Asian Biomedicine Vol. 11 No. 3 June 2017; 227 - 234 DOI: 10.5372/1905-7415.1103.553

Original article

Higher prevalence of metabolic syndrome among male employees of a gas refinery than in their counterparts in nonindustrial environments

Mohammad Reza Baghshini[1*], Irandokht Nikbakht-Jam[1*], Hossein Mohaddes-Ardabili[1], Alireza Pasdar[2#], Amir Avan[2], Maryam Tayefi[1], Amirhossein Sahebkar[3], Mohammad Sobhan Sheikh-Andalibi[4], Gordon A. Ferns[5], Majid Ghayour-Mobarhan[1]

[1]*Metabolic Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad 91388, Iran*

[2]*Department of Modern Sciences and Technologies, School of Medicine, Mashhad University of Medical Sciences Mashhad 91388, Iran*

[3]*Biotechnology Research Center, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad 91388, Iran*

[4]*Student Research Committee, Cardiovascular Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad 91388, Iran*

[5]*Division of Medical Education, Brighton and Sussex Medical School, University of Sussex, Brighton BN1 9PX, United Kingdom*

Background: Occupation and working conditions may affect the risk of developing metabolic syndrome (MetS), an important risk factor for diabetes and cardiovascular disease (CVD).

Objective: To investigate the prevalence of MetS and its risk factors in employees in an industrial workplace and compare them with those in employees from a nonindustrial setting.

Methods: Male employees (n = 757) from a gas-refinery and 2700 adult men from the general population of whom 750 were nonindustrial employees (Khorasan province, Iran), were evaluated for CVD risk factors, including those used to define MetS. Individuals were matched for age and educational attainment, and 670 industrial and 681 nonindustrial employees were included in the final analysis. International Diabetes Federation (IDF) and Adult Treatment Panel (ATP) III criteria were used for diagnosis of MetS. We compared MetS and its risk factors between the two groups.

Results: There were more gas refinery employees with a body mass index > 30 kg/m^2, abdominal obesity, and a high fasting blood glucose level than nonindustrial employees ($P < 0.01$). A diagnosis of MetS was significantly more likely in refinery workers than in nonindustrial employees (OR 1.38, 95% CI 1.10 to 1,737; $P = 0.005$). Scores of IDF and ATP III criteria in the refinery employees were significantly higher than for the nonindustrial employees ($P < 0.01$). The prevalence of hypertriglyceridemia in the refinery employees tended to be higher than in nonindustrial employees, but the difference was not quite significant ($P = 0.052$). Blood pressure in nonindustrial employees was significantly higher than in refinery employees ($P < 0.001$).

Conclusions: The prevalence of MetS among male gas refinery employees was higher than for male nonindustrial employees.

Keywords: Cardiovascular disease, industrial employees, metabolic syndrome, obesity

Cardiovascular disease (CVD) is a major cause of mortality and morbidity worldwide. Metabolic syndrome (MetS), an important risk factor for CVD, is associated with a 2-fold increase in consequences of CVD and 1.5-fold increase in the total mortality [1, 2]. The term MetS refers to a clustering of CVD risk factors including abdominal obesity, high blood pressure, high blood glucose, high levels of blood triglycerides, and low levels of high density lipoprotein (HDL) cholesterol [3].

Work place and working conditions can affect an employee's lifestyle including dietary intake, physical activity, sleep pattern, and their hobbies [4]. An inappropriate lifestyle is one of the most important

Correspondence to: Majid Ghayour-Mobarhan, Biochemistry and Nutrition Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad 91388, Iran. E-mail: ghayourm@mums.ac.ir

*These authors contributed equally. #Present address: Division of Applied Medicine, Medical School, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD, United Kingdom.

risk factors for MetS and CVD [5, 6]. Air pollution is another risk factor that can increase the risk of metabolic disorders. Recent epidemiological and experimental studies have reported an association between increased level of air pollution with insulin resistance, weight gain, and obesity [7-9]. Air pollution is higher in some industrial work environments, including those of the gas and petrochemical industries. This may also increase the risk of MetS and CVD among employees of those workplaces [10-12].

