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Health hazards of a sedentary occupation: Risk assessment of metabolic syndrome prevalence in taxi driving and other occupations

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ABSTRACT

Objectives: To determine the association between metabolic syndrome (MetS) prevalence and occupation—distinguished by being sedentary and nonsedentary and by socioeconomic status (SES)—with taxi driving as the representative sedentary occupation. Numerous occupations, lawyers, teachers, engineers, senior section chiefs of enterprises, taxi Driving, and so on are considered.

Methods: Two data sets with 64,578 cases were analyzed. MetSwasidentified according tocriteriaofthemodified Adult Treatment Panel III. A binary longitudinal algorithm was used to test factors for three age segments. R for Windows (version 3.5.1) was used for all statistical analyses.

Results: MetS prevalence was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. MetS was significantly more likely for sedentary occupations (OR = 0.89, $p < 0.001$) including taxi drivers (33.41%), managers (32.52%), and workers in the service sector (29.53%). Taxi drivers were most likely to have MetS. Those working in occupations that are sedentary and associated with a high SES were more likely to have MetS (OR = 1.02) compared with those working in sedentary occupations associated with no particular SES.

Conclusions: Because high-SES and sedentary occupations increase MetS risk, we suggest for the authorities to focus them, specifically in tracking their trends for MetS indexes and tailoring health promotion programs to these groups.

Keywords: Sedentary occupation, Metabolic Syndrome, Risk assessment, Regression Model, Binary Longitudinal Algorithm

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Strengths and limitations of this study

- Even though the association between metabolic syndrome (MetS) prevalence and numerous occupations involving socioeconomic status (SES) have been studied in some works, we might be the first one to evaluate sedentary/non-sedentary occupations and by SES extensively.
- Two data sets with 64,578 cases were employed.
- The results show that sedentary occupations with high SES are at higher risk of MetS than non-sedentary ones.
- The main limitations of this study is that the data was only collected in Taiwan. The results might be not the same for other countries.

INTRODUCTION

MetS has been established as a public health concern in Western countries and is an increasingly severe public health problem in East Asian countries. In the United States, 34% of adults satisfy the MetS criteria, which was formulated in the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III); in particular, US adults aged more than 60 years are more prone to having MetS [1]. The health status of the Taiwanese population was estimated in 2002 using the data of 7566 participants in a nationwide cross-sectional population-based survey, named the Taiwanese Survey on Prevalence of Hyperglycemia, Hyperlipidemia, and Hypertension (TwSHHH). Hwang et al. [2] reported that the prevalence of MetS in women increases rapidly after the menopausal period to become higher than that in men; they also noted MetS' high correlations with age as well as overweight and obesity. In other Asian countries, MetS is also an important health issue, and studies on MetS have been conducted in Thailand [3], Malaysia [4], South Korea [5], and Japan [6] in addition to studies in Taiwan [2, 7, 8].

MetS is highly correlated with overweight and obesity [2, 9], and it comprises a constellation of interrelated metabolic disorders—including hypertension [10, 11, 12], type 2 diabetes mellitus (T2DM) [13, 14, 15], cardiovascular disease (CVD) [11, 11, 15], and stroke [16, 17]. In addition, people with MetS have fivefold diabetes [18]. The scholarly evidence has also preponderantly indicated that individuals with MetS or a sedentary occupation have increased the incidence of T2DM and coronary heart disease as well as increased mortality due to CVD [11, 13, 14, 15, 19].

As a result, the reasons causing MetS must be investigated. The risk factors for MetS include aging, sedentary, long working hours, physical inactivity, Western diet, sleep durations greater than 7 hours [20], and high occupational stress [21]. Socioeconomic status (SES) and lifestyle are the possible risk factors for MetS [22, 23]. Of these factors, prolonged sitting is an ostensible risk factor for negative health outcomes across all ages due to the rapid automation of the workplace [24, 25]. More recent studies have begun discussing the correlation of sedentary occupation with MetS or CVD risk [9, 26, 27, 28, 29, 30]. Bakrania et al. [27] demonstrated that sedentary behavior affects not only physical but also cognitive health. Another study on workers in a petroleum company reported that sedentary behavior—specifically for 10 h/day with two-thirds of those 10 h spent sitting at work—was significantly associated with cardiometabolic risk factors [31]. An individual having a sedentary occupation is significantly more likely to be obese. Strauß et al. [9] found that office workers had a significantly greater abdominal waist circumference (WC) than do firefighters and that 33% of sedentary German office workers had MetS.

However, itsriskassociationmustbereplicatedwithrespect to occupational condition or SES [23, 31, 32, 33]. Al-Thani et al. [32] shown that no statistical significant association was founded for occupation. Mehrdad et al. [23] found the association between MetS and three job ranks in a company didn't cause significant difference. Therefore, this study focused on MetS prevalence—and the related chronic disease biochemical test indexes—with respect to occupation among adults in Taiwan. The current study focused on sedentary occupations and occupations associated with different SES brackets. We selected taxi driving as the representative sedentary occupation, in addition to analyzing some high-SES-associated occupations.

In Taiwan, taxi drivers work more than 10 hours a day. They spend most of their working hours in the vehicle, and their meal times are irregular. Wu [34] reported that taxi drivers have back pain caused by a sedentary lifestyle over the long term and a lack of outdoor activity. Similarly, Shin et al. [30] found that middle-aged male occupational drivers in South Korea'sGwangjucityweremorelikelytodevelopacardiovascular (CV) event compared with their peers of the same age in other occupations. According to the most recent survey report on taxi drivers in Taiwan by Taiwan's Ministry of Transportation and Communications[1], as of the end of September 2018, there were 86.6% were 54.2 years-old in average and spent 9.7 h/day driving, not including the time taken to eat and rest. Considering the aforementioned survey report, this study analyzed the health status of taxi drivers due to they are explicitly seating for a long time.

In addition, although there are numerous studies that include some occupations or SES condition, this research might be the first one to study those in other sedentary or more high-SES-associated occupations, especially occupations that increase MetS risk which haven't explored yet by prior researches. The occupation studied in this research include lawyers, teachers, engineers, senior section chiefs of enterprises, taxi Driving, and so on. The next section explain the methods used in this paper.

METHODS

Definition of a sedentary occupation

According to the US Department of Labor's Dictionary of Occupational Titles, sedentary work is the occasional exertion of >10 lbs of force and/or a frequent exertion of a negligible amount of force. In this definition, "occassional" and "frequent" are defined as being present <1/3 and 1/3–2/3 of the time, respectively. Such force can be used to lift, carry, push, pull, or move objects—including the human body. Sedentary work involves sitting most of the time, but it may involve walking or standing for brief periods [2]. Thus, a job was defined to be sedentary if walking and standing are required only occasionally and all other sedentary criteria are met [35].

