	Epidemiology
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Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, QUALITATIVE RESEARCH

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Title page

Full Title: Baseline risk factor prevalence among 15-17-year-old adolescents – Findings from National Noncommunicable Disease Monitoring Survey (NNMS) of India.

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Abstract

Objective To generate national estimates of key noncommunicable disease (NCD) risk factors for adolescents (15-17 years) identified in the National NCD Monitoring Framework and study knowledge, attitudes and practices towards risk behaviours among school going adolescents.

Design and setting A community-based, national cross-sectional survey conducted during 2017-18. Survey was coordinated by Indian Council of Medical Research (ICMR) – National Centre for Disease Informatics and Research (NCDIR) with ten reputed implementing research institutes/organizations across India.

Participants A multistage sampling design was adopted covering ages between 15-69 years — adolescents (15-17 years) and adults (18-69 years). The sample included 12,000 households drawn from 600 primary sampling units (PSUs). To estimate key NCD risk factors for adolescents, a separate sample size, study tools, data weightages and analysis was undertaken. All available adolescents (15-17 years) from the selected households were included for the survey.

Main outcomes measures Key NCD risk factors for adolescents (15-17 years) — current tobacco and alcohol use, dietary behaviours, insufficient physical activity, overweight and obesity.

Results Overall, 1402 households and 1531 adolescents completed the survey. Prevalence of current daily use of tobacco was 3.1% (95% CI: 2.0-4.7), 25.2% (95% CI: 22.2-28.5) adolescents showed insufficient levels of physical activity, 6.2% (95% CI: 4.9-7.9) were overweight and 1.8% (95% CI: 1.0-2.9) were obese. Two-thirds reported being imparted health education on NCD risk factors in their schools/colleges.

Conclusion The survey provides baseline data on NCD related key risk factors among 15-17 years in India. This national level data fills information gaps for this age group and helps assess India's progress towards NCD targets set for 2025 comprehensively. Though the prevalence of select risk factors is much lower than many developed countries, this study offers national evidence for re-visiting and framing appropriate policies, strategies for prevention and control of NCDs in younger age groups.

93 **Key words** Adolescents; India; Monitoring, Noncommunicable diseases; Public Health
94 Surveillance; Risk Factors.

95 **Summary box**

Strengths and limitations of this study

- Use of standard tools and methods on a nationally representative study design.
- Reliable data to fulfil needs of National NCD monitoring framework to monitor progress of actions to reduce NCDs amongst adolescents.
- Study included only adolescents of age 15-17 years, while adolescent age grup is 10-19 years.
- More relavant variables to adolescent NCDs could have enriched the survey.

96 **Main text**

97 **INTRODUCTION**

98 Adolescents (10-19 years) constitute 21% of India's total population, making it to be the
99 largest in the world (1.5 billion adolescents). [1-3] The health status during this phase of
100 growth and development has an important bearing on the overall health during her/his
101 adulthood. [4] Their ongoing transitional state of neural, psychological and physical
102 development makes them susceptible to certain behavioural risk factors — tobacco use,
103 alcohol consumption, unhealthy diet and insufficient physical activity. [4,5] However,
104 acquisition of these unhealthy behaviours often persists lifelong. This increases the risk for
105 developing noncommunicable diseases like cardiovascular diseases, respiratory diseases,
106 diabetes, hypertension, cancers and mental disorders from early adulthood onwards. [4,5]

107 Several studies have been undertaken to report use of tobacco, alcohol and other risk
108 factors in India. The differences in their objectives, inclusion of the NCD indicators, sample
109 size, methodology, age groups, and operational definitions used generalizability at national
110 level becomes difficult. [6-10] The National Family Health Survey (NFHS) - 3 conducted in
111 2005-06, reports the use of tobacco — 29% and 4% and alcohol use — 11% and 1% among
112 15-19 years boys and girls, respectively. [11] The same survey (NFHS - 4) repeated in
113 2015-16, reports tobacco use as 18.5% and 1.6% and alcohol use to be 8.9% and 0.5% in
114 boys and girls. [6] The WHO-NCD country profile for India 2018, reported current tobacco
115 smoking among those aged 15+ years to be 20% in boys and 2% in girls. [12] Nearly about
116 1.7% adolescent boys and 2.4% adolescent girls were overweight and these could
117

118 contribute to the rise in proportion of those with pre-diabetes in this age group. [13]
 119 Prevalence of obesity showed increasing trend from 2016 to 2025. [12] Increasing burden
 120 from NCDs is accelerated by the negative impact of globalization and unplanned
 121 urbanization. Insufficient physical activity and preferences for high salt, sugar and fatty
 122 foods, sedentary behaviours accelerate development of NCDs. [14]

123 Improving country-level surveillance and monitoring systems becomes the top priority to
 124 cope with the ever-expanding needs for policies, legislation, services and infrastructure to
 125 prevent and control NCDs. [14] India was the first country to adopt the World Health
 126 Organization (WHO) - Global Voluntary NCD Targets to be achieved by 2025 in 2014 and,
 127 framed its National NCD Monitoring Framework and Action Plan, which includes 10 targets
 128 and 21 indicators. There are three (out of twenty-one) indicators on related NCD risk factors
 129 for adolescents [15] (Table 1). Furthermore, the Sustainable Development Goals (SDGs)
 130 2030 includes ambitious targets related to NCDs and eleven out of eighteen SDGs and
 131 nineteen out of fifty-three health-associated SDG indicators address child and adolescent
 132 health. [16] The National Health Policy 2017 emphasises on health education and promotion
 133 as part of the curriculum in schools. [17]

Table 1 National NCD Monitoring framework [15] for adolescents

Framework element	Targets for 2025	
	Outcomes	Indicator
NCD Risk factors		
Obesity	Halt the rise in obesity	Prevalence of obesity in adolescents (defined as two standard deviations BMI for age and sex overweight according to the WHO Growth Reference).
Physical inactivity	10% Relative reduction in prevalence of insufficient physical activity	Prevalence of insufficiently active adolescents (defined as less than 60 minutes per day of physical activity).
Tobacco use	30% Relative reduction in prevalence of current tobacco use	Prevalence of current tobacco use (smoking and smokeless) among adolescents.

134 Recognizing the need for evaluation and monitoring of NCD risk factors, the National NCD
 135 Monitoring Survey was undertaken with primary objective to generate national level
 136 estimates of key NCD indicators identified in the national NCD monitoring framework. This
 137 paper exclusively presents and discusses the adolescent (15-17 years) risk factors for
 138 NCDs. [18] It also describes the school-based information collected under the adolescent
 139 study tools to understand the status of health education and promotion interventions in
 140 schools/colleges.

METHODS

Study setting

The National NCD Monitoring Survey was a community-based cross-sectional survey conducted in 2017-18. It covered age groups from 15-69 years, which included adolescent population aged 15-17 years as a sub-set. The survey was co-ordinated by the Central Coordinating Unit (CCU), the ICMR-NCDIR, Bengaluru and included primary sampling units from twenty-seven states of India and was implemented through a network of ten implementing research institutes / agencies of repute across the country. [18]

Sampling and study participants

The survey used stratified multistage sampling design across 27 states of India. Sample size was calculated based on previous estimates of prevalence of obesity (6%), [19] relative precision as half of prevalence, [20] design effect of 1.5 and non-response rate of 15%. Total estimated sample size for adolescents (15-17 years) was 1700. The PSUs were villages for rural areas and wards for urban areas. One Census Enumeration Block (CEB) from each ward was selected by random selection. Sampling frame was constituted for adults and adolescents together that was divided into four subgroups/strata urban/rural and men/women (2 x 2). The number of households to be covered was calculated as 12000 (6000 urban and 6000 rural) for adults keeping the prevalence of obesity among adults as 9%, relative precision of 15% and non-response rate of 15%. From each PSU, twenty households were selected through circular systematic sampling. Based on the proportion of adolescents as 10 to 15% from the Census 2011 and assuming 12% adolescents were available in the 12000 selected households for adults, the sample size for adolescents was expected to be 1440, if one adolescent was selected from each household. However, we covered all the available adolescents (15-17 years) in the selected household to reach the required sample size. [18]

Patient and public involvement

In the selected PSUs, the survey teams engaged with the local authorities, people's representatives and local population to explain the purpose and details of the survey prior to data collection. This ensured better participation, facilitation in the conduct of the survey and agreement of the community. The results of the survey have been shared with the health departments and local authorities. [18]