Few studies have assessed the health of employees in industrial workplaces. However, the working conditions of industrial workplace can have a significant impact on the lifestyle and health of employees [4, 13]. In the present study, we assessed the prevalence of MetS and its components in industrial workplace employees from a gas refinery in Sarakhs, compared with nonindustrial employees, living in Mashhad, Khorasan province, Iran.

Methods

Male employees of the Shahid Hasheminejad Gas Company of Khangiran gas refinery in Sarakhs (n = 757) and 2700 male individuals of the general population in Mashhad (Khorasan province, Iran), of whom 750 were selected as nonindustrial employees, were randomly selected from our male population and investigated for a number of CVD risk factors, including those used to define MetS. Each man in the general populations was assigned a number, and with a simple draw from 1 to 10, the number 3 was selected as the basis for starting the sampling, which proceeded at intervals of 3 (i.e. 3, 6, 9, 12 and so on) until all participants were assigned. The nonindustrial employees had administrative or service jobs in public nonindustrial workplaces in Mashhad city. The participants were matched for age (with an average age of 45 years) and educational attainment, and 670 industrial employees and 681 nonindustrial employees were included in the final data analysis. The flowchart of participants is shown in **Figure 1**. This study was conducted between May and December 2010.

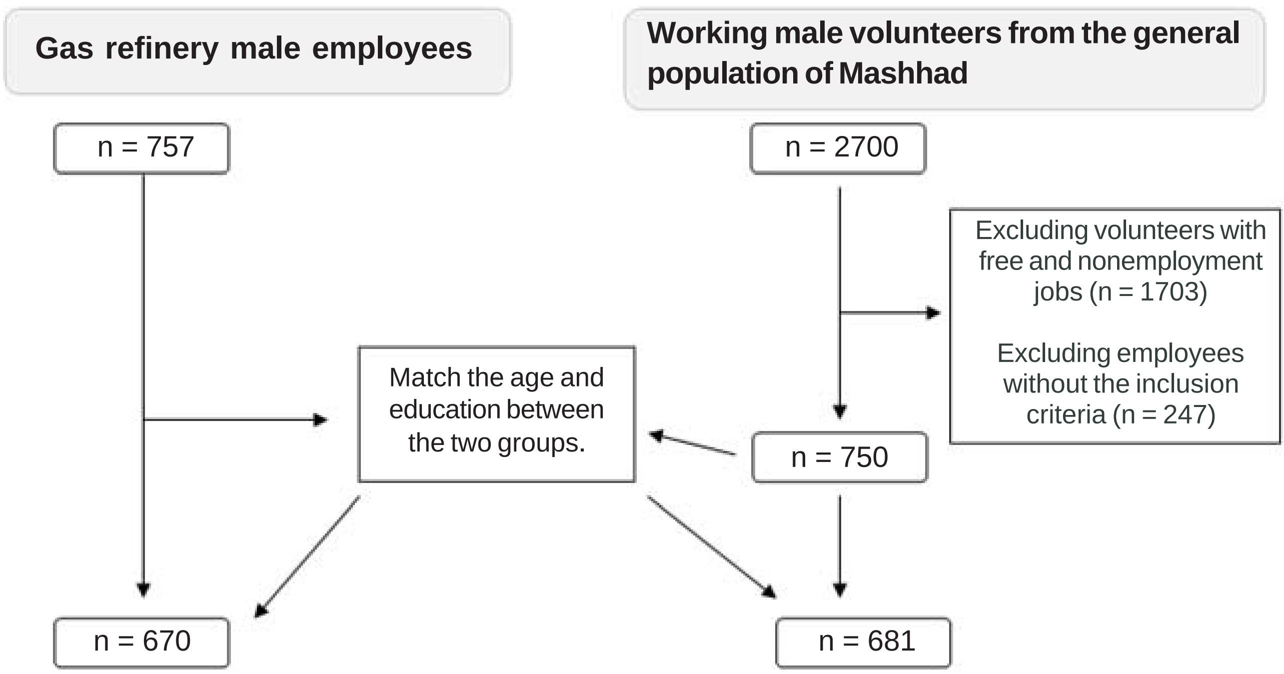

Figure 1. Flowchart of participants

Ethical considerations were in accordance with ethical standards of ethics committee of Mashhad University of Medical Sciences (Record No. IR. MUMS.REC.1389.83; Ref. 203356) following the contemporary revision of the Declaration of Helsinki. All individuals knowingly and voluntarily participated in this study and signed a written consent form.

