



Estimates of major non-communicable disease risk factors for India, 2010 & 2015: A summary of evidence

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Background & objectives: The National Monitoring Framework for the prevention and control of NCDs in India has set targets for reduction of risk factors relative to the measure recorded in 2010. Estimates for 2010 and 2015 were established using meta-analyses in the absence of a national risk factor survey till 2017.

Methods: We searched national survey reports and also articles published in English from India between 2008 and 2017 in PubMed, Google Scholar and Cochrane review databases for specific risk factors among 18-69 yr Indians. Quality of studies was evaluated using Joanna-Briggs tool, but all studies were included in analyses. Estimates for each of the eight strata by age, gender and place of residence, respectively, were generated. MetaXL was used to calculate the pooled estimate for 2010 and 2015 using a random effects model. Strata-specific estimates were combined to arrive at national estimate using population weight of each stratum. The credibility of the estimates was determined using four parameters - average Briggs score; representativeness of the contributing studies and precision and stability of the estimates.

Results: The estimates [95% confidence interval (CI)] for 2010 for different risk factors were as follows: current alcohol use, 15.7 per cent (13.2-18.2); current tobacco use, 27 per cent (21.4-32.6); household solid fuel use, 61.5 per cent (50.2-72.5); physical inactivity, 44.2 per cent (37.8-50.6); obesity, seven per cent (3.8-10.2) and raised blood pressure, 20.2 per cent (18.4-22.1). In 2015, compared to 2010, tobacco use showed a relative decline of 18 per cent, household solid fuel use of nine per cent and physical inactivity of 15 per cent. The estimates were stable for alcohol use, raised blood pressure and obesity between 2010 and 2015. All estimates varied between moderate and high degrees of credibility.

Interpretation & conclusions: The estimates are consistent with other available estimates and with current national-level initiatives focused on tobacco control and improving access to clean fuel. These estimates can be used to monitor progress on non-communicable disease risk factor targets for India.

Key words Credibility - meta-analysis - non-communicable disease - risk factors - systematic review

The 2011 United Nations Summit provided a global platform for non-communicable diseases (NCDs), and national governments were urged to ‘customize

the implementation’ of their commitments¹. A global monitoring framework (GMF) with voluntary targets was adopted to monitor global progress on NCDs². In

May 2013, the 66th World Health Assembly adopted the comprehensive GMF for the prevention and control of NCDs¹. The GMF included a set of indicators capable of application across regions and country settings to monitor trends and assess progress made in the implementation of national strategies and plans on NCDs³.

India became the first country globally to define its National Monitoring Framework with country-specific targets and indicators⁴. In the national advisory group consultation in June 2013, India identified 10 targets and 21 indicators to be achieved by 2025. The targets and their indicators address morbidity and mortality (2 indicators), risk factors (11 indicators) and national systems response (8 indicators). Among the key changes were the inclusion of an additional target of 50 per cent relative reduction in proportion of households using solid fuels as primary source of cooking and focus on the current use rather than the harmful use of alcohol⁴. All targets for risk factors are relative reduction as compared to 2010 values. The progress on the achievements to the targets was to be reviewed every five years (2015, 2020) till the 2025 deadline. As India lacks baseline values for 2010 to monitor the progress of its achievements, it is imperative to generate the 2010 baseline values while establishing mechanisms for measuring future national targets.

A review of the global status report on NCDs by the WHO showed that there were some important differences in the way the indicators were framed, which prevented India from adopting those as its baseline values⁵. These include the use of tobacco smoking in its report as opposed to India's focus on tobacco use (including smokeless tobacco) and focus on current alcohol use as opposed to harmful use of alcohol in the WHO report and non-inclusion of the solid-fuel use in the report^{4,5}. This study was initiated to assess the burden of NCDs and their risk factors, which included preparing national estimates for the prevalence of major NCD risk factors for 2010 and 2015 using available data from surveys and published literature. This study presents the result of this systematic exercise focusing only on those risk factors of NCDs for which targets have been established at the national level.

Material & Methods

Studies and reports published on Indian populations from 2008 to 2017 on the prevalence of one or more of

the following risk factors such as raised blood pressure, raised body mass index, physical inactivity, alcohol consumption, tobacco consumption and solid cooking fuel use. The list of risk factors and their definitions based on the WHO recommendations is shown in Table I. Raised blood sugar was removed from the list of risk factors to be studied to avoid duplication of work as diabetes was included in the list of diseases for which estimates were being prepared. Sodium intake was also dropped as initial review showed that there would not be enough studies to generate national-level estimates for 2010 and 2015.

Search strategy: PubMed, Google Scholar and Cochrane database were searched using the search strategy combining the terms, 'NCD risk factors', 'risk factor profile', 'lifestyle risk factors', 'epidemiology'. For each risk factor separate search strategies were developed (Supplementary Table I). Grey literature focusing on large-scale national survey reports was also identified. For all these multi-State surveys, each State was taken as a unit of study, if the information was available at State level. Two investigators screened all the abstracts of the articles and the reports, and then applied the eligibility criteria. They then independently extracted data from the articles using a data extraction form. Data extracted from each included article were publication date, study design, study duration and dates, participant data and results of the study. Critical appraisal was conducted using Joanna-Briggs (JBI) tool for prevalence studies, but no study was excluded based on poor quality⁶. Each of the papers was reviewed by at least two study investigators and a third investigator mediated any disagreements relating to eligibility, outcome definition or data.

Inclusion & exclusion criteria: All observational/cross-sectional/prevalence studies in English language between 2008 and 2017, at national or sub-national level conducted in India, covering any age group between 18 and 69 yr were included in the study. Community based studies covering either or both sexes and prevalence studies using identified case definitions by WHO were included. General review or policy papers or case-control studies or case reports and studies for which abstract were not available, studies involving special groups (occupation), subgroup or institution-based studies and studies which used case definitions other than that specified by WHO were excluded.

Statistical analysis: To generate a national estimate, India was divided into eight strata - age (18-44 and

Table I. Definition of indicators for different risk factors in India as per World Health Organization recommendations³

Risk factor	Indicators
Raised blood pressure	Prevalence: Percentage of hypertensive persons aged 18-69 yr with blood pressure $\geq 140/\geq 90$ mmHg and those on treatment
Raised BMI	
Overweight	Prevalence: Percentage of overweight persons aged 18-69 yr with BMI ≥ 25 kg/m ² -29.99 kg/m ²
Obesity	Prevalence: Percentage of obese persons aged 18-69 yr with BMI ≥ 30 kg/m ²
Physical inactivity	Prevalence: Percentage of persons aged 18-69 yr that are moderately physically active for less 150 min or vigorously active for <75 min in a week
Alcohol consumption	Percentage of persons aged 18-69 yr who consumed alcohol at least once in the last one year
Tobacco consumption	Percentage of persons aged 18-69 yr who currently consume tobacco products
Solid cooking fuel use	Prevalence: Percentage of households that currently use solid cooking fuel for cooking food
BMI, body mass index	

45-69 yr); gender (male and female) and place of residence (urban and rural). This was based on the preliminary analysis of data which showed that for most variables, these were major determinants of the risk factor levels. Risk factor data for each of the eight strata was abstracted. Data from studies that did not match with the included age group was extracted to the closest age stratum. For each risk factor, meta-analysis of the data in each stratum was conducted to determine the combined estimate. An established meta-analytic method was then adopted for pooling prevalence data using Meta-XL version 5.3, a plugin software package for Microsoft Excel (EpiGear International Pty Ltd., The Netherlands) and calculated pooled estimates separately for 2010 and 2015 using a random effects model (http://epigear.com/index_files/metaxl.html). The strata-specific estimates were combined to arrive at national estimate using population weight of each stratum. Population weights for 2010 and 2015 derived from the 2011 Census of India Report and Population Projections for India and States 2001-2026 report⁷ by Census

of India, respectively, were used (Supplementary Table II).

Even though the evaluation of the credibility of results from a meta-analysis has become important, not much guidance is available for rating credibility of population estimates generated by meta-analyses. There are two major approaches which deal with quality of evidence or confidence on results of the evidence synthesis process – GRADE and CINeMa^{8,9}. Both these approaches use the overlapping criteria of inconsistency/heterogeneity, indirectness, imprecision, reporting bias and study bias or limitations. Indirectness pertains to study happening in a group being used to make recommendations for another group and is not relevant to our purpose. Therefore the credibility of the estimate was assessed using four parameters: average JBI Score for the quality of studies; representativeness based on the number of zones (north, south, east, west, north-east and central) contributing to each of the estimates; relative precision by dividing the width of confidence interval (CI) with the estimate and consistency based on the difference in estimates across two time periods for subgroups of age, geographic location and gender. Details are provided in Supplementary Table III.

