

Risk Factors Associated with the Increasing Cardiovascular Diseases Prevalence in India: A Review

Deepa Shokeen* and Bani T Aeri

Department of Food and Nutrition, Institute of Home Economics, University of Delhi, New Delhi, India

Abstract

Non-communicable diseases in general and cardiovascular diseases (CVD) in particular are a big cause of concern worldwide especially in fast growing economy like India. CVD is one of the leading causes of deaths in India. Risk factors for cardiovascular disease are now significant in all populations. At least one-third of all CVD is attributable to five risk factors: tobacco use, alcohol use, high blood pressure, high cholesterol and obesity.

Methods: This article aspires to collate data gathered by relevant studies conducted after year 2000 and provide an overview of the prevalence of CVD in India and worldwide.

Results: Studies show an increased prevalence of cardiovascular risk factors in India as compared to other developing and developed countries with recent trends showing incidence in younger age group. It is seen to affect almost all sections of the society from young to old and most affluent to least affluent. High blood pressure, high cholesterol, diabetes, tobacco and alcohol use, as well as low vegetable and fruit intake, already figure among the top risk factors.

Conclusion: The prevalence of risk factors associated with CVD has increased and will keep on increasing in India as indicated by studies in the last decade and as predicted by the projections for future estimates. Some major risks are modifiable and they can be prevented, treated, and controlled. There are considerable health benefits at all ages, for both men and women, in stopping smoking, reducing cholesterol and blood pressure, eating a healthy diet and increasing physical activity.

Keywords: Prevalence; Cardiovascular disease; India; Risk factors

Introduction

India has seen a rapid transition in its disease burden (number of cases/lakh) over the past couple of decades. The load of communicable and non-communicable diseases (NCDs) is projected to get reversed in 2020 from its distribution in 1990 [1]. This is largely because, with India's economic growth and urbanization over the past decades, a large section of the population has moved towards unhealthy lifestyles with decreasing physical activity, increasing stress levels, and increasing intake of saturated fats and tobacco. The average life span has increased due to improvements in medical care; the rapidly ageing population, more prone to NCDs, will also fuel the growth of NCDs over the next few decades. Finally, most NCDs share common risk factors, whose prevalence is 53% in India and they generally occur as co-morbidities (Figure 1). The probability of dying between ages 30 and 70 years from the four main NCDs is 26%.

Cardiovascular diseases are the largest cause of mortality, accounting for around half of all deaths resulting from non-communicable diseases (NCDs). Overall, CVDs accounted for around one-fourth of all deaths in India in 2008. CVDs are expected to be the fastest growing chronic illnesses between 2005 and 2015, growing at 9.2% annually, and accounting for the second largest number of NCD patients after mental illnesses. A more worrying fact is that the incidences of CVDs have gone up significantly for people between the age 25 and 69 to 24.8%, which means we are losing more productive people to these diseases [2,3] (Figure 2).

Methods

In the present paper detailed review of all the relevant studies and projects relating to CVD epidemiology and prevention were done to serve as an exhaustive database on relevant information about CVD

in India. Journal articles were referred online through PubMed and Google scholar search engines. Original articles from journals like Indian Journal of Medical research, Journal of the Association of the