[1] https://www.motc.gov.tw/ch/home.jsp?id=56parentpath=0,6mcustomize=statistics101.jsp
[2] https://www.thehortongroup.com/resources/the-strength-test-levels

Definition of MetS

MetS was defined in this study according to guidelines from the Health Promotion Administration of Taiwan's Ministry of Health and Welfare. MetS prevalence was evaluated using the definitions of the modified ATP III and the MetS criteria for Taiwanese (MetS-TW). Five major factors were used to determine whether a person had MetS: WC, high blood pressure, fasting blood sugar (BS), triglyceride (TG) level, and HDL-C level. High blood pressure included the rates of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically, a Taiwanese person is defined as having MetS if they have three or more of the following five conditions in the ATP III: abdominal obesity, high TG, low HDL-C, hypertension, and hyperglycemia; the rules are detailed in Table 1.

Data resource and data collection

Two data sets were analyzed. The first was the New Taipei City Government Annual Taxi Health Examination Survey, which covers the 2012–2016 period and is conducted by Far Eastern Memorial Hospital (FEMH), and the second was the MJ Health Check-Up–Based Population Database (MJPD) (2012–2016). The MJPD is accessible to researchers upon request[3], and the data were collected from four MJ clinics, which provide periodical health examinations to their members. Each member participated in a check-up program that offered a reduced fee in exchange for returning to take the examination regularly over multiple years. All of the data sets used in this study were authorized and given to this study's researchers by the MJPD Health Research Foundation. The laboratory data of the two databases were obtained from the same biochemical examination apparatus (Hitachi-7600), and the data sets conform to the ISO-15189 guidelines. Regarding ethical data use, the protocol of this study was approved by the Research Ethics Review Committee at FEMH (FEMH-IRB-107126-E and) and the MJ Health Research Foundation.

Definition of other terms

Participants in both data sets had participated in one or more health examination sessions. A person can have one or more sets of records in the data sets. To distinguish between a person and the record of a person, we defined a "case" as a person and a "record" as the data on one person obtained from one health examination session.

[3] http://www.mjhrf.org/main/page/release1/en/release01

Data preprocessing

The FEMH database had 2,294 cases of taxi drivers (2,182 male and 112 female). To ensure representativeness in the analysis, we excluded female taxi drivers because their data only comprised 4.87% of the data set. The MJPD database had 117,076 cases (62,396 male and 54,680 female). We also excluded female taxi drivers to control for the effects of gender. Therefore, we analyzed data of 64,578 cases: 2,182 cases of taxi drivers from the FEMH database, and 62,396 health screening cases from the MJ database. After combining the two databases, MetS was identified based on the NCEP ATP III MetS criteria, and MetS prevalence was calculated. Because age has been demonstrated to be an essential influence on MetS risk, we stratified the data into ≤40-, 40–60-, and ≥60-year-old groups. We focused on the effect on MetS risk from occupation—distinguished first by whether the occupation is sedentary versus or non-sedentary and second, by the occupation'sassociationwithSES.Weemployednineoccupational categories: "Professional-1," including lawyers, teachers, accountants, and nurses; "Technical-2," including engineers, architects, and programmers; "Managerial-3," including senior executives of government departments or section chiefs of enterprises; "Sales-4;" "Service-5;" "Clerical and Administrative-6;" "Manual Labor-7;" "Taxi Driving-8;" and "Others-9." These categories fell into one of the following three groups, which were defined with respect to SES and sedentary status: (I) general and sedentary, (II) nonsedentary, and (III) sedentary and high-SES-associated. We excluded data entries falling under the occupational category "Others" and entries with missing values. Group I contained three categories: Service-5, Clerical and Administrative-6, and Taxi Driver-8; Group II contained two categories: Sales-4 and Manual Labor-7; and Group III contained three categories: Professional-1, Technical-2, and Managerial-3.

Statistical analysis

The statistical analysis and graphs in this study were performed using an R (v3.5.1) package for binary longitudinal data (*bild*). A p-value of <0.05 indicated statistical significance between the two test populations. In the univariate analysis, a two-sample independent *t* test was adopted to analyze the difference in the mean value of continuous variables between participants with and without MetS. An exact chi-square test was used to define the differences between categorical variables. Multiple logistic regression was used to determine the effect of all influential variables. Finally, the *bild* package was judged to be most suitable, considering that most participants were examined multiple times.

Table 1 MetS criteria

No.	Factors	Abnormal Condition
1	Fasting Plasma Glucose (FPG)	FPG ≥ 100mg/dL
2	High Density Lipoprotein Cholesterol (HDL-C)	Male < 40mg/dL or Female < 50mg/dL
3	High Blood Pressure	SBP ≥ 130mmHg or DBP ≥ 85mmHg
4	Triglyceride (TG)	TG ≥ 150mg/dL
5	Waist Circumference (WC)	Male ≥ 90 cm or Female ≥ 80 cm

RESULTS

We only analyzed the data of those who first, were taxi drivers and second, had two records in the database. Any personal information of all individuals was removed to protect their privacy. We analyzed 201,087 records in total, including those for gender, height, weight, WC, blood pressure, TG level, HDL-C, SBP, DBP, and fasting BS. We computed the BMI from the height and weight data. In the next sub-sections, we present the descriptive statistics and the correlations among factors.

Descriptive Statistics

After processing the data, the original database comprised 64,578 cases: 2,182 cases of taxi drivers from the FEMH database, and 62,396 health screening cases from the MJ database. We excluded the data entries with the occupational category "Others" and with "missing values," leaving 43,782 cases for data analysis. Of these 43,782 cases, 31,454 did not have MetS and 12,328 had MetS. MetS prevalance in this study thus was 28.16%. We conducted comparisons for the various physiological parameters, such as weight, SBP, and DBP (Table 2). Compared with those with MetS, individuals without MetS were healthier: their weight, SBP, WC, TG level, and BMI were lower and their HDL-C level was greater. All characteristics were significantly related to MetS ($p < 0.001$).

We further stratified the cases into three age groups: 21,410 cases were in the younger age group (≤40 years old), 20,565 cases were in the middle-aged group (40–60 years old), and 1,807 cases were in the older age group (>60 years old). Table 3 details the age-stratified data—most cases were aged ≤40 years. MetS prevalence was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. The result is consistent with studies reporting that MetS becomes more likely with age [1, 16]. Furthermore, as noted in table 3, all factors—such as weight, SBP, DBP, and WC—were significantly related ($p < 0.001$) to MetS prevalence for all age groups, identical to the findings for the unstratified data in Table 2.

Chi-square exact test and multiple logistic regression analysis

Because some variables for characteristics were categorical, we used a chi-square test to analyze the relationships among them. Table 4 presents the results. Age and occupation were significantly associated with MetS ($p < 0.001$). To explore the public perception of risk indicators of MetS, we further analyzed the eight aforementioned occupational categories. All occupation categories were significantly associated with MetS ($p < 0.001$) Among the occupations, taxi driving had the highest MetS prevalence (33.41%), which was much higher than the 28.16% prevalence in the unstratified data. The occupational categories with the highest MetS prevalence were Taxi Driver-8, Managerial-3, and Sales-4 at 33.41%, 32.52%, and 29.53%, respectively.