Results

The results of the literature search and decisions at different phases as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for each risk factor are shown in Table II. A total of 84 studies contributed to the estimates for 2010 and 45 studies contributed to 2015 and these are listed in Supplementary Table IVA and B, respectively. One study could contribute data to more than one risk factor. Overall, more studies contributed to estimates for overweight/obesity (81) and tobacco (54) as compared to estimates for alcohol (23) and physical inactivity (35). The data on solid fuel use were mainly from large national-level surveys as opposed to physical activity, which was not covered in any national-level survey.

Based on the above-defined criteria the credibility of the estimates generated for 2010 and 2015 was assessed. Overall, the estimates scored between moderate and high levels of credibility. They were least credible for overweight and obesity estimates and best for use of solid cooking fuel. There were no major differences in credibility scores for 2010 and 2015 (Table III).

Table II. Included studies as per Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines for each of the risk factors

	Alcohol consumption	Current tobacco consumption	Physical inactivity	Solid cooking fuel use	Raised blood pressure	Raised BMI
Studies identified by search	2836	3087	1271	1093	3342	3564
Studies excluded on screening						
As duplicates	46	36	24	16	79	68
Of title and abstract	2737	2965	1199	1070	3183	3382
Found ineligible after full review	34	38	21	3	40	46
Studies included	19	48	27	4	40	68
Additional studies identified	4	6	8	6	4	13
Studies used for meta-analysis	23	54	35	10	44	81
Total sample size (n)	1,554,011	1,989,242	112,004	2,010,333	1,585,463	1,958,831
BMI, body mass index						

Table III. Credibility assessment of estimates for the years 2010 and 2015

Risk factors	Year	Parameters*			
		Study quality	Representativeness	Precision	Stability
Alcohol Consumption	2010	Moderate	Moderate	High	High
	2015	High	Moderate	High	High
Current tobacco consumption	2010	High	High	High	Moderate
	2015	High	High	High	Moderate
Physical inactivity	2010	High	Moderate	High	High
	2015	High	Moderate	High	High
Solid cooking fuel use	2010	High	High	High	High
	2015	High	High	Moderate	High
Raised blood pressure	2010	High	High	High	Moderate
	2015	High	High	Moderate	Moderate
Overweight	2010	Moderate	High	Moderate	Low
	2015	High	High	High	Low
Obesity	2010	Moderate	High	Moderate	Moderate
	2015	High	High	Moderate	Moderate

*See Supplementary Table III for their definitions

The estimates for each of the risk factors for 2010 and 2015 are shown in Table IV. The estimate of current tobacco consumption showed an 18.5 per cent relative decline from 27 per cent (21.4-32.6%) in 2010 to 22 per cent (17.3-26.6%) in 2015. The absolute decline during this period was higher for men (42.6-35.4%) as compared to women (10.7-7.7%) and more for urban (30.3-15%) as compared to rural (35.7-32.6%). This resulted in narrowing of gender differential and widening of rural-urban differentials. The estimates for the use of solid fuel as a source of cooking showed a modest decline from 61.5 per cent (50.2-72.5) to 55.7

per cent (41.6-69.8) between 2010 and 2015 with a larger reduction occurring in urban areas (from 29 to 17%) as compared to rural areas (from 78 to 73%).

The estimates for current alcohol use remained around 15-16 per cent during both the time points of 2010 and 2015 with no major rural/urban or gender differentiates during this period. The estimates also showed higher consumption of alcohol among men as compared to women and similar prevalence in rural-urban areas. The estimates for prevalence of physical inactivity showed a 15.6 per cent relative decrease from 44.2 per cent (37.8-50.6%) in 2010 to 37.3 per

Table IV: Pooled estimate of prevalence of non-communicable disease-associated risk factors in India for 2010 and 2015

Risk factors	Estimate for the year 2010, % (95% CI)					Estimate for the year 2015, % (95% CI)				
	National	Men	Women	Rural	Urban	National	Men	Women	Rural	Urban
Alcohol consumption	15.7 (13.2-18.2)	26.6 (22.0-31.2)	4.3 (2.4-6.3)	22.4 (17.0-27.7)	17.3 (13.1-21.5)	15.6 (13.5-17.7)	28.4 (24.5-32.4)	1.9 (0.9-2.8)	19.4 (16.3-22.5)	20.2 (16.7-23.6)
Current tobacco consumption	27.0 (21.4-32.6)	42.6 (32.9-52.3)	10.7 (5.3-16.2)	35.7 (24.4-47.1)	30.3 (21.8-38.8)	22.0 (17.3-26.6)	35.4 (26.9-43.9)	7.7 (4.6-10.9)	32.6 (25.5-39.6)	15.1 (8.7-21.5)
Physical inactivity	44.2 (37.8-50.6)	34.7 (27.0-42.4)	54.1 (43.7-64.5)	35.4 (26.6-44.2)	54.5 (48.3-60.7)	37.3 (32.7-41.9)	32.8 (25.9-39.8)	42 (35.3-48.8)	49.9 (41.5-58.3)	30.7 (21.8-39.7)
Solid cooking fuel use	61.50 (50.2-72.5)	-	-	78 (66-89)	29 (19-40)	55.7 (41.6-69.8)	-	-	73 (52-92)	17 (41.6-69.8)
Raised blood pressure	20.2 (18.4-22.1)	14.1 (11.8-16.4)	26.6 (23.7-29.5)	20.8 (17.2-24.4)	28.0 (24.7-31.3)	21.6 (19.3-23.9)	21.8 (18.4-25.3)	21.3 (18.3-24.3)	23.1 (19.2-27.1)	33.9 (26.9-41.0)
Overweight	20.5 (12.6-28.4)	16.2 (2.9-29.5)	25.0 (16.8-33.1)	27.0 (12.4-43.0)	12.6 (0-25.2)	21.7 (18.0-25.4)	20.3 (14.4-26.1)	23.2 (18.8-27.7)	18.8 (11.5-26.1)	34.8 (24.9-44.7)
Obesity	7 (3.8-10.2)	5.4 (2.4-8.5)	8.6 (2.8-14.3)	4.8 (0.7-9)	13.4 (5.3-21.5)	7.7 (5.4-10.1)	5.5 (1.9-9.1)	10.1 (7.3-13.0)	6.0 (2.4-9.7)	14.9 (4.6-25.3)

CI, confidence interval

cent (32.7-41.9%) in 2015. The absolute decline was much higher for women (54.1-42%) who, nonetheless, continued to have higher levels of physical inactivity as compared to men who did not show much change during this period. Physical inactivity estimates showed an increase in rural residents (35.4-49.9%), whereas a significant decline was noted among the urban residents (54.5-30.7%).

The prevalence of raised blood pressure showed a small but insignificant increase from 20.2 per cent (18.4-22.1%) in 2010 to 21.6 per cent (19.3-23.9%) in 2015. While the estimates for men showed a significant increase (from 14.1 to 21.8%), women showed a small but non-significant decrease (from 26.6 to 21.3%). Both rural (from 20.8 to 23.1%) and urban areas (from 28.0 to 33.9%) showed an increase in the prevalence of raised blood pressure. The estimates for overweight showed a small insignificant increase; 20.5 per cent (12.6-28.4%) in 2010 and 21.7 per cent (18.0-25.4) in 2015. The estimate for men showed an increase (from 16.2 to 20.3%) while for women it showed a small decline (from 25 to 23%). A decline was noted among rural residents (27-18.8%) but an increase was seen among urban residents (from 12.6 to 34.8%). The estimates for obesity remained similar for all strata as well as at the national level during both the time periods.

Discussion

This data synthesis exercise for estimating 2010 baseline values for NCD-related indicators for whom national targets have been set along with the estimates for 2015, was conducted at the behest of the Ministry of Health and Family Welfare (MoHFW), Government of India. The strengths of this study are use of stratification to address population diversity, reasonable precision of the estimates and a transparent and standard approach to estimation and moderate-to-high levels of credibility of the estimates. While unlikely for the estimates for 2010, the estimates for 2015 could undergo a change as more studies are subsequently published. The weaknesses of the present investigation are lower precision of estimates at strata level and lack of national representativeness for some risk factors. Despite large number of individuals contributing to the estimates, the precision of estimates is only modest as meta-analysis considers the study as a unit. The precision is also affected by the number of strata used for estimation, with lesser number of strata resulting in more studies per strata and higher precision. However, given the fact that different risk factors

showed different variability across the three parameters (age, residence and sex), our choice of preferring validity over precision is reasonable.

