

# Disparities in the Prevalence of Metabolic Syndrome (MS) and its Components Among University Employees by Age, Gender and Occupation

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## ABSTRACT

**Background:** Metabolic Syndrome (MS), a known risk factor for Cardiovascular Disease (CVD) and type II diabetes is an emerging epidemic in China. Studies carried out on the general population indicate a varied clustering of cardiovascular risks in many parts of the country. However, there is limited data on its prevalence in the working population. Workplace can serve as an important place for prevention, control and management of CVD risks. The aim of this study was to investigate the prevalence of MS and its components among University workers, and determine how the prevalence varied according to sex and occupation.

**Methods:** This was a cross-sectional study of 2,428 University employees (22-60 years) who received an annual clinical examination at the University hospital. Anthropometric measurements, blood pressure, Fasting Plasma Glucose (FPG), and lipid profiles were measured. MS was defined according to the National Cholesterol Education Program Adult Treatment panel III modified criteria.

**Results:** Overall prevalence of MS was 6.1%, higher in males (5.1%) than females (1.1%), and increased with age. The most prevalent MS components in all workers were hypertension

(37.9%) and hypertriglyceridemia (20.8%), corresponding rates in males were 28.3% and 16.1% while females had a prevalence of 9.6% and 4.7%. After adjustment for age, administrative work was associated ( $p < 0.05$ ) with increased hypertension (odds ratio (OR) = 1.474; 95% confidence interval (CI), 1.146-1.896) and hyperglycemia (OR=1.469; 95% CI, 1.082-1.993) in male workers, and with hypertension (OR=1.492; 95% CI, 1.071-2.080) in females. However, prevalence of hypertriglyceridemia was lower (OR=0.390; 95% CI, 0.204-0.746) in female administrators compared to those in academics. Obesity, MS and reduced High Density Lipoprotein (HDL) cholesterol prevalence was not different ( $p > 0.05$ ) between the two occupations in both sexes.

**Conclusions:** Prevalence of MS and its components was higher in male workers than in females, increased with age, and were more common in administrative workers. The findings support the need for gender and occupation specific health interventions to prevent CVDs and type II diabetes in the workplace.

**Keywords:** Obesity, Dyslipidemia, Hyperglycemia, Hypertension, Cardiovascular diseases

## INTRODUCTION

CVD, a major cause of mortality is increasing at an alarming rate in China [1]. This is attributed to the rapid increase in overweight and obesity [2], and life style factors including physical inactivity, cigarette smoking and alcohol consumption [3]. Since the beginning of the 21st century, the country has made progress in prevention and control of non communicable diseases, however there are still large action gaps in implementation [4]. In the current National Plan for Prevention and Treatment of Non-Communicable Diseases (2012-2015), the main priorities are targeted towards prevention, timely detection and management of high-risk populations and promotion of healthy lifestyles [5]. However, the challenge is that the clustering of cardiovascular risks which include abdominal obesity, dyslipidemia, hypertension and hyperglycaemia usually termed as MS [6] is reported to be varied across many regions [7,8]. MS is almost becoming an epidemic, and is likely to overwhelm the health care systems and slow economic growth [9]. Importantly, MS is a recognized risk factor for CVD and type II diabetes with insulin resistance generally accepted as its underlying mechanism [10].

Workplace can serve as an important place for prevention, control and management of chronic diseases as workers represent a large proportion of the general population. Occupation has an influence on CVD risks attributable to work conditions such

night shifts, form and duration of work [11-13]. Thus, targeting MS in high risk occupations may aid in prevention, control and management of CVD and other related chronic diseases. However, the crucial basis for developing and implementing nutrition and health interventions in the workplace requires the determination of major CVD risks as well as their distribution patterns [14]. Also, age and sex variation in clustering of risks have important implications for interpreting the association between MS and mortality risk [15]. In China, extensive research on MS prevalence has been carried out on the general population [16, 17] however limited data is available on workers. In light of risk factors such as heavy workload, long working hours, extended work schedules in Chinese Universities [18,19], and differences in working conditions in comparison to the general population, the health status of university workers merits more attention. Therefore, the objective of this study was to investigate the prevalence of MS and its components among University workers, and determine how the prevalence varied according to sex and occupation.