We further analyzed the analyzed the associations between major factors in a multiple logistic regression (Table 5). BMI (%), body weight (kg), body fat percentage (%) and total cholesterol (mg/dL) were revealed to be the important risk factors for MetS ($p < 0.001$). Age is the most important risk indicator, with MetS becoming more likely with age. As for the three occupational groups that the eight occupational categories fell under, those in group-II (i.e., non-sedentary) occupations were less likely to develop MetS (OR = 0.89, CI: 0.82-0.97, $p = 0.0107$) compared with the two other groups, and those in group-III (i.e., sedentary and high-SES-associated) occupations were more likely to develop MetS compared with group-I occupations (i.e., sedentary occupations associated with no particular SES, including taxi driving) at an OR of 1.02 (CI: 0.96-1.09).

DISCUSSION

Owen et al. reported that the average person spends (1) 71% of their daily waking hours in a sedentary state and (2) only 30 min daily on moderate intensity physical activity on most days of a week [25]. As noted in the literature review in the Introduction section, MetS likelihood significantly increases with sedentary time and sedentary behavior [25, 36, 37]. Being sedentary also makes one significantly more likely to be obese

Table 2 Comparison of MetS characteristics

			Metabolism syndrome				
	Total		Without (n=31,454)		With (n=12,328)		
Variables	Mean	(SD)	Mean	(SD)	Mean	(SD)	p-value
Weight(Kg)	72.8	(11.3)	69.7	(9.3)	80.9	(12.1)	<0.001
SBP(mmHg)	120.6	(15.0)	116.8	(13.0)	130.3	(15.4)	<0.001
DBP(mmHg)	77.4	(10.5)	74.8	(9.2)	84.0	(10.6)	<0.001
WC(cm)	84.1	(8.7)	81.2	(7.0)	91.5	(8.3)	<0.001
Body Fat (%)	24.3	(5.5)	22.8	(4.8)	28.0	(5.3)	<0.001
FPG(mg/dl)	103.2	(18.7)	99.5	(12.6)	112.6	(26.8)	<0.001
TG(mg/dl)	136.8	(103.5)	113.6	(74.7)	196.0	(137.7)	<0.001
CHOL	197.5	(34.2)	195.4	(33.1)	202.8	(36.1)	<0.001
HDL-C(mg/dl)	52.0	(11.4)	54.3	(11.3)	46.0	(9.3)	<0.001
LDL-C(mg/dl)	124.8	(32.1)	122.9	(31.1)	129.6	(33.9)	<0.001
BMI(Kg/m2)	24.8	(3.4)	23.7	(2.7)	27.4	(3.5)	<0.001

Table 3 Comparisons of MetS characteristics stratified by age

	Age≤40 (n=21,410)			40<Age≤60 (n=20,565)			Age>60 (n=1,807)		
	Non MetS	MetS		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	70.8(9.7)	85.1(12.5)	<0.001	68.7(8.5)	78.6(11.0)	<0.001	64.9(8.5)	73.5(9.6)	<0.001
SBP(mmHg)	115.9(11.7)	128.9(14.7)	<0.001	117.1(13.7)	130.5(15.6)	<0.001	125.8(17.2)	139.2(16.2)	<0.001
DBP(mmHg)	73.4(8.6)	82.4(10.6)	<0.001	76.1(9.5)	85.0(10.5)	<0.001	77.8(10.5)	85.0(10.0)	<0.001
WC(cm)	80.8(7.2)	92.6(8.6)	<0.001	81.6(6.7)	90.6(8.1)	<0.001	83.0(7.4)	91.5(8.0)	<0.001
Body Fat (%)	23.3(5.0)	29.6(5.3)	<0.001	22.3(4.5)	27.0(5.0)	<0.001	21.3(4.8)	25.8(5.4)	<0.001
FPG(mg/dl)	97.8(9.3)	108.5(22.8)	<0.001	101.2(14.7)	114.6(27.7)	<0.001	103.3(21.0)	122.0(37.6)	<0.001
TG(mg/dl)	109.1(74.0)	198.9(148.4)	<0.001	120.1(77.0)	196.0(132.2)	<0.001	101.1(47.2)	173.7(103.5)	<0.001
CHOL	192.1(32.8)	203.5(36.2)	<0.001	199.6(33.0)	203.1(36.0)	<0.001	192.0(34.0)	194.6(35.3)	<0.001
HDL-C(mg/dl)	54.4(11.2)	45.4(8.9)	<0.001	54.2(11.3)	46.3(9.5)	<0.001	55.3(11.8)	46.3(10.5)	<0.001
LDL-C(mg/dl)	120.6(31.1)	131.9(33.9)	<0.001	125.8(30.9)	128.7(34.0)	<0.001	120.2(31.3)	122.0(32.0)	<0.001
BMI(Kg/m2)	23.7(2.9)	28.2(3.7)	<0.001	23.7(2.5)	27.0(3.2)	<0.001	23.8(2.8)	26.6(3.3)	<0.001

Table 4 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables

		Non-MetS		MetS		
Variables	Item	No.	(%)	No.	(%)	p-value
Age	Age≤40	16,483	(76.99)	4,927	(23.01)	<0.001
	40<Age≤60	13,813	(67.17)	6,752	(32.83)	<0.001
	Age>60	1,158	(64.08)	649	(35.92)	<0.001
Occupation	Professional-1	1936	(74.18)	674	(25.82)	<0.001
	Technical-2	12,603	(74.5)	4,314	(25.5)	<0.001
	Managerial-3	5,704	(67.48)	2,749	(32.52)	<0.001
	Sales-4	4,516	(70.47)	1,892	(29.53)	<0.001
	Service-5	1,557	(71.32)	626	(28.68)	<0.001
	Clerical and Administrative-6	1,558	(73.94)	549	(26.06)	<0.001
	Manual Labor-7	2,127	(72.79)	795	(27.21)	<0.001
	Taxi Driver-8	1,453	(66.59)	729	(33.41)	<0.001

Table 5 Multiple logistic regression results for risk-factor associations

Variables	Condition	OR	95%CI		p-value
Age	Age ≤ 40	1.00			
	40 < Age ≤ 60	2.32	2.20	2.46	<0.001
	Age > 60	3.65	3.22	4.14	<0.001
Occupation	Group-I*	1.00			
	Group-II†	0.89	0.82	0.97	0.0107
	Group-III‡	1.02	0.96	1.09	0.523
Weight(Kg)		1.03	1.03	1.04	<0.001
BMI		1.28	1.26	1.31	<0.001
Body Fat Percentage(%)		1.08	1.07	1.08	<0.001
HDL-C(mg/dl)		0.99	0.99	1.00	<0.001
Total Cholesterol(mg/dl)		1.01	1.01	1.01	<0.001

*Group-I: sedentary-related occupations with low social-economic status, including taxi drivers

†Group-II: non sedentary-related occupations

‡Group-III: sedentary-related occupations with high SES

[9], have poor cardiometabolic health [19, 31], and have poor cognitive health [27]. An increasing number of researchers are beginning to investigate the correlation of a sedentary occupation with MetS or CVD risk [9, 26, 27, 28, 29, 30]. However, most studies on MetS risk factors have focused on lack of physical activity rather than sedentary time or a sedentary occupation. These studies have noted that in adults, spending more time being sedentary increases metabolic risk [38, 39]. Recent research has also demonstrated that lifestyle andSESaresignificantriskfactorsforMetS[22,23]andCVD [22, 40, 41]. Nonetheless, Kim et al. argued that a causal relationship of SES with MetS and CVD risks—as indicated by the Framingham risk score—cannot be established by the current body of cross-sectional evidence [42]. Furthermore, scholars have yet to investigate the role of occupation in MetS risk, with occupation further distinguished by sedentary status and SES associations. In particular, MetS risk is likely to differ between those working in typically sedentary white-collar occupations (such as doctors, professors, managers, and engineers) and those working in sedentary blue-collar occupations (such as administrative staff, service staff, and even taxi drivers).

