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The prevalence of metabolic syndrome in South Asia: a systematic review

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Abstract The objective of this study was to estimate the prevalence of metabolic syndrome and its individual components in South Asia region. A search was conducted on PubMed, Scopus and OvidSP (MedLine and EMBASE) using the term 'metabolic syndrome', 'prevalence' and the name of each South Asian country for studies published on or after the year 2000. Reference lists and citation references of the included papers were also checked. Eligibility criteria were mainly population-based studies on both gender and healthy participants aged ≥18 years. Four definitions of metabolic syndrome were considered: the World Health Organisation (1999), Third Adult Treatment Panel (2001) and its modified version (2005) and International Diabetes Federation (2005). A total of 558 papers were retrieved from all sources, of which 16 relevant studies were identified comprising 14,515 males (44.1 %) and 18,390 females (55.9 %). The weighted mean prevalence of metabolic syndrome was 14.0 % (WHO), 26.1 % (ATPIII), 29.8 % (IDF) and 32.5 % (modified ATPIII). Low levels of HDL cholesterol and hypertension were prevalent in half of the study population. Overall, females had a higher prevalence of MS under all definitions except WHO. Females were more likely to have low levels of HDL cholesterol (68.8 vs 37.9 %) and central obesity (47.9 vs 37.9 %), whereas males were comparatively more hypertensive (42.3 vs 38.1 %). Despite the high rates of metabolic risk factors, research is extremely sparse in South Asia preventing knowledge of actual burden. Along with the increased access to clinical intervention, prevention strategies should be intensified with special attention to females.

Keywords Metabolic syndrome · Prevalence · Cardiovascular disease · South Asia

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Introduction

Metabolic syndrome (MS) refers to the constellation of risk factors related to cardiovascular disease (CVD) and diabetes. MS represents the clustering of mainly hyperglycaemia, hypertension, dyslipidemia and central obesity. These metabolic factors are co-occurring, inter-related and commonly share underlying causes, features and mechanisms [1]. Patients with MS are at two-fold risk of developing CVD over a period of 5 to 10 years and at five-fold risk of having type 2 diabetes compared to individuals without MS [2]. The major advantage of MS is not to function as a risk assessment tool, but rather to identify patients with a shared pathophysiology who are at high risk of developing CVD and diabetes [3]. MS also helps to induce and intensify lifestyle changes in clinical practice [4].

The prevalence of MS is high worldwide—35 % in the USA [5], 24.9 % in Latin America [6] and in the range between 20.7 and 37.2 % in the Gulf countries [7] under the Adult Treatment Panel (ATP III) criteria. South Asia is home to nearly one fourth of the world population and has the highest absolute burden of CVD in the world [8]. Also, CVD mortality rates in this region are higher than those in Western and East Asian countries [9]. The Global INTE

RHEART study reported that CVD prevails at a younger age in South Asians than in any other population [10].

The burden of CVD and its risk factors are escalating alarmingly in South Asia. For example, the global burden of disease has projected that India alone will have the highest number of individuals with CVD than in any other region by the year 2020 [11]. Likewise, the prevalence of MS components such as obesity, hypertension, dyslipidemia, along with lifestyle factors such as smoking is increasingly high in this region [9].

With this backdrop, the aims of this systematic review are to identify robust epidemiological evidence of MS in the South Asia region and to estimate the prevalence of MS and its individual components.

Methods

Inclusion and exclusion criteria

The main inclusion criterion was English language full text articles published on or after the year 2000 to July 2013. Likewise, only population-based studies on apparently healthy subjects aged ≥18 years, consisting both genders and sample size of more than 500, were included. Studies on patients, targeted to particular occupational groups, conducted in hospital settings and among South Asian immigrants were excluded.

Search and selection methods

The search yielded a total number of 558 papers: 369 from PubMed, 133 from Scopus, 49 from OvidSP (MedLine/EMBASE) and 7 from reference search. A search was conducted in three major biomedical databases: PubMed, OvidSP (MedLine and EMBASE) and Scopus. The search terms 'prevalence' and 'metabolic syndrome' were combined with the name of each South Asian country: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Studies were searched by titles and/or abstracts. Other search terms for 'metabolic syndrome'—'metabolic syndrome X', 'syndrome X', 'insulin resistance syndrome X', 'Reaven Syndrome X'—were also considered. In addition, reference lists were also scrutinized to find relevant published articles.

