REVIEW ARTICLE

PREVALENCE OF METABOLIC SYNDROME AMONG APPARENTLY HEALTHY WORKFORCE

Mudassar Ali Roomi, Masoud Mohammadnezhad*

Department of Physiology, Amna Inayat Medical College, Sheikhupura-Pakistan, *School of Public Health and Primary Care, Fiji National University-Fiji

Metabolic syndrome (MetS) is clustering of various cardiometabolic risk factors and it increases the risk of cardiovascular diseases and diabetes. Unhealthy lifestyle predisposes employees to increased risk of MetS. This systematic review was conducted to investigate the prevalence of MetS and its associated factors among working population. Studies published in English during 2005–2017 on the prevalence of MetS in workforce were searched. MetS was defined using Adult Treatment Panel-III criteria and searches were carried out in various databases using keywords for titles and/or abstracts. Forty articles, containing 435,013 participants aged 38.5 (18–64) years, were finally included. Overall average prevalence of MetS was 21.7% (6.1–58%). Average prevalence of MetS was higher in males (21.9%) than in females (14.1%). Region-wise prevalence of MetS was 27.93% in North America, 27.65% in South America, 21.27% in Asia, 16.04% in Africa, and 10.47% in Europe. Mean prevalence of each component of MetS was 39.1% for low HDL, 33.7% for hypertension, 30.8% for hypertriglyceridemia, 29.2% for central obesity, and 17.6% for hyperglycaemia. Major factors associated with MetS were male gender, aging, inactivity, smoking, stress, elevated liver enzymes, higher education, longer work experience, alcohol abuse, shift work, and lower fruit intake. Prevalence of MetS among workforce was high and it decreases work performance and increases personal and corporate health-care cost. Employees are suggested to enhance physical activity and adopt healthy lifestyle. Employers may increase the cardiometabolic health of their employees by increasing awareness, routine screening for MetS, and by providing various health promotion programs at the worksite.

Keywords: Cardiometabolic risk; Metabolic syndrome; Obesity; Occupational health

Citation: Roomi MA, Mohammadnezhad M. Prevalence of Metabolic Syndrome among Apparently Healthy Workforce: a systematic review. J Ayub Med Coll Abbottabad 2019;31(2):252–4.

INTRODUCTION

The economic growth and associated shifts in the sociodemographic features of people globally have led to changes in the lifestyle and diet with increased risk of non-communicable diseases (NCDs) e.g. obesity, metabolic syndrome (MetS), cardiovascular diseases (CVDs), diabetes mellitus and stroke etc. Metabolic syndrome is defined as a cluster of several metabolic abnormalities that include insulin resistance, dyslipidemia, hyperglycemia, high blood pressure, and abdominal obesity; insulin resistance is the key component.[1,2] Metabolic syndrome and its components are risks for CVDs and type 2 diabetes mellitus which can cause increased morbidity and mortality.[3–5] Clustering the components of MetS increases the risk of these NCDs and the risk is further increased in case of full MetS.[4] MetS is known as a lifestyle related disease associated with lack of physical activity and high-fat diet, smoking, and alcohol abuse.[6–8] People with MetS have 2–3 times risk for CVDs, and 3–5 times risk for diabetes compared with those who don't have MetS.[2,4,9,10] Nowadays, MetS has been considered as the main health risk for all populations in both developing and developed countries. Its prevention and treatment is a big challenge in medicine which increases the health-care cost so that it is an urgent priority for public health services in all countries.[11] The prevalence of MetS is growing, for example in South Korea it increased significantly from 24.9% in 1998 to 31.3% in 2007.[12] Its prevalence has been reported to be 14.9% among adults in Spain, 40% among Mexican adults[13], 23% in Germany[14], 20–30% in the USA[15], and 27.2% in Japan[16]. The prevalence of MetS can be affected by different factors such as gender, age, environmental setting, literacy and national health policy.[17] Males show a high prevalence compared with females. In a Japanese study, for example, its prevalence was 8–25% in males and 2–22% in females.[18,19] Older people have substantially higher prevalence compared with the younger people.[8,20] Retired, unemployed[21], bus drivers[22], university employees[23], and workers in the agricultural industry[24], oil industry[25], and health care sector[26] have shown different prevalence rates which highlights the role of employment status on MetS prevalence.

The work environment which is usually characterized by physical inactivity[27] can contribute to unhealthy lifestyle. MetS is a major health challenge among employees[27,28] who usually spend work hours in sedentary activities which increases the risk of obesity,

diabetes, and CVDs[29,30]. Workforce health can also be effort reward imbalance[28,31] which raises the risk of CVDs and metabolic disorders.[32]

for them to improve their health. Knowing the prevalence of the disease and factors affecting this disease can help people to improve workers' healthy behaviour.[11] For the health of workforce who include about half of the whole population worldwide[33], it is not only important to know individual factors affecting workers' health, it is also important to assess the work environment and the role of work-related factors in explaining workers' health patterns to implement more effective strategies and design effective lifestyle interventions to prevent MetS[34]. To the best of our knowledge, no systematic review has been conducted to study the prevalence of the MetS, its components and other associated factors among working population in the world. So, this systematic review was aimed to assess the prevalence of MetS, its components, and other determinants of MetS among workforce in various regions of the world.

MATERIAL AND METHODS

This systematic review study was conducted based on the Cochrane Library Guidelines.[35] PubMed, Scopus, Web of Science, Google Scholar, PsycINFO, and Mendeley databases were searched to find articles published in English language from 1st January 2005 to 31st December 2017. These databases were chosen based on their relevance and frequency of their use in previous similar studies. The prevalence of MetS among workforce was determined by using US National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP III or ATP-III) criteria. Keywords used to achieve the relevant studies were chosen based on the Medical Subject Headings (MeSH), keywords offered by databases, and the objectives of the study. Keywords included "prevalence", "metabolic syndrome", "cardiometabolic risk", "staff health OR occupational health", "workforce OR staff OR employees", "workplace OR work environment OR worksite". These keywords were used in various combinations. This review was restricted to healthy adult workers of both genders. Case reports, studies conducted on pregnant employees, and on any group of workers having a specific disease e.g. CVDs, diabetes, endocrine diseases, kidney diseases, and liver diseases were excluded. A Measurement Tool to Assess Systematic Reviews (AMSTAR) was used as a guide while performing this systematic review.[36]

Studies were reviewed by two independent reviewers in three steps after omitting the duplicated studies. First, the titles of all found studies were reviewed and those which did not meet the inclusion and exclusion criteria were excluded. Second, the abstracts of all the remained studies were reviewed and affected due to job stress, high work demands, and People who suffer MetS often have low level of knowledge towards the disease so it is very difficult after removing the irrelevant ones full-text of the remained studies were printed and reviewed by the reviewers (Figure-1). The bibliography of the relevant full-text studies were checked to include any other studies that were not available through the selected databases. Forty studies were finally considered for the analysis. An extraction sheet was developed and the information of the studies, profession of participants, study design, criteria used to define MetS, study population, prevalence of MetS, most common components of MetS, and factors associated with MetS were extracted and prepared for analysis. A descriptive statistical analysis was applied and the results were presented as figures and tables.

We used ATP III criteria for the diagnosis of MetS. According to original ATP III criteria[37,38] a person is diagnosed with MetS if he has ≥3 of the following risk factors: increased waist circumference, hypertriglyceridemia, reduced HDL ("good') cholesterol, raised blood pressure, and fasting hyperglycemia. The revised ATP III criteria[39] is similar to original ATP III criteria except that former criteria have a cut-off level of ≥100 mg/dL (5.6 mmol/L) for fasting hyperglycemia while it is ≥110 mg/dL (6.1 mmol/L) according to later criteria (Table-1). We used only one criterion to diagnose MetS in order to increase comparability between studies. Another reason for using ATP criteria was that it is very commonly used globally to diagnose MetS. Furthermore, American Heart Association also accepts the revised ATP criteria. Although some of the retrieved studies diagnosed MetS using multiple criteria e.g. ATP III, World Health Organization (WHO), International Diabetes Federation (IDF) criteria; however, we extracted information on the prevalence of MetS and its components only based on original or revised ATP III criteria.

RESULTS

A total of 1460 potentially relevant articles were retrieved during initial search of various databases (Figure-1). After excluding non-relevant, duplicate and review articles, the abstracts of 325 studies were examined. Based on the relevance of abstracts, 131 full-texts articles were read. Forty articles met the selection criteria and were finally used for this systematic review.