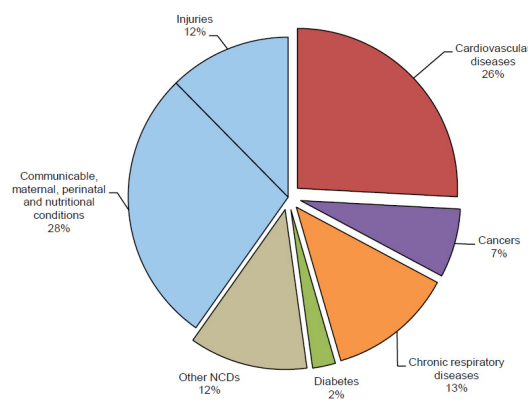


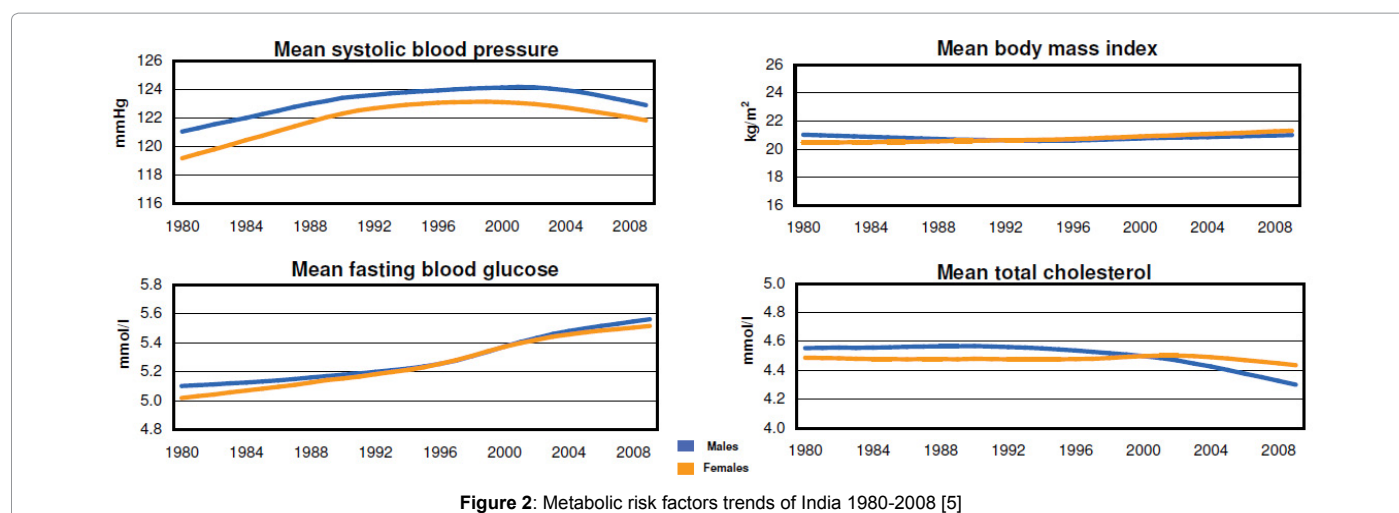
Figure 1: Proportional Mortality-India (% of total deaths, all ages, both sexes) [3]

*Corresponding author: Deepa Shokeen, Department of Food and Nutrition, Institute of Home Economics, F-4 Hauz Khas Enclave, University of Delhi, Hauz Khas, New Delhi, India – 110016, Tel: 919811103622; E-mail: deepashokeen99@gmail.com

Received October 29, 2014; Accepted November 25, 2014; Published November 27, 2014

Citation: Shokeen D, Aeri BT (2015) Risk Factors Associated with the Increasing Cardiovascular Diseases Prevalence in India: A Review. J Nutr Food Sci 5: 331. doi:10.4172/2155-9600.1000331

Copyright: © 2015 Shokeen D, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



Physicians of India, Journal of Cardiovascular Disease Research and the Internet Journal of Cardiology were studied. Articles published by authors in international journals such as Journal of American College of Cardiology, British Medical Journal, Bio Med Central were also reviewed. Reports of organisations such as World Health Organisation (WHO), World Bank, Ministry of Women and Child Development, Government of India, Centre for Chronic Disease Control (CCDC), National Cardiovascular Disease Database etc. were studied to project the data.

The keywords used for the search were “prevalence”, “coronary heart disease”, “cardiovascular disease”, “heart disease”, “in India”, “risk factors” etc. Only those articles that were available in full text format were analysed to arrive at the data collated. Criteria for selection of articles were the year in which studies were undertaken and published. Studies conducted after year 2000 were referred to. Any recent study that presented data on the basis of old studies was also rejected.