Before these estimates are accepted, they should be critically evaluated. As national-level studies conducted during this period have already been included in the process of generating these estimates, these cannot themselves be used for validation. We propose two ways to assess the reasonableness of our estimates. The first is to make comparisons of the change across strata over time for a risk factor and see if these are consistent with what is known about that risk factor and its control efforts in the country. The other way is to compare these estimates with those that have been generated by other global agencies and collaborations. This was done for each of the risk factors separately and as described below.

For alcohol, the present study reports that there may be a little change in the country as well as for gender and place of residence against a target of 10 per cent reduction by 2025. This is consistent with what is known about alcohol control strategy in India. India does not have a national alcohol control policy. While some States have alcohol prohibition policies, their implementation is quite erratic. Different reviews of India's alcohol control policy have identified its weaknesses and areas needing strengthening^{10,11}. There are two key indicators which WHO uses for alcohol consumption, one is on per capita consumption of liquor and the second one is on harmful use of alcohol. The Global Burden of Disease has estimated that there was a 38 per cent increase in per capita consumption of alcohol in India from 1990 to 2017¹². It is well documented that one of the characteristics of alcohol consumption in India is heavy episodic binge drinking rather than regular alcohol use. Thus, this increase in consumption need not necessarily mean increase in prevalence. Drafting a comprehensive national alcohol policy and working on its implementation is required if India has to bring down its alcohol consumption.

Current use of tobacco showed an 18.5 per cent decline between 2010 and 2015, against a target of 30 per cent decline by 2025. This is supported by the fact that India has shown a strong political will in its approach towards tobacco control and introduced most of the measures described under the Framework Convention of Tobacco Control. India has clearly outlined its tobacco control strategy and introduced necessary legislation to support this strategy. This

is consistent with 17 per cent decline in tobacco use between the two global adult tobacco surveys (2009-2010 and 2016-2017), which themselves have contributed to the current estimates¹³. A comparison of our estimate with other estimates is complicated by the use of smoked tobacco as a global indicator. The global tobacco epidemic report 2019 estimate for current tobacco use for India for 2017 at 27.8 per cent (20.8-34.3) is higher than our estimates 22.0 per cent (17.3-26.6%), though the CIs overlap. Our estimates for men seem to be almost same at 42.7 per cent (32.8-52.3), but differ for women with global report estimating it at 12.9 per cent (8.9-16.3) and our estimates being much lower at 7.7 per cent (4.6-10.9%)¹⁴. Further efforts to strengthen tobacco control need to address smokeless tobacco and tobacco use among women¹⁵.

Our estimate of 61.5 per cent of the households using solid fuel in 2010 is quite close to 61 per cent estimated by Bonjour *et al*¹⁶. The estimate of 55.5 per cent for 2017 by the India State-Level Disease Burden group matches quite well with 55.7 per cent for 2015 in India¹⁷. This is about 10 per cent lower than the target of 50 per cent relative reduction set by the government to India. Our data also show that rural India continues to have high solid fuel use. Keeping this in mind, India launched a national initiative named Prime Minister *Ujjwala Yojana* in 2016 to improve access of rural households to clean fuel (<https://www.pmujjwalayojana.com/about.html>). While it has made significant progress, it is facing significant implementation challenges that are being addressed, which makes it likely that the progress will be accelerated¹⁸.

Our estimates for physical inactivity showed a 15.6 per cent decline between 2010 and 2015 at national level which is steeper than the target set with women and urban areas showing significant improvement and worsening in rural areas. Guthold *et al*¹⁹ estimated physical inactivity levels for 2016 as 34.0 per cent (22.3-47.7), which is quite close to our estimate of 37.3 (32.7-41.9) for 2015. There has been some government-led initiative to promote physical activity in India, largely restricted to urban India, but the most decline in physical inactivity is being driven by increased awareness among the urban people. Anecdotal evidence is available to support lifestyle changes due to increased access to technology in rural areas resulting in decreased physical activity. Our estimates of levels of overweight and obesity for 2010 and 2015 are higher than those reported in the WHO

Global status report 2014²⁰. What is similar in both the estimates is that the overweight/obesity levels are relatively stagnant, which is in keeping with the target of halting the rise of overweight and obesity. A more vigorous effort addressing environmental, structural and information determinants is required to promote physical activity in India with special focus on women and rural areas. A recent review concluded that 'physical activity (PA) promotion seems to be lacking in the policy perspective and currently physical inactivity as a risk factor is not considered seriously'²¹.

Our estimates for 2010 for raised blood pressure (20.2%) are slightly lower than the WHO estimate for the same year (22.9%) as well as for 2015 (21.6 vs. 25.4%)²⁰. Our estimate is also lower than that of Anchala *et al*²² whose meta-estimate was 29.8 per cent (95% CI: 26.7-33.0) for studies conducted between 2011 and 2013, but their national estimate was based only on regional stratification. Both the estimates show that there has been a slight increase or little change as compared to the target of a 30 per cent reduction in raised blood pressure. India is currently focusing on increasing diagnosis and improving access to treatment of hypertension with the launch and expansion of the India Hypertension Control Initiative²³. However, the focus on prevention is weak with no specific major intervention aimed at salt reduction at population level. Major barriers indicated by the stakeholders for salt reduction in India were social and cultural beliefs, a large unorganized food retail sector and the lack of proper implementation of even existing food policies²⁴. These need to be addressed effectively.

In conclusion, this study provides with credible estimates for 2010 and 2015 for monitoring progress on the targets set for NCD prevention and control in India. These estimates enable us to clearly identify areas that India is doing well and areas that it should focus on in future, if it has to achieve the targets it has set for itself. The need for India to establish a sustainable surveillance mechanism for primary collection of data through a nationwide survey has already been repeatedly made²⁵. Furthermore, India completed a nationwide NCD monitoring survey in 2017-18. Reading of the recent nationwide NCD monitoring survey results (2017-18) in conjunction with these estimates can provide further useful insights on the trend of risk factors to improvise our strategies²⁶. Overall, it is suggested that these

mechanisms need to be institutionalized and linkages to policy and programmes must be strengthened.

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Supplementary Table I. Summary of search strategy used for review of literature for estimation of risk factors levels/prevalence

Risk factor	PubMed	Google Scholar	Cochrane
Alcohol consumption	((alcohol consumption OR behavioral risk factor) AND (prevalence OR epidemiology) AND India AND (“2007/01/01”[PDat] : “2017/12/31”[PDat]))	“alcohol consumption” “prevalence” “india” “behavioral risk factors” OR “lifestyle risk factors” OR “epidemiology”	(alcohol consumption):ti, ab, kw OR (alcohol intake):ti, ab, kw AND (prevalence):ti, ab, kw AND (India):ti, ab, kw
Current tobacco consumption	(((((tobacco consumption) OR smoking) OR tobacco) OR smokeless tobacco) AND prevalence) AND india AND (“2007/01/01”[PDat] : “2017/12/31”[PDat]))	prevalence india “lifestyle risk factors” OR “epidemiology” OR “tobacco consumption” OR “smoking” OR “smokeless” “behavioral risk factors”	(tobacco consumption):ti, ab, kw OR (smoking):ti, ab, kw OR (“tobacco chewing”):ti, ab, kw AND (prevalence):ti, ab, kw OR (“India”):ti, ab, kw
Physical inactivity	((physical inactivity or sedentary lifestyle or ncd lifestyle risk factors) and (prevalence) and india) AND (“2007/01/01”[PDat] : “2017/12/31”[PDat]))	“prevalence” “india” “physical inactivity” OR “sedentary lifestyle” OR “lifestyle risk factors”	(physical inactivity):ti, ab, kw OR (sedentary lifestyle):ti, ab, kw OR (lifestyle risk factors):ti, ab, kw AND (prevalence):ti, ab, kw AND (india):ti, ab, kw
Solid cooking fuel use	((“indoor air pollution” OR “household cooking fuel” OR “Solid cooking fuel”) AND prevalence AND india AND (“2000/01/01”[PDat] : “2017/12/31”[PDat]))	“prevalence” “India” “indoor air pollution” OR “household cooking fuel” OR “Solid cooking fuel”	(Solid cooking fuel):ti, ab, kw OR (indoor air pollution):ti, ab, kw OR (household air pollution):ti, ab, kw AND (prevalence):ti, ab, kw AND (India):ti, ab, kw
Raised BMI	(obesity OR overweight OR raised body mass index OR BMI OR ncd associated risk factors OR lifestyle risk factors) AND (prevalence OR epidemiology) AND india	india prevalence obesity OR overweight OR “body mass index” OR “lifestyle risk factors”	(obesity):ti, ab, kw OR (raised body mass index):ti, ab, kw OR (lifestyle risk factors):ti, ab, kw AND (prevalence):ti, ab, kw AND (india):ti, ab, kw
Raised blood pressure	(((((raised blood pressure OR hypertension OR lifestyle risk factors) AND (prevalence OR epidemiology) AND india))) AND (“2007/01/01”[PDat] : “2017/12/31”[PDat]))	prevalence india “raised blood pressure” OR hypertension OR “lifestyle risk factors” OR “cardiovascular risk factors”	(raised blood pressure):ti, ab, kw OR (hypertension):ti, ab, kw OR (lifestyle risk factors):ti, ab, kw AND (prevalence):ti, ab, kw AND (india):ti, ab, kw