Table-2 shows summary of characteristics of all the 40 selected studies. Eleven studies were published during 2005–2010, and the rest of 29 articles were published during 2011–2017. Of the total 40 studies, 18 were conducted in Asia (five in South Korea; three in Japan; two each in China, India, Iran, and Malaysia; one each in Taiwan, Thailand, and Russia). Eleven studies were carried out in North America (10 in

the USA, and one in Mexico). Five studies were conducted in Africa (one each from Ghana, Angola, Congo, Ethiopia, and Botswana).[40–44] All four European studies were from Spain.[45–48] Furthermore, there were two studies from South America (both from Brazil).[38,49]

Cross sectional study design was used by 36 studies; three studies were retrospective[50–52], and one was of prospective design[53]. The sample sizes of the individual studies ranged from 115 to 259,014 workers. The total number of participants from all the studies was 435,013. Eight studies included men only, one study[54] included women only, and the rest of 31 studies included both genders. The selected 40 studies included workers from diverse fields such as health professionals, bank employees, teachers, granite workers, professional drivers, and law enforcement officers etc. Age of the participants in various studies ranged from 18 to 64 (mean=38.5) years (Table-2).

Prevalence of metabolic syndrome

The average prevalence of MetS among all the studies was 21.7% with minimum prevalence being 6.1%[23] to maximum being 58%.[55] The average prevalence of MetS among males was 21.9% (range: 9.6–37.2%), and among females was 14.1% (range: 1–28.7%).

Prevalence of MetS was compared between males and females in 27 studies. Males had significantly higher prevalence of MetS than females in 22 studies. In rest of the five studies[40,41,43,44,56], females had significantly higher prevalence of MetS than males; four of these five studies were from Africa.

The region-wise average prevalence of MetS in the selected studies was found to be 21.27% in Asian studies, 27.93% in North American studies, 16.04% in African studies, 10.47% in European studies, and 27.65% in South American studies. We could not find any study to assess the prevalence of MetS among workforce in the South Pacific Region.

Prevalence of the components of metabolic syndrome

Low HDL cholesterol was the most common component of MetS with 39.1% mean prevalence (n=23 studies). Second and third most prevalent components of MetS were hypertension (33.7%) and hypertriglyceridemia (30.8%) respectively. The mean prevalence of central obesity and fasting hyperglycemia were calculated to be 29.2% and 17.6% respectively. Mean values and range for the prevalence of each component of MetS can be found in table 3. Out of total 40 studies, 25 have individually reported the first, second, and third most common components of MetS. Central obesity was reported as the first most common component of MetS by 4 studies[27,34,43,55] as the second most common component of MetS by 5 studies, and as the third most common component of MetS by 10 studies. The number of studies reporting hypertriglyceridemia, low HDL, hypertension, and fasting hyperglycemia as the first, second, and third most common components of MetS are presented in table-3.

Factors associated with metabolic syndrome

Factors associated with increased prevalence of MetS are presented in table-4. Increasing age was reported by 25 studies to be significantly associated with increased likelihood of having MetS. Nine studies reported the association between sedentary lifestyle and increased prevalence of MetS. Moreover, another five studies reported that cigarette smoking is associated with increased risk of having MetS. Other factors (e.g. psychological stress, alcohol abuse, shift work, and high job control etc.) associated with increased prevalence of MetS in the working population along with the number of studies that have reported this association can be found in table-4.

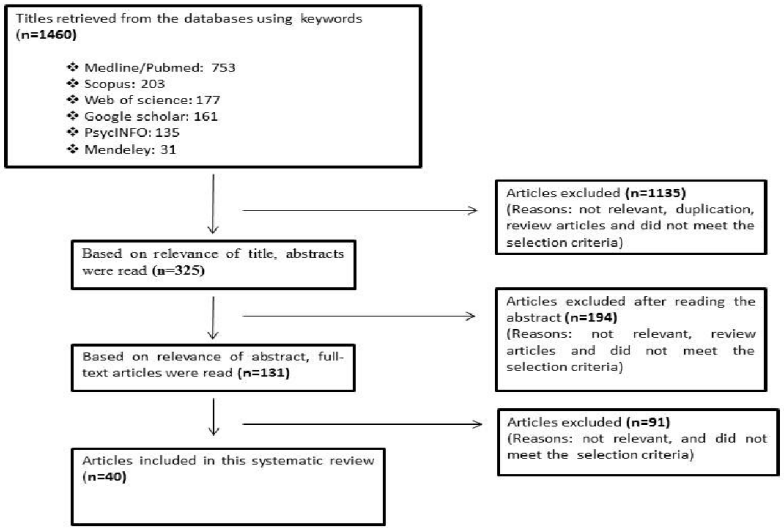

Figure-1: Flow diagram showing the selection of studies for this systematic review

Table-1: Criteria used to diagnose metabolic syndrome

Risk factor	NCEP-ATP III criteria, 2001[37,38]	Revised NCEP-ATP III criteria, 2005[39]
	Criteria required: **Any** ≥ 3 of the following	**Criteria required:** **Any** ≥3 of the following
Abdominal obesity **(↑ Waist circumference)**	**Men:** >40 in (102 cm) **Women:** > 35 in (88 cm)	**Men:** >40 in (102 cm) **Women:** >35 in (88 cm)
Hypertriglyceridemia	≥150 mg/dL (1.7 mmol/L)	≥150 mg/dL (1.7 mmol/L)
Reduced HDL ("good') cholesterol	**Men:** < 40 mg/dL (1.03 mmol/L) **Women:** <50 mg/dL (1.29 mmol/L)	**Men:** < 40 mg/dL (1.03 mmol/L) **Women:** <50 mg/dL (1.29 mmol/L)
Raised blood pressure	Systolic BP ≥130 mm Hg, or diastolic BP ≥85 mm Hg (or treated for hypertension)	Systolic BP ≥130 mm Hg, or diastolic BP ≥85 mm Hg (or treated for hypertension)
Fasting hyperglycaemia	≥110 mg/dL (6.1 mmol/L) or previously diagnosed type 2 diabetes mellitus	≥100 mg/dL (5.6 mmol/L) or previously diagnosed type 2 diabetes mellitus

Table-2: Summary of the 40 studies selected for this systematic review

First author, year, country (Ref. #)*	Profession of the participants	Study Design and Criteria used for diagnosis of MetS	Number, age and gender of Participants	Prevalence of Metabolic syndrome % (n)	Most common components of metabolic syndrome (MetS)	Factors associated with increased risk of metabolic syndrome (MetS)
Myong *et al*., 2012 South Korea[74]	Korean working population	cross-sectional, ATP III	Total n= 3,288, Males: 55% (n=1807), Females: 45% (n=1481), male age: 41.9±0.4 years, Female age:41.4±0.5 years	Overall prevalence of MetS: 21.8% (n=717), Prev. of MetS in males: 25.5% (n=461), Prev. of MetS in females: 15.9% (n=236).	Among those < 50 years of age, Low HDL was seen in 45.1% followed by ↑ TGs in 36.8% and then hypertension in 31.5% of the participants	Male gender, aging. Female manual workers had a higher prevalence of MetS than female non-manual workers among those younger than age 50.
Kang *et al*., 2013 South Korea[64]	Korean working population	cross-sectional, ATP III	Total n= 1,545, Men=55.5 % (n=858), Women:44.4% (n=687), Age: >20 years	Overall prevalence of MetS: 25.8% (n=399), Prev. of MetS in men=29.2% (n=250), Prev. of MetS in women=19.3% (n=132)	Low HDL-C in 64.4%, ↑ TGs in 29.1%, abdominal obesity in 26.5%	Male gender, Job control, heavy alcohol consumption, current smoking
Choi et et al., 2014 South Korea[65]	Workers from a wide range of small-sized companies having	cross-sectional, ATP III	Total n= 21784, Males: 75.7% (n=16488), Females: 24.3% (n=5296), Male age: 38.7±10.6 years, Female age: 40.5±11 years	Overall prevalence of MetS: 12 % (n=2618). Prev. of MetS in males= 13.4% (n=2210), Prev. of MetS in females: 7.7% (n=408)	In males: ↑ TGs (41.0%), HTN (19.9%), fasting hyperglycemia (12.7%). In females: Low HDL (17.8%), ↑ TGs (16.7%), hypertension (14.2%).	Male gender, aging, family history of CVD, MetS is more prevalent in non-manual workers (office workers/drivers) than in manual workers
Ryu *et al*., 2017 South Korea[34]	Office workers	cross-sectional, ATP III	Total n= 776, Males: 78.8% (n=610), Females:21.2% (n=164), Age: 37 (24–59) years	Overall prevalence of MetS: 13.5%(n=105), Prev. of MetS in males: 17% (n=104), Prev. of MetS in Females: 1% (n=1)	↑waist circumference in 27.5%, ↑ fasting glucose in 23.1% and ↑ TGs in 22.2% of the participants	Male gender. Having any medical health problems. more knowledge of MetS, higher BMI, current smoking and physical inactivity
Shiwaku *et al*., 2005 Japan, Korea & Mongolia[72]	Workers from different companies	cross-sectional, ATP III	Total n= 1,384, (Japanese: 719, Korean: 408, Mongolian: 257) Males= 50.7% (n=702) Females= 49.3% (n=682) Age= 30–60 years	Overall prev. of MetS: 12.9% (n=179). The prev. of MetS was 12% for Japanese, 13% for Koreans, and 16% for Mongolians. Prev. of MetS in males= 14.4%, (n=101), Prev. of MetS in females: 11.4% (n=78)	Most common MetS comp. in men was ↑ TGs, while in females it was low HDL.	Male gender, Note: The ATP III-BMI25 definition is suitable for the determination of MetS among Japanese and Koreans, and the ATP III-BMI30 is more appropriate for Mongolians.
Kawada *et al*., 2010. Japan[75]	A wide age range of workers	cross-sectional, ATP III	n= 4278 men Age: 20–59 years	Overall prevalence of MetS: 20.9%, (n=892)		Aging
Ojima *et al*., 2015 Japan[76]	Middle-aged Japanese employees.	cross-sectional, AHA	n= 4716 males Age: 42 or 46 years.	Overall prevalence of MetS: 11 % (n=521)	Hypertension (29.7%), followed by dyslipidemia (28%) and then central obesity (24.2%)	Participants with decayed teeth showed a ↑ prevalence of MetS, overweight or obesity, hypertension, dyslipidemia, and hyperglycemia
Shafei *et al*., 2011. Malaysia[54]	Female nurses	cross-sectional, ATP III	Total n= 404 females, Age: 42.1±7.19 years	The prevalence of MetS: 24.3% (n=98)		Aging, total years of employment and one-way commuting time to work (minutes).