Results

Modifiable and non-modifiable risk factors associated with CVDs

Modifiable risk factors are those that can easily be changed to reduce the risk of the occurrence of the disease, while non-modifiable risk factors like age and genetic makeup can't be controlled. Age is a powerful cardiovascular risk factor. The rapidly growing burden of CVD in India is accelerated by population ageing. Most NCDs are strongly associated and causally linked with four particular behaviours: tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol. These behaviours lead to four key metabolic/physiological changes: raised blood pressure, overweight/obesity, hyperglycemia and hyperlipidemia. In terms of attributable deaths, the leading risk factor associated with NCD, globally, is raised blood pressure (to which 13% of global deaths are attributed), followed by tobacco use (9%), raised blood glucose (6%), physical inactivity (6%), and overweight and obesity (5%) [4].

The leading behavioural and metabolic risk factor associated with NCD's in India is raised blood pressure (to which 32.5% of deaths are attributed), followed by raised cholesterol (27.1%), physical inactivity (14%), tobacco smoking (13.9%), raised blood glucose (10%) and overweight and obesity (12.9%) [3,5] (Table 1).

India is not just the diabetes capital of the world with more than 50 million patients, it also has the highest prevalence of metabolic syndrome and obesity - 20 million Indians are obese today with 70 million projected by 2025; 20% of Indians suffer from hypertension [6]. These factors together have accelerated the growth of cardiovascular diseases in India as well as the mortality levels from these diseases. In the present review our focus will be metabolic and behavioural risk factors.

Hypertension (Raised Blood Pressure)

Worldwide, raised blood pressure is estimated to cause 7.5 million deaths, about 12.8% of the total of all annual deaths [7,8]. This accounts for 57 million DALYS (Disability Adjusted Life Years) or 3.7% of total DALYS. Raised blood pressure is a major risk factor for coronary heart disease and cerebrovascular disease [9].

According to NCD Country profiles, 2011, raised blood pressure is the most prevalent risk factor of all in India (32.5%) [5]. A study of men and women aged 35-69 years in Mumbai showed that on average 20% had a medical history of hypertension, rising to 26% based on measurement of blood pressure [10]. In fact, it has been estimated that even 7-10% of schoolchildren in India suffer from hypertension and 15-16% have high cholesterol levels [11]. In terms of numbers, estimates suggest the number of people in India with hypertension will almost double, from 118.2 million in 2000 to 213.5 million by 2025 [12].

Diabetes (Raised Blood Sugar)

Diabetes is another major risk factor of CVD. Diabetes is defined as having a fasting plasma glucose value ≥ 7.0 mmol/l (126 mg/dl). Impaired glucose tolerance and impaired fasting glycaemia are risk categories for future development of diabetes and CVD [9].

In terms of absolute numbers of individuals with diabetes, India, Pakistan and Bangladesh make up three of the top ten countries globally [13] and together, the region with the highest number of diabetes-related deaths currently [14]. India alone is estimated to have 50.8 million inhabitants with diabetes, the most of any country worldwide [14]. Propelled by socio-economic transformation, population ageing, burgeoning levels of overweight [15] and proliferation of individuals and children with pre-diabetes (impaired glucose regulation) [16], increase in Type-2 diabetes mellitus has emerged as a great burden in itself, along with adding to further risks of CHD [14,17,18].

NCD Mortality			
<i>2008 estimates</i>			
	Males	Females	
Total NCD deaths (000s)	2967.6	2273.8	
NCD death under age 60 (percent of all NCD deaths)	38.0	32.1	
Age-standardized death rate per 100 000			
All NCDs	781.7	571.0	
Cancers	78.8	71.8	
Chronic respiratory diseases	178.4	125.5	
Cardiovascular diseases and diabetes	386.3	283.0	
Behavioral risk factors			
Estimated prevalence (%)	Males	Females	Total
Current daily tobacco smoking (2011)	25.1	4.0	15
Total alcohol per capita consumption, in liters of pure alcohol (2010)	8.0	0.5	4.3
Physical inactivity (2008)	10.8	17.3	14.0
Metabolic risk factors			
<i>2008 estimated prevalence (%)</i>	Males	Females	Total
Raised blood pressure	33.2	31.7	32.5
Raised blood glucose	10.0	10.0	10.0
Overweight	9.9	12.2	11.0
Obesity	1.3	2.4	1.9
Raised cholesterol	25.8	28.3	27.1

Table 1: NCD mortality, behavioural and metabolic risk factors prevalence estimates of India [3,5].