## MATERIALS AND METHODS

### Study Participants and Research Design

This was a cross-sectional study of 2,428 University employees who received an annual clinical examination at Jiangnan University

Hospital. Some variables were missing in 155 participants hence were not included in analysis. A total of 2,273 participants were therefore evaluated (male, 1,198; female, 1,075). Workers were then categorised into two occupation groups: administration and academic. Administrators are involved with office work while those in academic are involved with research, teaching or combination. All the survey protocols were approved by Jiangnan University ethical committee and the hospital management. Informed consent was given by all participants. Study protocols were conducted in accordance with the Declaration of Helsinki recommendations of 1975, revised 2000.

## Data Collection

### Physical assessment

The anthropometric measurements, weight (kg) and height (m) were measured using weight-height machine (HW-700, Zhengzhou, China) and used to compute body mass index (BMI). BMI  $\geq 28$  Kg/m<sup>2</sup> was defined as obesity. Systolic and diastolic blood pressure (mmHg) was measured on the upper right arm using standard sphygmomanometer (YE-665 A, Jiangsu, China) after at least five minutes of rest. All measurements were taken by trained medical personnel.

### Blood sample collection and preparation

The overnight fasting blood samples were obtained in the morning by venipuncture and collected into vacutainer tubes. Blood samples were kept on ice immediately and plasma separated by centrifugation, (KDC-1044, Hangzhou, China) at 1000  $\times$  g for 10 minutes at 4°C. Using standard biochemical reagents (Jiancheng Bioengineering Institute, Nanjing, PR China), an automatic Biochemical Analyser (HF 400, Shanghai, China) was used to measure enzymatically the levels of FPG, lipid profiles; triglycerides (TG), Total Cholesterol (TC), Low Density Lipoprotein (LDL) cholesterol and High-Density Lipoprotein (HDL) cholesterol. All biochemical analyses were conducted at Jiangnan University hospital laboratory. MS was defined according to the Modified criteria of the National Cholesterol Education Program Adult Treatment panel [20].

### Statistical Analysis

Data were analysed with Statistical Package for Social Scientists for Windows, 18 (SPSS, Inc. Chicago, USA). Independent samples t-test was used to compare means. Chi-square ( $\chi^2$ ) test was used to compare categorical variables. Conditional forward and backward binary logistic regression was used to examine associations.  $p < 0.05$  was considered statistically significant.

## RESULTS

### Anthropometric and Metabolic Characteristics of the Study Population

The measured anthropometric and metabolic characteristics of the participants are shown in [Table/Fig-1]. The average age was 42.5  $\pm$  8.6 years; females (40.5  $\pm$  8.0 years) being younger than males (44.4  $\pm$  8.8 years). The BMI for the total adult population was within normal reference levels (22.94  $\pm$  3.06 kg/m<sup>2</sup>). As compared with females, males had higher ( $p < 0.01$ ) BMI, systolic and diastolic blood pressure, FPG, TC, TG and LDL cholesterol. However, females showed elevated ( $p < 0.01$ ) HDL cholesterol.