BMI, body mass index

Supplementary Table II. Population weights for national estimates

Variables	Year	
	2010	2015
Rural male		
18-44	0.2400	0.163718
45-69	0.1000	0.082776
Rural female		
18-44	0.2300	0.160105
45-69	0.1000	0.08095
Urban male		
18-44	0.1200	0.179202
45-69	0.0500	0.090605
Urban female		
18-44	0.1200	0.161161
45-69	0.0500	0.081483

Supplementary Table III. Parameters for credibility index

Parameters	High	Moderate	Low
Average JBI score of the studies	8-9	5-7	0-4
Representativeness of the studies	Covers all 6 zones	Covers 4-5 zones	Covers 0-3 zones
Precision of the estimate	CI/estimate ≤ 0.5	CI/estimate = 0.5-1.5	CI/estimate ≥ 1.5
Stability of the estimate between 2010 and 2015 by region, gender or age	Change in none or 1 variable	Change in 2 variables	Change in all the three variables
CI, confidence interval			

Supplementary Table IVA. Studies selected for generating estimates for year 2010

Study	Year of survey	Risk factors	Critical appraisal score
Bhardwaj SD, Shewte MK, Bhatkule PR, Khadse JR. Prevalence of risk factors for non-communicable disease in a rural area of Nagpur district, Maharashtra – A WHO STEP wise approach. <i>Int J Biol Med Res</i> 2012; 3 : 1413-8.	2008	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7
Bhagyalaxmi A, Atul T, Shikha J. Prevalence of risk factors of non-communicable diseases in a District of Gujarat, India. <i>J Health Popul Nutr</i> 2013; 31 : 78-85.	2008	Raised BMI, physical inactivity, raised blood pressure	7
Wu F, Guo Y, Chatterji S, Zheng Y, Naidoo N, Jiang Y, <i>et al.</i> Common risk factors for chronic non-communicable diseases among older adults in China, Ghana, Mexico, India, Russia and South Africa: The study on global AGEing and adult health (SAGE) wave 1. <i>BMC Public Health</i> 2015; 15 : 88.	2007-2010	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	5.5
Anjana RM, Pradeepa R, Das AK, Deepa M, Bhansali A, Joshi SR, <i>et al.</i> Physical activity and inactivity patterns in India—results from the ICMR-INDIAB study (Phase-1)[ICMR-INDIAB-5]. <i>Int J Behav Nutr Phys Act</i> 2014; 11 : 26.	2008-2010	Physical inactivity	8
Aslesh OP, Mayamol P, Suma RK, Usha K, Sheeba G, Jayasree AK. Level of physical activity in population aged 16 to 65 years in rural Kerala, India. <i>Asia Pac J Public Health</i> 2016; 28 (Suppl 1) : 53S-61S.	2012	Physical inactivity	8
Agrawal R, Chaturvedi M, Singh S, Gupta SC. An epidemiological study of dietary and exercise habits as co-relates of hypertension in person aged 45 and above in Agra district. <i>Indian J Community Health</i> 2012; 24 : 91-6.	2009-2010	Physical inactivity	7.5
Chockalingam K, Vedhachalam C, Rangasamy S, Sekar G, Adinarayanan S, Swaminathan S, <i>et al.</i> Prevalence of tobacco use in urban, semi urban and rural areas in and around Chennai City, India. <i>PLoS One</i> 2013; 8 : e76005.	2009-2011	Tobacco consumption	7.5
Barik A, Rai RK, Gorain A, Majumdar S, Chowdhury A. Socio-economic disparities in tobacco consumption in rural India: Evidence from a health and demographic surveillance system. <i>Perspect Public Health</i> 2016; 136 : 278-87.	2010-2011	Tobacco consumption	7
Oommen AM, Abraham VJ, George K, Jose VJ. Rising trend of cardiovascular risk factors between 1991–1994 and 2010–2012: A repeat cross sectional survey in urban and rural Vellore. <i>Indian Heart J</i> 2016; 68 : 263-9.	2010-2012	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	7
Garg A, Anand T, Sharma U, Kishore J, Chakraborty M, Ray PC, <i>et al.</i> Prevalence of risk factors for chronic non-communicable diseases using who steps approach in an adult population in Delhi. <i>J Family Med Prim Care</i> 2014; 3 : 112-8.	2011-2012	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7.5

Contd...

Study	Year of survey	Risk factors	Critical appraisal score
Oommen AM, Abraham VJ, George K, Jose VJ. Prevalence of risk factors for non-communicable diseases in rural & urban Tamil Nadu. <i>Indian J Med Res</i> 2016; <i>144</i> : 460-71.	2010-2012	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	6
Misra PJ, Mini GK, Thankappan KR. Risk factor profile for non-communicable diseases among Mishing tribes in Assam, India: Results from a WHO STEPs survey. <i>Indian J Med Res</i> 2014; <i>140</i> : 370-8.	2011	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7.5
Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, <i>et al.</i> Prevalence of generalized & abdominal obesity in urban & rural India-the ICMR-INDIAB Study (Phase-I)[ICMR-INDIAB-3]. <i>Indian J Med Res</i> 2015; <i>142</i> : 139-50.	2008-2010	Raised BMI, raised blood pressure	8
Lavery AA, Palladino R, Lee JT, Millett C. Associations between active travel and weight, blood pressure and diabetes in six middle income countries: A cross-sectional study in older adults. <i>Int J Behav Nutr Phys Act</i> 2015; <i>12</i> : 65.	2007-2010	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity	6.5
Krishnan MN, Zachariah G, Venugopal K, Mohanan PP, Harikrishnan S, Sanjay G, <i>et al.</i> Prevalence of coronary artery disease and its risk factors in Kerala, South India: A community-based cross-sectional study. <i>BMC Cardiovasc Disord</i> 2016; <i>16</i> : 12.	2011	Raised BMI, physical inactivity, raised blood pressure	8.5
Manimunda SP, Benegal V, Sugunan AP, Jeemon P, Balakrishna N, Thennarusu K, <i>et al.</i> Tobacco use and nicotine dependency in a cross-sectional representative sample of 18,018 individuals in Andaman and Nicobar Islands, India. <i>BMC Public Health</i> 2012; <i>12</i> : 515.	2007-2009	Tobacco consumption	6.5
Gupta A, Gupta R, Sharma KK, Lodha S, Achari V, Asirvatham AJ, <i>et al.</i> Prevalence of diabetes and cardiovascular risk factors in middle-class urban participants in India. <i>BMJ Open Diabetes Res Care</i> 2014; <i>2</i> : e000048.	2006-2010	Tobacco consumption, raised blood pressure	7
Walia R, Bhansali A, Ravikiran M, Ravikumar P, Bhadada SK, Shanmugasundar G, <i>et al.</i> High prevalence of cardiovascular risk factors in Asian Indians: A community survey-Chandigarh Urban Diabetes Study (CUDS). <i>Indian J Med Res</i> 2014; <i>139</i> : 252-9.	2008-2009	Raised BMI, raised blood pressure	8
Kumar SG, Sundaram ND. Prevalence and risk factors of hypertension among bank employees in urban Puducherry, India. <i>Int J Occup Environ Med</i> 2014; <i>5</i> : 344-94.	2012	Tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	6.5
Manimunda SP, Sugunan AP, Benegal V, Balakrishna N, Rao MV, Pesala KS. Association of hypertension with risk factors & hypertension related behaviour among the aboriginal Nicobarese tribe living in Car Nicobar Island, India. <i>Indian J Med Res</i> 2011; <i>133</i> : 287-93.	2007-2009	Tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	9