Individuals who were employed at the time of study (having a full-time job; at least 37.5 hours per week), within the age range of 25–70 years old and were apparently healthy, without a history of chronic and systemic disease, were selected for this study. The results of pre-employment health screening of the employees had supported their health status at the recruitment time. All participants who were unwilling to continue to take part in the study for any reason, those who were self-employed, and those who had chronic and systemic diseases, or did not cooperate for anthropometric and biochemical assessment, were excluded. International Diabetes Federation (IDF) criteria and Adult Treatment Panel III (ATP III) criteria were used to assess the risk factors for MetS (**Figures 2** and **3**).

Participant characteristics and demographic information

Anthropometric assessments including of height, weight, waist and hip circumference were made. Demographic information such as age, education, and clinical history was recorded using a questionnaire. Standing height was measured without shoes (cm) using a wall-mounted stadiometer. Maximum hip circumference and minimum waist circumference (between below the chest and above the navel) were measured as hip and waist circumferences. Blood pressure in all participants was measured with the participant in a sitting position using the right arm of the participant who was rested for at least 15 min before blood pressure measurements.

Blood sampling and laboratory tests

Blood samples were taken in the morning after 12 h of fasting. After centrifugation, the isolated sera were stored at –80°C until the relevant tests were conducted. Fasting blood-glucose (FBG) levels, serum triglyceride (TG), and high-density lipoprotein (HDL) were measured using routine laboratory protocols with appropriate commercial kits.

Statistical analyses

All statistical analyses were performed using SPSS for Windows (version 16, SPSS Inc). Comparisons were performed using an independent sample *t* test, Mann–Whitney *U* test, χ^2 test, or binary logistic regression were conducted depending on the distribution and type of the data. $P < 0.05$ was considered as significant.

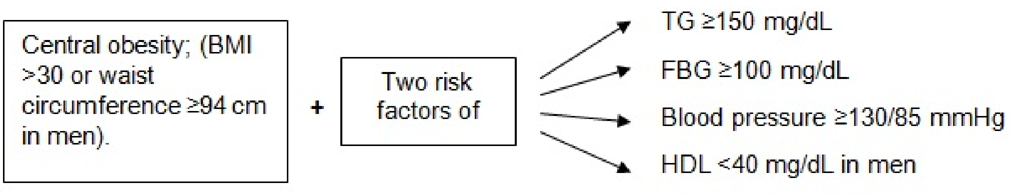

Figure 2. The diagnosis of metabolic syndrome by International Diabetes Federation criteria. BMI, body mass index; TG, triglycerides; FBG, fasting blood-glucose level; HDL, high-density lipoprotein.

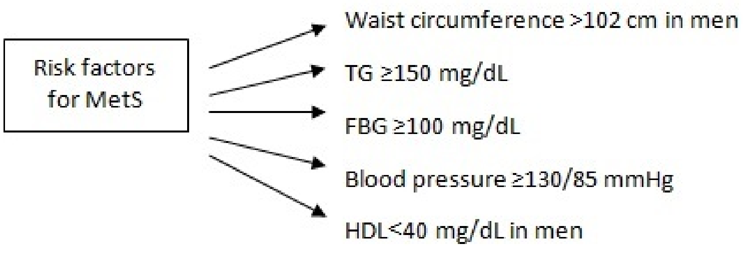

Figure 3. The diagnosis of metabolic syndrome by Adult Treatment Panel III criteria. BMI, body mass index; TG, triglycerides; FBG, fasting blood-glucose level; HDL, high-density lipoprotein.