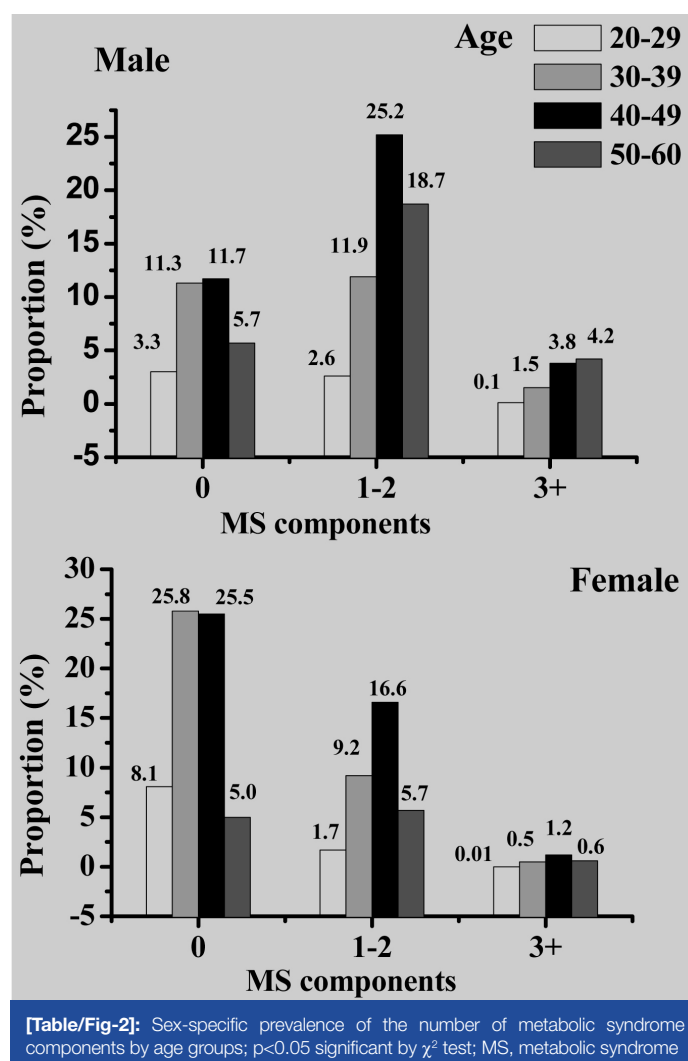
### Prevalence of Metabolic Abnormalities by Sex and Age Groups

Workers were categorized into four age groups: 20-29, 30-39, 40-49 and 50-60 years old. Prevalence of MS components varied across age groups in both males ( $\chi^2=74.896$ ,  $p=0.001$ ) and females ( $\chi^2=53.587$ ,  $p=0.001$ ). As shown [Table/Fig-2], prevalence in the number of components was greater in 40-49 years age group among males (25.2%) and females (16.6%). Overall, MS prevalence was

6.1%, and was higher ( $p < 0.01$ ) in males (5.1%) than females (1.1%) [Table/Fig-3]. The most prevalent component in all participants was hypertension (37.9%), followed by elevated TG (20.8%), reduced HDL (13.8%), hyperglycemia (13.3%) and obesity (4%). Male workers showed higher prevalence than females. Hypertension (28.3%) and elevated TG (16.1%) were most frequent in males while hypertension (9.6%) and reduced HDL (7.7%) were common in females. Furthermore, prevalence increased ( $p < 0.05$ ) with age up to 49 years, and declined in the older age group [Table/Fig-4].

Characteristic	All (n=2273)	Male (n=1198)	Female (n=1,075)	p
Age (years)	42.5 $\pm$ 8.6	44.4 $\pm$ 8.8	40.5 $\pm$ 8.0	0.001
Weight (kg)	1.67 $\pm$ 0.07	71.46 $\pm$ 16.72	56.31 $\pm$ 7.10	0.001
BMI (Kg/m <sup>2</sup> )	22.94 $\pm$ 3.06	24.08 $\pm$ 2.92	21.64 $\pm$ 2.68	0.001
Systolic BP (mmHg)	120.34 $\pm$ 14.94	125.59 $\pm$ 14.07	114.48 $\pm$ 13.68	0.001
Diastolic BP (mmHg)	81.22 $\pm$ 9.87	85.26 $\pm$ 9.16	76.71 $\pm$ 8.610	0.001
Fasting plasma glucose	5.13 $\pm$ 0.82	5.30 $\pm$ 0.99	4.93 $\pm$ 0.50	0.001
Total cholesterol (mmol/L)	5.13 $\pm$ 0.94	5.22 $\pm$ 0.97	4.99 $\pm$ 0.89	0.001
Triglycerides (mmol/L)	1.31 $\pm$ 0.86	1.54 $\pm$ 0.94	1.04 $\pm$ 0.66	0.001
LDL (mmol/L)	2.68 $\pm$ 0.77	2.84 $\pm$ 0.77	2.48 $\pm$ 0.71	0.001
HDL (mmol/L)	1.52 $\pm$ 0.39	1.39 $\pm$ 0.36	1.64 $\pm$ 0.37	0.001