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Study	Year of survey	Risk factors	Critical appraisal score
Dutta A, Ray MR. Prevalence of hypertension and pre-hypertension in rural women: A report from the villages of West Bengal, a state in the eastern part of India. <i>Aust J Rural Health</i> 2012; 20 : 219-25.	2007-2011	Raised BMI, raised blood pressure, indoor air pollution	8
Norboo T, Stobdan T, Tsering N, Angchuk N, Tsering P, Ahmed I, <i>et al.</i> Prevalence of hypertension at high altitude: Cross-sectional survey in Ladakh, Northern India 2007–2011. <i>BMJ Open</i> 2015; 5 : e007026.	2007-2011	Raised BMI, raised blood pressure	8
Bhattacharjee S, Datta S, Roy JK, Chakraborty M. A cross-sectional assessment of risk factors of non-communicable diseases in a sub-Himalayan region of West Bengal, India using who steps approach. <i>J Assoc Physicians India</i> 2015; 63 : 34-40.	2012	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	9
Manjrekar S, Sherkhane M, Chowti J. Behavioral risk factors for noncommunicable diseases in working and nonworking women of urban slums. <i>J Midlife Health</i> 2014; 5 : 143-9.	2011-2012	Raised BMI, physical inactivity, raised blood pressure	9
Bowen L, Taylor AE, Sullivan R, Ebrahim S, Kinra S, Krishna KR, <i>et al.</i> Associations between diet, physical activity and body fat distribution: A cross sectional study in an Indian population. <i>BMC Public Health</i> 2015; 15 : 281.	2009-2010	Physical inactivity	6.5
Sowmya N, Lakshmi Priya N, Arumugam K, Venkatachalam S, Vijayalakshmi P, Ruchi V, <i>et al.</i> Comparison of dietary profile of a rural south Indian population with the current dietary recommendations for prevention of non-communicable diseases (CURES 147). <i>Indian J Med Res</i> 2016; 144 : 112-9.	2007-2010	Raised BMI, physical inactivity	5.5
Choudhary S, Choudhary RC, Mude A, Wagh V. Profile of physical inactivity as a risk factor for non-communicable diseases in a rural population. <i>J Evol Med Dent Sci</i> 2014; 3 : 6794-802.	2008-2010	Physical inactivity	8.5
Daniel CR, Prabhakaran D, Kapur K, Graubard BI, Devasenapathy N, Ramakrishnan L, <i>et al.</i> A cross-sectional investigation of regional patterns of diet and cardio-metabolic risk in India. <i>Nutr J</i> 2011; 10 : 12.	2006-2008	Raised BMI, tobacco consumption, raised blood pressure	8
Oyebode O, Pape UJ, Lavery AA, Lee JT, Bhan N, Millett C. Rural, urban and migrant differences in non-communicable disease risk-factors in middle income countries: A cross-sectional study of WHO-SAGE data. <i>PLoS One</i> 2015; 10 : e0122747.	2007-2010	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	7.5
Bansal SK, Goel D, Saxena V, Kandpal SD, Gray WK, Walker RW. The prevalence of hypertension and hypertension risk factors in a rural Indian community: A prospective door-to-door study. <i>J Cardiovasc Dis Res</i> 2012; 3 : 117-23.	2010	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	6
Das P, Basu M, Chowdhury K, Mallik S, Dhar G, Biswas A. Observational assessment and correlates to blood pressure of future physicians of Bengal. <i>Niger J Clin Pract</i> 2013; 16 : 433-8.	2011	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	8

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Study	Year of survey	Risk factors	Critical appraisal score
Kumar P, Singh C, Agarwal N, Pandey S, Ranjan A, Singh G. Prevalence of risk factors for non-communicable disease in a rural area of Patna, Bihar – A WHO step wise approach. <i>Indian J Prev Soc Med</i> 2013; 44 : 47.	2012	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	9
Agrawal M, Jain S, Maitin N, Gupta T, Maitin S. Prevalence and predictors of tobacco use among general public of Gorakhpur District, India. <i>J Oral Biol Craniofac Res</i> 2015; 5 : 16-20.	2012	Tobacco consumption	7.5
Gupta R, Sharma KK, Gupta A, Agrawal A, Mohan I, Gupta VP, <i>et al.</i> Persistent high prevalence of cardiovascular risk factors in the urban middle class in India: Jaipur Heart Watch-5. <i>J Assoc Physicians India</i> 2012; 60 : 11-6.	2009-2010	Raised BMI, physical inactivity, raised blood pressure	6.5
Deedwania P, Gupta R, Sharma KK, Gupta BK, Gupta A, Saboo B, <i>et al.</i> Geographic epidemiology of cardiometabolic risk factors in middle class urban residents in India: Cross-sectional study. <i>J Glob Health</i> 2015; 5 : 010411.	2006-2010	Raised BMI, tobacco consumption, physical inactivity, raised blood pressure	8
Mohan I, Gupta R, Misra A, Sharma KK, Agrawal A, Vikram NK, <i>et al.</i> Disparities in prevalence of cardiometabolic risk factors in rural, urban-poor, and urban-middle class women in India. <i>PLoS One</i> 2016; 11 : e0149437.	2006-2010	Raised BMI, tobacco consumption, physical inactivity, raised blood pressure	7
Panigrahi A, Das BC, Panigrahi M. Tobacco use among daily wage laborers in the city of Bhubaneswar, Odisha, India. <i>J Public Health (Oxf)</i> 2013; 21 : 57-61.	2010	Tobacco consumption	7
Patil A, Khona P, Patil M. Prevalence of tobacco consumption in an urban area Belgaum, Karnataka, India. <i>Int J Community Med Public Health</i> 2016; 3 : 3059-62.	2011	Tobacco consumption	7
Junapudi SS, Meesala L. A comparative study of prevalence of tobacco use among urban population of Harzpena and rural population of Patancheru, Hyderabad. <i>J Evol Med Dent Sci</i> 2014; 3 : 7737-45.	2008-2009	Tobacco consumption	6.5
Ansari ZA, Bano SN, Zulkifle M. Prevalence of tobacco use among power loom workers – A cross-sectional study. <i>Indian J Community Med</i> 2010; 35 : 34-9.	2007	Tobacco consumption	7
Bodhare TN, Venkatesh K, Bele S, Kashiram G, Devi S, Vivekanand A. Behavioural risk factors for non-communicable disease among rural adults in Andhra Pradesh. <i>Natl J Community Med</i> 2013; 4 : 439-42.	2012	Tobacco consumption, alcohol consumption, raised blood pressure	7
Kulkarni N, Shilpa K, Naik V, Mallapur D. Epidemiological correlates of tobacco consumption among women in reproductive age group – A community based cross sectional study in the rural area of Belgaum District, Karnataka, South India. <i>Int J Community Med Public Health</i> 2016; 3 : 3161-5.	2011	Tobacco consumption	7
Bartwal J, Awasthi S, Rawat CM, Arya A. Awareness and pattern of tobacco use among the medical students of Government Medical College. <i>Indian J Community Health</i> 2014; 26 : 155-9.	2012	Tobacco consumption	6