First author, year, country (Ref. #)*	Profession of the participants	Study Design and Criteria used for diagnosis of MetS	Number, age and gender of Participants	Prevalence of Metabolic syndrome % (n)	Most common components of metabolic syndrome (MetS)	Factors associated with increased risk of metabolic syndrome (MetS)
Chee *et al*., 2014 Malaysia[77]	Among government employees	cross-sectional, ATP III	Total n= 659, Males: 23.4% (n=154), Females: 76.6% (n=505), Age: 34.49±8.80 years	Overall prevalence of MetS: 27.9% (n=184)	Hypertension in 43.7%, Low HDL in 43.4%, Abdominal obesity in 36.4% of the participants	Male gender, aging, current behavioral stage of physical activity
Prabhakaran *et al*., 2005. India[60]	Industrial population	cross-sectional, ATP III	n= 2122 men. Age: 20-59 (42) years	Overall prevalence of MetS: 28.1% (n=596)	↑ TGs in 57.9%, Low HDL in 67.2%, Hyperglycemia in 37% of participants	Aging
Srilakshmi *et al*., 2015. India[78]	Granite workers	cross-sectional, ATP III	n= 210 males, Age=20-50 years	Prevalence of MetS: 33 % (n=69)	Elevated BP in 40%, Abdominal obesity in 29%, low HDL in 34%	Sedentary lifestyle and stress
Alavi *et al*., 2015 Iran[58]	Office workers	cross-sectional, ATP III	Total n= 1488, men: 92% (n=1372), women:8% (n=116), Age= 36±7.7 years	Overall prevalence of MetS was 35.9% (n=534), Prevalence in men: 37.2% (n=510), Prevalence in women:20.6% (n=24)	↑ TGs in 45.9% of participants, low HDL level in 45.5%, Hypertension in 21.1%	Male gender, aging office work, University education, lack of physical activity, low intake of fruits and smoking
Ebrahimi *et al*., 2016 Iran[79]	Professional drivers	cross-sectional, ATP III	n= 991 males Age=42.17±10.65 years	Prevalence of MetS= 26.1% (n= 257)	Low HDL in 79.3% of participants, ↑ triglycerides (TGs) in 56.3%, Abdominal obesity in 25.2%	Aging, Being a professional driver
Cheserek *et al.,* 2014 China[23]	University workers-administration and academic	cross-sectional, ATP III	Total n= 2273, Males: 53% (n=1198), Females: 47% (n=1075), Age:22–60 (42.5±8.6) years	Overall prevalence of MetS: 6.1% (n=139), Prev. of MetS in males: 9.6% (n=115), Prev. of MetS in females: 2.23 % (n=24),	Hypertension in 37.9%, ↑ TGs in 20.8%, Reduced HDL in 13.8%	Male gender, aging. High prevalence in those with administrative jobs.
Wang *et al*., 2016 China[50]	employees from govt. institutions, universities or companies	Retrospective observational study, ATP III	Total n= 33149, Men= 58.3% (n=19337), Women= 41.7% (n=13812), Age=43.8±12.8 years,	Overall prevalence of MetS: 25.7% (n=8519), Prevalence of MetS in men: 30.9% (n=5975), Prev. of MetS in women: 18.4%(n=2541)	Within the metabolic syndrome group most common component was overweight/obesity	Male gender and aging
Lu *et al*., 2017 Taiwan[67]	Workers at steel plants.	cross-sectional, ATP III	Total n= 1732 men, day workers: 862, shift workers: 870, Age: 42±8 years	Overall prevalence of MetS: 29.4%(n=509), Prev. of MetS in shift workers: 31.7% (n=276), Prev. of MetS in day workers: 27.0% (n=233)	Among shift workers, Hypertension was present in 50.1%, Central obesity in 38.9% and ↑ TGs in 36.2%	Shift work was independently associated with MetS.
Patrakitkomjorn *et al*., 2011 Thailand[51]	Hospital staff	Retrospective study, ATP III	Total n=1,373 Males=16.2% (n=223) Females=83.8% (n=1150)	Overall prev. of MetS: 9.7% (n=133), Prev. of Intermediate MetS: 46% (n= 611), prev. of MetS in males= 18% (n=41), prev. of MetS in females= 8% (n=92)		Male gender, aging. ↑ creatinine, ↑ uric acid and ↑ AST levels.
Konradi *et al*., 2011 Russia[27]	Bank employees	cross-sectional, ATP III	Total n= 1561 Males: 21.6% (n=338), Females: 78.4% (n=1223), Mean Age=38.5 years	Overall prevalence of MetS: 18.8% (n=293) Prevalence in men: 28.4% (n=96) Prevalence in women:16.2% (n=198)	Abdominal obesity in 45.6% Hypertension in 35.2% ↑ TGs in 28.4% of the participants	Male gender, Aging Low physical activity, smoking, & alcohol abuse
Godefroi *et al*., 2005 USA[57]	Primarily white-collar (e.g., engineers, accountants)	cross-sectional, ATP III	Total n=871, Men=68% (n=592), Women= 32% (n=279), Age: 21–77 years	Overall prevalence of MetS: 27% (n=234), Prevalence of MetS in men: 30.2% (n=180), Prev. of MetS in women: 19.7% (n= 55)	Among individuals with MetS, 29.8% had ↑ TGs levels, 28.1% were hypertensive and 23.0% had abdominal obesity.	Male gender, aging, sedentary lifestyle. History of hypertension, heart disease, or stroke. Those with an increased heart rate and ↑ levels of C-reactive protein.
Burton *et al*., 2008 USA[70]	Employees from large, multistate financial services Corporation.	Cross-sectional, AHA	Total n= 5512, Males= 38.7% (n=2133), Females= 61.3% (n=3379), Age: 18-64 years	Overall prev. of MetS: 22.6% (n = 1247), Prev. of MetS in males: 23.7% (n=505), Prev. of MetS in females: 22% (n=742)	The most common comp of MetS was low HDL-C (41.1%) followed by high BP (38.3%) and then ↑ TGs (31.5%)	Male gender, MetS was associated with poor perceived health, ↑ illness days, and an ↑ trend of STD incidence