The current results indicated that those working in sedentary, high-SES-associated occupations are at a higher risk of MetS. We also confirmed the importance of age as a MetS risk factor (Table4). In particular, we further stratified the cases into three age groups: 21,410 cases were in the younger age group (≤40 years old), 20,565 cases were in the middle-aged group (40–60 years old), and 1,807 cases were in the older age group (>60 years old). Most cases were in the younger age group. Moreover, MetS prevalence was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively, and the middle-aged significantly higher than younger people. Regarding occupation, sedentary (group-I) occupations were more significantly associated with MetS related to nonsedentary (group-II) occupations (OR = 0.89, p = 0.0107). Taxi drivers (33.41%), managers (32.52%) and service staff (29.53%) were the three occupational groups most likely to get MetS. Furthermore, as noted in Table 5, those in sedentary occupations that are associated with a high SES (group-III) were more likely to have MetS compared with those working in sedentary (group-I) occupations associated with no SES in particular (OR = 1.02).

CONCLUSIONS

Although prolonged sitting is an ostensibly novel risk factor for health outcomes across all ages, its association must be replicated in occupational conditions [31]. In this study, we noted that age and occupation categories were risk factors for MetS, although a sedentary occupation has been known to be unhealthy. The study found that taxi drivers were indeed a high-risk group. However, high-SES-associated but sedentary occupations, such as a lawyer, teacher, accountant, doctor, nurse, engineer, and manager, were also high-risk groups for MetS. A study in South Korea's Gwangju city noted bus drivers to be a high-risk group for MetS and CV [30], but without specifically analyzing the occupational categories in the communities that taxi drivers were living in. In the current study, taxi driving, among eight occupational categories, had the highest MetS prevalence. However, after the eight categories were grouped into three groups, sedentary (group-I) occupations, of which taxi driving falls under, had a lower MetS prevalence than did sedentary and high-SES (group-III) occupations. This means that in general, high-SES and sedentary workers are more at risk of MetS than their low-SES and sedentary counterparts. Nevertheless, those in non-sedentary (group-II) occupations (e.g., sales and manual labor) had a lower risk of MetS compared with their sedentary counterparts. We recommend for government authorities to focus on taxi drivers, sedentary blue-collar workers, and sedentary high-SES workers in their policies, particularly in tailoring health promotion programs to these groups.

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FOOTNOTES

Contributors

M.-S.C. (Ming-Shu Chen) conceived and designed the experiments; M.-S.C. and C.-H.C. (Chi-Hao Chiu) performed the experiments; C.-H.C., and S.-H.C. (Shih-Hsin Chen) analyzed the data; M.-S.C. were supervised the study; M.-S.C. contributed investigation material; M.-S.C., C.-H.C., and S.-H.C. wrote this paper together. S.-H.C. submitted this paper.

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COMPETING INTERESTS

The authors declare no conflicts of interest concerning this study.

Ethics approval

Ethical approval was obtained from the Research Ethics Review Committee at the Far Eastern Memorial Hospital in New Taipei City, Taiwan (Institutional Review Board approval number: FEMH-IRB-107126-E, v.02; board meeting and approval date: September 10, 2018). The MJ Health Research Foundation also approved this study. This study also has a PPS receipt (ClinicalTrials.gov ID: NCT04142593, Date: October 25, 2019)

Data sharing statement

The data used in this study are restricted by the Research Ethics Review Committee of the Far Eastern Memorial Hospital (FEMH-IRB-107126-E, v.02) in order to protect participant privacy. Data are available from Ming-Shu Chen (email: tree1013@gmail.com) for researchers who meet the criteria for access to confidential data.

Consent to patient and public involvement statement

Not applicable.

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Last Update: 10/25/2019 04:49

ClinicalTrials.gov ID: NCT04142593

Study Identification

Unique Protocol ID: 107126-E

Brief Title: Application of Decision Analysis Techniques' in Huge Health-checkup Database to Explore the High-risk Group With Metabolic Syndrome

NOTE : Brief Title should have no more than 120 characters.

Official Title: Application of Decision Analysis Techniques' in Huge Health-checkup Database to Explore the High-risk Group With Metabolic Syndrome

Secondary IDs:

Study Status

Record Verification: October 2019

Overall Status: Active, not recruiting

Study Start: September 1, 2018 [Actual]

Primary Completion: September 15, 2019 [Actual]

Study Completion: September 30, 2021 [Anticipated]

Sponsor/Collaborators

Sponsor: Far Eastern Memorial Hospital

Responsible Party: Sponsor

Collaborators:

Oversight

U.S. FDA-regulated Drug: No

U.S. FDA-regulated Device: No

U.S. FDA IND/IDE: No

Human Subjects Review: Board Status: Exempt

Data Monitoring:

Study Description

Brief Summary: Application of Decision Analysis Techniques' in Huge Health-checkup Database to Explore the High-risk Group With Metabolic Syndrome (MetS)

Detailed Description: According to the American Heart Association#AHA#modified Adult Treatment Panel III#ATP-III# and the criteria of Health Promotion Administration, Taiwan. Five indices are used to define metabolic syndrome#MetS): including waist circumference #WC), high blood pressure#H/P#, fasting plasma glucose#FPG#, triglyceride#TG#, and high-density lipoprotein-cholesterol#HDL-C#. The recent researches showed us, there was no research applying the five criteria into their decision model. This study proposal will be the first study which evaluated the importance of the criteria related to apply these indices and decision model into the clinic for risk factors assessment.

This study was divided into 2 stages: (1) to analyze the big database of health examination to find out the major decision-making analysis module of MetS, including the level of importance and decision-making weight of 5 indicators, which can be provided as reference for suggestions on clinical medical treatments or health education focuses of health management of sub-health population; (2) to analyze other demographic variables of the database (educational background, residence, occupation, etc.) and the variables affecting health patterns (including smoking, drinking, long-term sitting work pattern) to find out the important variables affecting high risk group for MetS among populations of all ages, in order to investigate the improvement strategies for early prevention or intervention of important variables. As aging society is coming, it is estimated that the elderly people over the age of 65 in Taiwan will reach 20% by 2025. According to the estimation of Executive Yuan, the growth rate of healthcare service industry will reach at least 17%, and the annual output value will reach USD 18 billion. Therefore, this study intends to develop strategies for preventing chronic illness in the middle-aged and elderly people and find out the characteristic variables of high risk group according to different age groups to further reduce the incidence of MetS or CVD.