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Study	Year of survey	Risk factors	Critical appraisal score
Ismail I, Kulkarni A, Meundi A, Amruth M. A community-based comparative study of prevalence and risk factors of hypertension among urban and rural populations in a coastal town of south India. <i>Sifa Med J</i> 2013; 3 : 41-7.	2010-2013	Tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	8
Mallik D, Mahapatra B, Chakrabarti P, Mukhopadhyay D, Sinhababu A, Kumar P. Prevalence of diabetes mellitus, impaired fasting glucose, impaired glucose tolerance, and its correlates among police personnel in Bankura district of west Bengal. <i>Indian J Public Health</i> 2013; 57 : 24-8.	2011	Raised BMI, raised blood pressure	6
Sharma D, Vatsa M, Lakshmy R, Narang R, Bahl VK, Gupta SK. Study of cardiovascular risk factors among tertiary hospital employees and their families. <i>Indian Heart J</i> 2012; 64 : 356-63.	2008	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7.5
Menon J, Vijayakumar N, Joseph JK, David PC, Menon MN, Mukundan S, <i>et al.</i> Below the poverty line and non-communicable diseases in Kerala: The Epidemiology of Non-communicable Diseases in Rural Areas (ENDIRA) study. <i>Int J Cardiol</i> 2015; 187 : 519-24.	2010-2012	Tobacco consumption	7
Yip W, Wong TY, Jonas JB, Zheng Y, Lamoureux EL, Nangia V, <i>et al.</i> Prevalence, awareness, and control of hypertension among Asian Indians living in urban Singapore and rural India. <i>J Hypertens</i> 2013; 31 : 1539-46.	2007-2008	Raised blood pressure	6
Mohan V, Deepa M, Farooq S, Datta M, Deepa R. Prevalence, awareness and control of hypertension in Chennai-the Chennai urban rural epidemiology study (CURES-52). <i>J Assoc Physicians India</i> 2007; 55 : 326-32	2007-2010	Raised BMI, raised blood pressure	7
Sekhri T, Kanwar RS, Wilfred R, Chugh P, Chhillar M, Aggarwal R, <i>et al.</i> Prevalence of risk factors for coronary artery disease in an urban Indian population. <i>BMJ Open</i> 2014; 4 : e005346.	2009-2012	Raised BMI, raised blood pressure	5
Shrivastava SR, Ghorpade AG, Shrivastava PS. A community-based cross-sectional study of cardiovascular risk in a rural community of Puducherry. <i>Heart Views</i> 2015; 16 : 131-6.	2011-2012	Raised BMI, physical inactivity	8
Ramakrishnan J, Majgi SM, Premarajan KC, Lakshminarayanan S, Thangaraj S, Chinnakali P. High prevalence of cardiovascular risk factors among policemen in Puducherry, South India. <i>J Cardiovasc Dis Res</i> 2013; 4 : 112-5.	2008-2009	Raised BMI, raised blood pressure	8
Pratim DP, Bhaswati S, Nilanjan G, Ashique FK, Subhasis C, Arpita D, <i>et al.</i> Hypertension and related morbidity among geriatric population of Eastern India. <i>Mater Sociomed</i> 2012; 24 : 29-33.	2009-2010	Raised blood pressure	6.5
Lakshman A, Manikath N, Rahim A, Anilakumari VP. Prevalence and risk factors of hypertension among male occupational bus drivers in North Kerala, South India: A cross-sectional study. <i>ISRN Prev Med</i> 2014; 2014 : 318532.	2008	Tobacco consumption, alcohol consumption, raised blood pressure	6.5

Contd...

Study	Year of survey	Risk factors	Critical appraisal score
Panesar S, Chaturvedi S, Saini NK, Avasthi R, Singh A. Prevalence and predictors of hypertension among residents aged 20–59 years of a slum-resettlement colony in Delhi, India. <i>WHO South East Asia J Public Health</i> 2013; 2 : 83-7.	2010-2012	Raised BMI, alcohol consumption, physical inactivity, raised blood pressure	6
Huffman MD, Prabhakaran D, Osmond C, Fall CH, Tandon N, Lakshmy R, <i>et al.</i> Incidence of cardiovascular risk factors in an Indian urban cohort: Results from the New Delhi Birth Cohort. <i>J Am Coll Cardiol</i> 2011; 57 : 1765-74	2006-2009	Raised BMI, alcohol consumption, raised blood pressure	5.5
Mallik D, Mukhopadhyay DK, Kumar P, Sinhababu A. Hypertension, prehypertension and normotension among police personnel in a district of West Bengal, India. <i>J Assoc Physicians India</i> 2014; 62 : 12-6.	2011	Raised BMI, tobacco consumption, physical inactivity, raised blood pressure	7.5
Premkumar R, Pothen J, Rima J, Arole S. Prevalence of hypertension and prehypertension in a community-based primary health care program village at central India. <i>Indian Heart J</i> 2016; 68 : 270-7.	2012	Raised blood pressure	8
Aswin K, Ghorpade AG, Kar SS, Kumar G. Cardiovascular disease risk factor profiling of group C employees in JIPMER, Puducherry. <i>J Family Med Prim Care</i> 2014; 3 : 255-9.	2011	Raised BMI, physical inactivity	8
Kamal R, Kesavachandran CN, Bihari V, Sathian B, Srivastava AK. Alterations in lung functions based on BMI and Body fat% among obese Indian population at National Capital Region. <i>Nepal J Epidemiol</i> 2015; 5 : 470-9.	2010	Raised BMI	7
Sharma PK, Ganguly E. Morbidity profile of long-distance truck drivers in Hyderabad city, India. <i>J Dr NTR Univ Health Sci</i> 2014; 3 : 234-7.	2011	Raised BMI	4
Kshatriya GK, Acharya SK. Triple burden of obesity, undernutrition, and cardiovascular disease risk among Indian tribes. <i>PLoS One</i> 2016; 11 : e0147934.	2011-2013	Raised BMI, raised blood pressure	7
Cherian J, Singh Z, Bazroy J, Jacob Purty A, Natesan M, Kantilal Chavada V. Study of morbidity pattern among salt workers in Marakkanam, Tamil Nadu, India. <i>J Clin Diagn Res</i> 2015; 9 : LC01-3.	2010-2011	Raised BMI, raised blood pressure	7.5
Manimunda SP, Sugunan AP, Thennarasu K, Pandian D, Pesala KS, Benegal V. Alcohol consumption, hazardous drinking, and alcohol dependency among the population of Andaman and Nicobar Islands, India. <i>Indian J Public Health</i> 2017; 61 : 105-11.	2007-2009	Alcohol consumption	7
Rustagi N, Taneja DK, Mishra P, Ingle GK. Cardiovascular risk behavior among students of a medical college in Delhi. <i>Indian J Community Med</i> 2011; 36 : 51-3.	2009-2010	Tobacco consumption, alcohol consumption, physical inactivity	7.5
Kumar R, Goel N, Gupta N, Singh K, Nagar S, Mittal J. Indoor air pollution and respiratory illness in children from rural India: <i>A pilot study.</i> <i>Indian J Chest Dis Allied Sci</i> 2014; 56 : 79-83.	2011	Indoor air pollution	7

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Study	Year of survey	Risk factors	Critical appraisal score
Patel AB, Meleth S, Pasha O, Goudar SS, Esamai F, Garces AL, <i>et al.</i> Impact of exposure to cooking fuels on stillbirths, perinatal, very early and late neonatal mortality – A multicenter prospective cohort study in rural communities in India, Pakistan, Kenya, Zambia and Guatemala. <i>Matern Health Neonatol Perinatol</i> 2015; 1 : 18.	2011-2012	Indoor air pollution	6
Bhardwaj R, Kandori A, Marwah R, Vaidya P, Singh B, Dhiman P, <i>et al.</i> Prevalence, awareness and control of hypertension in rural communities of Himachal Pradesh. <i>J Assoc Physicians India</i> 2010; 58 : 423-4, 429.	2008	Raised blood pressure	5.5
Kokiwar PR, Gupta SS, Durge PM. Prevalence of hypertension in a rural community of central India. <i>J Assoc Physicians India</i> 2012; 60 : 26-9.	2010	Raised blood pressure	7
Yuvaraj BY, Nagendra Gowda MR, Umakantha AG. Prevalence, awareness, treatment, and control of hypertension in rural areas of Davanagere. <i>Indian J Community Med</i> 2010; 35 : 138-41.	2008	Raised blood pressure	6.5
Bhardwaj S, Misra A, Misra R, Goel K, Bhatt SP, Rastogi K, <i>et al.</i> High prevalence of abdominal, intra-abdominal and subcutaneous adiposity and clustering of risk factors among urban Asian Indians in North India. <i>PLoS One</i> 2011; 6 : e24362.	2009	Raised BMI, raised blood pressure	7.5
Pandey RM, Agrawal A, Misra A, Vikram NK, Misra P, Dey S, <i>et al.</i> Population-based intervention for cardiovascular diseases related knowledge and behaviours in Asian Indian women. <i>Indian Heart J</i> 2013; 65 : 40-7.	2010	Raised BMI, raised blood pressure	7
Gupta R, Deedwania PC, Achari V, Bhansali A, Gupta BK, Gupta A, <i>et al.</i> Normotension, prehypertension, and hypertension in urban middle-class subjects in India: Prevalence, awareness, treatment, and control. <i>Am J Hypertens</i> 2013; 26 : 83-94.	2009-2010	Raised BMI, tobacco consumption, raised blood pressure	8
Sharma KH, Sahoo S, Shah KH, Patel AK, Jadhav ND, Parmar MM, <i>et al.</i> Are Gujarati Asian Indians ‘older’ for their ‘vascular age’ as compared to their ‘Chronological age’? <i>QJM</i> 2015; 108 : 105-12.	2011	Raised BMI, raised blood pressure	6.5
Dua S, Bhuker M, Sharma P, Dhall M, Kapoor S. Body mass index relates to blood pressure among adults. <i>N Am J Med Sci</i> 2014; 6 : 89-95.	2012	Raised BMI, raised blood pressure	8
Shah A, Afzal M. Prevalence of diabetes and hypertension and association with various risk factors among different Muslim populations of Manipur, India. <i>J Diabetes Metab Disord</i> 2013; 12 : 52.	2011	Raised blood pressure	6
Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and predictors of adult hypertension in an urban eastern Indian population. <i>Heart Asia</i> 2012; 4 : 49-52.	2010	Raised BMI, raised blood pressure	8
Acharyya T, Kaur P, Murhekar MV. Prevalence of behavioral risk factors, overweight and hypertension in the urban slums of North 24 Parganas District, West Bengal, India, 2010. <i>Indian J Public Health</i> 2014; 58 : 195-8.	2010	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	7.5