Results

We included 670 male employees of a gas refinery in Sarakhs, Iran, and 681 nonindustrial male employees from Mashhad who participated in the present study (**Figure 1**). The age range and education level of the 2 groups were similar (**Table 1**, *P* > 0.05). Anthropometric indices of obesity including body mass index, waist circumference, and waist-to-hip ratio of the refinery employees were significantly higher than those of their nonindustrial employee counterparts (*P* < 0.01, **Table 1**). FBG in the refinery employees was significantly higher than in the nonindustrial employees (**Table 1**, *P* < 0.001). The serum TG level of the refinery employees tended to be higher than that of nonindustrial employees, but the difference was not quite significant (*P* = 0.052, **Table 1**). Blood pressure in the nonindustrial employees was significantly greater than in the refinery employees (*P* < 0.001, **Table 1**). The prevalence of MetS by either the IDF or ATP III criteria was significantly higher in the refinery employees than nonindustrial employees (*P* < 0.001, **Table 2**). Scores of both IDF and ATP III criteria in the refinery employees were significantly higher than for nonindustrial employees (*P* < 0.01 **Table 2**).

There were significantly more men with obesity, abdominal obesity, and high blood glucose working as refinery employees than among the nonindustrial employees (*P* < 0.01 **Table 2**). However, there were less men with hypertension among the refinery employees than among the nonindustrial employees (*P* < 0.001, **Table 2**).

Binary logistic regression was performed to determine the association between the kind of employee (gas refinery or nonindustrial employee) and MetS. Gas refinery employees had a greater chance of having MetS than nonindustrial employees (OR 1.38, 95% CI 1.10 to 1,737; *P* = 0.005).

Table 1. Characteristics of the participants in the study

	Nonindustrial employees (n = 681)	**Gas refinery employees** (n = 670)	***P***
Age (y)	45.1 ± 6.3	45.0 ± 7.5	0.87
Education attainment*	3 (3–5)	3 (3–5)	0.17
Weight (kg)	76.37 ± 12.02	79.46 ± 12.03	<0.001
Height (cm)	169.9 ± 6.7	170.5 ± 6.6	0.077
BMI (kg/m^2)	26.47 ± 3.90	27.33 ± 3.78	<0.001
Waist circumference (cm)	93.0 ± 9.9	95.8 ± 9.6	<0.001
Hip circumference (cm)	101.4 ± 7.2	103.3 ± 9.0	<0.001
Waist/hip ratio	0.91 ± 0.06	0.93 ± 0.15	0.01
FBG (mg/dL)	87.7 ± 33.5	102.3 ± 31.1	<0.001
TG (mg/dL)	128 (84–182)	134 (95–190)	0.052
HDL-C (mg/dL)	40.18 ± 9.73	40.56 ± 11.47	0.51
Systolic BP (mmHg)	119.6 ± 15.9	115.8 ± 14.8	<0.001
Diastolic BP (mmHg)	79.5 ± 10.7	77.2 ± 9.9	<0.001

***1**, High school diploma or less; 2, associate degree and bachelor degree; 3 Masters and PhD; 4, religious education. BMI, body mass index; FBS, fasting blood glucose; TG, serum triglycerides; HDL-C, high-density lipoprotein cholesterol; BP; blood pressure. Values are expressed as mean ± standard deviation, and median and interquartile range (Q1–Q3).

Table 2. Comparison of the prevalence of metabolic syndrome between the two groups

	Nonindustrial employees (n = 681)	**Gas refinery employees** (n = 670)	***P***
Metabolic syndrome (by the IDF criteria)	29.8% (n = 203)	37% (n = 248)	0.005
Metabolic syndrome (by the ATP III criteria)	18.2% (n = 124)	25.8% (n = 173)	0.001
IDF score ≥3	32.6% (n = 222)	40% (n = 268)	0.005
ATP III score ≥3	18.2% (n = 124)	25.8% (n = 173)	0.001

Frequency of the metabolic syndrome features between groups

	Nonindustrial employees (n = 681)	**Gas refinery employees** (n = 670)	***P***
Waist circumference ≥94 cm	48.5% (n = 330)	61.8% (n = 414)	<0.001
Waist circumference ≥102 cm	18.3% (n = 124)	24.4% (n = 162)	0.006
BMI >30 (K/m^2)	17.2% (n = 117)	22.8% (n = 153)	0.008
TG 150 mg/dL	38.5% (n = 262)	42.2% (n = 283)	0.18
BP 130/85 (mmHg)	35.2% (n = 240)	23.3% (n = 156)	<0.001
BP 140/90 (mmHg)	24.8% (n = 169)	16.4% (n = 110)	<0.001
FBG 100 mg/dL	12.3% (n = 84)	29.6% (n = 198)	<0.001
HDL-C <40 mg/dL	56.8% (n = 387)	56.3% (n = 377)	0.82

IDF, International Diabetes Federation; ATP, Adult Treatment Panel; BMI, body mass index; TG, serum triglycerides; BP; blood pressure; FBS, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol.