Study characteristics

This systematic review examined a total of 16 studies comprising 14,515 males (44.1 %) and 18,390 females (55.9 %). Ten studies were conducted in India [12–21], two each in Sri Lanka [22, 23] and Bangladesh [24, 25] and one each in Pakistan [26] and Nepal [27]. Eight studies were carried out in urban settings [12–15, 18, 19, 21, 22], three in rural [24–26], four in both urban and rural [16, 17, 20, 23], and one study did not mention setting [27]. No single study was found from Maldives, Bhutan or Afghanistan. Fifteen included studies that were cross-sectional and one was longitudinal. Ten studies mentioned the study year, out of which six were conducted between 2005 and 2010. Three studies had a participant range of 500–1000, nine had between 500 and 2500 participants and four studies had more than 2500 participants.

Thirteen studies selected study participants by randomized sampling method, whereas in two studies [21, 27], they were selected non-randomly. The response rate of the participants varied from 61.3 to 98.2 %.

The detailed summary of the included studies is presented in the supplementary material 2.

Data extraction and quality appraisal

A data extraction form was developed using the Centre for Reviews and Dissemination guidance template [28]. The data form recorded basic information (authors, study year, title of paper, journal details), detailed information of each shortlisted article (study design, study location, study objectives, study population, sample size, key findings), and finally the reviewers comments. The accuracy of the extracted data was double checked, and amendments were made. The quality of the studies was assessed using the Critical Appraisal Skill Program (CASP) checklist for systematic reviews [29].

The flow diagram of article selection process is shown in Fig. 1.

Definitions

This study considered the four key definitions of MS: the World Health Organisation (WHO, 1999) [30], the National

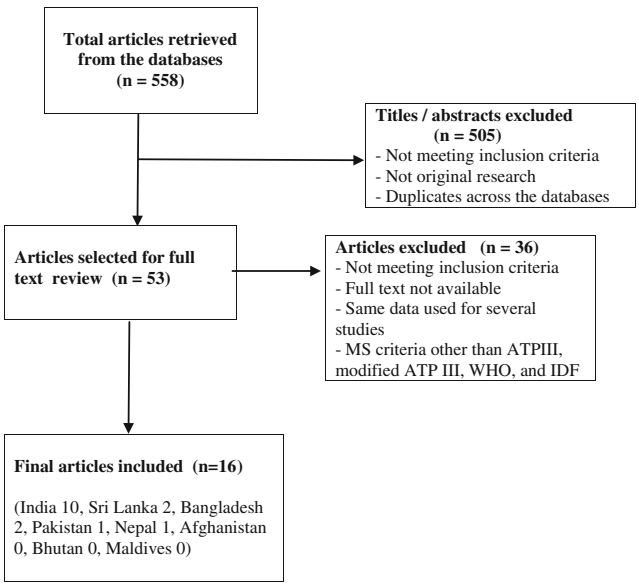

Fig. 1 Flow diagram for selection of the articles

Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATPIII,2001) [31], and its modified version 2005 [32], and the definition defined by the International Diabetes Federation (IDF, 2005) [33]. These definitions mostly consisted of fasting glucose, blood pressure, triglycerides, high-density lipoprotein cholesterol (HDL) and obesity as components. However, these definitions vary in cut-off points and have differences in the terms of prioritizing certain components. Details of these definitions are presented in the supplementary material 1.

Use of MS definitions

Four studies used ATP III definition only [14, 15, 20, 25], three studies considered modified ATP III definition only [13, 18, 21] and one study used IDF definition only [23]. Likewise, three studies followed ATP III and IDF definitions [16, 26, 27], one study followed modified ATP III and IDF definitions [22] and one study considered ATP III and modified ATP III definitions [17]. Further, one study each used WHO, ATP III and IDF definitions [12]; WHO, modified ATP III and IDF definitions [24]; and ATP III, modified ATPIII and IDF definitions [19].