The proportion of coronary disease patients with diabetes varies across countries, but approximately one-fifth of clinical trials (18%) and registry patients (15.1-21.4%) are documented as known diabetes patients [19]. However, India stands out as an anomaly with 30.4% and 39.1% of CHD patients reporting known diabetes in national and international prospective registries [20,21].

Raised Blood Cholesterol

Excess calories in the body are converted into triglycerides and stored in fat cells throughout the body. Low-density lipoprotein (LDL) cholesterol is deposited in the walls of arteries and causes atherosclerosis. In general, lower LDL cholesterol numbers are better for vascular health. High-density lipoprotein (HDL) cholesterol protects against vascular disease by removing the “bad” cholesterol out of the walls of arteries. Total blood cholesterol is a measure of LDL cholesterol, HDL cholesterol and other lipid components. High triglycerides increase the risk of atherosclerotic CVD. Raised blood cholesterol increases the risk of heart disease and stroke [9]. Globally, one third of ischaemic heart disease is attributable to high cholesterol [7,22].

Overall, raised cholesterol is estimated to cause 2.6 million deaths (4.5% of total) and 29.7 million DALYS, or 2% of total DALYS globally [1]. In 2008, the prevalence of raised total cholesterol among adults – defined as total cholesterol \geq 6.2 mmol/l (240 mg/dl) – was 9.7% (8.5%

for males and 10.7% for females). Raised cholesterol is the second leading NCD risk factor with 27.1% of prevalence in India (Males- 25.8%, Females- 28.3%) [5,8].

Dietary Factors

There is a considerable body of evidence regarding the nutritional background of atherosclerosis in general and coronary heart disease in particular. High dietary intakes of saturated fat, trans-fat, cholesterol and salt and low intake of fruits, vegetables and fish are linked to cardiovascular risk [7-9,22-24].

Approximately 16 million (1.0%) DALYs and 1.7 million (2.8%) of deaths worldwide are attributable to low fruit and vegetable consumption [7]. Adequate consumption of fruit and vegetables reduces the risk of CVD [7,25,26]. Frequent consumption of high-energy foods, such as processed foods that are high in fats and sugars, promotes obesity compared to low-energy foods [27]. A healthy diet can contribute to a healthy body weight, a desirable lipid profile and a desirable blood pressure [28].

In India changes in lifestyle, wealth, and the availability of “Western-style” foods have had a dramatic impact on the diets of children. More than one-third of school children eat pizza and drink colas, and almost one-quarter eat burgers once or more in a week. There is consistent overconsumption of carbonated drinks by more than seven times the recommended level by school children and more than two-thirds (68%) led a sedentary lifestyle [10].

Street foods, such as fried and stuffed balls with potatoes, pulses and spices are very popular in India. They are also almost always deep fried and therefore high in saturated and trans-fats, which may increase cholesterol, placing individuals at greater risk of heart disease. A report in the journal Nutrition and Food Science concludes that Indian snacks are very energy dense (148-603 kcal/100 g) and trans-fat varies from 0.1-19.8 g/100 g [29]. Coupled with inactivity, high consumption of such energy-dense foods can lead to overweight and increase the risk of CVD.

Obesity

Obesity is a growing health problem in both developed and developing countries [30]. Prospective epidemiological studies have shown a relationship between overweight or obesity and cardiovascular morbidity, CVD mortality and total mortality. Obesity is strongly related to major cardiovascular risk factors such as raised blood pressure, glucose intolerance, type-2-diabetes and dyslipidaemia [8,9,31-33].

Between 1998–2006, across India as a whole, the prevalence of overweight/ obesity among women aged 15-49 years increased substantially, from 10.6 to 14.8% [34]. In urban areas, the prevalence in 2006 was 28.9% compared to 8.6% in rural areas [34]. In a study of men and women aged 35-69 years old in Mumbai, 46% of the 743 surveyed were classed as obese [11]. Migration to urban areas in India may be associated with increases in obesity [35], and this increases other risk factors for health. India also has very high number of overweight/obese schoolchildren among Indian cities. A recent study found that a total 30.4% of school children in private schools, and 7.9% in government schools were obese [10]. Importantly, whilst there are concerns about the rise in obesity, at the same time there remain concerns about under-nutrition in India too [36].