Discussion

The results of the present study showed that the prevalence of MetS and obesity were higher in the gas refinery employees than the nonindustrial employees. Several previous studies have suggested the importance of occupational health promotion for increasing employees' performance [14-16], but there are few studies about health of industrial employees.

Schultz and his colleagues studied the prevalence of MetS in 4188 employees of a midwestern U.S. manufacturing company. In their study, 30% of employees met the criteria for MetS based according to ATP III criteria. They also reported an increased risk of MetS increases the risk of other health problems and financial losses because of increased health care costs and declining employee performance [13]. They suggested there is a need to pay more attention to the health of the factory workers, and proposed planning for health promotion, screening, and clinical care of employees at risk. Our present study was a comparison of the prevalence of MetS between industrial and nonindustrial employees. The results of our study also suggest that there is a need to pay more attention to the health of workers in an industrial workplace.

Tsai and his colleagues studied the prevalence of MetS in 4666 Taiwanese high-tech industry workers, according to World Health Organization criteria [17]. They reported that the prevalence of MetS was about 8% and was higher in men. This prevalence of MetS was less than in the general population of Taiwan, and they stated that this was probably because of the lower age range of the employees compared with the general population. We have avoided this problem by using an age-matched comparator sample. Thankappan and his colleagues evaluated MetS and its risk factors in 2321 Indian industrial workers. The overall prevalence of MetS found by their study was 28.4% according to the IDF criteria; however, they did not compare industrial and nonindustrial employees [18]. Kang and his colleagues studied the prevalence of MetS and its components in 1545 Korean employees. According to the ATP III criteria, the prevalence of metabolic syndrome was about 21% in employee participants in their study. These investigators suggested that more attention should be paid to control and management of metabolic syndrome in Korean workers. However, the type of work place was not identified and no comparison was made between different employees in their study [19].

Vangelova and colleagues studied the prevalence of hypertension and dyslipidemia in 545 male industrial workers within an environment that was both noisy and hot [20]. They reported that noise exposure was associated with increased blood pressure. In a further study, Vangelova and colleagues examined the relationship between the hot environment and dyslipidemia [21]. Their results showed that the warm weather in the workplace was associated with an increased risk of dyslipidemia. Gas refinery workers in our present study are also exposed to a hot environment, but not so much to noise. The prevalence of dyslipidemia in the gas refinery employees was higher than for the nonindustrial workers in our present study, and this is consistent with findings of Vangelova and colleagues.

In our present study, blood glucose of industrial workers was significantly higher than in nonindustrial employees. Previous studies have suggested associations between air pollution and pancreatic β-cell dysfunction, insulin resistance, and diabetes [22, 23]. Recent evidence suggests that environmental toxins including persistent organic pollutants can affect mitochondrial function and subsequently cause insulin resistance [7]. Environmental pollutants may also affect endocrine regulation of metabolism, and likely increase the chances of weight gain and obesity [8].

In our present study, the mean blood pressure of the gas refinery workers and prevalence of hypertension were less than in nonindustrial employees. Stress is an important cause of hypertension and some previous studies have shown that there is a significant association between socioeconomic status, stress, and blood pressure levels [24-27, 30]. Gas refinery employees in Iran generally receive a higher salary and better facilities than employees in the general population. A better socioeconomic status is likely to be effective in reducing their stress and blood pressure. This hypothesis has not been evaluated in our present study, but warrants further investigation.

The main advantage and innovation of the present study compared with previous studies are the comparison of MetS and its components between industrial and nonindustrial employees. The main limitations of this study are that it cannot evaluate possible causes of increased risk of MetS including lifestyle of the employees, nor did it examine the association between their ethnicity or origin.