We calculated mean prevalence (weighted) of MS and its individual components as follows: sum of number of cases in all or relevant studies/sum of number of participants in all or relevant studies × 100. In a few studies, prevalence data were available only in certain categories, mainly by gender, urban and rural setting and ethnicity. In such cases, we calculated the overall prevalence by combining the existing data. The sex standardized mean prevalence of MS was calculated considering total study participants as a standard population.

Results

Prevalence of metabolic syndrome

The mean prevalence of MS (weighted) was 26.1 % (ATP III), 29.8 % (IDF), 32.5 % (modified ATP III) and 14.0 % (WHO). By any definitions, the prevalence ranged from 8.6 to 46.1 %. The sex standardized mean prevalence of MS was 25.4 % (ATPIII), 28.8 % (IDF), 36.2 % (modified ATPIII) and 13.9 % (WHO). The weighted mean prevalence of MS and its individual components are shown in Table 1.

The prevalence of MS was highly reported in the Punjabi community in India (35.8 %) [19] by ATP III criteria; in rural area of Pakistan (40.0 %) [26] by IDF criteria; in Colombo, Sri Lanka (46.1 %) [22] by modified ATP III criteria; and in Chennai city, India (23.2 %) [12] by WHO criteria.

The weighted mean prevalence of MS was higher in females than that in males [ATP: 29.5 vs 22.1 %; IDF: 34.3 vs 18.8 %; modified ATP III: 35.8 vs 28.8 %], except when considering the WHO definition (12.8 vs 15.6 %). The gender difference in the prevalence of MS was more pronounced in rural areas of Pakistan [26] where the difference in the prevalence was 37 % by the IDF criteria (males, 13 %; females, 50 %) and 20 % by ATP III criteria (males, 20 %; females, 40 %). However, examining the studies individually, only one study under ATP III criteria [15], none of the studies under IDF criteria, three studies under modified ATP III criteria [13, 17, 21], and one study under WHO criteria [12] reported higher prevalence in males. The prevalence of MS was found nearly two-fold higher in males than in females in a study carried out in Mumbai city, India [21].

Seven studies [14, 15, 17–19, 22, 23] reported age-adjusted prevalence, of which four [14, 18, 19, 23] studies compared it with crude prevalence. Age-adjusted prevalence was lower in all of the studies.

Nine studies provided prevalence of MS by age group. In eight studies [14, 15, 18, 19, 22–24, 27], the prevalence was observed to be increased with the increment in age, and it was highest in the age group above 50 years. However, an Indian study [21] demonstrated fairly equal prevalence in the age group 20–40 and 41–60 years (20.6 and 20.7 %, respectively) and decrement in the subjects older than 61 years.

The weighted mean prevalence of MS in the countries of South Asia is presented in Fig. 2.

Prevalence of individual components of MS

Nine studies [12–14, 16–19, 22, 27] provided all individual components of MS, whereas five [15, 20, 21, 23, 26] provided some of them, and two [24, 25] provided none. Four studies [14, 15, 21, 26] analysed individual components of MS by age group.

Low HDL cholesterol

Fourteen studies reported the prevalence of low levels of HDL cholesterol. The weighted mean prevalence was 57.9 %. The prevalence range was 31.6 % [22] to 79.6 % [26]. In seven studies [12, 14, 17, 20, 23, 26, 27], low HDL cholesterol was found in more than half of the study participants. Eleven studies reported the prevalence by gender which provided weighted mean prevalence of 37.9 % for males and strikingly 68.8 % for females. All of the studies showed higher prevalence in females than in males. Four studies presented the prevalence of low levels of HDL cholesterol with age group. In general, the prevalence trend was observed to be higher in younger age groups for both genders. A Pakistani [26] and Indian [21] study identified a highest prevalence in the youngest age group (20–40 years). An Indian study [15] reported highest in the age group of 30–39 years in both genders, whereas another Indian study [14] reported highest in the age group

Table 1 The weighted mean prevalence of metabolic syndrome and individual components