1

2 172 **Study tools and data collection**

3
4 173 The study tools were adapted from the WHO-STEP wise approach to Surveillance (STEPS),
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6 174 [21] Integrated Disease Surveillance Project (IDSP) - NCD risk factor survey, [19] WHO-
7
8 175 Global School Student Health Survey (GSHS) [22] and the WHO-Global Adult Tobacco
9
10 176 Survey (GATS). [23] All tools were translated to eleven regional languages of India and
11 177 validated with back-translation. The data were collected using an open-source android-
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13 178 based application, open data kit (ODK) [24,25] in portable handheld devices, with built-in
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15 179 quality checks. Structured interview schedules used for collection of information on
16 180 demographic characteristics, behavioural risk factors (tobacco, alcohol use, diet, physical
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18 181 activity) and metabolic risk factors (overweight and obesity). Prior informed consent was
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20 182 sought from parent/guardian and assent was obtained from the selected participant to be
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22 183 interviewed and measured. Anthropometric measurements of height and weight were
23 184 measured using standard procedures — portable stadiometer (SECA 213) and digital
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25 185 weighing scale (SECA 803) recommended by WHO-STEPS; survey teams ensured that the
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27 186 instruments were calibrated regularly and maintained calibration log books; both height and
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29 187 weight were measured in barefoot and with light clothing with erect body posture, head
30 188 looking straight facing interviewer and arms on the side. Survey also collected
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32 189 school/college related information from the same selected adolescent who reported going
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34 190 to school in the last 12 months. In this section, we obtained data on availability of shops
35 191 selling tobacco nearby school vicinity, time spent by adolescents in physical activity in
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37 192 schools, type of food available in canteen and information on health promotion and
38
39 193 education materials at schools/colleges. All the information was collected at the selected
40 194 household itself. [18]

42 43 195 **Ethical clearance and permissions**

44
45 196 ICMR-NCDIR and all implementing agencies obtained ethical clearances from their
46
47 197 respective institutional ethics committees. An assent from the adolescent respondent was
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49 198 obtained along with consent from parent/guardian. Apart from this, a separate participant
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51 199 anthropometry reporting form was used to obtain consent for measurement of height and
52 200 weight. Those found with any risk factor were referred to nearest public health facility for
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54 201 counselling and further management.

56 57 202 **Quality assurance**

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59 203 National and regional level workshops were organized to impart training in field operations,
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204 consenting procedures and interviewing techniques, data collection in handheld devices,

maintaining privacy and confidentiality. A mock field survey was undertaken in two non-selected PSUs in all the survey sites and re-trainings were given periodically along with clarifying issues confronted in the field. Standard operational definitions [26] were used for estimating behavioural and metabolic risk factors (tobacco use, alcohol use, diet, physical activity, BMI). [18] The senior investigators monitored data collection and, site visits by experts were undertaken for on the spot assessments and matters were resolved.

Statistical analysis

The data were imported from ODK platform to IBM SPSS Version 22.0 (IBM Corp, Armonk, NY, USA). It was cleaned and weighted to provide prevalence estimates at the level of the population, households, area of residence (urban and rural) and gender. Data were analysed in STATA 14.1 (StataCorp LP, College Station, Texas, USA) by complex survey analysis and the results presented in descriptive statistics with mean and proportion with 95% confidence interval (CI).

RESULTS

During household mapping and listing, a total of 1819 adolescents were identified from 1402 participating households. Of them, 1643 adolescents participated (176 adolescents did not participate as the households were found locked in spite of 4 attempts made over 2 consecutive days) in the survey. A total of 1531 adolescents completed the survey (112 adolescents refused after initial acceptance or mid-way) with an overall response rate of 93.2%.

Parameter	Urban	Rural	Boys	Girls	Overall
Tobacco use (%)					
Ever use/ experimented any form of tobacco	5.6 (3.6-8.8)	7.7 (5.5-10.6)	11.9 (9.0-15.6)	1.7 (0.6-4.3)	7.0 (5.4-9.1)
Current daily use*					
Any form of tobacco	1.9 (0.8-4.5)	3.6 (2.3-5.8)	5.5 (3.5-8.6)	0.4 (0.1-1.3)	3.1 (2.0-4.7)
Smoked tobacco	0.1 (0.0-0.6)	0.4 (0.1-1.3)	0.4 (0.1-1.5)	0.2 (0.0-1.2)	0.3 (0.1-0.9)
Smokeless tobacco	1.9 (0.8-4.5)	3.4 (2.1-5.6)	5.2 (3.3-8.2)	0.4 (0.1-1.3)	2.9 (1.9-4.5)
Both smoked and smokeless	0.1 (0.0-0.7)	0.2 (0.0-0.8)	0.2 (0.0-0.6)	0.2 (0.0-1.2)	0.2 (0.0-0.5)

Thoughts about harm from second hand tobacco smoke					
Thought that inhaling smoke from other people's tobacco smoking can cause harm	86.9 (82.3-90.4)	84.4 (80.1-88.0)	86.6 (82.1-90.2)	83.6 (79.3-87.2)	85.2 (82.0-88.0)
Alcohol use (%)					
Ever consumed	3.2 (1.5-6.6)	3.6 (2.1-6.1)	5.4 (3.3-8.6)	1.4 (0.6-3.1)	3.5 (2.2-5.4)
Consumed in last 12 months	1.1 (0.4-2.6)	1.4 (0.7-2.8)	1.8 (1.0-3.4)	0.7 (0.2-2.0)	1.3 (0.7-2.3)
Consumed in last 30 days	0.9 (0.3-2.5)	0.4 (0.1-1.2)	0.8 (0.3-2.0)	0.3 (0.1-1.0)	0.5 (0.2-12.0)
Binge drinking**	0.2 (0.02-0.6)	0.1 (0.01-0.6)	0.2 (0.1-0.7)	0.0 (0.0-0.0)	0.1 (0.03-0.4)
Dietary behaviours					
Usually consumed any of the food items at least once in a week					
Fried items	52.9 (46.1-59.6)	47.6 (42.6-52.6)	55.3 (49.9-60.5)	42.7 (37.7-47.9)	49.3 (45.2-53.3)
Chips / Namkeen	58.3 (52.4-63.9)	49.2 (44.1-54.3)	49.9 (44.1-55.7)	54.4 (49.5-59.1)	52.1 (48.1-56)
Pizza / Burger	10.1 (6.0-16.5)	4.7 (3.3-6.8)	7.3 (5.0-10.4)	5.5 (3.4-8.7)	6.4 (4.7-8.8)
Instant noodles	31.8 (24.9-39.7)	13.1 (10.1-16.7)	16.1 (12.6-20.3)	22.1 (17.4-27.7)	19.0 (15.7-22.7)
Cold aerated drinks	23.2 (18.3-28.9)	15.9 (12.6-19.9)	24.5 (20.4-29.1)	11.4 (8.3-15.4)	18.2 (15.4-21.5)
Fresh fruits / Fresh juices	49.0 (42.4-55.5)	27.0 (22.3-32.3)	37.2 (31.8-43)	30.3 (25.6-35.5)	33.9 (30.0-38.1)
Energy drinks	11.6 (7.4-17.7)	4.2 (2.1-8.2)	6.6 (3.8-11.3)	6.4 (3.9-10.4)	6.5 (4.4-9.6)
Breakfast related information					
Skipping breakfast on all 30 days (%)	4.6 (1.8-11.4)	3.7 (2.2-6.0)	3.8 (1.9-7.3)	4.1 (2.6-6.5)	4.0 (2.5-6.3)
Skipping breakfast on any one day in last 30 days (%)	48.7 (42.3-55.1)	48.1 (43.3-52.9)	45.8 (40.6-51.2)	50.9 (45.8-56.1)	48.3 (44.4-52.2)
Number of days breakfast was skipped in a month (Mean)	9.5 (7.2-11.8)	9.7 (8.1-11.2)	9.2 (7.4-11.0)	10.0 (8.6-11.3)	9.6 (8.3-10.9)
Physical activity					
Insufficient physical activity [¶] (%)	38.0 (31.9-44.4)	19.3 (16.2-22.9)	21.5 (17.3-26.3)	29.3 (25.1-33.9)	25.2 (22.2-28.5)
Minutes being sedentary in a day (Mean)	361.4 (314.9-407.9)	331.2 (297.2-365.2)	331.1 (298.5-363.7)	351.2 (318.8-383.7)	340.7 (313.2-368.2)

Doing physical activity in school/college (%)	68.0 (60.1-75.0)	62.3 (56.4-67.8)	69.1 (63.3-74.3)	58.2 (52.1-63.9)	64.3 (59.6-68.7)
Minutes spent in physical activity per day at school (Mean)	18.0 (14.7-21.3)	15.3 (12.8-17.7)	20.0 (17.1-23.0)	11.8 (9.6-14.0)	16.1 (14.1-18.1)
Metabolic risk factors^{††}					
Mean BMI (Kg/m ²)	19.5 (19.0-19.9)	18.4 (18.2-18.7)	18.5 (18.1-18.8)	19.1 (18.8-19.4)	18.8 (18.5-19.0)
Overweight (including obesity) (%)	11.9 (9.0-15.7)	3.6 (2.4-5.3)	6.4 (4.5-8.9)	6.1 (4.3-8.7)	6.2 (4.9-7.9)
Obesity (%)	3.5 (1.9-6.5)	0.9 (0.4-2.3)	2.6 (1.4-4.7)	0.8 (0.3-2.3)	1.8 (1.0-2.9)
* Defined as use of any form of tobacco (smoke and/or smokeless) daily in last 12 months preceding the survey.					
** Defined as those engaged in five or more standard drinks of alcohol for boys and four or more for girls in a single drinking occasion in the past 30 days.					
†† Insufficient physical activity in adolescents was percentage doing less than 60 minutes of moderate to vigorous intensity physical activity daily, which is equivalent to <1680 MET minutes per week and calculated as [60 minutes * 4 MET * 7 days].					
††† The BMI (as per WHO)** was used to categorise the respondents into overweight and obesity. Overweight was ≥ 1SD BMI for age and sex (equivalent to BMI 25Kg/m ² at 19 years) and obesity was ≥ 2SD BMI for age and sex (equivalent to BMI 30Kg/m ² at 19 years), as per WHO.					