Our study has limitations including a lack of evaluation of employees' lifestyle including their physical activity and diet, and we recommend comparison of the employees' lifestyles for the future studies. Another limitation was that the study was not designed to assess the risk, risk factors, or severity of risk factors, and further studies are recommended to identify them. An investigation to find the causes of the higher blood pressure in the nonindustrial employees is warranted.

In summary, the results of our study showed that MetS and its components in the gas refinery industrial employees were significantly more prevalent than in nonindustrial staff. Previous studies have shown that air pollution and industrial chemical pollutants may be associated with increased risk of metabolic disorders and CVD [9, 28, 29]. Possible causes of the higher prevalence of MetS in the industrial employees are inappropriate diet and poor lifestyle, including inadequate physical activity and inappropriate sleep patterns. Industrial working conditions and a hot environment may exacerbate these underlying causes of MetS.

We recommend more comprehensive and detailed studies and measurement of the amount of chemical pollutants in the environmental air and in the participant's blood samples in future studies. This is needed to evaluate the association between MetS risk factors and levels of contaminants in the blood. In addition, it may be useful to evaluate the relationship between blood levels of contaminants and disturbance of weight-controlling hormones in future studies. We also recommend comparison of the lifestyle of the employees and investigating the possible causes of lower blood pressure in the gas refinery staff compared with nonindustrial employees.

Author contributions

MB, HM-A, AP, AA, MT, AS, MSS-A, GAF, MG-M substantially contributed to the conception and design of the study. MB, HM-A, MT, and MSS-A substantially contributed to conducting the study and collection of the data. IN-J and MT conducted the statistical analyzes. IN-J drafted the manuscript. MG-M, GAF, AP, AA, and AS supervised the study and critically revised the final manuscript. All authors reviewed the final version of the article and approved it. All the authors have approved the final article and take responsibility for the statements therein.

Acknowledgments

We appreciate the contributions of and thank Mahmoud Ebrahimi, Mohsen Mohebati, Alireza Heidari-Bakavoli and Mahsa Eghbali for conducting and collecting data for the study. We thank the volunteers for this study and appreciate their participation. This work was supported by a grant from the Mashhad University of Medical Science, Mashhad, Iran.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. 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; 56:1113-32.
2. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation. 2009; 120:1640-45.
3. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: definitions and controversies. BMC Med. 2011; 9:48. doi:10.1186/1741-7015-9-48.
4. Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Cutlip RG, Krajnak KM, et al. Work, obesity, and occupational safety and health. Am J Public Health. 2007; 97:428-36.
5. Dichi I, Simao AN, Vannucchi H, Curi R, Calder PC. Metabolic syndrome: epidemiology, pathophysiology, and nutrition intervention. J Nutr Metab. 2012; 2012: 584541. doi:10.1155/2012/584541.
6. Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. Diabetes. 2007; 56:2655-67.
7. Lim S, Cho YM, Park KS, Lee HK. Persistent organic pollutants, mitochondrial dysfunction, and metabolic syndrome. Ann N Y Acad Sci. 2010; 1201:166-76.
8. Lyche JL, Nourizadeh-Lillabadi R, Karlsson C, Stavik B, Berg V, Skåre JU, et al. Natural mixtures of POPs affected body weight gain and induced transcription of genes involved in weight regulation and insulin signaling. Aquat Toxicol. 2011; 102:197-204.
9. Brook RD, Rajagopalan S, Pope CA, 3rd, Brook JR, Bhatnagar A, Diez-Roux AV, et al. Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association. Circulation. 2010; 121:2331-78.
10. Lin MC, Chiu HF, Yu HS, Tsai SS, Cheng BH, Wu TN, et al. Increased risk of preterm delivery in areas with air pollution from a petroleum refinery plant in Taiwan. J Toxicol Environmental Health A. 2001; 64:637-44.
11. Samet JM, Dominici F, Curriero FC, Coursac I, Zeger SL. Fine particulate air pollution and mortality in 20 U.S. cities, 1987–1994. New Engl J Med. 2000; 343: 1742-49.
12. Brook RD, Franklin B, Cascio W, Hong Y, Howard G, Lipsett M, et al. Air pollution and cardiovascular disease: a statement for healthcare professionals from the Expert Panel on Population and Prevention Science of the American Heart Association. Circulation. 2004; 109:2655-71.
13. Schultz AB, Edington DW. Metabolic syndrome in a workplace: prevalence, co-morbidities, and economic impact. Metab Synd Relat Disord. 2009; 7:459-68.
14. Kuoppala J, Lamminpaa A, Husman P. Work health promotion, job well-being, and sickness absences—a systematic review and meta-analysis. J Occup Environ Med. 2008; 50:1216-27.
15. Schultz AB, Edington DW. Employee health and presenteeism: a systematic review. J Occup Rehabil. 2007; 17:547-79.
16. Laing SS, Hannon PA, Talburt A, Kimpe S, Williams B, Harris JR. Increasing evidence-based workplace health promotion best practices in small and low-wage companies, Mason County, Washington, 2009. Prev Chronic Dis. 2012; 9:E83.
17. Tsai TY, Cheng JF, Lai YM. Prevalence of metabolic syndrome and related factors in Taiwanese high-tech industry workers. Clinics. 2011; 66:1531-5.
18. Thankappan KR, Mini GK. Prevalence and correlates of metabolic syndrome among industrial workers in Kerala, India. In Recorded Annual Meeting Presentations (RAMP) of the 143rd Meeting of the American Public Health Association. 2015, Oct 31–Nov 04; Chicago, IL, USA. No. 322752.
19. Kang DR, Ha Y, Hwang WJ. Prevalence and associated risk factors of the metabolic syndrome in the Korean workforce. Ind Health. 2013; 51:256-65.
20. Vangelova KK, Deyanov CE. Blood pressure and serum lipids in industrial workers under intense noise and a hot environment. Rev Environ Health. 2007; 22: 303-11.
21. Vangelova K, Deyanov C, Ivanova M. Dyslipidemia in industrial workers in hot environments. Cent Eur J Public Health. 2006; 14:15-7.