Study	Hazarika et al. [53]	Prabhakaran et al.[54]	Mehan et al. [55]	Kaur et al. [56]	Kar et al. [57]	Sharma et al. [58]	The Indian Migration study [59]
Year	2004	2005	2006	2007	2010	2012	2014
Sample Size	3180	2122	4955	2262	400	1500	6555
Tobacco Smoking (%)	12.5	36.0	17.8	20.2	M=58.0, F=9.2	-	11.5
Alcohol Consumption (%)	36.4	-	13.4	34.8	M=54, F=NA	-	13.5
Physical Inactivity (%)	25.5	-	M=14.8, F=55	-	M=21, F=10	M=70.9, F=65.6	38.7
Overweight (%)	27.4	6.0	M=16.0, F=21.9	21.1	M=15, F=22	15.8	23.9
Obese (%)	0.9	3.3	-	6.9	-	58.6	-
Increased Waist Circumference (%)	-	43	26.3	50.1	M=94, F=86	M=19.3, F=31.1	-
Hypertension (%)	33.3	30	36.7	17.2	M=37, F=34	M=10.2, F=7.4	24.5
Diabetes (%)	-	15	-	3.4	-	-	9.9
High Total Cholesterol (%)	-	30.1	-	30.3	-	-	-
High LDL (C) (%)	-	67.2	-	-	-	-	-
Low HDL (C) (%)	-	33	-	-	-	M=53.4, F=64.6	-

M= Males, F=Females

Table 2: Profile of reported risk factors for cardiovascular diseases in India.

Physical Inactivity

People who are insufficiently physically active have a 20% to 30% increased risk of all-cause mortality compared to those who engage in at least 30 minutes of moderate intensity physical activity most days of the week. In adults, participation in 150 minutes of moderate physical activity each week (or equivalent) is estimated to reduce the risk of ischaemic heart disease by approximately 30% and the risk of diabetes by 27% [9]. Many studies that have examined the association between physical activity and CVDs [8,9,37-40] have reported reduced risk of death from coronary heart disease and reduced risk of overall CVDs, coronary heart disease and stroke, in a dose-response fashion.

According to non-communicable country profile of India estimated physical inactivity prevalence in males was 10.8% and in females was 17.3% (14% both) [5]. A more recent study done using cluster sampling in 6198 subjects (3426 men and 2772 women) from eleven cities across India showed that 38.8% of men and 46.1% of women were physically inactive [41]. In 2008, 31.3% of adults aged 15 or older (28.2% men and 34.4% women) were insufficiently physically active [8].

Tobacco

Smoking is estimated to cause nearly 10% of CVD [7]. Risks to health from tobacco use result not only from direct consumption of tobacco, but also from exposure to second-hand smoke [42,43]. Nearly six million people die from tobacco use and exposure to second hand smoke each year, accounting for 6% of all female and 12% of all male deaths in the world [8,44]. By 2030, tobacco-related deaths are projected to increase to more than eight million deaths every year [7,8].

In 2003, 34.6% of men and 3.4% of women and in 2008, 25% of men and 4% of women aged 18 years and over smoked across India [3,45]. Among adolescents, 12.9% of those aged 13-15 years reported being current smokers in 2000-2003, and 21.9% were past smokers [46]. Oral smokeless tobacco is the dominant form of tobacco use in India. A major category of commercially manufactured oral smokeless tobacco in India is termed gutka. Over the past decade, the rate of growth of gutka use has overtaken that of smoking forms of tobacco [47], which may impact rates of smoking related CVD. Tobacco use data from latest survey results in India suggested that 19% of youth and

24.7% of adults use tobacco and smoke cigarettes. Smokeless tobacco prevalence was 9% in youth and 25.9% in adults [48].