Tobacco and alcohol use

Only 3.1% (95% CI: 2.0-4.7) of adolescents reported current use of any form of tobacco daily in last 12 months preceding the survey. The proportion was higher in rural areas [3.6% (95% CI: 2.3-5.8)] and among boys [5.5% (95% CI: 3.5-8.6)]. Nearly double the proportion [7.0% (95% CI: 5.4-9.1)] reported to have experimented using smoking or smokeless tobacco. Prevalence of smokeless tobacco use [2.9% (95% CI: 1.9-4.5)] was higher than the use of smoked tobacco [0.3% (95% CI: 0.1-0.9)]. Findings showed that smokeless tobacco use was higher in rural [3.4% (95% CI: 2.1-5.6)] than urban areas [1.9% (95% CI: 0.8-4.5)] and among boys [5.2% (95% CI: 3.3-8.2)] than girls [0.4% (95% CI: 0.1-1.3)]. (Table 2)

More than three-fourth of adolescents [85.2% (95% CI: 82.0-88.0)] recognized that second hand smoke was harmful, with higher in urban areas [86.9% (95% CI: 82.3-90.4)] and among boys [86.6 (95% CI: 82.1-90.2)] (Table 2).

Alcohol consumption proportion were lesser in girls with not much urban-rural differences. (Table 2).

Dietary behaviours

Nearly half adolescents reported consuming chips/namkeen (Indian savories which are salted and fried) [52.1% (95% CI: 48.1-56.0)] and fried items [49.3% (95% CI: 45.2-53.3)] at least once a week. One-third [33.9% (95% CI: 30.0-38.1)] reported consuming fresh fruits/fresh juices at least once a week. These findings were reported higher by adolescents in urban areas and boys (*Table 2*).

In last 30 days, 48.3% reported skipping breakfast on at least one day and 4.0% skipped breakfast on all 30 days. Breakfast was reportedly skipped on an average for 10 days [9.6 days (95% CI: 8.3-10.9)], which was similar across all strata (*Table 2*).

Physical inactivity

One-fourth of adolescents were physically inactive, higher proportion being urban residents [38.0% (95% CI: 31.9-44.4)] and girls [29.3 (95% CI: 25.1-33.9)]. Total of 64.3% (95% CI: 59.6-68.7) adolescents reported doing physical activity in school/college and on an average spent 16.1 minutes per day. (*Table 2*).

Overweight and Obesity

Mean BMI and proportion of overweight and obesity was higher in urban areas [Mean BMI: 19.5 Kg/m²; Overweight: 11.9% (95% CI: 9.0-15.7); Obesity: 3.5% (95% CI: 1.9-6.5)]. (*Table 2*).

School / college related information

Majority (94.2%) of adolescents had completed formal schooling and among them 84.2% boys and 73.9% girls completed high-school and higher secondary education. (*Figure 1*). Overall, 86.8% adolescents from urban and 74.0% from rural areas reported attending school/college in the last 12 months. (*Table 3*)

Table 3: School / college related information reported in the last 12 months (Percentage with 95% CI)

15 - 17 years	Urban	Rural	Boys	Girls	Overall
Percentage who attended school/college in the last 12 months	86.8 (81.3-90.8)	74.0 (69.6-78.0)	84.0 (80.2-87.2)	71.5 (66.6-76.0)	78.0 (74.6-81.2)
Noticed any poster/wall painting/ signboard/ display on the following topics					
Harmful effects of tobacco	41.4 (34.3-48.8)	40.5 (34.8-46.5)	42.7 (36.7-48.9)	38.4 (32.7-44.6)	40.8 (36.3-45.5)

No smoking sign	45.7 (38.9-52.7)	43.1 (37.3-49.2)	46.4 (40.5-52.4)	41.0 (35.1-47.3)	44.0 (39.5-48.7)
Harmful effects of alcohol	35.3 (28.7-42.5)	26.3 (21.3-32.0)	31.8 (26.1-38.1)	26.4 (21.7-31.8)	29.4 (25.3-33.9)
Promotion material on healthy diet	43.6 (37.0-50.5)	31.6 (26.3-37.5)	35.9 (30.4-41.8)	35.8 (30.1-41.9)	35.8 (31.6-40.4)
Promotion material on physical activity	40.8 (34.3-47.7)	30.4 (24.8-36.7)	33.4 (27.8-39.6)	34.9 (29.2-41.1)	34.1 (29.7-38.8)
Percentage who reported being taught in schools about;					
Ill effects of tobacco	67.0 (59.3-73.8)	66.5 (61.3-71.4)	67.3 (61.3-72.7)	65.9 (59.6-71.6)	66.7 (62.4-70.7)
Ill effects of alcohol	65.0 (57.6-71.7)	66.6 (61.8-71.1)	67.2 (61.7-72.7)	64.6 (58.4-70.3)	66.0 (62.0-69.8)
Benefits of healthy diet	69.0 (62.2-75.1)	65.2 (59.9-70.2)	67.7 (62.1-72.9)	65.1 (58.9-70.8)	66.6 (62.4-70.5)
Benefits of physical activity	63.2 (57.1-68.9)	64.8 (59.7-69.6)	63.1 (57.8-68.2)	65.6 (60.2-70.7)	64.2 (60.3-68.0)
Tobacco related information					
Noticed teacher/staff smoke in school/college premises in last 12 months	16.2 (11.5-22.5)	18.1 (14.4-22.5)	20.4 (16.3-25.3)	13.7 (10.0-18.4)	17.5 (14.4-20.9)
Any shop within 100 metres of school /college selling tobacco	48.2 (41.1-55.4)	42.9 (37.3-48.6)	48.5 (42.8-54.4)	39.8 (33.9-46.0)	44.7 (40.3-49.2)
School/college canteen related information					
Presence of canteen	34.7 (27.8-42.2)	21.4 (16.4-27.4)	24.7 (19.7-30.5)	27.7 (22.0-34.3)	26.0 (21.9-30.6)
Reported availability of High fat, Salt and sugar (HFSS) foods in school/college canteen	94.0 (88.3-97.0)	83.0 (69.8-91.2)	86.1 (74.1-93.0)	90.6 (88.3-94.9)	88.2 (80.8-93.0)

More than two-fifth [44.7% (95% CI: 40.1-49.2)] of adolescents going to school or college in last one year reported presence of shop selling tobacco within 100 metres of school/college. Nearly one-fifth [17.5% (95% CI: 14.4-20.9)] adolescents reported noticing teacher/school staff smoking within the premises (*Table 3*).

Nearly one-third of adolescents reported to have noticed health promotion materials (any poster/wall painting/ signboard) displayed in their schools/colleges. Two-thirds of them reported health education being provided in their schools/colleges on benefits of healthy diet, physical activity, ill effects of tobacco and alcohol use. (*Table 3*).

DISCUSSION

NNMS was a large national level comprehensive survey designed to provide baseline values on the National targets of the NCD monitoring framework and Action Plan. It covered information on behavioural and metabolic risk factors for adolescents (15-17 years) to fill national level data gaps for this age group. In addition, this survey included separate set of questions corresponding to school-based information. These are of much relevance to strengthen Government of India school-based health promotion services e.g. Poshan Abhiyaan, Safe and Nutritious food campaign, Rashtriya Bal Swasthya Karyakram, Rashtriya Kishor Swasthya Karyakram etc. [5, 27-28]

In comparison to several other countries, the prevalence of selected behavioural and metabolic risk factors among adolescents in India was much lower. [29-31] The prevalence of binge drinking among adolescents 10-19 years was 56% in Denmark, 35% in European countries, 17.7% in USA, 10.3% in Korea, 8% in Iceland and 7.1% in Hong Kong. [29] More than 70% of boys and girls aged 10-19 years were doing insufficient physical activity across the world. [30] Prevalence of obesity was 21% in USA, 15% in the UAE, 9% in the UK and China. [31] Thus in India, aggressive redressal to modify these unhealthy behavioural indices could have major benefits in controlling and tackling NCDs before they attain higher proportions in adulthood.

Several national surveys have been conducted in India either as standalone or surveys with some of these risk factors as components. [6-11,32,33] The differences in their study objectives, design, methodology, age inclusion criteria and operational definitions limits comparisons to be made.

High prevalence of tobacco use (any form) and alcohol consumption among boys than girls were similar (NNMS) to those reported in other surveys like GATS-2, NFHS-4 and Magnitude of substance use in India-2019. [6-8] Use of smokeless tobacco higher than smoked tobacco was also consistent with findings from GATS-2. [7] Prevalence of current daily use of tobacco was 3.1% and GATS-2 reports current use of tobacco being 12.4%. These expected variations are related to differences in study design, sampling strategy, coverage, age groups selected, weighting procedures and the questionnaires adopted. [7] On close examination, we found similar tobacco consumption prevalence (3%) amongst those who were aged between 15-17 years in the GATS-2 survey.