Conditions

Conditions: Mets

Keywords: Metabolic Syndrome#MetS#
Classification
Decision Tree
Risk Factors Assessment

Study Design

Study Type: Observational [Patient Registry]

Observational Study Model: Other

Time Perspective: Other

Biospecimen Retention: None Retained

Biospecimen Description:

Enrollment: 100000 [Anticipated]

Number of Groups/Cohorts: 1

Target Follow-Up Duration: 10 Years

Groups and Interventions

Intervention Details:
no

no

Outcome Measures

Primary Outcome Measure:

1. analyze the big database of health examination to find out the major decision-making analysis module of MetS
   This study plans to use decision analysis and new statistical techniques, including decision tree algorithms; random forest algorithms; multivariate linear regression combinations and hierarchical linear models, and with a large number of health databases.

   Analysis, through the comprehensive health check report and physiological indicator data accumulated over many years, find more key variables or physiological indicators that can be used to evaluate MetS or CVD, in order to provide government departments, medical institutions or nationals early Detect or prevent, and further reduce the overall rate of MetS in Taiwan at this stage.

   [Time Frame: no]

Eligibility

Study Population: As aging society is coming, it is estimated that the elderly people over the age of 65 in Taiwan will reach 20% by 2025. According to the estimation of Executive Yuan, the growth rate of healthcare service industry will reach at least 17%, and the annual output value will reach USD 18 billion. Therefore, this study intends to develop strategies for preventing chronic illness in the middle-aged and elderly people and find out the characteristic variables of high risk group according to different age groups to further reduce the incidence of MetS or CVD.

Sampling Method: Non-Probability Sample

Minimum Age:

Maximum Age:

Sex: All

Gender Based: No

Accepts Healthy Volunteers: No

Criteria: Inclusion Criteria:

1. In 2006-2016, the MJ Health Research Foundation's member,which continuously tested twice or more of the annual health check database , about 90,000 people.
2. The person who was in charge of the taxi driver health checkup project commissioned by the New North City Transportation Bureau at Far Eastern Memorial Hospital, data period 2012-2016, about 2,000 people.

Exclusion Criteria:

- no

Contacts/Locations

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IPDSharing

Plan to Share IPD: No
no

References

Citations:

Links:

Available IPD/Information:

亞東紀念醫院人體試驗審議委員會

Research Ethics Review Committee
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人體試驗/研究許可書

西元二○一八年九月十日

案件編號：107126-E
計畫名稱：應用決策分析技術於巨量健檢資料庫以探討新陳代謝症候群之高危風險族群
計畫主持人：陳銘樹
共/協同主持人：吳彥雯
研究成員：邱琦皓、吳冠葶、楊雅如、葉欣
計畫書版本：Version6, 20180829, FEMH-107126-E
受試者說明及同意書版本：免除受試者說明及同意書
中文摘要：Version2,20180830, FEMH-107126-E
英文摘要：Version1,20180620, FEMH-107126-E
試驗期間：2018 年 9 月 10 日至 2021 年 9 月 1 日
試驗人數：100000 (亞東：2000)
追蹤審查頻率：一年

上述計畫已於本院人體試驗審議委員會審查，同意人體試驗/研究進行。有效期限自二○一八年九月十日至二○一九年九月十日。(依照 ICH-GCP 規定，臨床試驗每屆滿一年，人體試驗委員會必須重新審查是否繼續進行。請於有效期限到期二個月前繳交持續審查報告以利本會進行審查)

主任委員 張淑雯

Permission of Clinical Trial
Far Eastern Memorial Hospital

Date: September 10, 2018

FEMH No.: 107126-E
Protocol Title: Application of decision analysis techniques' in huge health-checkup database to explore the high-risk group with metabolic syndrome (MetS)
Principal investigator: Ming-Shu Chen
Co- investigator: Yen-Wen Wu
Research Associate: Chi-Hao Chiu, Guan-Ting Wu, Ya-Ru Yang, Xin Ye
Protocol Version: Version6, 20180829, FEMH-107126-E
Informed Consent Form: Waiver
Chinese Synopsis: Version2,20180830, FEMH-107126-E
English Synopsis: Version1,20180620, FEMH-107126-E
Trial period: September 10, 2018 to September 1, 2021
Number of subjects: 100000 (FEMH: 2000)
Continuing review frequency: One year

Above study has been approved by the Research Ethics Review Committee of the Far Eastern Memorial Hospital and valid since September 10, 2018 to September 10, 2019. The Committee is organized and operates according to Good Clinical Practice and the applicable laws and regulations. Apply for a continuing review not less than two months prior to approval expiration date.

Shu-Wen Chang M.D., Professor of Ophthalmology
Chairman
Research Ethics Review Committee

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Health informatics
Keywords:	Other metabolic, e.g. iron, porphyria < DIABETES & ENDOCRINOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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ABSTRACT

Objectives: To determine the association between metabolic syndrome (MetS) prevalence and occupation—distinguished by being sedentary and nonsedentary and by socioeconomic status (SES). There are eight occupation categories are extensively considered. Numerous occupations, lawyers, teachers, engineers, senior section chiefs of enterprises, taxi driving, and so on are considered.
Methods: Two data sets with 64,578 cases were analyzed. MetS was identified according to criteria of the modified Adult Treatment Panel III. A multiple logistic regression algorithm was used to test factors for three age segments. R for Windows (version 3.5.1) was used for all statistical analyses.
Results: MetS prevalence was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. MetS was significantly more likely for sedentary occupations (OR = 0.89, p < 0.001) including taxi drivers (33.41%), managers (32.52%), and workers in the service sector (29.53%). Taxi drivers were most likely to have MetS. Those working in occupations that are sedentary and associated with a high SES were more likely to have MetS (OR = 1.02) compared with those working in sedentary occupations associated with no particular SES.
Conclusions: Because high-SES and sedentary occupations increase MetS risk, we suggest for the authorities to focus them, specifically in tracking their trends for MetS indexes and tailoring health promotion programs to these groups.

Keywords: Sedentary occupation, Metabolic Syndrome, Risk assessment, Regression Model

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Strengths and limitations of this study

- We might be the first one to evaluate sedentary/non-sedentary occupations and by SES extensively.
- Two data sets with 64,578 cases were employed.
- Three occupation groups include general sedentary-related, non-sedentary related, and sedentary-related with high-SES.
- Chi-square test are used to evaluate the categorical factors of in three age groups and occupations, and multiple logistic regression tests the risk-factor associations
- The main limitations of this study is that the data was only collected in Taiwan, which might be not the same for other countries.

INTRODUCTION

MetS has been established as a public health concern in Western countries and is an increasingly severe public health problem in numerous countries. In the United States, 34% of adults satisfy the MetS criteria, which was formulated in the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III); in particular, US adults aged more than 60 years are more prone to having MetS [1]. The health status of the Taiwanese population was estimated in 2002 using the data of 7566 participants in a nationwide cross-sectional population-based survey, named the Taiwanese Survey on

Prevalence of Hyperglycemia, Hyperlipidemia, and Hypertension (TwSHHH). Hwang et al. [2] reported that the prevalence of MetS in women increases rapidly after the menopausal period to become higher than that in men; they also noted MetS' high correlations with age as well as overweight and obesity. In other Asian countries, MetS is also an important health issue, and studies on MetS have been conducted in Thailand [3], Malaysia [4], South Korea [5], and Japan [6] in addition to studies in Taiwan [2, 7, 8].