First author, year, country (Ref. #)*	Profession of the participants	Study Design and Criteria used for diagnosis of MetS	Number, age and gender of Participants	Prevalence of Metabolic syndrome % (n)	Most common components of metabolic syndrome (MetS)	Factors associated with increased risk of metabolic syndrome (MetS)
Schultz *et al*., 2009 USA[69]	Employees of a manufacturing corporation	cross-sectional, ATP III	Total n= 4188, Males= 83.4% (n= 3492), Females= 16.6% (n= 696), Average age: 40.8 years	Overall prev. of MetS: 30.2% (n=1266). Prev. of MetS in males: 32.5% (n=1134) Prev. of MetS in Females: 18.9% (n=132)	↑ TGs was the most common risk, followed by ↑ BP and then obesity	Male gender, Health care cost & presenteeism ↑ with ↑ in no. of components of MetS. Those with MetS were more likely to report arthritis, diabetes, depression, chronic pain, heart problems, acid reflux, stroke & chronic bronchitis/emphysema
Yoo *et al*., 2009 USA[63]	Law enforcement officers	cross-sectional, ATP III	n= 386 white males, Age= 39.1 (8.7) 23–60 years	Overall prevalence of MetS: 23.1% (n=89)		Physical inactivity
Davila *et al*., 2010 USA[56]	Workers from 40 various occupations	cross-sectional, ATP III	Total n= 8457 Males=53.5% (4523), Females=46.5% (3934)	Overall prevalence of MetS: 18.7% (1581). Prevalence of MetS in males: 20.2% (914), Prevalence of MetS in females:21.4% (842)		Female gender, aging transportation & material occupations
Birnbaum *et al*., 2011 USA[80]	Office-based employees	cross-sectional, ATP III	Total n= 203, Males=66% (n=134), Females= 34%, (n=69), Age: 45±8.59 years	Overall prevalence of MetS: 23.6 % (n=48). Prevalence of MetS in males: 25.8% (n=34) Women 20.3% (n=14).	Hypertension in 55.2%, ↑ TGs in 47.8%, Obesity in 33.0%	Male gender, aging
Burton et al., 2014. USA[52]	Employees of US-based Fortune 100 company	retrospective observational study, AHA	Total n= 4345, Males= 34.1% (n= 1483), Females= 65.9% (n=2862), Average age: 41.6 years	Overall prevalence: 30.2% (n=1312) Prev. of MetS in males: 33.1% (n= 491) Prevalence in females: 28.7% (n= 823)	The most common component of MetS was low HDL-C, followed by abdominal obesity and then ↑ TGs	Male gender, aging, ↑ Health care costs, ↑ % of absenteeism & presenteeism, ↑ risk for self-reported illness absence days, safety belt use, stress, smoking, depression, and osteoporosis.
Capizzi *et al*., 2010 USA[71]	Employees from a large manufacturing firm.	cross-sectional, ATP III	Total n= 1813, Males= 74.6% (n=1352), Females= 25.4% (n=461), Age= 44.8±0.3 years	Overall prevalence of MetS: 20.4% (n=370), Prev. of MetS in males: 22.8% (n=309), Prev. of MetS in females: 13.2% (n=61)	Among employees with MetS, the most common component was ↑ TGs (42.7%) followed by hypertension (37.2%) and then low HDL (35.7%).	Male gender, MetS appeared to adversely interact with mental health in men
Goetzel *et al*., 2017 USA[81]	Employees at Lockheed Martin Corporation, USA	Observational study, AHA	Total n= 10,018, Males:62.44% (n=6255), Females:37.56% (n=3763), Mean age: 45.5 years	Overall prevalence of MetS: 24.9% (n=2494)	56.8% had high cholesterol, 57.4% were obese, and 34.0% of the participants had high BP	
Lemke *et al*., 2017. USA[55]	US long-haul truck drivers.	cross-sectional, ATP III	n=115 males Age: 46.6(±10.5) years	Prevalence of MetS: 58% (n=66)	↑ Waist circumference in 79%, low HDL in 66 %, and ↑ TGs in 50 %	Longer work experience and work day sleep quality
Flores et al., 2016. Mexico[53]	Mexican health workers	Cohort Study ATP III	Total n= 1462, Males: 24.8% (n=363), Females75.2%(n=1099),	Overall prevalence of MetS: 28.6% (n=418)		↑ ALT levels were associated with increased risk of MetS
Garrido *et al*., 2009 Botswana[40]	Health care workers at Kanye 7th -day Adventist Hospital, Kanye	cross-sectional, ATP III	Total n= 150, Men= 29.3% (n=44), Women= 70.7% (n=106), Age=39.2±11 (22–65) years	Overall prevalence of MetS: 34.0% (n=51), Prev. of MetS in men: 15.9% (n=7), Prev. of MetS in women: 41.5% (n=44)	Low HDL in 80%, Hypertension in 44%, Abdominal obesity in 42% of the participants	Female gender and aging
Owiredu *et al*., 2011 Ghana[42]	Active sportspersons & sedentary workers	cross-sectional, ATP III	Total n= 186 Age= 43.56±1.06 years	The prevalence of MetS: 7.4% (n=14)	Reduced HDL in 39.4%, Hypertension in 25.0%, Abdominal obesity in 12.2%	Sedentary lifestyle
Tran *et al*., 2011 Ethiopia[44]	Bank Employees and teachers	cross-sectional, ATP III	Total n = 1935, Males= 60.5 % (1171), Females= 39.5% (764)	Overall Prevalence of MetS: 12.5% (n=242) Prevalence in men: 10.0% (n=117), Prevalence in women:16.2% (n=124)	In women: Low HDL in 23.2%, central obesity in 19.6% and ↑ TGs in 19.5%. Among men: Low HDL in 23.4%, high BP in 21.8% and ↑ TGs in 21.3%.	Female gender and aging

First author, year, country (Ref. #)*	Profession of the participants	Study Design and Criteria used for diagnosis of MetS	Number, age and gender of Participants	Prevalence of Metabolic syndrome % (n)	Most common components of metabolic syndrome (MetS)	Factors associated with increased risk of metabolic syndrome (MetS)
Gombet *et al*., 2012 Congo[43]	Bank employees	cross-sectional, ATP III	Total n= 126, Males= 55.6% (n=70), Females= 44.4% (n=56), Age= 42±9 years	The prevalence of MetS: 8.7% (n=11)	Abdominal obesity in 39.7%, Fasting hyperglycemia in 26.2%, Known hypertension in 26.2 %	Female gender, aging. a pro-inflammatory state (↑ ESR),↑ liver enzymes, longer duration of rural–urban migration
Magalhães *et al*., 2014 Angola[41]	Employees of a public university	cross-sectional, ATP III	Total n= 615, males: 47.8 % (n=294), females: 52.2 % (n=321), Age= 44.5±10.6 years	The prevalence of MetS: 17.6% (n= 108)	Low HDL in 50.1%, Hypertension in 45.2%, Overweight in 29.3%.	Female gender and aging
Alegría E, *et al*., 2005 Spain[45]	Employees from a large car factory & a department Store	cross-sectional, ATP III	Total n= 7256, Males: 82.4% (n=5979), Females: 17.6% (n=1277), Age= 45.4±9.8 years	Overall prevalence of MetS: 10.2% (n=743) Prev. of MetS in men: 11.9% (n=716), Prev. of MetS in women: 2.11% (n= 27)	Hypertension in 40% of the workers, Obesity in 28.5%, ↑ TGs in 18.3%	Male gender, aging, obesity, hypertension and diabetes. High prevalence of MetS in manual workers than office workers and managers (an inverse relationship with social class).
Sa´nchez-Chaparro *et al*., 2008 Spain[46]	Non-manual and manual workers.	cross-sectional, ATP III	Total n= 259,014 Males:72.9%(n=188,804), Females:27.1%(n=70,210), Age: 36.4 [16-74] years	Overall prev. of MetS: 9.5% (n=24606), Prev. of MetS in men: 11.6% (n=21901), Prev. of MetS in women: 4.1% (n=2878)		Male gender, Aging. Among females, the age-adjusted prevalence of MetS was higher in blue-collar (manual) than in white-collar (non-manual) workers
Tauler *et al*., 2014 Spain[47]	Workers from post offices, health dept. and public administration	cross-sectional, ATP III	Total n= 43265 Males= 56.7% (n=24529) Females=43.3% (n=18736) Age: 20–65 years	Overall prev. of MetS: 7.35% (n=3180), Prev. of MetS in males: 9.93% (n=2435), Prev. of MetS in females: 3.98% (n=745)		Male gender, aging
Romero-Saldaña *et al*. 2016. Spain[48]	Workers from a Local government office	cross-sectional, ATP III	Total n= 636, Males: 67.9% (n=432), Females: 32.1% (n=204), Age: 45.1±8.8 years	Overall prevalence of MetS: 14.9% (n=95), Prev. of MetS in males: 19.4% (n=84), Prev. of MetS in females: 5.4%(n=11)		Male gender, Sedentary/light Physical activity associated with MetS
Salaroli *et al*., 2013. Brazil[38]	Bank employees	cross-sectional, ATP III	Total n = 501. Males: 50.9% (n=255), Females: 40.1% (n=246) Age=20-64 years	Overall prevalence of MetS: 17.2% (n=86), Prev. in men:19.6% (n=50), Prevalence in women:14.6% (n=36)		Male gender, aging Individuals with college degrees, overweight and obesity
Ribeiro *et al*., 2015. Brazil[49]	Nursing personnel	Descriptive study ATP III	n= 226, Age: 23-66 years	Overall prevalence of MetS: 38.1% (n=86)		Aging, anxiety and stress

*studies are listed by regions/continents: first Asian studies, then North American, followed by African, European and South American studies. Studies from each country in a region are grouped and listed in chronological order.