Variables	Male (%)	Female (%)	Total (%)	Range (%)
MS definition				
ATP III	22.1	29.5	26.1	18.3–35.8
IDF	18.8	34.3	29.8	11.2–40.0
Modified ATPIII	28.8	35.8	32.5	19.5–46.1
WHO	15.6	12.8	14.0	8.6–23.2
Individual MS components				
Low HDL-C	37.9	68.8	57.9	31.6–79.6
Hypertriglyceridemia	37.2	36.1	37.2	25.2–55.1
Hyperglycaemia	27.9	27.6	28.9	9.2–65.1
Hypertension	42.3	38.1	48.5	21.2–81.1
Adbominal obesity	11.2	29.8	23.4	10.0–70.9
Abdominal obesity (South Asian cut-off)	37.9	47.9	43.2	21.6–60.3

of 30–39 years among females and in 40–49 years among males. The mean value of HDL cholesterol in males and females was given in four studies, out of which three [15, 17, 22] documented higher values in females, one [16] reported higher in males, one [26] showed similar value in both.

Hypertriglyceridemia

The weighted mean prevalence of hypertriglyceridemia was 37.2 %. Thirteen studies included the prevalence of high levels of triglycerides in the range varying from 25.2 % [12]

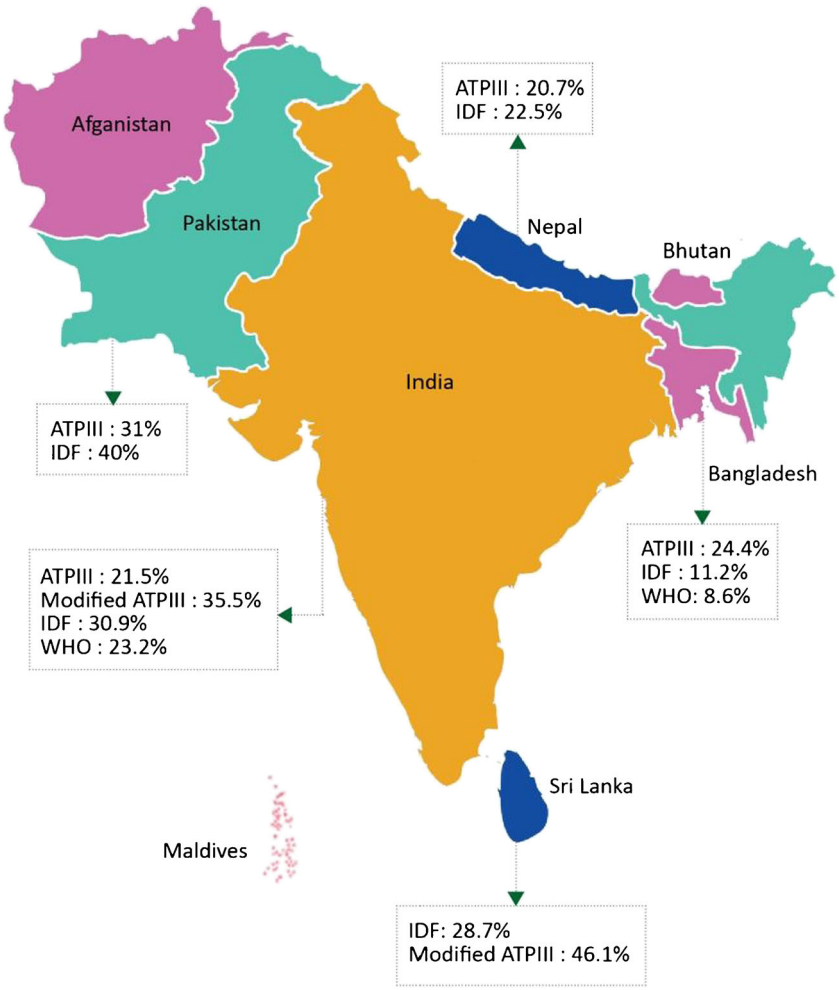

Fig. 2 The weighted mean prevalence of metabolic syndrome by country of South Asia

to 55.1 % [23]. The weighted mean prevalence was marginally higher in males (37.2 %) than that in females (36.1 %). Eleven studies provided the prevalence of hypertriglyceridemia by gender; however, only three studies [19, 20, 26] showed higher prevalence of triglyceride in females. According to age groups, hypertriglyceridemia was mostly observed among participants in middle age of 40–60 years for both genders.