MetS is highly correlated with overweight and obesity [2, 9], and it comprises a constellation of interrelated metabolic disorders—including hypertension [10], type 2 diabetes mellitus (T2DM) [11, 12, 13], cardiovascular disease (CVD) [13, 14], and stroke [15]. In addition, people with MetS have fivefold diabetes [16]. The scholarly evidence has also preponderantly indicated that individuals with MetS or a sedentary occupation have increased the incidence of T2DM and coronary heart disease as well as increased mortality due to CVD [11, 12, 13, 14, 17]. The other study also pointed out the reduced muscular strength is also associated with increased CVD and CVD-related mortality [18].

As a result, the reasons causing MetS must be investigated. The risk factors for MetS include aging, sedentary, long working hours, physical inactivity, Western diet, sleep duration greater than 7 hours [19], and high occupational stress [20]. Socioeconomic status (SES) and lifestyle are the possible risk factors for MetS [21, 22]. Of these factors, prolonged sitting is an ostensible risk factor for negative health outcomes across all ages due to the rapid automation of the workplace [23, 24]. More recent studies have begun discussing the correlation of sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 28, 29, 30].

Bakrania et al. [26] demonstrated that sedentary behavior affects not only physical but also cognitive health. Leischik et al. [31] compared the 97 firefighters, 55 policemen, and 46 sedentary office workers in German. Sedentary occupations show to be associated with obesity and metabolic syndrome in middle-aged men. The other study on workers in a petroleum company reported that sedentary behavior—specifically for 10 h/day with two-thirds of those 10 h spent sitting at work—was significantly associated with cardiometabolic risk factors [32]. An individual having a sedentary occupation is significantly more likely to be obese. Strauß et al. [9] found that office workers had a significantly greater abdominal waist circumference (WC) than do firefighters and that 33% of sedentary German office workers had MetS. Later on, Strauß et al. [33] further evaluated 10-year cardiovascular risk for 46 office workers in German by using the Framingham score. The office workers has tendency cardiovascular risk and higher rate of MetS.

However, its risk association must be replicated with respect to occupational condition or SES [22, 32, 34, 35]. SES is a combination of salary, social status, and education and can be evaluated by occupation or work status [36]. Al-Thani et al. [34] shown that no statistical significant association was founded for occupation. Mehrdad et al. [22] found the association between MetS and three job ranks in a company didn't cause significant difference. Therefore, this study focused on MetS prevalence—and the related chronic disease biochemical test indexes—with respect to occupation among adults in Taiwan. The current study focused on sedentary occupations and occupations associated with different SES condition. We selected taxi driving as the representative sedentary occupation, in addition to analyzing some high-SES-associated occu- pations.

Finally, although there are numerous studies that include some occupations or SES condition [22, 32, 34, 35], this research might be the first one to study those in sedentary or more high-SES-associated occupations, especially occupations that increase MetS risk which haven't explored yet by prior researches. There are eight major occupations and then to be allocated in three groups, including general sedentary occupation, non-sedentary occupation, and sedentary occupations with high-SES. Our hypothesis includes whether there is a difference between the sedentary occupation, and high-SES would cause higher MetS prevalence. The next section explains the methods used in this paper.

METHODS

Definition of a sedentary occupation and SES

According to the US Department of Labor's Dictionary of Occupational Titles, sedentary work is the occasional exertion of >10 lbs of force and/or a frequent exertion of a negligible amount of force. In this definition, "occassional" and "frequent" are defined as being present <1/3 and 1/3–2/3 of the time, respectively. Such force can be used to lift, carry, push, pull, or move objects—including the human body. Sedentary work involves sitting most of the time, but it may involve walking or standing for brief periods [1]. Thus, a job was defined to be sedentary if walking and standing are required only occasionally and all other sedentary criteria are met [37]. In this research, we select the taxi drivers, clerical, and administrative jobs as the representative belonged to the sedentary-related occupations in comparison with other non-sedentary-related, and sedentary-related high-SES jobs in the analysis to compare three categories of occupations. The rationale

[1] https://www.thehortongroup.com/resources/the-strength-test-levels

and hypothesis of this study are based on the previous studies to determine whether sedentary-related occupations have a higher risk of developing MetS, and at the same time compare the differences between high-SES and non-SES in sedentary occupations.

We employed eight occupational categories: Professional-1, Technical-2, Managerial-3, Sales-4, Service-5, Clerical and Administrative-6, Manual Labor-7, and Taxi Driving-8. The detail occupations of the Professional-1, Technical-2, and Managerial-3 categories are shown in Table 1. According to Jans et al. [38], there are differences in sitting time among occupational groups as well as business sectors in Dutch. We put the occupation categories into three groups: general sedentary-related (Group-I), non sedentary-related (Group-II), and sedentary-related and high-SES (Group-III), based on occupational environment and social-economic status (SES) of occupations. The arrangement of the eight occupations is illustrated in Table 2.

Definition of MetS

MetS was defined in this study according to guidelines from the Health Promotion Administration of Taiwan's Ministry of Health and Welfare. MetS prevalence was evaluated using the definitions of the modified ATP III and the MetS criteria for Taiwanese (MetS-TW). Five major factors were used to determine whether a person had MetS: WC, high blood pressure, fasting blood sugar (BS), triglyceride (TG) level, and HDL-C level. High blood pressure included the rates of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically, a Taiwanese person is defined as having MetS if they have three or more of the following five conditions in the ATP III: abdominal obesity, high TG, low HDL-C, hypertension, and hyperglycemia; the rules are detailed in Table 3.

Data resource and data collection

We obtained two datasets from the New Taipei City Government Annual Taxi Health Examination Survey and MJ Health Check-Up–Based Population Database (MJPD). The duration of the first dataset covered the 2012–2016 period and was conducted by Far Eastern Memorial Hospital (FEMH)[2]. The second dataset MJPD was collected from four MJ clinics, which provide periodical health examinations to their members, which is accessible to researchers upon request[3].

All of the data sets used in this study were authorized and given to this study's researchers by the MJPD Health Research Foundation with FEMH IRB approval. The laboratory data of the two databases were obtained from the same biochemical examination apparatus (Hitachi-7600). The two datasets conform to the ISO-15189 guidelines. Regarding ethical data use, the protocol of this study was approved by the Research Ethics Review Committee at FEMH (FEMH-IRB-107126-E and) and the MJ Health Research Foundation.

Data preprocessing

The FEMH database had 2,294 cases of taxi drivers (2,182 male and 112 female). To ensure representativeness in the analysis, we excluded female taxi drivers because their data only comprised 4.87% of the data set. The MJPD database had 117,076 cases (62,396 male and 54,680 female). We also excluded female taxi drivers to control for the effects of gender. Therefore, we analyzed data of 64,578 cases: 2,182 cases of taxi drivers from the FEMH database, and 62,396 health screening cases from the MJ database. After combining the two databases, MetS was identified based on the NCEP ATP III MetS criteria, and MetS prevalence was calculated.

Because age has been demonstrated to be an essential influence on MetS risk, we stratified the data into ≤40-, 40–60-, and ≥60-year-old groups. We focused on the effect on MetS risk from occupation—distinguished first by whether the occupation is sedentary versus or non-sedentary and second, by the occupation's association with SES.