Table-3: Number of studies reporting first, second, and third most common components of MetS (n=25 studies)

	Central obesity	↑ TGs	Low HDL	Hypertension	Fasting hyperglycaemia
Mean Prevalence (range)	29.2 (4–79)%	30.8 (3.9–57.9)%	39.1 (9.5–80.0)%	33.7 (9.4–55.2)%	17.6 (5.7–37.0)%
1st most common component of MetS	3 articles	5 articles	9 articles	8 articles	0 article
2nd most common component of MetS	5 articles	7 articles	4 articles	7 articles	3 articles
3rd most common component of MetS	11 articles	6 articles	3 articles	4 articles	1 article

Table-4: Factors associated with increased prevalence of metabolic syndrome

Factors associated with increased prevalence of metabolic syndrome along with the number of studies that have reported this association	
➢ Aging: 25 studies	➢ Alcohol abuse: 2 studies[27,64]
➢ Sedentary lifestyle: 9 studies	➢ Family history of diabetes, CVD: 1 study[65]
➢ Smoking: 5 studies[27,34,52,58,64]	➢ Lower intake of fruits: 1 study[58]
➢ Psychological stress/depression: 4 studies[49,52,69,78]	➢ Longer duration of rural-urban migration: 1 study[43]
➢ Elevated liver enzymes (ALT, AST, gamma GT): 3 studies[43,51,53]	➢ More knowledge of MetS: 1 study[34]
➢ Manual workers: 3 studies[45,46,74]	➢ High job control: 1 study[64]
➢ Non-manual workers e.g. administrators, office workers, drivers: 2 studies[58,65]	➢ Shift work: 1 study[67]
➢ Higher education: 2 studies[38,58]	➢ Absenteeism: 1 study[52]
➢ Longer work experience: 2 studies[54,55]	➢ Increased trend of STD illness: 1 study[70]
➢ Being a professional driver: 2 studies[55,79]	➢ Increased illness days: 1 study[70]
➢ Presenteeism: 2 studies[52,69]	➢ Decayed tooth: 1 study[76]
➢ Increased health-care cost: 2 studies[52,69]	➢ Increased ESR: 1 study[43]
	➢ Increased CRP: 1 study[57]
	➢ Increased creatinine & uric acid: 1 study[51]

Abbreviations: AHA, American Heart Association; BMI, Body Mass Index; BP, Blood Pressure; CVDs, Cardiovascular Diseases; HDL, High Density Lipoproteins; IDF, International Diabetes Federation; LDL, Low Density Lipoproteins; MetS, Metabolic syndrome; NCDs, Non-communicable Diseases; NCEP ATP-III, National Cholesterol Education Program Adult Treatment Panel III; TGs, Triglycerides; WHO, World Health Organization

DISCUSSION

Prevalence of metabolic syndrome

In this systematic review, overall average prevalence of MetS among all the studies was calculated to be 21.7%. This means, more than 1/5th of the adult workers suffer from MetS. However, in some of the studies used for this review this prevalence was as low as 6.1%[23] and in some others as high as 58%[55]. Such a high prevalence of MetS in otherwise healthy-looking working population is worrisome as MetS increases the risk of having CVDs[57] and diabetes mellitus.

The average prevalence of MetS among males (21.9%) was higher than the average prevalence of MetS among females (14.1%). Twenty two out of 27 studies, which have compared the prevalence of MetS between males and females, have reported significantly higher prevalence of MetS among males. This indicates that male gender is more likely to be affected by MetS among working population. Another study[58] has reported that male office workers are more likely to be affected by MetS than female office workers. However, in five studies used for this systematic review females had higher prevalence of MetS than males. Interestingly, four of these five studies were from Africa. African females may be more prone to develop MetS than African males. One of the implications of these finding may be that male employees should be given repeated awareness of their increased risk of having MetS, and the importance of adopting a healthy lifestyle. This does not mean that females should be ignored while targeting the high-risk male group.

It is interesting to note that six studies[40,47,49,51,53,54] reported high prevalence of MetS among health-care providers e.g. doctors and nurses. As health professionals are more likely to be aware of various NCDs and their risk factors, general public may expect them to be healthier than general population. This high prevalence of MetS and its components among health professionals, who themselves are responsible for promoting health and healthy behaviours among the general population, is worrisome. As health care providers have immediate access to the medical care, the diagnosis and management of MetS and its components should be even more expeditious among them.[40]

North American studies showed highest (27.93%) average prevalence of MetS, followed by South American studies (27.65%). It means that in Americas, more than 1/4th of the working population is suffering from MetS. There were 11 studies from North America but only two studies from South America. Therefore, the average prevalence of MetS that we found may be representative of the prevalence of MetS in North America. However, the average prevalence of MetS that we found may not be true representative of the prevalence of MetS in other South American countries as the only two South American studies used were from Brazil.[38,49] Average prevalence of MetS in the Asian studies was calculated to be 21.27%. It means more than 1/5th of the adult workers in Asia are having MetS; however, this prevalence varies on the basis of age, gender and country. The least average prevalence of MetS (10.47%) was found in European studies. However, all the four European studies[45–48] were from only one country- Spain. Therefore, this average prevalence of MetS may not be true representative of the prevalence of MetS in other European countries. We also noted that no study has assessed the prevalence of MetS among workforce in the South Pacific Region; hence, there is need to evaluate the burden of MetS and its components among workforce in this region of the world where risk of NCDs is very high.[59]

In this systematic review, MetS was defined by only one (ATP III) criteria to enhance comparability among studies. The other criteria e.g. IDF criteria and WHO criteria were not used as the cut-off values of the parameters (variables) used to diagnose MetS are somewhat different from ATP III.[37] However, it is important to mention here that the average prevalence of MetS by using the other criteria **(**IDF, WHO**)** might have been even higher than we found by using ATP III criteria as has been evidenced by some studies.[27,43,60]

Prevalence of the components of metabolic syndrome

Central obesity

In this review, the mean prevalence of central obesity was calculated to be 29.2% which is lower than its mean prevalence (45.8%) in another systematic review on MetS in Latin America.[61] However, our study is not limited to any one region; hence, it is giving a global value of the prevalence of central obesity among workforce. Furthermore, we found that central obesity was reported to be the 1st, 2nd and 3rd most common component of MetS in three, five, and eleven original articles, respectively. As central obesity is associated with increased likelihood of MetS[45], weight loss along with dietary and other lifestyle modifications should be considered as important measures for the prevention and management of MetS.

Elevated blood pressure

We found that hypertension was the second most prevalent (33.7%) component of MetS. Hypertension was reported to be the 1st, 2nd and 3rd most common component of MetS in eight, seven, and four original articles, respectively (Table-3). Hypertension is a well-established major modifiable risk factor for CVDs. The significance of hypertension as an important component of MetS can be understood by the findings of a study[48] in which 77.9% of all the cases of MetS were detected by using only two non-invasive parameters (waist/hip ratio and hypertension).

Dyslipidemia

Low HDL cholesterol and hypertriglyceridemia are two of the biochemical components of MetS. Low HDL was the first most common component of MetS with mean prevalence of 39.1% which is lower than the mean prevalence (62.9%) in another systematic review.[61] Low HDL was reported to be the 1st, 2nd and 3rd most common component of MetS in nine, four, and three original articles, respectively. Hypertriglyceridemia was the third most prevalent (30.8%) component of MetS. The mean prevalence of hypertriglyceridemia in our study is lower than the prevalence (46.7%) in another regional systematic review on the prevalence of MetS.[61] Hypertriglyceridemia was reported to be the 1st, 2nd and 3rd most common component of MetS in five, seven, and six original articles, respectively (Table-3).

Fasting hyperglycemia

Fasting hyperglycemia was reported to be the 2nd and 3rd most common component of MetS in three, and one original articles, respectively (Table-3). Central obesity measured as increased waist circumference is an important component of MetS which often contributes to insulin resistance and hyperglycemia.[62] So, decrease in weight may lead to enhanced glucose tolerance.

Factors associated with metabolic syndrome

Irrespective of the criteria used, aging was associated with increased prevalence of MetS in both genders as reported by 25 studies. One of its implications may be that there should be more robust adoption of healthy lifestyle for the prevention MetS and its components among older workers.