Other Determinants of CVDs

Socio-economic status of individuals indirectly influences cardiovascular health as well as health in general. These determinants shape a set of socioeconomic positions within hierarchies of power, prestige and access to resources. Several structural mechanisms are responsible for creating the differential social positions of individuals, including governance, education systems, labour market structures and the presence or absence of these can affect individual's health status as well as CVD outcomes by impacting behavioural and metabolic cardiovascular risk factors, psychosocial status, living conditions and the health system [49].

CVD is also driven by the negative effects of unregulated globalization and unplanned urbanization in India [50,51]. For example, irresponsible marketing supported by multinational food co-operations are targeting children and adolescents to promote consumption of "junk" food with high levels of energy, fat and salt.

Excessive alcohol intake has been associated with increasing prevalence of CVD and is one of the leading causes of death in India [52]. 4.5% of the global burden of disease (DAILYs) is caused due to harmful use of alcohol. On average, adult per capita consumption of alcohol in India was estimated to be 32.1% in males and 10.6% in females. In general, prevalence of heavy episodic drinking was found higher in males and abstention was higher in females [52].

India has seen a rapid transition in its disease burden (number of cases/lakh) over the past couple of decades. The load of communicable and non-communicable diseases (NCDs) is projected to get reversed in 2020 from its distribution in 1990 [1]. This is largely because, with India's economic growth and urbanization over the past decades, a large section of the population has moved towards unhealthy lifestyles with decreasing physical activity, increasing stress levels, and increasing intake of saturated fats and tobacco as supported by the compilation of the profile of various risk factors from various epidemiological studies done in India in Table 2. Finally, most NCDs share common risk factors, whose prevalence is high in India and they generally occur as

co-morbidities [60].

Discussion and Conclusions

The information presented above clearly suggests that NCDs in general and CVDs in particular are a big cause of concern for India. The prevalence of CVD are precipitated by risk factors such as high blood pressure, high cholesterol, obesity, or the presence of diabetes, which can, to a large extent, be prevented or controlled through the consumption of a healthy diet, regular exercise and avoiding tobacco [61].

These diseases are a global health problem with no geographic, gender, or socio-economic boundaries. The need of the hour is not only the improvements in existing heart remedies and surgical methods but also to extend preventive strategies such as improved life style, nutritious and healthy food, corporate health protection initiatives, health wellness programmes to full effect to combat CVD. At the individual level, a change in the dietary and lifestyle practices which include healthy food habits, regular physical activity and methods of de-stressing would help in preventing/delaying the onset of the risk factors associated with cardiovascular health.