In India, the Cigarette and other Tobacco Products Act (COTPA) - 2003 has restrictions on the sale of tobacco products within 100 meters of schools. [34] NNMS findings reveal 44.7%

1
2 304 of adolescents reported presence of a shop selling tobacco within 100 metres of school
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4 305 /college indicating easy access. Several other studies [35-37] conducted in different parts
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6 306 of India showed violations of the COTPA. Improved implementation, monitoring and
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8 307 enforcement of COTPA, in both urban and rural areas is needed.
9

10 308 NNMS results current alcohol use in last 12 months (1.3%) among adolescents aged 15-17
11
12 309 years were similar to findings reported from Magnitude of substance use in India – 2019
13
14 310 (1.3%) among those aged 10-17 years. [8]
15

16 311 The mean BMI among boys (18.5 Kg/m²) and girls (19.1 Kg/m²) observed in this study was
17
18 312 closer to findings from age-wise split results of NFHS-4 (men: 19.3 Kg/m² and women: 19.4
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20 313 Kg/m² among 15-19 years). [6] The prevalence of overweight among boys (6.4%) and girls
21
22 314 (6.1%) from current survey was found to be similar. This finding was nearly similar to NFHS-
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24 315 4 (Men: 4.8% and Women: 4.2% among 15-19 years). [6] Overall 6.2% (95% CI: 4.9-7.9)
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26 316 of adolescents were overweight (including obesity) which was comparable to the findings
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28 317 (5%) from Comprehensive National Nutrition Survey, 2016-17 (among 10-19 years). [10]
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30 318 India is experiencing rapid nutrition transition. [38] Preference to packaged, processed and
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32 319 hyperpalatable foods over nutritious traditional diet or home cooked meals, sedentary
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34 320 lifestyles and lack of adequate physical activity are major contributors. We observed that
35
36 321 nearly 50% of adolescents consumed fried items at least once in a week, higher proportion
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38 322 were boys (55.3%), these findings were similar to those reported in NFHS-4 (47.4% among
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40 323 boys aged between 15-19 years).[6] Also, a larger proportion (88.2%) availability of HFSS
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42 324 food in their school/college canteen, indicates easy access to unhealthy food items.

43 325 Government of India flagship initiatives like mid-day meal program, Poshan Abhiyaan, Eat
44
45 326 Right India have been implemented across the country to improve the nutritional outcomes
46
47 327 in children and adolescents. Regulations on taxation, food advertisements and guidelines
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49 328 for food nutrition labels have been issued by the Food Safety and Security Authority of India
50
51 329 (FSSAI). [27-28, 39-40] The Safe and Nutritious food campaign helps schools promote
52
53 330 healthy dietary habits. [5] Three specific policies were brought out in the year 2018 to
54
55 331 address adolescent health — (i) National regulations on marketing of all foods and
56
57 332 beverages high in sugar, salt and fat to children; (ii) prohibit sales of tobacco products to
58
59 333 minors; and (iii) marketing of alcohol to adolescents. [28, 39-41] Regular physical activity
60
334 has positive impacts on cardiorespiratory and muscular fitness, bone and functional health,
335 low risk of NCDs and better mental health. This study reports a quarter of adolescents being
336 insufficiently physically active. India is been able to take initiatives at community level

337 through programs like Fit India Movement, yet there are concerns which need a different
338 policy perspective on outdoor activity and high levels of air pollution. [42,43]

339 Recently, school health programmes were incorporated into the Health and Wellness
340 component of the Ayushman Bharat to strengthen health promotion activities. [44] In the
341 year 2018, Government of India adopted the WHO policy of National standards for health
342 promoting schools with an objective to provide healthy environment through health
343 education and community/ school outreach activities. [41,45-47]

344 **Strengths and limitations**

345 The strengths of this study include, it being a large nationally representative survey with high
346 survey response rates. Being able to generate baseline national evidence on NCD risk
347 factors in this age group would strengthen policy and program intervention in India. Data
348 were collected by skilled and trained personnel using globally standardized questionnaires.
349 Though the prevalence of risk factors among adolescents in India is much lower compared
350 to the western countries like the US and the UK, stronger public health initiatives are needed
351 in mitigating risk exposures during this key phase of growth and development. The study
352 has limitations in covering only the 15-17 years age group and not all adolescents from 10-
353 19 years. Our data collection was directed to fulfill the National NCD Monitoring Framework
354 and Action Plan for India, as the country needed baseline evidence to track NCDs and its
355 risk factors. However, there is much scope to expand the data collection tools to incorporate
356 additional indicators relevant to NCDs — e.g socio-economic factors, stress, sleep patterns
357 and other social factors needs further examination to provide a comprehensive picture of
358 the determinants of risk factors in adolescents.

359 **CONCLUSION**

360 Through this survey we have been able to establish a standardized method of data
361 collection. It recognized the need to strengthen functioning of school/college health
362 promotion programmes. Such surveys should be repeated at periodic intervals so as to drive
363 evidence-based programming, policy, resource allocation and map trends and track
364 progress being made in tackling NCDs at younger age groups.

365 **STATEMENTS**

- 366 1. **Ethics approval:** The study was approved by the Institutional Ethics Committee of the
367 Coordinating Centre, ICMR-NCDIR. Approval no: NCDIR/IEC/2017/4 dated 03 February
368 2017. Every implementing agency obtained their ethics approval from their own

1
2
3 369 Institutional ethics Committee before starting the survey. All the study participants were
4 370 enrolled only after obtaining written informed consent. An assent from the adolescent
5
6 371 respondent was obtained along with consent from parent/guardian.

7
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40
41 391 preparation of the manuscript.

42 392 7. **Data availability Statement:** The National Noncommunicable Disease Monitoring
43
44 393 Survey (NNMS) report is available at <https://www.ncdirindia.org/nnms/>. Further data are
45
46 394 available upon request.

47 395 8. **Transparency statement:** The manuscript is an honest, accurate, and transparent
48
49 396 account of the study being reported; that no important aspects of the study have been
50
51 397 omitted; and that any discrepancies from the study as originally planned.

52 398 9. **Reproducing figures:** Not applicable

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57 524 FIGURE LEGENDS

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525 1. **Figure 1:** Highest educational status among adolescents (15-17 years) by area of
526 residence and gender.

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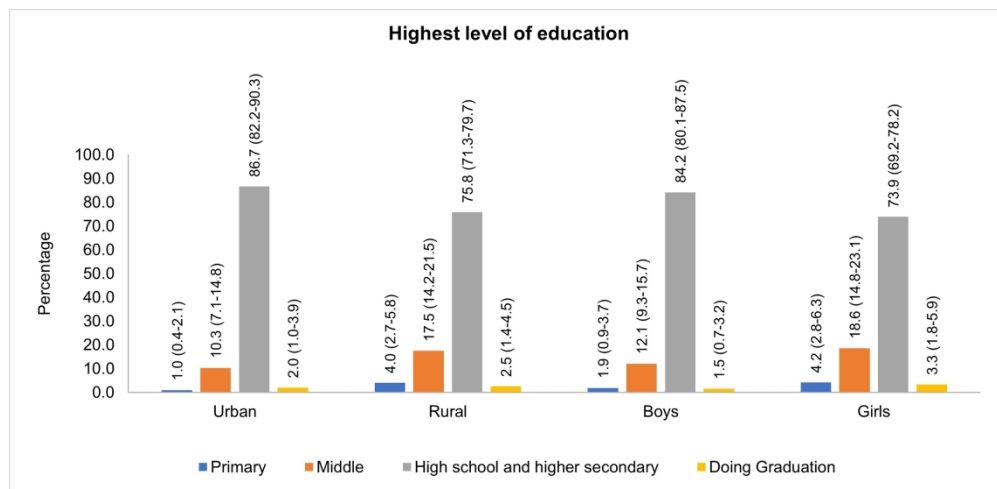


Figure 1: Highest educational status among adolescents (15-17 years) by area of residence and gender.

218x106mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	-

1 2 3 4 5 6	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-12
7 8 9			(b) Report category boundaries when continuous variables were categorized	8-12
10 11			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
12 13 14	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
15	Discussion			
16	Key results	18	Summarise key results with reference to study objectives	13-14
17 18 19 20	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-15
21 22 23 24	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
25 26	Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15
27	Other information			
28 29 30 31	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Title page

Full Title: Baseline risk factor prevalence among 15-17-year-old adolescents – Findings from National Noncommunicable Disease Monitoring Survey (NNMS) of India.

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Abstract

Objective To generate national estimates of key noncommunicable disease (NCD) risk factors for adolescents (15-17 years) identified in the National NCD Monitoring Framework and, study the knowledge, attitudes and practices towards NCD risk behaviours among school-going adolescents.

Design and setting A community-based, national, cross-sectional survey conducted during 2017-18. The survey was coordinated by the Indian Council of Medical Research (ICMR) – National Centre for Disease Informatics and Research (NCDIR) with ten reputed implementing research institutes/organizations across India in urban and rural areas.

Participants A multistage sampling design was adopted covering ages between 15-69 years — adolescents (15-17 years) and adults (18-69 years). The sample included 12,000 households drawn from 600 primary sampling units (PSUs). All available adolescents (15-17 years) from the selected households were included in the survey.

Main outcome measures Key NCD risk factors for adolescents (15-17 years) — current tobacco and alcohol use, dietary behaviours, insufficient physical activity, overweight and obesity.