Statistical analysis

The statistical analysis and graphs in this study were performed using an R (v3.5.1) package for multiple logistic regression. A p-value of <0.05 indicated statistical significance between the two test populations. In the univariate analysis, a two-sample independent *t* test was adopted to analyze the difference in the mean value of continuous variables between participants with and without MetS. An exact chi-square test was used to define the differences between categorical variables. Multiple logistic regression was used to determine the effect of all influential variables.

RESULTS

We only analyzed the data of those who first, were taxi drivers and second, had two records in the database. Any personal information of all individuals was removed to protect their privacy. We analyzed 201,087 records in total, including those for gender, height, weight, WC, blood pressure, TG level, HDL-C, SBP, DBP, and fasting BS. We computed the BMI

[2] FEMH is one of the exclusive hospitals that mainly undertakes the annual health check-up of taxi drivers in New Taipei City, and it is also the hospital with the largest number of services and the largest hospital in New Taipei City.

[3] http://www.mjhrf.org/main/page/release1/en/release01

Table 1 Detail Occupation groups in the Professional-1, Technical-2, and Managerial-3 categories

Categories	Occupations
Professional-1	Lawyers, teachers, accountants, and nurses
Technical-2	Engineers, architects, and programmers
Managerial-3	Senior executives of government departments or section chiefs of enterprises

Table 2 Sedentary versus non-sedentary occupation categories association with SES

Group number	Type	Categories
Group-I	General sedentary-related	Service-5, ClericalandAdministrative-6, andTaxi Driver-8
Group-II	Non sedentary-related	Sales-4, and Manual Labor-7
Group-III	Sedentary-related and high-SES	Professional-1, Technical-2, and Managerial-3

Table 3 MetS criteria

No.	Factors	Abnormal Condition
1	Fasting Plasma Glucose (FPG)	FPG ≥ 100mg/dL
2	High Density Lipoprotein Cholesterol (HDL-C)	Male < 40mg/dL or Female < 50mg/dL
3	High Blood Pressure	SBP ≥ 130mmHg or DBP ≥ 85mmHg
4	Triglyceride (TG)	TG ≥ 150mg/dL
5	Waist Circumference (WC)	Male ≥ 90 cm or Female ≥ 80 cm

from the height and weight data. In the next sub-sections, we present the descriptive statistics and the correlations among factors.

Descriptive Statistics

After processing the data, the original database comprised 64,578 cases: 2,182 cases of taxi drivers from the FEMH database, and 62,396 health screening cases from the MJ database. We excluded the data entries with the occupational category "Others" and with "missing values," leaving 43,782 cases for data analysis. Of these 43,782 cases, 31,454 did not have MetS and 12,328 had MetS. MetS prevalance in this study thus was 28.16%. We conducted comparisons for the various physiological parameters, such as weight, SBP, and DBP (Table 4). Compared with those with MetS, individuals without MetS were healthier: their weight, SBP, WC, TG level, and BMI were lower and their HDL-C level was greater. All characteristics were significantly related to MetS ($p < 0.001$).

We further stratified the cases into three age groups: 21,410 cases were in the younger age group (≤40 years old), 20,565 cases were in the middle-aged group (40–60 years old), and 1,807 cases were in the older age group (>60 years old). Table 5 details the age-stratified data—most cases were aged ≤40 years. MetS prevalence was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. The result is consistent with studies reporting that MetS becomes more likely with age [1, 15]. Furthermore, as noted in table 5, all factors—such as weight, SBP, DBP, and WC—were significantly related ($p < 0.001$) to MetS prevalence for all age groups, identical to the findings for the unstratified data in Table 4.

Chi-square exact test and multiple logistic regression analysis

Because some variables for characteristics were categorical, we used a chi-square test to analyze the relationships among them in Table6. Age and occupation were significantly associated with MetS ($p < 0.001$). To explore the public perception of risk indicators of MetS, we further analyzed the eight aforementioned occupational categories. All occupation categories were significantly associated with MetS ($p < 0.001$) Among the occupations, taxi driving had the highest MetS prevalence (33.41%), which was much higher than the 28.16% prevalence in the unstratified data. The occupational categories with the highest MetS prevalence were Taxi Driver-8, Managerial-3, and Sales-4 at 33.41%, 32.52%, and 29.53%, respectively.

We analyzed the associations between major factors in a multiple logistic regression model in Table 7. BMI (%), body weight (kg), body fat percentage (%) and total cholesterol (mg/dL) were revealed to be the important risk factors for MetS ($p < 0.001$). Age is the most important risk indicator,

Table 4 Comparison of MetS characteristics

	Total		Metabolism syndrome Without (n=31,454)		Metabolism syndrome With (n=12,328)		
Variables	Mean	(SD)	Mean	(SD)	Mean	(SD)	p-value
Weight(Kg)	72.8	(11.3)	69.7	(9.3)	80.9	(12.1)	<0.001
SBP(mmHg)	120.6	(15.0)	116.8	(13.0)	130.3	(15.4)	<0.001
DBP(mmHg)	77.4	(10.5)	74.8	(9.2)	84.0	(10.6)	<0.001
WC(cm)	84.1	(8.7)	81.2	(7.0)	91.5	(8.3)	<0.001
Body Fat (%)	24.3	(5.5)	22.8	(4.8)	28.0	(5.3)	<0.001
FPG(mg/dl)	103.2	(18.7)	99.5	(12.6)	112.6	(26.8)	<0.001
TG(mg/dl)	136.8	(103.5)	113.6	(74.7)	196.0	(137.7)	<0.001
CHOL	197.5	(34.2)	195.4	(33.1)	202.8	(36.1)	<0.001
HDL-C(mg/dl)	52.0	(11.4)	54.3	(11.3)	46.0	(9.3)	<0.001
LDL-C(mg/dl)	124.8	(32.1)	122.9	(31.1)	129.6	(33.9)	<0.001
BMI(Kg/m2)	24.8	(3.4)	23.7	(2.7)	27.4	(3.5)	<0.001