**[Table/Fig-1]:** Anthropometric and metabolic characteristics of adults by sex. Data are expressed as means  $\pm$  standard deviation; fasting plasma glucose in mmol/L; BMI, body mass index; BP, blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein cholesterol;  $P < 0.01$  statistically significant by independent samples t-test



**[Table/Fig-2]:** Sex-specific prevalence of the number of metabolic syndrome components by age groups;  $p < 0.05$  significant by  $\chi^2$  test; MS, metabolic syndrome

	All (n=2273)	Male (n=1198)	Female (n=1075)	p
Metabolic syndrome	139 (6.1)	115 (5.1)	24 (1.1)	0.001
High body mass index	75 (4.0)	65 (3.5)	10 (0.5)	0.001
Hypertension	857 (37.9)	640 (28.3)	217 (9.6)	0.001
Hyperglycemia	294 (13.3)	234 (10.6)	60 (2.7)	0.001
Elevated triglycerides	462 (20.8)	357 (16.1)	105 (4.7)	0.001
Reduced HDL	307 (13.8)	137 (6.2)	170 (7.7)	0.001

**[Table/Fig-3]:** Prevalence of metabolic syndrome and its components by sex. Data shown are n (%); HDL, high density lipoprotein cholesterol; p<0.01 statistically significant by  $\chi^2$  test

## Metabolic Syndrome and Occupation

[Table/Fig-5] shows the association of occupation with MS and each of its components. After adjustment for age and BMI, there was no difference ( $p>0.05$ ) between MS prevalence in administrators and those in academic. Overall, workers in administration had increased ( $p<0.05$ ) body weight, hypertension and hyperglycemia while no difference was found in dyslipidemia. After adjustment for age, male administrators showed increased hypertension and hyperglycemia while females had higher hypertension and lower prevalence of hypertriglyceridemia compared to those in academics. In both sexes, no difference ( $p>0.05$ ) was found in reduced HDL, and elevated TG in males.

	Male					Female				
	20-29 (n=97)	30-39 (n=290)	40-49 (n=476)	50-60 (n=335)	p	20-29 (n=103)	30-39 (n=373)	40-49 (n=455)	50-60 (n=144)	p
MS	1(0.1)	18(1.5)	44(3.8)	49(4.2)	0.001**	0(0)	5 (0.5)	13 (1.2)	6 (0.6)	0.035*
High BMI	2(0.2)	14(1.4)	25(2.6)	23(2.4)	0.376	2(0.2)	2(0.2)	4(0.5)	2(0.2)	0.435
Hypertension	21(1.8)	109(9.3)	273(23.3)	222(19)	0.001**	3(0.3)	40(3.8)	123(11.8)	48(4.6)	0.001**
High FPG	4(0.3)	27(2.4)	89(7.8)	109(9.5)	0.001**	2(0.2)	16(1.6)	27(2.6)	14(1.4)	0.005*
High TG	8(0.7)	73(6.4)	162(14.1)	109(9.5)	0.001**	5(0.5)	25(2.4)	49(4.8)	23(2.3)	0.001**
Low HDL	7(0.6)	33(2.9)	56(4.9)	37(3.2)	0.946	12(1.2)	66(6.5)	73(7.1)	16(1.6)	0.427

**[Table/Fig-4]:** Sex-specific prevalence of metabolic syndrome and its components by age groups. Data shown are n (%); MS, metabolic syndrome; BMI, body mass index (kg/m<sup>2</sup>); FPG, fasting plasma glucose; TG, triglycerides; HDL, high density lipoprotein cholesterol; \*p<0.01, \*\*p<0.05 statistically significant by  $\chi^2$  test