References

1. Nutrition Transition in India, 1947-2007. Ministry of Women and Child Development, Government of India. 2008.
2. International Heart Protection Summit, September (2011) Cardiovascular diseases in India: Challenges and way ahead. India: ASSOCHAM.
3. World Health Organization (2014) Non-communicable Diseases Country Profiles.
4. World Health Organization (2009) Global health risks: mortality and burden of disease attributable to selected major risks. Geneva.
5. World Health Organization (2011) Non-communicable Diseases Country Profiles.
6. Cleveland Clinic (2014) Smoking and Heart Disease.
7. World Health Organization (2009) Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva.
8. World Health Organization. Global status report on non-communicable diseases 2010. Geneva, WHO, 2010.
9. World Health Organization. Prevention of cardiovascular disease: Guidelines for assessment and management of cardiovascular risk. Geneva, WHO, 2007.
10. Pandey V (2010) Mumbai Number 2 on Child Obesity List: Study. *Daily News & Analysis (DNA)*.
11. Daniel CR, Prabhakaran D, Kapur K, Graubard BI, Devasenapathy N, et al. (2011) A cross-sectional investigation of regional patterns of diet and cardio-metabolic risk in India. *Nutr J* 10: 12.
12. World Bank (2011) Capitalizing on the demographic transition: Tackling non-communicable diseases in South Asia. Washington: The World Bank.
13. Wild S, Roglic G, Green A, Sicree R, King H (2004) Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27: 1047-1053.
14. (2009) International Diabetes Federation (IDF). *Diabetes atlas (4th edn)*.
15. Gupta R, Misra A, Pais P, Rastogi P, Gupta VP (2006) Correlation of regional cardiovascular disease mortality in India with lifestyle and nutritional factors. *Int J Cardiol* 108: 291-300.
16. Mohan V, Jaydip R, Deepa R (2007) Type 2 diabetes in Asian Indian youth. *Pediatr Diabetes* 8 Suppl 9: 28-34.
17. Economic Intelligence Unit. *The silent epidemic: An economic study of diabetes in developed and developing countries*. New York, London, Hong Kong: The Economist, June 2007.
18. Gupta R, Kumar P (2008) Global diabetes landscape - Type 2 diabetes mellitus in south Asia: Epidemiology, risk factors, and control. *Insulin* 3: 78-94.
19. McGuire DK, Emanuelsson H, Granger CB (2000) Influence of diabetes mellitus on clinical outcomes across the spectrum of acute coronary syndromes. Findings from the GUSTO-IIb study. GUSTO IIb Investigators. *Eur Heart J* 21: 1750-1758.
20. Prabhakaran D, Yusuf S, Mehta S, Pogue J, Avezum A, et al. (2005) Two-year outcomes in patients admitted with non-ST elevation acute coronary syndrome: results of the OASIS registry 1 and 2. *Indian Heart J* 57: 217-225.
21. Xavier D, Pais P, Devereaux PJ, Xie C, Prabhakaran D, et al. (2008) Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. *Lancet* 371: 1435-1442.
22. World Health Organization. *The global burden of disease: 2004 update*. Geneva World Health Organization, 2008.
23. World Health Organization. *Diet, nutrition and the prevention of chronic diseases*. Report of a joint WHO/FAO expert consultation. Geneva, WHO, 2003.
24. Resolution WHA61.14. WHO 2008-2013 Action plan for the global strategy for prevention and control of non-communicable diseases. Geneva, World Health Organization, 2008.
25. Bazzano LA, Serdula MK, Liu S (2003) Dietary intake of fruits and vegetables and risk of cardiovascular disease. *Curr Atheroscler Rep* 5: 492-499.
26. Kotseva R, Wood D, De Backer G (2010) EUROASPIRE Study Group. EUROASPIRE III. Management of cardiovascular risk factors in asymptomatic high-risk patients in general practice: Cross-sectional survey in 12 European countries. *European Journal of Cardiovascular Prevention and Rehabilitation* 17: 530-540.
27. World Health Organization (2007) *Prevention of cardiovascular disease: Pocket guidelines for assessment and management of cardiovascular risk*.
28. Strazzullo P, D'Elia L, Kandala NB, Cappuccio FP (2009) Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. *BMJ* 339: b4567.
29. Agrawal A, Gupta R, Varma K (2008) High trans-fatty acid content in common Indian fast foods. *Nutrition & Food Science* 38: 564-569.
30. *World Development Indicators*, World Bank. 2012.
31. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, et al. (2011) National, regional, and global trends in body-mass index since 1980: Systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet* 337: 557-567.
32. Government of Great Britain. *Obesity: Third report of session 2003-2004*. Volume 1: Report, together with formal minutes. Document HC 23-1. London, House of Commons, 2004.
33. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ; Comparative Risk Assessment Collaborating Group (2002) Selected major risk factors and global and regional burden of disease. *Lancet* 360: 1347-1360.
34. Balarajan Y, Villamor E (2009) Nationally representative surveys show recent increases in the prevalence of overweight and obesity among women of reproductive age in Bangladesh, Nepal, and India. *J Nutr* 139: 2139-2144.
35. Ebrahim S, Kinra S, Bowen L, Andersen E, Ben-Shlomo Y, et al. (2010) The effect of rural-to-urban migration on obesity and diabetes in India: a cross-sectional study. *PLoS Med* 7: e1000268.
36. Pednekar MS, Hakama M, Hebert JR, Gupta PC (2008) Association of body mass index with all-cause and cause-specific mortality: findings from a prospective cohort study in Mumbai (Bombay), India. *Int J Epidemiol* 37: 524-535.
37. Guthold R, Cowan MJ, Autenrieth CS, Kann L, Riley LM (2010) Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. *J Pediatr* 157: 43-49.
38. Oguma Y, Shinoda-Tagawa T (2004) Physical activity decreases cardiovascular disease risk in women: Review and metaanalysis. *American Journal of Preventative Medicine* 26: 407-418.
39. Wendel-Vos GC, Schuit AJ, Feskens EJ, Boshuizen HC, Verschuren WM, et al. (2004) Physical activity and stroke. A meta-analysis of observational data. *Int J Epidemiol* 33: 787-798.
40. Berlin JA, Colditz GA (1990) A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol* 132: 612-628.