Sedentary lifestyle was also reported by nine studies to increase the prevalence of MetS. Indoor jobs which require minimal physical activity increase the risk of MetS. These days, we spend most of our awake time in the offices which decreases the amount of physical activity which we can do during 24 hours. Most of the office workers e.g. doctors, university employees, teachers, bankers, administrators etc. are at increased risk of MetS due to their sedentary lifestyle. WHO emphasizes that health promotion and awareness of wellbeing at the worksite is very important to reduce the risk of MetS and other NCDs. It may be useful to create opportunities for employees to do exercise at the worksite. Yoo *et al*[63] have suggested that increasing physical activity decreases the risk of MetS; furthermore, increased physical activity may also buffer the influence of perceived stress on the development of MetS.

Four studies[27,34,52,58] have reported that smoking is also associated with increased likelihood of having MetS and its individual components in both genders. In one of the studies, it was observed that current smoking is associated with increased prevalence of MetS in women but not in men.[64] One of the implications of these findings may be that there might be beneficial effects of workplace-based interventions for smoking cessation on reducing the prevalence of MetS and its components among working population.[34]

Alcohol abuse was also reported by two studies[27,64] to be associated with increase occurrence of MetS. Hence, employees may be benefitted by decreasing or avoiding the alcohol intake. Another study[65] reported that having family history of CVDs and diabetes mellitus also increases the risk of having MetS. So, the persons having family history of CVDs and/or diabetes mellitus should be warned to adopt a

healthy lifestyle for preventing or delaying the development of MetS.

One of the studies[58] reported that there was higher prevalence of MetS among those with low intake of fruits. Evidence suggests that higher intake of fruits and vegetables may decrease the development of MetS and its components.[66] This protection provided by fruits and vegetables against cardio-metabolic risk factors may be due to the presence of dietary fibres, essential antioxidants, vitamins and minerals in fruits and vegetables.

Another study[67] showed that shift-workers were more likely to have MetS than day-workers. Furthermore, increased circulating levels of resistin and total white blood cell counts were observed among shift-workers. This suggests that cardiometabolic changes among shift-workers may have been induced by chronic inflammation.[67] As shift-work is likely to decrease sleep quality among shift-workers, this increased prevalence of MetS may have been caused by poor sleep as suggested by other studies.[68]

MetS affects the performance of working population and increases financial burden on individuals and their companies. Two studies[52,69] reported that MetS was associated with increased likelihood of presenteeism. Another study suggested that there was an increased risk of absenteeism among those with MetS.[52] Presenteeism is being on job but not fully functioning due to some medical or other condition. Absenteeism is the habitual pattern of being absent from job without any good reason. Both presenteeism and absenteeism decrease the productivity of employees and their companies.

Schultz *et al*[69] has mentioned that increase in the number of components of MetS increases health-care cost in the employees. Workers with MetS who do sufficient exercise have lower health-care cost per annum compared with non-sufficient exercisers. Workers with MetS, in general, are more likely to have poor physical and mental health as compared to those without MetS.[52,70,71]

Strengths and limitations

There are several strengths of this systematic review. To the best of our knowledge, this is the first systematic review in the world on the prevalence of MetS and its components among apparently healthy working population. We have reviewed studies published on both genders during last 13 years. Most of the studies (n=29) were published recently between 2011 and 2017 with a high total number (n=435,013) of participants. We have used only one (ATP III) criteria for the diagnosis of MetS with the advantage of enhancing comparability among studies.

There are some potential limitations for this systematic review as well. First, studies published only in English language were used; however, studies published in non-English language were less than 5% which were less likely to affect the results. Secondly, some studies have used original ATP-III criteria (2001) and some other studies have used revised ATP-III criteria (2005) for the diagnosis of MetS. Moreover, a few studies[45,69,72] used BMI, instead of waist circumference, to define central obesity. These slight variations of ATP-III criteria may have some potential effect on the comparability of studies. Thirdly, studies from different countries have included employees with different mean ages. Moreover, most of the studies included both genders; however, some studies included only male or female participants. These variations in the age and gender of the participants may also have affected the comparability of the prevalence of MetS among studies. Lastly, meta-analysis was not done.

Recommendations

As the adult population is predominantly the working population in most of the countries, it is very important that workforce should be living a healthy life so that they may contribute to the development of their institutions and nations. As evidence has suggested very high prevalence of MetS among workforce, there is need to start onsite programs for health promotion and prevention of MetS. Such programs may include MetS awareness[56], regular physical exercise, and lifestyle modifications e.g. cessation of smoking and alcohol abuse, healthy eating habits.[27,50] Individuals at high risk of future CVDs should be identified/screened and managed properly. Some researchers[73] have given the idea of pre-metabolic syndrome which is presence of any two components of MetS however the person does not meet the full criteria for diagnosis of MetS. Diagnosing and managing such cases who just have pre-metabolic syndrome may be a better approach to prevent or delay the progression to full blown MetS. Such primordial ad primary prevention programs may reduce the productivity losses due to MetS.[44,52,60,69] Some studies[23,40,65] suggest that there should be routine screening for MetS especially among those with family history of CVD.

Moreover, gender and occupation specific interventions are required to prevent the risk of diabetes mellitus and CVDs. Capizzi *et al*[71] have studied that health promotion programs at the worksite can lead to an improvement in the cardio-metabolic and mental health of the employees. It is also recommended that studies are performed in Pakistan to determine the prevalence of MetS and its components among employees of different professions e.g. bankers, teachers, professional drivers, and hospital employees etc.

CONCLUSIONS

Irrespective of the criteria used to diagnose MetS, working population has high prevalence of MetS and its various components. Although, there is high prevalence of MetS in both the genders, males usually have higher prevalence than females. MetS decreases the quality of life and productivity; persons with MetS are more likely to report poor mental health. MetS also increases the health care cost; thus, it may increase financial burden on employees and their employers. Preventive measures e.g. eating healthy diet, regular physical activities and other lifestyle modifications may be very helpful for the employees to decreases their risk of having MetS and its various components. It may be wise for the employers to provide worksite health promotion programs (e.g. onsite fitness centre) and routine medical check-ups for their employees. Such activities may reduce cardio-metabolic risk, and can increase the physical and mental fitness among employees leading to enhanced productivity for employees and their companies.

Acknowledgements: We are thankful to Dr. Ayodele Akinremi, Adjunct Professor from the School of Health Sciences Fiji National University, for his assistance during the initial stages of this systematic review.

Conflicts of interest: Authors have no conflicts of interest to declare.

AUTHORS' CONTRIBUTION

MAR: Contributed to conceptualization of the idea, literature search, data extraction, data analysis, abstract, introduction, methods, results, discussion and references management. MM: Contributed to literature search, introduction and methods.