Results Overall, 1402 households and 1531 adolescents completed the survey. Prevalence of current daily use of tobacco was 3.1% (95% CI: 2.0-4.7), 25.2% (95% CI: 22.2-28.5) adolescents showed insufficient levels of physical activity, 6.2% (95% CI: 4.9-7.9) were overweight and 1.8% (95% CI: 1.0-2.9) were obese. Two-thirds reported being imparted health education on NCD risk factors in their schools/colleges.

Conclusion The survey provides baseline data on NCD related key risk factors among 15-17 years in India. This national-level data fills information gaps for this age group and helps assess India's progress towards NCD targets set for 2025 comprehensively. Though the prevalence of select risk factors is much lower than in many developed countries, this study offers national evidence for re-visiting and framing appropriate policies, strategies for prevention and control of NCDs in younger age groups.

Keywords Adolescents; India; Monitoring, Noncommunicable diseases; Public Health Surveillance; Risk Factors.

93 Summary box

Strengths and limitations of this study

- The use of standard tools and methods on a nationally representative study design.
- Generated reliable data to fulfil the needs of the National NCD Monitoring Framework and provide baseline evidence to monitor the progress of actions.
- The study included only adolescents of age 15-17 years, while the adolescent age group is 10-19 years.
- Self-reported behavioural risk factor information may have been influenced by recall bias and responses in socially desirable ways.

94 Main text

95 INTRODUCTION

96 Adolescents (10-19 years) constitute 21% of India's total population, making it to be the
97 largest in the world (1.5 billion adolescents). [1-3] The health status during this phase of
98 growth and development has an important bearing on the overall health during her/his
99 adulthood. [4] Their ongoing transitional state of neural, psychological and physical
100 development makes them susceptible to certain behavioural risk factors — tobacco use,
101 alcohol consumption, unhealthy diet and insufficient physical activity. [4,5] However,
102 acquisition of these unhealthy behaviours often persists lifelong. This increases the risk for
103 developing noncommunicable diseases like cardiovascular diseases, respiratory diseases,
104 diabetes, hypertension, cancers and mental disorders from early adulthood onwards. [4,5]

105 Several studies have been undertaken to report the use of tobacco, alcohol and other risk
106 factors in India. The differences in their objectives, inclusion of the NCD indicators, sample
107 size, methodology, age groups, and operational definitions used generalizability at the
108 national level becomes difficult. [6-10] The National Family Health Survey (NFHS) - 3
109 conducted in 2005-06, reports the use of tobacco — 29% and 4% and alcohol use — 11%
110 and 1% among 15-19 years boys and girls, respectively. [11] The same survey (NFHS - 4)
111 repeated in 2015-16, reports tobacco use as 18.5% and 1.6% and alcohol use to be 8.9%
112 and 0.5% in boys and girls. [6] The World Health Organization (WHO)-NCD country profile
113 for India 2018, reported current tobacco smoking among those aged 15+ years to be 20%
114 in boys and 2% in girls. [12] Nearly about 1.7% of adolescent boys and 2.4% of adolescent
115 girls were overweight and these could contribute to the rise in the proportion of those with
116 pre-diabetes in this age group. [13] The prevalence of obesity shows an increasing trend
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2 118 from 2016 to 2025. [12] The increasing burden from NCDs is accelerated by the negative
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4 119 impact of globalization and unplanned urbanization. Insufficient physical activity and
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6 120 preferences for high salt, sugar and fatty foods, sedentary behaviours accelerate the
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8 121 development of NCDs. [14]

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10 122 Improving country-level surveillance and monitoring systems becomes the top priority to
11
12 123 cope with the ever-expanding needs for policies, legislation, services and infrastructure to
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14 124 prevent and control NCDs. [14] In 2014, India was the first country to adopt the WHO -
15 125 Global Voluntary NCD Targets to be achieved by 2025 and, framed its National NCD
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17 126 Monitoring Framework and Action Plan, which includes 10 targets and 21 indicators. Three
18
19 127 out of twenty-one indicators on NCD risk factors are related to adolescents [15] (*Table 1*).
20 128 Furthermore, the Sustainable Development Goals (SDGs) 2030 includes ambitious targets
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22 129 related to NCDs and eleven out of eighteen SDGs and nineteen out of fifty-three health-
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24 130 associated SDG indicators address child and adolescent health. [16] The National Health
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26 131 Policy 2017 emphasises health education and promotion as part of the curriculum in
27 132 schools. [17]

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31 **Table 1 National NCD Monitoring framework [15] for adolescents**

Framework element	Targets for 2025	Indicator
	Outcomes	
NCD Risk factors		
Obesity	Halt the rise in obesity	Prevalence of obesity in adolescents (defined as two standard deviations BMI for age and sex overweight according to the WHO Growth Reference).
Physical inactivity	10% Relative reduction in the prevalence of insufficient physical activity	Prevalence of insufficiently active adolescents (defined as less than 60 minutes per day of physical activity).
Tobacco use	30% Relative reduction in the prevalence of current tobacco use	Prevalence of current tobacco use (smoking and smokeless) among adolescents.

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49 133 Recognizing the need for evaluation and monitoring of NCD risk factors, the National NCD
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51 134 Monitoring Survey was undertaken with a primary objective to generate national-level
52 135 estimates of key NCD indicators identified in the national NCD monitoring framework. This
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54 136 paper exclusively presents and discusses the adolescent (15-17 years) risk factors for
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56 137 NCDs. [18] It also describes the school-based information collected under the adolescent
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58 138 study tools to understand the status of health education and promotion interventions in
59 139 schools/colleges.
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141 **METHODS**

142 **Study setting**

143 The National NCD Monitoring Survey was a community-based cross-sectional survey
144 conducted in 2017-18. It covered age groups from 15-69 years, which included the
145 adolescent population aged 15-17 years as a sub-set. The survey was coordinated by the
146 Central Coordinating Unit (CCU), the ICMR-NCDIR, Bengaluru and included primary
147 sampling units from twenty-seven states of India and was implemented through a network
148 of ten implementing research institutes/agencies of repute across the country. [18]

149 **Sampling and study participants**

150 The survey used a stratified multistage sampling design across 27 states of India. The
151 sample size was calculated based on previous estimates of the prevalence of obesity (6%),
152 [19] relative precision as half of the prevalence, [20] design effect of 1.5 and non-response
153 rate of 15%. The total estimated sample size for adolescents (15-17 years) was 1700. The
154 PSUs were villages for rural areas and wards for urban areas. One Census Enumeration
155 Block (CEB) from each ward was selected by random selection. The sampling frame was
156 constituted for adults and adolescents together that was divided into four subgroups/strata
157 urban/rural and men/women (2 x 2). The number of households to be covered was
158 calculated as 12000 (6000 urban and 6000 rural) for adults keeping the prevalence of
159 obesity among adults as 9%, relative precision of 15% and non-response rate of 15%. From
160 each PSU, twenty households were selected through circular systematic sampling. Based
161 on the proportion of adolescents as 10 to 15% from the Census 2011 and assuming 12%
162 adolescents were available in the 12000 selected households for adults, the sample size for
163 adolescents was expected to be 1440 if one adolescent was selected from each household.
164 However, we covered all the available adolescents (15-17 years) in the selected household
165 to reach the required sample size. [18]

166 **Patient and public involvement**

167 In the selected PSUs, the survey teams engaged with the local authorities, people's
168 representatives and local population to explain the purpose and details of the survey before
169 data collection. This ensured better participation, facilitation in the conduct of the survey and
170 agreement of the community. The results of the survey have been shared with the health
171 departments and local authorities. [18]

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2 172 **Study tools and data collection**

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4 173 The study tools were adapted from the WHO-STEP wise approach to Surveillance (STEPS),
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6 174 [21] Integrated Disease Surveillance Project (IDSP) - NCD risk factor survey, [19] WHO-
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8 175 Global School Student Health Survey (GSHS) [22] and the WHO-Global Adult Tobacco
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10 176 Survey (GATS). [23] All tools were translated to eleven regional languages of India and
11 177 validated with back-translation. The data were collected using an open-source Android-
12
13 178 based application, an Open Data Kit (ODK) [24,25] in portable handheld devices, with built-in
14
15 179 quality checks. Structured interview schedules were used for the collection of information on
16 180 demographic characteristics, behavioural risk factors (tobacco, alcohol use, diet, physical
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18 181 activity) and measurements of height and weight were recorded to estimate the metabolic
19
20 182 risk factors (overweight and obesity). Prior informed consent was sought from the
21
22 183 parent/guardian and assent was obtained from the selected participant to be interviewed
23 184 and measured. Height and weight were measured using standard procedures using a
24
25 185 portable stadiometer (SECA 213) and digital weighing scale (SECA 803) recommended by
26
27 186 WHO-STEPS. The survey teams ensured that all instruments were calibrated regularly and
28
29 187 maintained calibration logbooks. Both height and weight were measured in barefoot and
30 188 light clothing with erect body posture, head looking straight and facing the interviewer with
31
32 189 arms on his/her side. The survey also collected school/college-related information from the
33
34 190 same selected adolescent who reported going to school in the last 12 months. In this section,
35 191 we obtained details on the availability of shops selling tobacco nearby their schools, time
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37 192 spent in physical activity in schools, type of food available in their canteens and availability
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39 193 of health promotion materials as well as information on health education being imparted. All
40 194 the information was collected at the selected household itself. [18]

42 43 195 **Ethical clearance and permissions**

44
45 196 ICMR-NCDIR and all implementing agencies obtained ethical clearances from their
46
47 197 respective institutional ethics committees. Assent from the adolescent respondent was
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49 198 obtained along with consent from the parent/guardian. Apart from this, a separate participant
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51 199 anthropometry reporting form was used to obtain consent for measurement of height and
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53 200 weight. Those found with any risk factor were referred to the nearest public health facility for
54 201 counselling and further management.