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Study	Year of survey	Risk factors	Critical appraisal score
Bhadoria AS, Kasar PK, Toppo NA, Bhadoria P, Pradhan S, Kabirpanthi V. Prevalence of hypertension and associated cardiovascular risk factors in Central India. <i>J Family Community Med</i> 2014; 21 : 29-38.	2012	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7
National Institute of Medical Statistics, Indian Council of Medical Research (ICMR). <i>Non-communicable Disease Risk Factors Survey-Phase I</i> . New Delhi: ICMR-NIMS; 2009.	2007-2008	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	7
World Health Organization. International Institute for Population Sciences (IIPS). <i>Global Adult Tobacco Survey, 2009-2010</i> . Mumbai: WHO; 2010.	2009-2010	Tobacco consumption	9
International Institute for Population Sciences (IIPS), Ministry of Health & Family Welfare, Government of India. <i>District Level Household and Facility Survey 2007-08</i> . Mumbai: International Institute for Population Sciences (IIPS), MoHFW, GoI; 2010.	2007-2008	Solid cooking fuel use	8
Office of the Registrar General and Census Commissioner, Institute of Economic Growth, Delhi. <i>Sample Registration System Baseline Survey 2014</i> . New Delhi: Office of the Registrar General and Census Commissioner; 2012.	2012	Solid cooking fuel use	9
Office of the Registrar General and Census Commissioner, India, Institute of Economic Growth, Delhi University. <i>Annual Health Survey Report: A Report on Clinical, Anthropometric and Bio-chemical Survey Part-II</i> . New Delhi: Office of the Registrar General and Census Commissioner, India; 2012.	2012	Raised BMI	9
BMI, body mass index			

Supplementary Table IVB: Studies selected for generating estimates for the year 2015

Study	Year of survey	Risk factors	Critical appraisal score
Thakur JS, Jeet G, Pal A, Singh S, Singh A, Deepti SS, <i>et al.</i> Profile of risk factors for non-communicable diseases in Punjab, Northern India: Results of a state-wide STEPS survey. <i>PLoS One</i> 2016; <i>11</i> : e0157705.	2014-2015	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	7
Bahety H, Das BR, Das N, Kakoti G, Agarwal P. Assessment of lifestyle associated behavioural risk factors for cardiovascular diseases among medical students in Assam, India. <i>Int J Health Sci Res</i> 2015; <i>5</i> : 1-7.	2014	Tobacco consumption, physical inactivity	6
Negi PC, Chauhan R, Rana V, Lal K. Epidemiological study of non-communicable diseases (NCD) risk factors in tribal district of Kinnaur, HP: A cross-sectional study. <i>Indian Heart J</i> 2016; <i>68</i> : 655-62.	2014	Raised BMI, alcohol consumption	7.5
Tripathy JP, Thakur JS, Jeet G, Chawla S, Jain S, Prasad R. Urban rural differences in diet, physical activity and obesity in India: Are we witnessing the great Indian equalisation? Results from a cross-sectional STEPS survey. <i>BMC Public Health</i> 2016; <i>16</i> : 816.	2014-2015	Raised BMI, physical inactivity	6
Gupta RK, Verma AK, Shora TN, Kumari R, Langer B. Tobacco abuse: Prevalence, patterns and awareness among rural adults – A population based study. <i>JK Sci</i> 2016; <i>18</i> : 201-5.	2014	Tobacco consumption	7
Chebrolu K, Koganti VB, Budimelli S. Prevalence of tobacco use among the adult males in a South Indian Village. <i>J Evol Med Dent Sci</i> 2014; <i>3</i> : 14137-46.	2014	Tobacco consumption	7.5
Ravi K, Dais D, Krishnaveni K, Sambathkumar R. Non-communicable diseases: Prevalence and risk factors among adults in rural community. <i>Int J ChemTech Res</i> 2017; <i>10</i> : 197-202.	2015	Tobacco consumption, alcohol consumption, physical inactivity	5
Rane PP, Narayanan P, Binu VS, Unnikrishnan B. Prevalence of tobacco and alcohol consumption among fishermen in Udupi Taluk, Karnataka, India: A cross-sectional study. <i>Asian Pac J Cancer Prev</i> 2016; <i>17</i> : 1733-7.	2015	Tobacco consumption	7
Dasappa H, Fathima FN, Prabhakar R, Sarin S. Prevalence of diabetes and pre-diabetes and assessments of their risk factors in urban slums of Bangalore. <i>J Family Med Prim Care</i> 2015; <i>4</i> : 399.	2012-2013	Raised BMI, raised blood pressure	8
Anjana RM, Sudha V, Nair DH, Lakshmi priya N, Deepa M, Pradeepa R, <i>et al.</i> Diabetes in Asian Indians-how much is preventable? Ten-year follow-up of the Chennai Urban Rural Epidemiology Study (CURES-142). <i>Diabetes Res Clin Pract</i> 2015; <i>109</i> : 253-61.	2013	Raised BMI, physical inactivity	8
Newtonraj A, Natesan Murugan ZS, Chauhan RC, Velavan A, Manikandan MA. Factors associated with physical inactivity among adult urban population of Puducherry, India: A population based cross-sectional study. <i>J Clin Diagn Res</i> 2017; <i>11</i> : LC15-7.	2013	Tobacco consumption, physical inactivity	9
Binu J, Harnagle RA. Study on the prevalence of overweight and obesity and its influencing factors among rural geriatric population in Kerala. <i>Int J Curr Microbiol Appl Sci</i> 2014; <i>3</i> : 284-93.	2013	Raised BMI	6