	Model	All (n=780)			Male (n=448)			Female (n=332)		
		OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p
Metabolic syndrome	1	1.602	1.136-2.259	0.007*	1.737	1.181-2.555	0.005*	0.741	0.292-1.885	0.530
	2	1.172	0.897-1.834	0.172	1.467	0.981-2.193	0.062	0.653	0.254-1.676	0.375
	3	1.059	0.691-1.623	0.794	1.233	0.774-1.964	0.378	0.394	0.114-1.371	0.143
Obesity	1	1.988	1.250-3.161	0.004*	1.699	1.025-2.816	0.040*	2.533	0.727-8.828	0.145
	2	1.855	1.154-2.984	0.011*	1.634	0.974-2.744	0.063	2.640	0.750-9.291	0.131
Hypertension	1	1.798	1.506-2.147	0.001**	1.748	1.377-2.219	0.001**	1.681	1.234-2.292	0.001**
	2	1.493	1.233-1.808	0.001**	1.474	1.146-1.896	0.002*	1.492	1.071-2.080	0.018*
	3	1.362	1.090-1.703	0.007*	1.313	0.993-1.737	0.056	1.389	0.933-2.069	0.105
Hyperglycemia	1	1.611	1.270-2.044	0.001**	1.786	1.337-2.386	0.001**	0.933	0.529-1.647	0.811
	2	1.321	1.028-1.698	0.030*	1.469	1.082-1.993	0.014*	0.897	0.503-1.598	0.712
	3	1.196	0.882-1.620	0.249	1.391	0.984-1.967	0.062	0.662	0.322-1.361	0.262
High triglycerides	1	1.153	0.941-1.413	0.170	1.287	0.998-1.661	0.052	0.776	0.493-1.221	0.273
	2	1.019	0.824-1.259	0.864	1.221	0.998-1.589	0.138	0.635	0.392-1.026	0.064
	3	0.886	0.681-1.154	0.370	1.062	0.786-1.436	0.694	0.390	0.204-0.746	0.004
Low HDL	1	0.943	0.731-1.217	0.652	1.016	0.704-1.467	0.933	0.925	0.647-1.323	0.670
	2	0.982	0.755-1.277	0.892	1.027	0.701-1.503	0.893	0.962	0.667-1.386	0.834
	3	1.035	0.770-1.390	0.821	1.044	0.683-1.596	0.841	1.050	0.688-1.602	0.820

**[Table/Fig-5]:** Odds ratios and 95% confidence intervals for workers in administration. Reference, workers in academics; HDL, high-density lipoprotein cholesterol; OR, odds ratio; CI, confidence interval; model 1, crude; model 2, after adjustment for age; model 3, after adjustment for body mass index; \*p<0.01, \*\*p<0.05, statistically significant by binary logistic regression

	Male			Female		
	Lecturers* (n=344)	Professors* (n=406)	p	Lecturers (n=442)	Professors (n= 301)	p
MS	21 (3.3)	33 (5.1)	0.315	13 (2.0)	4 (0.6)	0.248
High BMI	9 (1.7)	22 (4.1)	0.058	3 (0.6)	2 (0.4)	0.920
Hypertension	130 (20.2)	174 (27.1)	0.189	74 (11.6)	43 (6.8)	0.977
High FPG	41 (6.5)	61 (9.7)	0.252	22 (3.6)	16 (2.6)	0.534
High TG	74 (11.8)	11 (17.7)	0.081	45 (7.3)	25 (4.0)	0.760
High HDL	34 (5.4)	38 (6.1)	0.737	68 (11.0)	39 (6.3)	0.827

**[Table/Fig-6]:** Prevalence of metabolic syndrome and its components in academic workers by professional position. Data shown are n (%); \*Includes teaching and technical staff; †includes associate and full professors; HDL, high density lipoprotein cholesterol; p >0.05 statistically non-significant by  $\chi^2$  test

Workers in academic were further grouped into two professional positions: Lecturers/Technicians and Professors (Associate and Full). The mean age for male ( $42.2 \pm 8.7$ ) and female lecturers ( $38.9 \pm 7.4$ ) was lower as compared to the professors ( $41.2 \pm 7.9$ ,  $41.6 \pm 8.2$  respectively). There was no significant ( $p > 0.05$ ) difference in the prevalence of all the metabolic risks between the two professional positions in both sexes [Table/Fig-6].