41. Gupta R, Deedwania PC, Sharma K, Gupta A, Guptha S, et al. (2012) Association of educational, occupational and socioeconomic status with cardiovascular risk factors in Asian Indians: a cross-sectional study. *PLoS One* 7: e44098.
42. World Health Organization. Global estimate of the burden of disease from second-hand smoke. Geneva, WHO, 2010.
43. World Health Organization. WHO report on the global tobacco epidemic: The MPOWER Package. Geneva, WHO, 2008.
44. Causes of death, World Health Organization, Geneva, 2008.
45. World Health Organization (2004) The atlas of heart disease and stroke. World Data Tables. [pdf] Geneva: World Health Organization.
46. Shah PB, Pednekar MS, Gupta PC, Sinha DN (2008) The relationship between tobacco advertisements and smoking status of youth in India. *Asian Pac J Cancer Prev* 9: 637-642.
47. World Health Organization (2006) Tobacco: Deadly in any form or disguise. [pdf] Geneva: World Health Organization.
48. Natuzzi E (2013) Neglected tropical diseases: is it time to add *Helicobacter pylori* to the list? *Glob Health Promot* 20: 47-48.
49. World Health Organization. Equity, social determinants and public health programmes. Geneva, WHO, 2010.
50. Mathenge W, Foster A, Kuper H (2010) Urbanization, ethnicity and cardiovascular risk in a population in transition in Nakuru, Kenya: a population-based survey. *BMC Public Health* 10: 569.
51. Vorster HH (2002) The emergence of cardiovascular disease during urbanisation of Africans. *Public Health Nutr* 5: 239-243.
52. World Health Organization (2004) Indian alcohol consumption level and patterns.
53. Hazarika NC, Narain K, Biswas D, Kalita HC, Mahanta J (2004) Hypertension in the native rural population of Assam. *Natl Med J India* 17: 300-304.
54. Prabhakaran D, Shah P, Chaturvedi V, Ramakrishnan L, Manhapra A, et al. (2005) Cardiovascular risk factor prevalence among men in a large industry of northern India. *Natl Med J India* 18: 59-65.
55. Mehan MB, Srivastava N, Pandya H (2006) Profile of non communicable disease risk factors in an industrial setting. *J Postgrad Med* 52: 167-171.
56. Kaur P, Rao TV, Sankarasubbaiyan S, Narayanan AM, Ezhil R, et al. (2007) Prevalence and distribution of cardiovascular risk factors in an urban industrial population in south India: a cross-sectional study. *J Assoc Physicians India* 55: 771-776.
57. Kar SS, Thakur JS, Viridi NK, Jain S, Kumar R (2010) Risk factors for cardiovascular diseases: is the social gradient reversing in northern India? *Natl Med J India* 23: 206-209.
58. Sharma M, Mahna R (2012) Obesity, Metabolic Syndrome and Physical Activity in Indian Adults. *J Metabolic Syndr* 1: 114.
59. Shridhar K, Dhillon PK, Bowen L, Kinra S, Bharathi AV, et al. (2014) The Association between a Vegetarian Diet and Cardiovascular Disease (CVD) Risk Factors in India: The Indian Migration Study. *PLoS One* 9: e110586.
60. World Heart Federation (2012) Urbanization and cardiovascular disease: Raising heart-healthy children in today's cities. Geneva: World Heart Federation.
61. World Health Organization and UNHABITAT, Hidden Cities: Unmasking and overcoming health inequities in urban settings. [pdf] Geneva: World Health Organization.