Hyperglycaemia

The prevalence of hyperglycaemia was given in 11 studies. The weighted mean prevalence was 28.9 %, and the prevalence range was between 9.2 % [17] and 65.1 % [22]. Ten studies described the prevalence by gender which demonstrated that males and females had fairly equal weighted mean prevalence (males 27.9 % vs females 27.6 %). While considering individual studies, only three [18, 19, 26] reported higher prevalence in females. For both genders, increased prevalence of hyperglycaemia was observed with increasing age.

Hypertension

Nine studies provided the prevalence of hypertension with the weighted mean prevalence of 48.5 %. This prevalence varied from 21.2 % [13] to 81.1 % [23]. Males had higher weighted mean prevalence of hypertension compared to females (males, 42.3 %; females, 38.1 %). Among the eight studies which showed gender wise prevalence, only two studies [17, 22] reported slightly higher prevalence in females than that in males. Hypertension was found increase along with increasing age for both genders.

Abdominal obesity

The prevalence of abdominal obesity was presented in 11 studies. Not considering the South Asian cut-off point, the weighted mean prevalence was 23.4 %, in the range of 10.0 % [27] to 70.9 % [21]. Females had nearly three times higher weighted mean prevalence than males (females, 29.8 %; males, 11.2 %). Gender wise prevalence was shown in six studies, and females had decidedly greater prevalence in all of these. The difference in the prevalence was at least 9.5 % [17] and 29.3 % [19] in maximum.

Moreover, the weighted mean prevalence of abdominal obesity increased sharply to 43.2 % while considering the South Asian cut-off point for waist circumference (male, ≥90 cm; female, ≥80 cm) [33]. Six studies [13, 16–19, 22] presented abdominal obesity with the South Asian cut-off point. According to this cut-off, females had considerably higher weighted mean prevalence (females 47.9 % vs males 37.9 %). Similarly, by age group, abdominal obesity was observed highly prevalent among middle age (40–60 years) participants for both genders. Six studies reported the mean value of WC by gender, of which five [13, 15–17, 22] noted higher mean value in males, but one [26] showed higher in females.

Urban and rural difference

The weighted mean prevalence of MS in urban areas was higher than in the rural areas by all definitions except WHO (ATPIII, 28.7 vs 21.6 %; modified ATPIII, 38.8 vs 11.7 %; IDF, 34.1 vs 19.2 %; and WHO, 23.2 vs 30.7 %). The difference was more striking in modified ATPIII criteria. In both settings, females had usually higher weighted mean prevalence of MS than in males. Table 2 shows the weighted mean prevalence of MS by urban and rural setting for both genders.

Discussion

The findings of this review suggest that more than one quarter of the participants had MS, with more propensity in females. South Asians residing in urban areas had markedly higher prevalence of MS, in both genders. Low levels of HDL-cholesterol were found in nearly 70 % of females and were more prevalent in young people of both genders. Another striking finding was that hypertension was observed in nearly half of the participants and central obesity in more than one third. Further, we found that males were more likely to have increased levels of hypertension, whereas females were

Table 2 The weighted mean prevalence of metabolic syndrome in urban and rural setting

MS definitions	Male (%)	Female (%)	Total (%)
ATPIII			
Urban	23.9	33.2	28.7
Rural	16.7	24.8	21.6
Modified ATPIII			
Urban	34.6	42.9	38.8
Rural	11.9	11.6	11.7
IDF			
Urban	25.8	41.1	34.1
Rural	10.4	24.7	19.2
WHO			
Urban	27.3	19.7	23.2
Rural	30.0	31.1	30.7

comparatively more likely to have low levels of HDL-cholesterol and central obesity.