REFERENCES

1. Huang PL. A comprehensive definition for metabolic syndrome. Dis Model Mech 2009;2(5–6):231–7.
2. IDF Worldwide Definition of the Metabolic Syndrome | International Diabetes Federation . [cited 2016 Apr 27]. Available from: http://www.idf.org/metabolic-syndrome
3. Mottillo S, Filion KB, Genest J, Joseph L, Pilote L, Poirier P, *et al*. The metabolic syndrome and cardiovascular risk: A systematic review and meta-analysis. J Am Coll Cardiol 2010;56(14):1113–32.
4. Gami AS, Witt BJ, Howard DE, Erwin PJ, Gami LA, Somers VK, *et al*. Metabolic syndrome and risk of incident cardiovascular events and death: a systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol 2007;49(4):403–14.
5. Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J, *et al*. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002;288(21):2709–16.
6. Mamcarz A, Podolec P, Kopeć G, Czarnecka D, Rynkiewicz A, Stańczyk J, *et al*. Polish forum for prevention guidelines on metabolic syndrome. Kardiol Pol 2010;68(1):121–4.
7. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: Prevalence, numerical estimates, and projections. Diabetes Care 1998;21(9):1414–31.
8. Ford ES. Risks for all-cause mortality, cardiovascular disease, and diabetes associated with the metabolic syndrome: A summary of the evidence. Diabetes Care 2005;28(7):1769–78.
9. Grundy SM. Metabolic syndrome pandemic. Arterioscler Thromb Vasc Biol 2008;28(4):629–36.
10. Wannamethee SG, Shaper AG, Lennon L, Morris RW. Metabolic syndrome vs Framingham Risk Score for prediction of coronary heart disease, stroke, and type 2 diabetes mellitus. Arch Intern Med 2005;165(22):2644–50.
11. Marks S. Culturally Sensitive Education Can Decrease Hispanic Workers' Risk of Metabolic Syndrome. Work Heal Saf 2016;64(11):543–9.
12. Lim S, Shin H, Song JH, Kwak SH, Kang SM, Yoon JW, *et al*. Increasing prevalence of metabolic syndrome in Korea: The Korean National Health and Nutrition Examination Survey for 1998-2007. Diabetes Care 2011;34(6):1323–8.
13. Rojas R, Aguilar-Salinas CA, Jiménez-Corona A, Shamah-Levy T, Rauda J, Ávila-Burgos L, *et al*. Metabolic syndrome in Mexican adults: results from the National Health and Nutrition Survey 2006. Salud Publica Mex 2010;52(Suppl 1):S11–8.
14. Neuhauser H, Ellert U. Prävalenz des metabolischen Syndroms in Deutschland: eine Sensitivitätsanalyse. In: Meeting abstract science ggmed 2005. [Internet]. [cited 2016 Mar 15]. Available from: http://www.egms.de/en/meetings/gmds2005/05gmds183. shtml
15. Wild SH, Byrne CD. The global burden of the metabolic syndrome and its consequences for diabetes and cardiovascular disease. In: Byrne CD, Wild SH, editors. The metabolic syndrome. Chichester: John Wiley & Sons, 2005; p.1–42.
16. Kanauchi M, Kanauchi K. Prevalence and distribution of ideal cardiovascular health metrics and association with metabolic syndrome in Japanese male workers. Int J Cardiol 2016;221:428–9.
17. Leischik R, Dworrak B, Strauß M, Przybylek B, Dworrak T, Schöne D, *et al*. Plasticity of Health. Ger J Med 2016;1:1–17.
18. Nakao YM, Miyawaki T, Yasuno S, Nakao K, Tanaka S, Ida M, *et al*. Intra-abdominal fat area is a predictor for new onset of individual components of metabolic syndrome: MEtabolic syndRome and abdominaL ObesiTy (MERLOT study). Proc Jpn Acad Ser B Phys Biol Sci 2012;88(8):454–61.
19. Kuzuya M, Ando F, Iguchi A, Shimokata H. Age-specific change of prevalence of metabolic syndrome: Longitudinal observation of large Japanese cohort. Atherosclerosis 2007;191(2):305–12.
20. Aguilar M, Bhuket T, Torres S, Liu B, Wong RJ. Prevalence of the metabolic syndrome in the United States, 2003-2012. JAMA 2015;313(19):1973–4.
21. Al-Daghri NM, Alkharfy KM, Al-Attas OS, Khan N, Alfawaz HA, Alghanim SA, *et al*. Gender-dependent associations between socioeconomic status and metabolic syndrome: A cross-sectional study in the adult Saudi population. BMC Cardiovasc Disord 2014;14:51.
22. Shin SY, Lee CG, Song HS, Kim SH, Lee HS, Jung MS, *et al*. Cardiovascular disease risk of bus drivers in a city of Korea. Ann Occup Environ Med 2013;25(1):34.
23. Cheserek MJ, Wu GR, Shen LY, Shi YH, Le GW. Disparities in the Prevalence of Metabolic Syndrome (MS) and its Components Among University Employees by Age, Gender and Occupation. J Clin Diagn Res 2014;8(2):65–9.
24. Pokharel DR, Khadka D, Sigdel M, Yadav NK, Acharya S, Kafle RC *et al*. Prevalence of metabolic syndrome in Nepalese type 2 diabetic patients according to WHO, NCEP ATP III, IDF and Harmonized criteria. J Diabetes Metab Disord 2013;13(1):104.
25. Tabatabaie AH, Shafiekhani M, Nasihatkon AA, Rastani IH,

Tabatabaie M, Borzoo AR, *et al*. Prevalence of metabolic syndrome in adult population in Shiraz, southern Iran. Diabetes Metab Syndr 2015;9(3):153–6.
26. Adeoye AM, Adewoye IA, Dairo DM, Adebiyi A, Lackland DT, Ogedegbe G, *et al*. Excess Metabolic Syndrome Risks Among Women Health Workers Compared With Men. J Clin Hypertens (Greenwich) 2015;17(11):880–4.
27. Konradi AAO, Rotar OP, Korostovtseva LS, Ivanenko VV, Solntcev VN, Anokhin SB, *et al*. Prevalence of metabolic syndrome components in a population of bank employees from St. Petersburg, Russia. Metab Syndr Relat Disord 2011;9(5):337–43.
28. Bernardo AFB, Fernandes RA, da Silva AKF, Valenti VE, Pastre CM, Vanderlei LCM. Influence of risk behavior aggregation in different categories of physical activity on the occurrence of cardiovascular risk factors. Int Arch Med 2013;6(1):26.
29. Choi BK, Schnall PL, Yang H, Dobson M, Landsbergis P, Israel L, *et al*. Sedentary work, low physical job demand, and obesity in US workers. Am J Ind Med 2010;53(11):1088–101.
30. Sisson SB, Camhi SM, Church TS, Martin CK, Tudor-Locke C, Bouchard C, *et al*. Leisure Time Sedentary Behavior, Occupational/Domestic Physical Activity, and Metabolic Syndrome in U.S. Men and Women. Metab Syndr Relat Disord 2009;7(6):529–36.
31. Lin YP, McCullagh MC, Kao TS, Larson JL. An Integrative Review: Work Environment Factors Associated With Physical Activity Among White-Collar Workers. West J Nurs Res 2014;36(2):262–83.
32. Steptoe A, Kivimäki M. Stress and Cardiovascular Disease: An Update on Current Knowledge. Annz Rev Public Health 2013;34(1):337–54.
33. Burton J, WHO. WHO healthy workplace framework and model: Background and supporting literature and practices. 2010. [Internet]. [cited 2016 Apr]. Available from: http://www. who.int/ occupational_ health/healthy_workplace_framework.pdf
34. Ryu H, Chin DL. Factors associated with metabolic syndrome among Korean office workers. Arch Environ Occup Health 2017;72(5):249–57.
35. Henderson LK, Craig JC, Willis NS, Tovey D, Webster AC. How to write a Cochrane systematic review. Nephrology (Carlton) 2010;15(6):617–24.
36. AMSTAR - Assessing the Methodological Quality of Systematic Reviews [Internet]. [cited 2018 Jan 22]. Available from: https://amstar.ca/
37. Parikh RM, Mohan V. Changing definitions of metabolic syndrome. Indian J Endocrinol Metab 2012;16(1):7–12.
38. Salaroli LB, Saliba RAD, Zandonade E, Molina Mdel C, Bissoli NS. Prevalence of metabolic syndrome and related factors in bank employees according to different defining criteria, Vitória/ES, Brazil. Clinics (São Paulo, Brazil) 2013;68(1):69–74.
39. Chackrewarthy S, Gunasekera D, Pathmeswaren A, Wijekoon CN, Ranawaka UK, Kato N, *et al*. A Comparison between Revised NCEP ATP III and IDF Definitions in Diagnosing Metabolic Syndrome in an Urban Sri Lankan Population: The Ragama Health Study. ISRN Endocrinol 2013;2013:320176.
40. Garrido RA, Semeraro MB, Temesgen SM, Simi MR. Metabolic syndrome and obesity among workers at Kanye Seventh-Day Adventist Hospital, Botswana. S Afr Med J 2009;99(5):331–4.
41. Magalhães P, Capingana DP, Mill JG. Prevalence of the metabolic syndrome and determination of optimal cut-off values of waist circumference in university employees from Angola. Cardiovasc J Afr 2014;25(1):27–33.
42. Owiredu W, Amidu N, Gockah-Adapoe E, Ephraim R. The prevalence of metabolic syndrome among active sportsmen/sportswomen and sedentary workers in the Kumasi metropolis. J Sci Technol 2011;31(1):23–6.
43. Gombet T, Longo-Mbenza B, Ellenga-Mbolla B, Ikama MS, Mokondjimobe E, Kimbally-Kaky G, *et al*. Aging, female sex, migration, elevated HDL-C, and inflammation are associated with prevalence of metabolic syndrome among African bank employees. Int J Gen Med 2012;5:495–503.
44. Tran A, Gelaye B, Girma B, Lemma S, Berhane Y, Bekele T, *et al*. Prevalence of Metabolic Syndrome among Working Adults in Ethiopia. Int J Hypertens 2011;2011:193719.
45. Alegría E, Cordero A, Laclaustra M, Grima A, Leon M, Casasnovas JA, *et al*. Prevalence of metabolic syndrome in the Spanish working population: MESYAS registry. Rev Esp Cardiol 2005;58(7)797–806.
46. Sánchez-Chaparro MA, Calvo-Bonacho E, González-Quintela A, Fernández-Labandera C, Cabrera M, Sáinz JC, *et al*. Occupation-related differences in the prevalence of metabolic syndrome. Diabetes Care 2008;31(9):1884–5.
47. Tauler P, Bennasar-Veny M, Morales-Asencio JM, Lopez-Gonzalez AA, Vicente-Herrero T, De Pedro-Gomez J, *et al*. Prevalence of premorbid metabolic syndrome in Spanish adult workers using IDF and ATP III diagnostic criteria: relationship with cardiovascular risk factors. PLoS One 2014;9(2):e89281.
48. Romero-Saldana M, Fuentes-Jimenez FJ, Vaquero-Abellan M, Alvarez-Fernandez C, Molina-Recio G, Lopez-Miranda J. New non-invasive method for early detection of metabolic syndrome in the working population. Eur J Cardiovasc Nurs 2016;15(7):549–58.
49. Ribeiro RP, Marziale MH, Martins JT, Ribeiro PH, Robazzi ML, Dalmas JC. Prevalence of Metabolic Syndrome among nursing personnel and its association with occupational stress, anxiety and depression. Rev Lat Am Enfermagem 2015;23(3):435–40.
50. Wang X, Yang F, Bots ML, Guo WY, Zhao B, Hoes AW, *et al*. Prevalence of the Metabolic Syndrome Among Employees in Northeast China. Chin Med J (Engl) 2015;128(15):1989–93.
51. Patrakitkomjorn S, Khongsri S, Chawarit S, Promdee L, Teerajetgul Y. Metabolic syndrome in staff of the Maharaj Nakhon Si Thammaraj Hospital: high prevalence of 1 to 2 metabolic components in population. J Med Technol Phys Ther 2011;23(1):25–33.
52. Burton WN, Chen CY, Li X, Schultz AB, Abrahamsson H. The Association of Self-Reported Employee Physical Activity With Metabolic Syndrome, Health Care Costs, Absenteeism, and Presenteeism. J Occup Environ Med 2014;56(9):919–26.
53. Flores YN, Auslander A, Crespi CM, Rodriguez M, Zhang ZF, Durazo F, *et al*. Longitudinal association of obesity, metabolic syndrome and diabetes with risk of elevated aminotransferase levels in a cohort of Mexican health workers. J Dig Dis 2016;17(5):304–12.
54. Shafei MN, Awang AF, Mohamad WM. Prevalence of metabolic syndrome and its associated factors among female nurses in a teaching hospital in North-Eastern state of Malaysia. J Public Health Epidemiol 2011;3(9):394–400.
55. Lemke MK, Apostolopoulos Y, Hege A, Wideman L, Sönmez S. Work organization, sleep and metabolic syndrome among long-haul truck drivers. Occup Med (Lond) 2017;67(4):274–81.
56. Davila EP, Florez H, Fleming LE, Lee D J, Goodman E, LeBlanc WG, *et al*. Prevalence of the metabolic syndrome among US workers. Diabetes Care 2010;33(11): 2390–5.
57. Godefroi R, Klementowicz P, Pepler C, Lewis B, Mcdonough K, Goldberg RJ. Metabolic Syndrome in a Screened Worksite Sample : Prevalence and and Predictors. Cardiology 2005;103(3):131–6.
58. Alavi S, Makarem J, Mehrdad R, Abbasi M. Metabolic Syndrome: A Common Problem among Office Workers. Int J Occup Environ Med 2015;6(1):34–40.