56 57 202 **Quality assurance**

58
59 203 National and regional level workshops were organized to impart training in field operations,
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204 consenting procedures, interviewing techniques, data collection in handheld devices,

importance and methods to maintain privacy and confidentiality. A mock field survey was undertaken in two non-selected PSUs in all the survey sites. Periodic re-trainings were delivered along with clarification of issues confronted in the field. Standard operational definitions [26] were used for estimating behavioural and metabolic risk factors (tobacco use, alcohol use, diet, physical activity, BMI). [18] The senior investigators monitored data collection and, site visits by experts were undertaken for on the spot assessments any matters identified were immediately resolved.

Statistical analysis

The data were imported from the ODK platform to IBM SPSS Version 22.0 (IBM Corp, Armonk, NY, USA). It was cleaned and weighted to provide prevalence estimates at the level of the population, households, area of residence (urban and rural) and gender. Data were analysed in STATA 14.1 (StataCorp LP, College Station, Texas, USA) by complex survey analysis and the results presented in descriptive statistics with mean and proportion with 95% confidence interval (CI).

RESULTS

During household mapping and listing, a total of 1819 adolescents were identified from 1402 participating households. Of them, 1643 adolescents participated (176 adolescents did not participate as the households were found locked despite 4 attempts made over 2 consecutive days) in the survey. A total of 1531 adolescents completed the survey (112 adolescents refused after initial acceptance or mid-way) with an overall response rate of 93.2%.

Table 2: NCD risk factors in adolescents of 15-17 years (Percentage) and (Mean) with 95% CI

Parameter	Urban	Rural	Boys	Girls	Overall
Tobacco use (%)					
Ever use/ experimented any form of tobacco	5.6 (3.6-8.8)	7.7 (5.5-1.06)	11.9 (9.0-15.6)	1.7 (0.6-4.3)	7.0 (5.4-9.1)
Current daily use*					
Any form of tobacco	1.9 (0.8-4.5)	3.6 (2.3-5.8)	5.5 (3.5-8.6)	0.4 (0.1-1.3)	3.1 (2.0-4.7)
Smoked tobacco	0.1 (0.0-0.6)	0.4 (0.1-1.3)	0.4 (0.1-1.5)	0.2 (0.0-1.2)	0.3 (0.1-0.9)
Smokeless tobacco	1.9 (0.8-4.5)	3.4 (2.1-5.6)	5.2 (3.3-8.2)	0.4 (0.1-1.3)	2.9 (1.9-4.5)

Both smoked and smokeless	0.1 (0.0-0.7)	0.2 (0.0-0.8)	0.2 (0.0-0.6)	0.2 (0.0-1.2)	0.2 (0.0-0.5)
Thoughts about harm from second-hand tobacco smoke					
Thought that inhaling smoke from other people's tobacco smoking can cause harm	86.9 (82.3-90.4)	84.4 (80.1-88.0)	86.6 (82.1-90.2)	83.6 (79.3-87.2)	85.2 (82.0-88.0)
Alcohol use (%)					
Ever consumed	3.2 (1.5-6.6)	3.6 (2.1-6.1)	5.4 (3.3-8.6)	1.4 (0.6-3.1)	3.5 (2.2-5.4)
Consumed in last 12 months	1.1 (0.4-2.6)	1.4 (0.7-2.8)	1.8 (1.0-3.4)	0.7 (0.2-2.0)	1.3 (0.7-2.3)
Consumed in last 30 days	0.9 (0.3-2.5)	0.4 (0.1-1.2)	0.8 (0.3-2.0)	0.3 (0.1-1.0)	0.5 (0.2-12.0)
Binge drinking**	0.2 (0.02-0.6)	0.1 (0.01-0.6)	0.2 (0.1-0.7)	0.0 (0.0-0.0)	0.1 (0.03-0.4)
Dietary behaviours					
Usually consumed any of the food items at least once a week					
Fried items	52.9 (46.1-59.6)	47.6 (42.6-52.6)	55.3 (49.9-60.5)	42.7 (37.7-47.9)	49.3 (45.2-53.3)
Chips / Namkeen	58.3 (52.4-63.9)	49.2 (44.1-54.3)	49.9 (44.1-55.7)	54.4 (49.5-59.1)	52.1 (48.1-56)
Pizza / Burger	10.1 (6.0-16.5)	4.7 (3.3-6.8)	7.3 (5.0-10.4)	5.5 (3.4-8.7)	6.4 (4.7-8.8)
Instant noodles	31.8 (24.9-39.7)	13.1 (10.1-16.7)	16.1 (12.6-20.3)	22.1 (17.4-27.7)	19.0 (15.7-22.7)
Cold aerated drinks	23.2 (18.3-28.9)	15.9 (12.6-19.9)	24.5 (20.4-29.1)	11.4 (8.3-15.4)	18.2 (15.4-21.5)
Fresh fruits / Fresh juices	49.0 (42.4-55.5)	27.0 (22.3-32.3)	37.2 (31.8-43)	30.3 (25.6-35.5)	33.9 (30.0-38.1)
Energy drinks	11.6 (7.4-17.7)	4.2 (2.1-8.2)	6.6 (3.8-11.3)	6.4 (3.9-10.4)	6.5 (4.4-9.6)
Breakfast related information					
Skipping breakfast on all 30 days (%)	4.6 (1.8-11.4)	3.7 (2.2-6.0)	3.8 (1.9-7.3)	4.1 (2.6-6.5)	4.0 (2.5-6.3)
Skipping breakfast on any one day in last 30 days (%)	48.7 (42.3-55.1)	48.1 (43.3-52.9)	45.8 (40.6-51.2)	50.9 (45.8-56.1)	48.3 (44.4-52.2)
Number of days breakfast was skipped in a month (Mean)	9.5 (7.2-11.8)	9.7 (8.1-11.2)	9.2 (7.4-11.0)	10.0 (8.6-11.3)	9.6 (8.3-10.9)
Physical activity					
Insufficient physical activity [¶] (%)	38.0 (31.9-44.4)	19.3 (16.2-22.9)	21.5 (17.3-26.3)	29.3 (25.1-33.9)	25.2 (22.2-28.5)

Minutes being sedentary in a day (Mean)	361.4 (314.9-407.9)	331.2 (297.2-365.2)	331.1 (298.5-363.7)	351.2 (318.8-383.7)	340.7 (313.2-368.2)
Doing physical activity in school/college (%)	68.0 (60.1-75.0)	62.3 (56.4-67.8)	69.1 (63.3-74.3)	58.2 (52.1-63.9)	64.3 (59.6-68.7)
Minutes spent in physical activity per day at school (Mean)	18.0 (14.7-21.3)	15.3 (12.8-17.7)	20.0 (17.1-23.0)	11.8 (9.6-14.0)	16.1 (14.1-18.1)
Metabolic risk factors^{††}					
Mean BMI (Kg/m ²)	19.5 (19.0-19.9)	18.4 (18.2-18.7)	18.5 (18.1-18.8)	19.1 (18.8-19.4)	18.8 (18.5-19.0)
Overweight (including obesity) (%)	11.9 (9.0-15.7)	3.6 (2.4-5.3)	6.4 (4.5-8.9)	6.1 (4.3-8.7)	6.2 (4.9-7.9)
Obesity (%)	3.5 (1.9-6.5)	0.9 (0.4-2.3)	2.6 (1.4-4.7)	0.8 (0.3-2.3)	1.8 (1.0-2.9)
* Defined as the use of any form of tobacco (smoke and/or smokeless) daily in the last 12 months preceding the survey.					
** Defined as those engaged in five or more standard drinks of alcohol for boys and four or more for girls in a single drinking occasion in the past 30 days.					
† Insufficient physical activity in adolescents was percentage doing less than 60 minutes of moderate to vigorous-intensity physical activity daily, which is equivalent to <1680 MET minutes per week and calculated as [60 minutes * 4 MET * 7 days].					
†† The BMI (as per WHO)** was used to categorise the respondents into overweight and obesity. Overweight was ≥ 1SD BMI for age and sex (equivalent to BMI 25Kg/m ² at 19 years) and obesity was ≥ 2SD BMI for age and sex (equivalent to BMI 30Kg/m ² at 19 years), as per WHO.					