## DISCUSSION

The present study demonstrates differences in the prevalence of MS and its components by age, gender and occupation among University workers. This is in concurrence with findings from other occupations [11, 12]. In the study, MS components occurred more frequently in male workers than females and increased with age [Table/Fig-2]. Hypertension and elevated TG were more common in males while hypertension and reduced HDL cholesterol were frequent in females [Table/Fig-3]. This gender disparity is attributed to age and endogenous sex hormones that mediate cholesterol metabolism in a sexually dimorphic manner [21]. Majority of the females were pre-menopausal and thus could have benefited from protective effects of estrogen on cardiovascular risks [22]. Moreover, males have more visceral adipose tissue that increases over expression of inflammatory markers associated with increased cardiovascular risks [23]. Other plausible factors may include dietary habits, known CVD risk factors such as cigarette smoking and alcohol consumption common in Chinese men than women [2, 3]. Of remarkable interest is the high prevalence of hypertension in both male and female workers which may suggest it as the main determinant for CVD risks in this working population.

The differential clustering of metabolic risks by gender is consistent with findings from the general population in China [7,8,16,17], however, prevalence was lower in University workers. Also, metabolic risks increased with age [Table/Fig-4], but declined after 49 years, an observation previously made on Taiwanese high-tech industry workers [24]. These two observations may be attributed to 'healthy worker effect' as workers with compromised health may choose to leave employment or retire early. Age and gender specific clustering pattern of metabolic risks supports the importance of tailoring nutrition and health intervention strategies to certain groups and not generalizing intervention programmes in the population [15]. Moreover, convincing evidence show that MS component combinations give differing contributions to CVD risks in populations, and between men and women [25]. Thus, identification of the most prevalent components of MS and distribution patterns in population groups is important in achieving better results in health intervention strategies [14].

Furthermore, occupation was observed to influence MS components as reported in other workplace [13]. After adjustment for age, administrative work associated with increased prevalence of hypertension and hyperglycemia in male workers, and hypertension in females [Table/Fig-5]. However, administrative females showed lower prevalence of elevated TG as compared with those in academics. Prevalence of obesity, low HDL and MS was not different between the two occupations in both sexes. In addition, there was no association between professional position and metabolic risks in academic workers [Table/Fig-6]. The differences in cardiovascular risks in administrative and academic work may be ascribed to nature of work in the two occupation groups. Administrative or office work involves sedentary behavior characterized by too much sitting while academic work may require movements to lecture buildings. Too much acute and chronic uninterrupted sitting is associated with impaired cardiometabolic risks independently of physical activity [26] due to low energy expenditure, reduced insulin action [27] and reduced skeletal muscle lipoprotein lipase activity [28]. In this regard, sedentary behaviours could potentially be targeted independently from physical activity and dietary intake interventions to reduce MS in the workplace.

The differences in metabolic risks in University workers may also be attributed to work related stress [29]. Although not evaluated in the current study, empirical studies in China report increased occupational stress among university employees related to work conditions [18,19]. It is expected that workers with greater work demands will have more stress which can cause them to adopt unhealthy lifestyles that are risk factors for CVDs. Therefore, identifying the most important cardiovascular risk factors in the workplace may be a useful step towards prevention, control and management of chronic diseases. A limitation of the study is the cross-sectional nature of the design which may not allow causal or directional inferences, and thus the need for a longitudinal study.

## CONCLUSION

Prevalence of MS and its components was higher in male workers than females, increased with age, and were more common in administrative workers. The findings support the need for gender and occupation specific health interventions that promote employee health and help prevent CVDs and type II diabetes in the workplace.

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