59. Low WY, Lee YK, Samy AL. Non-communicable diseases in the Asia-Pacific region: Prevalence, risk factors and community-based prevention. Int J Occup Med Environ Health 2015;28(1):20–6.
60. Prabhakaran D, Shah P, Chaturvedi V, Ramakrishnan L, Manhapra A, Reddy KS. Cardiovascular risk factor prevalence among men in a large industry of northern India. Natl Med J India 2005;18(2):59–65.
61. Márquez-Sandoval F, Macedo-Ojeda G, Viramontes-Hörner D, Fernández Ballart JD, Salas Salvadó J, Vizmanos B. The prevalence of metabolic syndrome in Latin America: a systematic review. Public Health Nutr 2011;14(10):1702–13.
62. Kahn SE, Hull RL, Utzschneider KM. Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature 2006;444(7121):840–6.
63. Lim Yoo H, Joey Eisenmann MC, Franke WD. Independent and Combined Influence of Physical Activity and Perceived Stress on the Metabolic Syndrome in Male Law Enforcement Officers. J Occup Environ Med 2009;51(1):46–53.
64. Kang DR, Ha Y, Hwang WJ. Prevalence and associated risk factors of the metabolic syndrome in the Korean workforce. Ind Health 2013;51(3):256–65.
65. Choi SK, Jo JA, Hwang SY. Prevalence of Metabolic Syndrome and Its Predicting Factors among Small-sized Company Workers. Korean J Adult Nurs 2014;26(2):244–52.
66. Liu S, Manson JE, Lee IM, Cole SR, Hennekens CH, Willett WC, *et al*. Fruit and vegetable intake and risk of cardiovascular disease: the Women's Health Study. Am J Clin Nutr 2000;72(4):922–8.
67. Lu YC, Wang CP, Yu TH, Tsai IT, Hung WC, Lu IC, *et al*. Shift work is associated with metabolic syndrome in male steel workers-the role of resistin and WBC count-related metabolic derangements. Diabetol Metab Syndr 2017;9:83.
68. Lam JC, Ip MS. Sleep & the metabolic syndrome. Indian J Med Res 2010;131:206–16.
69. Schultz AB, Edington DW. Metabolic syndrome in a workplace: prevalence, co-morbidities, and economic impact. Metab Syndr Relat Disord 2009;7(5):459–68.
70. Burton WN, Chen CY, Schultz AB, Edington DW. The Prevalence of Metabolic Syndrome in an Employed Population and the Impact on Health and Productivity. J Occup Environ Med 2008;50(10):1139–48.
71. Capizzi JA, Allen GJ, Murphy D, Pescatello LS. The interactive effects of metabolic syndrome, blood pressure, and mental health in worksite employees. Phys Sportsmed 2010;38(1):45–53.
72. Shiwaku K, Nogi A, Kitajima K, Anuurad E, Enkhmaa B, Yamasaki M, *et al*. Prevalence of the metabolic syndrome using the modified ATP III definitions for workers in Japan, Korea and Mongolia. J Occup Health 2005;47(2):126–35.
73. Vidigal F de C, Ribeiro AQ, Babio N, Salas-Salvadó J, Bressan J. Prevalence of metabolic syndrome and pre-metabolic syndrome in health professionals: LATINMETS Brazil study. Diabetol Metab Syndr 2015;7:6.
74. Myong JP, Kim HR, Jung-Choi K, Baker D, Choi B. Disparities of Metabolic Syndrome Prevalence by Age, Gender and Occupation among Korean Adult Workers. Ind Health 2012;50(2):115–22.
75. Kawada T, Otsuka T, Inagaki H, Wakayama Y, Li Q, Li YJ, *et al*. Increase in the prevalence of metabolic syndrome among workers according to age. Aging Male 2010;13(3):184–7.
76. Ojima M, Amano A, Kurata S. Relationship between decayed teeth and metabolic syndrome: data from 4716 middle-aged male Japanese employees. J Epidemiol 2015;25(3):204–11.
77. Chee HP, Hazizi AS, Barakatun Nisak MY, Mohd Nasir MT. Metabolic Risk Factors among Government Employees in Putrajaya , Malaysia. Sains Malays 2014;43(8):1165–74.
78. Srilakshmi P, Swetha D, Bhaskar M, Rambabu K, Madhulatha M. Prevalence of metabolic syndrome in granite workers. J Evid Based Med Hlthc 2015;2(42):7341–5.
79. Ebrahimi MH, Delvarianzadeh M, Saadat S. Prevalence of metabolic syndrome among Iranian occupational drivers. Diabetes Metab Syndr 2016;10(1 Suppl 1):S46–51.
80. Birnbaum HG, Mattson ME, Kashima S, Williamson TE. Prevalence rates and costs of metabolic syndrome and associated risk factors using employees' integrated laboratory data and health care claims. J Occup Environ Med 2011;53(1):27–33.
81. Goetzel RZ, Kent K, Henke RM, Pack C, D'Arco M, Thomas J, *et al*. Prevalence of Metabolic Syndrome in an Employed Population as Determined by Analysis of Three Data Sources. J Occup Environ Med 2017;59(2):161–8.

Submitted: 16 March, 2018	*Revised: 1 May, 2018*	*Accepted: 6 May, 2018*

Address for Correspondence:

Mudassar Ali Roomi, Associate Professor in Medical Physiology. Department of Physiology, Amna Inayat Medical College, Sheikhupura-Pakistan

Email: mudassarroomi@hotmail.com