Our findings indicate that the prevalence of MS in South Asia stands neither in a lower position nor in a higher position across the globe, while comparing it with the systematic reviews or best available studies from other parts of the world. Our findings are fairly similar to the results of systematic reviews of Latin American countries [24.9 % (ATP III)] [6], a nationally representative study of Australia [22.1 % (ATP III), 30.7 % (IDF)] [34] and combined prospective studies of Europe [15 % (WHO)] [35]. In contrast, our study reported distinctly higher prevalence than in the African studies (0 to 7.9 % by any definitions) [36, 37], and a nationally representative study of Eastern Asia (China) [13.7 % (ATP III)] [38]. However, our figure is lower than the prevalence identified in a national survey of America [35 % (ATP III), 39 % (IDF)] [5] and in a systematic review of the Gulf countries [20.7–37.2 % (ATP III), 29.6–36.2 % (IDF)] [7].

This study demonstrated low HDL cholesterol as the most frequent individual component of MS with weighted mean prevalence of 57.9 %, and considerably higher among the females. A Latin American systematic review [6] also displayed highest prevalence of low HDL cholesterol (62.9 %), and also at greater proportion among the females, but the gender difference was much wider in our finding. Hypertension was shown to be the most prominent MS component in Europe (63.5 %) [35] and in Eastern Asia (41.2 %) [38]. Central obesity, which was the third most prevalent MS component in our study (44.5 %), was the most prevalent one in the USA (38.6 %) [5] and in Africa [37].

The underlying factors behind the high prevalence of dyslipidemia, hypertension and central obesity among South Asians could be multifarious. However, an increasing trend of urbanization and predilection towards 'westernized' lifestyle are mainly implicated [39–41], which could influence glucose intolerance, abdominal obesity and dyslipidemia. Misra et al. [42] suggested the possible role of body composition in the genesis of atherogenic dyslipidemia among South Asians. They argued that a higher percentage of body fat, excess truncal fat and increased intra-abdominal fat accumulation may be linked with insulin resistance and consequent dyslipidemia. Moreover, the INTERHEART study also found lower prevalence of protective factors in South Asian controls compared with controls from other countries (moderate or high intensity exercise, 6.1 vs 21.6 %; daily intake of fruits and vegetables, 26.5 vs 45.2 %) [10].

Some of the studies showed a genetic susceptibility of South Asians to central obesity and MS [43], low levels of HDL-cholesterol [44] and serum lipids and obesity [45]. Moreover, some genetically based hypotheses have also been postulated which may explain South Asians propensity to central obesity, namely 'the thrifty genotype' [46], 'the thrifty phenotype' [47], 'adipose tissue compartment overflow hypothesis' [48], 'variable disease selection hypothesis' [49] and 'the mitochondrial efficiency hypothesis' [50]. The vast majority of these genetic studies were limited to Indians and migrant Indian populations. In addition, the prevalence of MS among migrant South Asians living in western countries was also higher when compared with multiple ethnic group populations [51, 52] which suggests that modifiable correlates of MS may not be solely responsible for its increasing rates.

In this study, higher prevalence of MS in females was found compared to males. This finding can be partly explained by the explanation that culturally South Asian females are mostly engaged in the household tasks and have a more sedentary lifestyle than males. South Asian women also have poor access to the health services resulting in both late diagnosis and poor management of the disease [53].

Limitations of this review included not being able to search grey literature, only considering articles published in English language on or beyond the year 2000, and heterogeneity in the methodological quality of the studies (mainly discrepancies in measuring waist circumference and some variations in the cut-off value). Similarly, we could not rule out the possible bias due to the disproportionately higher representation of Indian studies. The main strength of this review is that we explored three major medical databases PubMed, OvidSP (MedLine and EMBASE) and Scopus. Also, we considered the most common definitions of MS.

Conclusion

South Asian countries have witnessed increasing burden of risk factors and diseases related with metabolic root. Nonetheless, they are grappling with limited health care resources and capacity. The actual burden of MS in South Asia is still obscure because none of the South Asian countries have nationally representative studies. The research environment should be consolidated, and research capacity should be strengthened. This systematic review suggests that MS is very common in this region and deserves urgent attention from both the clinical and public health viewpoint. Along with affordable and increased access to medical treatment, an intensified approach on primordial and primary prevention of metabolic disorders should be the utmost priority for South Asian countries, with special attention to females. Finally, heterogeneity of included studies limits our ability to conduct a meta-analysis. This needs to be addressed in the future.

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