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Study	Year of survey	Risk factors	Critical appraisal score
Arora D, Marya CM, Menon I, Oberoi SS, Dhingra C, Anand R. Cross sectional survey on association between alcohol, betel-nut, cigarette consumption and health promoting behavior of industrial workers in Ghaziabad. <i>Asian Pac J Cancer Prev</i> 2015; 16 : 139-44.	2013	Tobacco consumption, alcohol consumption, physical inactivity	6
Srivastav S, Mahajan H, Goel S, Mukherjee S. Prevalence of risk factors of noncommunicable diseases in a rural population of district Gautam-Budh Nagar, Uttar Pradesh using the World Health Organization STEPS approach. <i>J Family Med Prim Care</i> 2017; 6 : 491.	2013	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	8
Joy T, Sreelakshmi M, Nimitha P, Leelamoni K. Prevalence of tobacco use in an urban slum population in Kochi, Kerala. <i>Natl J Res Community Med</i> 2017; 6 : 110-5.	2015	Tobacco consumption	7.5
Patel J, Mubashir A, Shruti M, Maheswar DM. Prevalence of tobacco consumption and its contributing factors among students of a private medical college in Belgaum: A cross sectional study. <i>Ethiop J Health Sci</i> 2016; 26 : 209-16.	2014	Tobacco consumption	7
Dixit AM, Jain PK, Agarwal R, Gupta S, Shukla SK, Rani V. Prevalence and pattern of tobacco use in rural community of Jaipur, Rajasthan (India): A cross sectional study. <i>Natl J Community Med</i> 2015; 6 : 16-20.	2013	Tobacco consumption	6
Hussain C, Gopi A. Tobacco prevalence and usage pattern among Bengaluru urban slum dwellers. <i>Int J Community Med Public Health</i> 2016; 3 : 432-6.	2015	Tobacco consumption	8
Verma P, Saklecha D, Kasar P. A study on prevalence of tobacco consumption in tribal district of Madhya Pradesh. <i>Int J Community Med Public Health</i> 2017; 5 : 76.	2015	Tobacco consumption	7.5
Tiwari RV, Gupta A, Agrawal A, Gandhi A, Gupta M, Das M. Women and tobacco use: Discrepancy in the knowledge, belief and behavior towards tobacco consumption among urban and rural women in Chhattisgarh, central India. <i>Asian Pac J Cancer Prev</i> 2015; 16 : 6365-73.	2013	Tobacco consumption	7
Ramesh CKV. Prevalence of tobacco consumption among adults in urban field practice area NMC, Raichur, Karnataka, India. <i>Int J Community Med Public Health</i> 2016; 3 : 2100-5.	2013	Tobacco consumption	8
Das R, Tripura K, Datta SS, Bhattacharjee P, Majumder M, Singh KM. A cross-sectional study on prevalence and determinants of tobacco use among young and adult males (18-60 years) in a peri-urban area of Agartala, Tripura. <i>Health Agenda</i> 2015; 3 : 1-6.	2015	Tobacco consumption	7.5
Janakiram C, Joseph J, Vasudevan S, Taha F, Venkitachalam R, Antony B, et al. Prevalence and dependency of tobacco use in an indigenous population of Kerala, India. <i>J Oral Hyg Health</i> 2016; 4 : 1.	2015	Tobacco consumption	7
Tondare MB, Havale NG, Bedre RC, Kesari P. Prevalence of risk factors of non-communicable diseases among rural population of Bidar. <i>Int J Community Med Public Health</i> 2017; 4 : 2681-5.	2016-2017	Tobacco consumption	8.5

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Study	Year of survey	Risk factors	Critical appraisal score
Jha SK, Pandey S, Singh RK, Rawat CM, Silan V, Majra JP. Prevalence of hypertension and diabetes and their risk factors among rural populations of Uttarakhand. <i>Int J Health Sci Res</i> 2016; 6 : 44-50.	2014	Raised BMI, tobacco consumption, alcohol consumption, raised blood pressure	7.5
Prajapati D, Kedia G. Prevalence of diabetes and its risk factors: A cross-sectional study in Ahmedabad, Gujarat. <i>Int J Med Sci Public Health</i> 2016; 5 : 425-30.	2013-2014	Tobacco consumption, physical inactivity	6
Chhaya J, Devalia J, Kedia G. Prevalence of risk factors and its association with non-communicable disease among the faculty members of teaching institute of Ahmedabad city, Gujarat: <i>A cross-sectional study</i> . <i>Int J Sci Study</i> 2015; 3 : 159-62.	2012-2013	Raised BMI, physical inactivity, raised blood pressure	7
Tripathy JP, Thakur JS, Jeet G, Chawla S, Jain S. Alarmingly high prevalence of hypertension and pre-hypertension in North India-results from a large cross-sectional STEPS survey. <i>PLoS One</i> 2017; 12 : e0188619.	2014-2015	Raised BMI, tobacco consumption, alcohol consumption, physical inactivity, raised blood pressure	9
Patel SA, Dhillon PK, Kondal D, Jeemon P, Kahol K, Manimunda SP, <i>et al</i> . Chronic disease concordance within Indian households: A cross-sectional study. <i>PLoS Med</i> 2017; 14 : e1002395.	2013-2014	Raised BMI, raised blood pressure	7.5
Goswami AK, Gupta SK, Kalaivani M, Nongkynrih B, Pandav CS. Burden of hypertension and diabetes among urban population aged ≥ 60 years in South Delhi: A community-based study. <i>J Clin Diagn Res</i> 2016; 10 : LC01-5.	2015	Raised blood pressure	9
Deo MG, Pawar PV, Kanetkar SR, Kakade SV. Prevalence and risk factors of hypertension and diabetes in the Katkari tribe of coastal Maharashtra. <i>J Postgrad Med</i> 2017; 63 : 106.	2012-2014	Raised BMI, raised blood pressure	8
Ganesh KS, Naresh AG, Bammigatti C. Prevalence and risk factors of hypertension among male police personnel in urban Puducherry, India. <i>Kathmandu Univ Med J</i> 2014; 12 : 242-6.	2013	Raised BMI, physical inactivity, raised blood pressure	5.5
Little M, Humphries S, Patel K, Dewey C. Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: A cross-sectional study. <i>BMC Obes</i> 2016; 3 : 12.	2013-2014	Raised BMI, raised blood pressure	7
Debnath S. BMI is a better indicator of cardiac risk factors, as against elevated blood pressure in apparently healthy female adolescents and young adult students: Results from a cross-sectional study in Tripura. <i>Indian J Community Med</i> 2016; 41 : 292.	2014-2015	Raised BMI	7
Sen P, Das S, Choudhuri D. Correlates of cardiometabolic risk factors among women of an ethnic tribal community of Tripura. <i>Indian J Public Health</i> 2017; 61 : 208.	2014-2015	Raised BMI, raised blood pressure	6
Ramanan VV, Singh SK. A study on alcohol use and its related health and social problems in rural Puducherry, India. <i>J Family Med Prim Care</i> 2016; 5 : 804.	2012-2013	Alcohol consumption	8.5

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Study	Year of survey	Risk factors	Critical appraisal score
Sau A. AUDIT (Alcohol Use Disorders Identification Test) to estimate the pattern and correlates of alcohol consumption among the adult population of West Bengal, India: A community based cross-sectional study. <i>J Clin Diagn Res</i> 2017; 11 : LC01-4.	2016	Alcohol consumption	8
Rathod SD, Nadkarni A, Bhana A, Shidhaye R. Epidemiological features of alcohol use in rural India: A population-based cross-sectional study. <i>BMJ Open</i> 2015; 5 : e009802.	2013-2014	Alcohol consumption	7
Meshram II, Rao MV, Rao VS, Laxmaiah A, Polasa K. Regional variation in the prevalence of overweight/obesity, hypertension and diabetes and their correlates among the adult rural population in India. <i>Br J Nutr</i> 2016; 115 : 1265-72.	2014	Raised BMI, raised blood pressure	8
Singh M, Kotwal A, Mittal C, Babu SR, Bharti S, Ram CV. Prevalence and correlates of hypertension in a semi-rural population of Southern India. <i>J Hum Hypertens</i> 2018; 32 : 66-74.	2016	Raised blood pressure	9
Banerjee S, Mukherjee TK, Basu S. Prevalence, awareness, and control of hypertension in the slums of Kolkata. <i>Indian Heart J</i> 2016; 68 : 286-94.	2014	Raised blood pressure	8
International Institute for Population Sciences (IIPS), Ministry of Health & Family Welfare, Government of India. <i>National Family Health Survey (NFHS-4), 2015-16: India</i> . New Delhi: IIPS, MoHFW, GoI; 2016.	2015-2016	Raised BMI, tobacco consumption , alcohol consumption, raised blood pressure, solid cooking fuel use	9
National Nutrition Monitoring Bureau. <i>Diet and Nutritional Status of Urban Population in India and Prevalence of Obesity, Hypertension, Diabetes and Hyper Lipidemia in Urban Men and Women- NNMB Brief Report on Urban Nutrition</i> . New Delhi: ICMR-National Institute of Nutrition; 2017.	2015-2016	Raised BMI, raised blood pressure	9
Tata Institute of Social Sciences (TISS), Mumbai and Ministry of Health and Family Welfare, Government of India. <i>Global Adult Tobacco Survey GATS 2 India 2016-17</i> . New Delhi: MoHFW, GoI; 2018.	2016-2017	Tobacco consumption	9
International Institute for Population Sciences (IIPS), Ministry of Health & Family Welfare, Government of India. <i>District Level Household and Facility Survey-4, 2012-13</i> . Mumbai: IIPS, MoHFW, GoI. Available from: http://rchiips.org/DLHS-4.html .	2012-2013	Tobacco consumption, solid cooking fuel use, raised blood pressure	9

BMI, body mass index