Tobacco and alcohol use

Only 3.1% (95% CI: 2.0-4.7) of adolescents reported current use of any form of tobacco daily in the last 12 months preceding the survey. The proportion was higher in rural areas [3.6% (95% CI: 2.3-5.8)] and among boys [5.5% (95% CI: 3.5-8.6)]. Nearly double the proportion [7.0% (95% CI: 5.4-9.1)] reported having experimented using smoking or smokeless tobacco. Prevalence of smokeless tobacco use [2.9% (95% CI: 1.9-4.5)] was higher than the use of smoked tobacco [0.3% (95% CI: 0.1-0.9)]. Findings showed that smokeless tobacco use was higher in rural [3.4% (95% CI: 2.1-5.6)] than urban areas [1.9% (95% CI: 0.8-4.5)] and among boys [5.2% (95% CI: 3.3-8.2)] than girls [0.4% (95% CI: 0.1-1.3)]. (Table 2)

More than three-fourth of adolescents [85.2% (95% CI: 82.0-88.0)] recognized that second hand smoke was harmful, with higher in urban areas [86.9% (95% CI: 82.3-90.4)] and among boys [86.6 (95% CI: 82.1-90.2)] (Table 2).

Alcohol consumption proportion was lesser in girls with not many urban-rural differences. (Table 2).

241 Dietary behaviours

242 Nearly half of adolescents reported consuming chips/namkeen (Indian savouries which are
 243 salted and fried) [52.1% (95% CI: 48.1-56.0)] and fried items [49.3% (95% CI: 45.2-53.3)] at
 244 least once a week. One-third [33.9% (95% CI: 30.0-38.1)] reported consuming fresh
 245 fruits/fresh juices at least once a week. These findings were reported higher by adolescents
 246 in urban areas and boys (*Table 2*).

247 In the last 30 days, 48.3% reported skipping breakfast on at least one day and 4.0% skipped
 248 breakfast on all 30 days. Breakfast was reportedly skipped on an average for 10 days [9.6
 249 days (95% CI: 8.3-10.9)], which was similar across all strata (*Table 2*).

250 Physical activity

251 One-fourth of adolescents were insufficiently physically active, higher proportion being
 252 urban residents [38.0% (95% CI: 31.9-44.4)] and girls [29.3 (95% CI: 25.1-33.9)]. A total of
 253 64.3% (95% CI: 59.6-68.7) adolescents reported doing physical activity in their
 254 schools/colleges and on average spent 16.1 minutes per day. (*Table 2*).

255 Overweight and Obesity

256 Mean BMI and proportion of overweight and obesity was higher in urban areas [Mean BMI:
 257 19.5 Kg/m²; Overweight: 11.9% (95% CI: 9.0-15.7); Obesity: 3.5% (95% CI: 1.9-6.5)]. (*Table*
 258 *2*).

259 School/college-related information

260 The majority (94.2%) of adolescents had completed formal schooling and among them,
 261 84.2% boys and 73.9% girls completed high-school and higher secondary education. (*Figure*
 262 *1*). Overall, 86.8% of adolescents from urban and 74.0% from rural areas reported attending
 263 school/college in the last 12 months. (*Table 3*)

Table 3: School/college-related information reported in the last 12 months (Percentage with 95% CI)

15 - 17 years	Urban	Rural	Boys	Girls	Overall
Percentage who attended school/college in the last 12 months	86.8 (81.3-90.8)	74.0 (69.6-78.0)	84.0 (80.2-87.2)	71.5 (66.6-76.0)	78.0 (74.6-81.2)

Noticed any poster/wall painting/ signboard/ display on the following topics

Harmful effects of tobacco	41.4 (34.3-48.8)	40.5 (34.8-46.5)	42.7 (36.7-48.9)	38.4 (32.7-44.6)	40.8 (36.3-45.5)
No smoking sign	45.7 (38.9-52.7)	43.1 (37.3-49.2)	46.4 (40.5-52.4)	41.0 (35.1-47.3)	44.0 (39.5-48.7)
Harmful effects of alcohol	35.3 (28.7-42.5)	26.3 (21.3-32.0)	31.8 (26.1-38.1)	26.4 (21.7-31.8)	29.4 (25.3-33.9)
Promotion material on healthy diet	43.6 (37.0-50.5)	31.6 (26.3-37.5)	35.9 (30.4-41.8)	35.8 (30.1-41.9)	35.8 (31.6-40.4)
Promotion material on physical activity	40.8 (34.3-47.7)	30.4 (24.8-36.7)	33.4 (27.8-39.6)	34.9 (29.2-41.1)	34.1 (29.7-38.8)
Percentage who reported being taught in schools about;					
Ill effects of tobacco	67.0 (59.3-73.8)	66.5 (61.3-71.4)	67.3 (61.3-72.7)	65.9 (59.6-71.6)	66.7 (62.4-70.7)
Ill effects of alcohol	65.0 (57.6-71.7)	66.6 (61.8-71.1)	67.2 (61.7-72.7)	64.6 (58.4-70.3)	66.0 (62.0-69.8)
Benefits of healthy diet	69.0 (62.2-75.1)	65.2 (59.9-70.2)	67.7 (62.1-72.9)	65.1 (58.9-70.8)	66.6 (62.4-70.5)
Benefits of physical activity	63.2 (57.1-68.9)	64.8 (59.7-69.6)	63.1 (57.8-68.2)	65.6 (60.2-70.7)	64.2 (60.3-68.0)
Tobacco-related information					
Noticed teacher/staff smoke in school/college premises in last 12 months	16.2 (11.5-22.5)	18.1 (14.4-22.5)	20.4 (16.3-25.3)	13.7 (10.0-18.4)	17.5 (14.4-20.9)
Any shop within 100 metres of school /college selling tobacco	48.2 (41.1-55.4)	42.9 (37.3-48.6)	48.5 (42.8-54.4)	39.8 (33.9-46.0)	44.7 (40.3-49.2)
School/college canteen related information					
Presence of canteen	34.7 (27.8-42.2)	21.4 (16.4-27.4)	24.7 (19.7-30.5)	27.7 (22.0-34.3)	26.0 (21.9-30.6)
Reported availability of High fat, Salt and sugar (HFSS) foods in school/college canteen	94.0 (88.3-97.0)	83.0 (69.8-91.2)	86.1 (74.1-93.0)	90.6 (88.3-94.9)	88.2 (80.8-93.0)

More than two-fifth [44.7% (95% CI: 40.1-49.2)] of adolescents going to school or college in the last 12 months reported the presence of a shop selling tobacco within 100 metres of school/college. Nearly one-fifth [17.5% (95% CI: 14.4-20.9)] adolescents reported noticing teacher/school staff smoking within the premises (Table 3).

Nearly one-third of adolescents reported having noticed health promotion materials (any poster/wall painting/ signboard) displayed in their schools/colleges. Two-thirds of them

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2 270 reported health education being provided in their schools/colleges on benefits of a healthy
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4 271 diet, physical activity, ill effects of tobacco and alcohol use. (Table 3).
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7 272 **DISCUSSION**

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10 273 NNMS was a large national-level comprehensive survey designed to provide baseline
11 274 values on the National targets of the NCD Monitoring Framework and Action Plan. It covered
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13 275 information on behavioural and metabolic risk factors for adolescents (15-17 years) to fill
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15 276 national-level data gaps for this age group. In addition, this survey included a separate set
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17 277 of questions corresponding to school-based information. These are of much relevance to
18 278 strengthen the Government of India school-based health promotion services like the Poshan
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20 279 Abhiyaan, Safe and Nutritious food campaign, Rashtriya Bal Swasthya Karyakram,
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22 280 Rashtriya Kishor Swasthya Karyakram etc. [5, 27-28]
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26 281 In comparison to several countries, the prevalence of selected behavioural and metabolic
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28 282 risk factors in India was much lower among adolescents. [29-31] The prevalence of binge
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30 283 drinking amongst those aged 10-19 years was 56% in Denmark, 35% in European countries,
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32 284 17.7% in the USA, 10.3% in Korea, 8% in Iceland and 7.1% in Hong Kong. [29] More than
33 285 70% of boys and girls aged 10-19 years were doing insufficient physical activity across the
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35 286 world. [30] The prevalence of obesity was 21% in the USA, 15% in the UAE, 9% in the UK
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37 287 and China. [31] However, aggressive redressal to modify these unhealthy behavioural
38 288 indices in India when at much lower proportions could have major benefits in controlling and
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40 289 tackling NCDs before they attain higher proportions in adulthood.

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43 290 There have been several flagship initiatives, regulations, policy and programmatic
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45 291 measures taken by the Government of India to address the mounting transitions in
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47 292 adolescent health. [27-28, 32-40] Numerous national surveys have been undertaken in
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49 293 India either as standalone or surveys with some of the risk factors as components. [6-
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51 294 11,41,42] The differences in their study objectives, design, methodology, age inclusion
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53 295 criteria and operational definitions limits comparisons and creates knowledge lacunae in this
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55 296 age group. This highlights the need for sustained surveillance mechanisms using
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57 297 standardized methodology.

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298 The high prevalence of tobacco use (any form) and alcohol consumption among boys than
299 girls were similar (NNMS) to those reported in other surveys like GATS-2, NFHS-4 and
300 Magnitude of substance use in India-2019. [6-8] Use of smokeless tobacco higher than
301 smoked tobacco was also consistent with findings from GATS-2. [7] The prevalence of

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2
3 302 current daily use of tobacco was 3.1% (NNMS) and GATS-2 reported the current use of
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5 303 tobacco as 12.4%. These expected variations are related to differences in study design,
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7 304 sampling strategy, coverage, age groups selected, weighting procedures and the
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9 305 questionnaires adopted. [7] On close examination, we found a similar prevalence of tobacco
10 306 use (3%) in the 15-17 years age group in the GATS-2 survey.