22. Dangi-Garimella S. Environmental pollutants: a risk factor for obesity and diabetes. Am J Manag Care. 2014; 20(10 Spec No):E8.
23. Hectors TL, Vanparys C, van der Ven K, Martens GA, Jorens PG, Van Gaal LF, et al. Environmental pollutants and type 2 diabetes: a review of mechanisms that can disrupt beta cell function. Diabetologia. 2011; 54: 1273-90.
24. Colhoun HM, Hemingway H, Poulter NR. Socio-economic status and blood pressure: an overview analysis. J Hum Hypertens. 1998; 12:91-110.
25. Kapuku G, Treiber F, Davis H. Relationships among socioeconomic status, stress induced changes in cortisol, and blood pressure in African American males. Ann Behav Med. 2002; 24:320-25.
26. Baum A, Garofalo JP, Yali AM. Socioeconomic status and chronic stress. Does stress account for SES effects on health? Ann N Y Acad Sci. 1999; 896: 131-44.
27. Steptoe A, Kunz-Ebrecht S, Owen N, Feldman PJ, Willemsen G, Kirschbaum C, et al. Socioeconomic status and stress-related biological responses over the working day. Psychosom Med. 2003; 65:461-70.
28. Park SK, Auchincloss AH, O'Neill MS, Prineas R, Correa JC, Keeler J, et al. Particulate air pollution, metabolic syndrome, and heart rate variability: the multi-ethnic study of atherosclerosis (MESA). Environ Health Perspect. 2010; 118:1406-11.
29. Chuang KJ, Yan YH, Cheng TJ. Effect of air pollution on blood pressure, blood lipids, and blood sugar: a population-based approach. J Occup Environ Med. 2010; 52:258-62.
30. Schmidt B, Bosch JA, Jarczok MN, Herr RM, Loerbroks A, van Vianen AE, Fischer JE. Effort–reward imbalance is associated with the metabolic syndrome — Findings from the Mannheim Industrial Cohort Study (MICS). Int J Cardiol. 2015; 178:24-8.