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12 307 In India, the Cigarette and Other Tobacco Products Act (COTPA) - 2003 has restrictions on
13 308 the sale of tobacco products within 100 meters of schools. [32] NNMS revealed 44.7% of
14 309 adolescents to have reported the presence of a shop selling tobacco within 100 metres of
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16 310 their schools or colleges, indicating easy access to tobacco products in schools/college
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18 311 vicinity. Several other studies [43-45] conducted in different parts of India showed violations
19 312 of the COTPA. These findings recommend the need for better implementation, monitoring
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21 313 and enforcement of COTPA in both urban and rural areas. The prevalence of current alcohol
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23 314 use in the last 12 months (1.3%) among adolescents (15-17 years) was similar to those
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25 315 reported by the Magnitude of substance use in India – 2019 (1.3%) amongst the 10-17 years
26 316 age group. [8]

27
28 317 The mean BMI among boys (18.5 Kg/m²) and girls (19.1 Kg/m²) observed in this study were
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30 318 closer to findings from age-wise split results of NFHS-4 (men: 19.3 Kg/m² and women: 19.4
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32 319 Kg/m² among 15-19 years). [6] The prevalence of overweight among boys (6.4%) and girls
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34 320 (6.1%) from the current survey were found to be nearly similar to NFHS-4 (Men: 4.8% and
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36 321 Women: 4.2% among 15-19 years). [6] Overall, 6.2% (95% CI: 4.9-7.9) of adolescents were
37 322 overweight (including obesity) and these were comparable to the findings (5%) from the
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39 323 Comprehensive National Nutrition Survey, 2016-17 (among 10-19 years). [10]

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41 324 India is undergoing a rapid nutrition transition [46] wherein preference for packaged,
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43 325 processed and hyper-palatable foods over traditional nutritious diet or home-cooked meals
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45 326 are the major contributors. In addition, sedentary lifestyles and lack of adequate physical
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47 327 activity fuel these challenges. Nearly, half of adolescents consumed fried items at least once
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49 328 a week and a higher proportion were boys (55.3%). Also, a larger proportion (88.2%)
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51 329 reported availability of HFSS food in their school/college canteen, indicating easy access to
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53 330 unhealthy food items. The preferences to packaged, high salt and fried foods were similar
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55 331 to those reported in NFHS-4 (47.4% among boys aged between 15-19 years).[6]

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57 332 The Government of India flagship initiatives like the mid-day meal program, Poshan
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59 333 Abhiyaan, Eat Right India have been implemented across the country to improve the
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334 nutritional outcomes in children and adolescents. Regulations on taxation, food

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advertisements and guidelines for food nutrition labels have been issued by the Food Safety and Security Authority of India (FSSAI). [27-28, 33-34] The Safe and Nutritious food campaign help schools promote healthy dietary habits. [5] Three specific policies were brought out in the year 2018 to address adolescent health — (i) National regulations on the marketing of all foods and beverages high in sugar, salt and fat to children; (ii) prohibit sales of tobacco products to minors; and (iii) marketing of alcohol to adolescents. [28, 33-35]

Regular physical activity has multiple benefits on cardiorespiratory and muscular fitness, improves bone and functional health, lowers risk from NCDs and improves mental well-being. This survey estimated that a quarter of adolescents were insufficiently physically active. Though India has been able to take initiatives at the community level to promote and encourage physical activity through programs like Fit India Movement, there is a need to strengthen such efforts. [36] Also, some concerns on the outdoor activity being influenced by the high levels of air pollution need urgent policy and program action. [47]

Recently, school health programmes were incorporated into the Health and Wellness component of the Ayushman Bharat to strengthen health promotion activities. [37] In the year 2018, the Government of India adopted the WHO policy of National standards for health-promoting schools to provide a healthy environment through health education and community/school outreach activities. [38-40]

Strengths and limitations

The strengths of this study include, NNMS being a large nationally representative survey with high survey response rates. Being able to generate baseline national evidence on NCD risk factors in this age group would strengthen policy and program interventions in India. Though the prevalence of risk factors among adolescents in India is much lower compared to the western countries like the US and the UK, stronger public health initiatives are needed in mitigating risk exposures during this key phase of growth and development. The study has limitations in covering only the 15-17 years age group and not all adolescents from 10-19 years. Self-reported information of behavioural risk factors might be associated with socially desirable responses and recall bias. To facilitate appropriate responses and limit such biases, adequate time was spent on every question maintaining privacy and confidentiality of participant responses. Also, the interviews were conducted by skilled and trained personnel using globally standardized questionnaires and show cards to facilitate recall of health risk behaviours. Our data collection was directed to fulfil the National NCD Monitoring Framework and Action Plan for India, as the country needed baseline evidence

to track NCDs and their risk factors. However, there is much scope to expand the data collection tools to incorporate additional indicators relevant to NCDs — e.g., socio-economic factors, stress, sleep patterns and other social factors need further examination to provide a better comprehensive picture of the determinants of risk factors in adolescents.

CONCLUSION

Through this survey, we have been able to establish a standardized method of data collection. It has recognized the need to strengthen the functioning of school/college health promotion programmes. Such surveys should be repeated at periodic intervals to drive evidence-based programming, policy, resource allocation and map trends as well as track progress being made in tackling NCDs at younger age groups.

STATEMENTS

- Ethics approval:** The study was approved by the Institutional Ethics Committee of the Coordinating Centre, ICMR-NCDIR. Approval no: NCDIR/IEC/2017/4 dated 03 February 2017. Every implementing agency obtained their ethics approval from their own Institutional ethics Committee before starting the survey. All the study participants were enrolled only after obtaining written informed consent. Assent from the adolescent respondent was obtained along with consent from the parent/guardian.
- Patient consent for publication:** Not required.
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- Author Contributions:** Concept and design of manuscript by authors PM, VK and SL with contributions from AK. PM, VK and SL drafted, modified, and finalized it. Authors PM, VK, SL, AK, HKC, HRS, RA, BN, AL, MB, SK, BKP, PRR, PR, PSS, RS, MT, TGM provided expertise and reviewed the manuscript. Methodology, data curation and formal analysis by VK and HKC. Investigation and supervision from AK, HRS, RA, BN, AL, MB, SK, BKP, PRR, PR, PSS, RS, MT, NA, TGM, PJB, RPJ, AP, AG, DK, BKB, RKT, MKG, NR, AVT, KRT, SGA SGG and SCS. Resources by PM, HRS, RA, PG and VUK. Software by authors RA, PG and VUK. Validation by PM, VK, SL, AK, HKC, RA, BN, PG, AL, MB, SK, BKP, PRR, PR, PSS, RS, MT and TGM. Visualization by PM, VK, SL, AK and HRS. All authors have agreed to the final version of the manuscript.
- Competing interests:** None declared.

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7. **Data availability Statement:** The National Noncommunicable Disease Monitoring Survey (NNMS) report is available at <https://www.ncdirindia.org/nnms/>. Further data are available upon request.
8. **Transparency statement:** The manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned.
9. **Reproducing figures:** Not applicable.

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26 537 FIGURE LEGENDS

- 27
28 538 1. **Figure 1:** Highest educational status among adolescents (15-17 years) by area of
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30 residence and gender.
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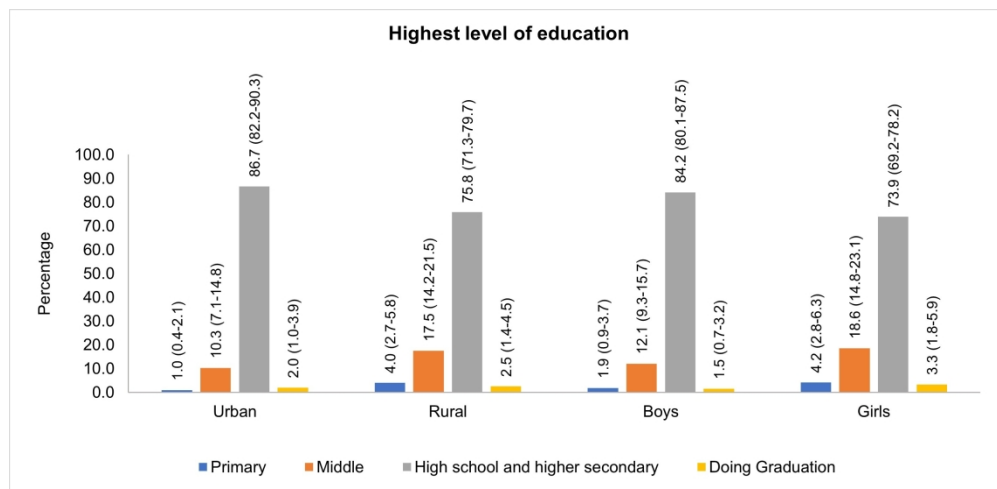


Figure 1: Highest educational status among adolescents (15-17 years) by area of residence and gender.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	-

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2	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
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13	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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15	Discussion		
16	Key results	18	Summarise key results with reference to study objectives
17	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
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21	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
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25	Generalisability	21	Discuss the generalisability (external validity) of the study results
26			
27	Other information		
28	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
29			
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*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.