Table 5 Comparisons of MetS characteristics stratified by age

	Age≤40 (n=21,410)			40<Age≤60 (n=20,565)			Age>60 (n=1,807)		
	Non MetS	MetS		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	70.8(9.7)	85.1(12.5)	<0.001	68.7(8.5)	78.6(11.0)	<0.001	64.9(8.5)	73.5(9.6)	<0.001
SBP(mmHg)	115.9(11.7)	128.9(14.7)	<0.001	117.1(13.7)	130.5(15.6)	<0.001	125.8(17.2)	139.2(16.2)	<0.001
DBP(mmHg)	73.4(8.6)	82.4(10.6)	<0.001	76.1(9.5)	85.0(10.5)	<0.001	77.8(10.5)	85.0(10.0)	<0.001
WC(cm)	80.8(7.2)	92.6(8.6)	<0.001	81.6(6.7)	90.6(8.1)	<0.001	83.0(7.4)	91.5(8.0)	<0.001
Body Fat (%)	23.3(5.0)	29.6(5.3)	<0.001	22.3(4.5)	27.0(5.0)	<0.001	21.3(4.8)	25.8(5.4)	<0.001
FPG(mg/dl)	97.8(9.3)	108.5(22.8)	<0.001	101.2(14.7)	114.6(27.7)	<0.001	103.3(21.0)	122.0(37.6)	<0.001
TG(mg/dl)	109.1(74.0)	198.9(148.4)	<0.001	120.1(77.0)	196.0(132.2)	<0.001	101.1(47.2)	173.7(103.5)	<0.001
CHOL	192.1(32.8)	203.5(36.2)	<0.001	199.6(33.0)	203.1(36.0)	<0.001	192.0(34.0)	194.6(35.3)	<0.001
HDL-C(mg/dl)	54.4(11.2)	45.4(8.9)	<0.001	54.2(11.3)	46.3(9.5)	<0.001	55.3(11.8)	46.3(10.5)	<0.001
LDL-C(mg/dl)	120.6(31.1)	131.9(33.9)	<0.001	125.8(30.9)	128.7(34.0)	<0.001	120.2(31.3)	122.0(32.0)	<0.001
BMI(Kg/m2)	23.7(2.9)	28.2(3.7)	<0.001	23.7(2.5)	27.0(3.2)	<0.001	23.8(2.8)	26.6(3.3)	<0.001

Table 6 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables

		Non-MetS		MetS		
Variables	Item	No.	(%)	No.	(%)	p-value
Age	Age≤40	16,483	(76.99)	4,927	(23.01)	<0.001
	40<Age≤60	13,813	(67.17)	6,752	(32.83)	<0.001
	Age>60	1,158	(64.08)	649	(35.92)	<0.001
Occupation	Professional-1	1936	(74.18)	674	(25.82)	<0.001
	Technical-2	12,603	(74.5)	4,314	(25.5)	<0.001
	Managerial-3	5,704	(67.48)	2,749	(32.52)	<0.001
	Sales-4	4,516	(70.47)	1,892	(29.53)	<0.001
	Service-5	1,557	(71.32)	626	(28.68)	<0.001
	Clerical and Administrative-6	1,558	(73.94)	549	(26.06)	<0.001
	Manual Labor-7	2,127	(72.79)	795	(27.21)	<0.001
	Taxi Driver-8	1,453	(66.59)	729	(33.41)	<0.001

with MetS becoming more likely with age. As for the three occupational groups that the eight occupational categories fell under, those in group-II (i.e., non-sedentary) occupations were less likely to develop MetS (OR = 0.89, CI: 0.82-0.97, p = 0.0107) compared with the two other groups.

DISCUSSION

Owen et al. [24] reported that the average person spends (1) 71% of their daily waking hours in a sedentary state and (2) only 30 min daily on moderate intensity physical activity on most days of a week. As noted in the literature review in the introduction section, MetS likelihood significantly increases with sedentary time and sedentary behavior [24, 39, 40]. Being sedentary also makes one significantly more likely to be obese [9], have poor cardiometabolic health [17, 32], and have poor cognitive health [26]. An increasing number of researchers are beginning to investigate the correlation of a sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 29, 30].

However, most studies on MetS risk factors have focused on lack of physical activity rather than sedentary occupation. These studies have noted that in adults, spending more time being sedentary increases metabolic risk [41, 42]. Recent research has also demonstrated that lifestyle and SES are significant risk factors for MetS [21, 22] and CVD [21, 43, 44]. Nonetheless, Kim et al. [45] argued that a causal relationship of SES with MetS and CVD risks—as indicated by the Framingham risk score—cannot be established by the current body of cross-sectional evidence. Furthermore, scholars have yet to investigate the role of occupation in MetS risk, with occupation further distinguished by sedentary status and SES associations. In particular, MetS risk is likely to differ between those working in typically sedentary white-collar occupations (such as doctors, professors, managers, and engineers) and those working in sedentary blue-collar occupations (such as administrative staff, service staff, and even taxi drivers).

The current results indicated that those working in general sedentary and high-SES-associated occupations are at a higher risk of MetS compared with non-sedentary occupations. We also confirmed the importance of age as a MetS risk factor (Table 6). In particular, we further stratified the cases into three age groups: 21,410 cases were in the younger age group (≤40 years old), 20,565 cases were in the middle-aged group (40–60 years old), and 1,807 cases were in the older age group (>60 years old). Most cases were in the younger age group. Moreover, MetSprevalencewas23.01%, 32.83%, and35.92% for the younger, middle-aged, and older age groups, respectively, and the middle-aged significantly higher than younger people. Regarding occupation, sedentary (group-I) occupations were more significantly associated with MetS related to non-sedentary (group-II)occupations (OR=0.89, p=0.0107). Taxi drivers (33.41%), managers (32.52%) and service staff (29.53%) were the three occupational groups most likely to get MetS. This study compared three categories of occupation and focused on sedentary behavior and high SES. However three categories comparisons cannot reveal each effect of sedentary behavior and SES, it should be the limitation. In addition, the people belonged to high-SES may have better capability to cope with non-communication diseases compared with general sedentary occupations [36]. This reason might causes the odds ratio of sedentary and high-SES group is not significant compared with general sedentary group.

CONCLUSIONS

Although prolonged sitting is an ostensibly novel risk factor for health outcomes across all ages, its association must be replicated in occupational conditions [32]. In this study, we noted that age and occupation categories were risk factors for MetS, although a sedentary occupation has been known to be unhealthy. The study found that taxi drivers were indeed a high-risk group. However, high-SES-associated but sedentary occupations, such as a lawyer, teacher, accountant, doctor, nurse, engineer, and manager, were also high-risk groups for MetS. A study in South Korea's Gwangju city noted bus drivers to be a high-risk group for MetS and CV [30], but without specifically analyzing the occupational categories in the communities that taxi drivers were living in. In the current study, taxi driving, among eight occupational categories, had the highest MetS prevalence. However, after the eight categories were grouped into three groups, general sedentary occupations (group-I), of which taxi driving falls under, had a lower MetS prevalence than did sedentary and high-SES (group-III) occupations. This means that in general, high-SES and sedentary workers has a little-bit more risk than the general sedentary counterparts. Nevertheless, those in non-sedentary(group-II)occupations(e.g., salesandmanuallabor) had a lower risk of MetS compared with their sedentary counterparts. We recommend for government authorities to focus on taxi drivers, sedentary blue-collar workers, and sedentary high-SES workers in their policies, particularly in tailoring health promotion programs to these groups, such as aerobic exercise [46] or physical activities [28, 47]

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Table 7 Multiple logistic regression results for risk-factor associations

Variables	Condition	OR	95%CI		p-value
Age	Age ≤ 40	1.00			
	40 < Age ≤ 60	2.32	2.20	2.46	<0.001
	Age > 60	3.65	3.22	4.14	<0.001
Occupation	Group-I*	1.00			
	Group-II†	0.89	0.82	0.97	0.0107
	Group-III‡	1.02	0.96	1.09	0.523
Weight(Kg)		1.03	1.03	1.04	<0.001
BMI		1.28	1.26	1.31	<0.001
Body Fat Percentage(%)		1.08	1.07	1.08	<0.001
HDL-C(mg/dl)		0.99	0.99	1.00	<0.001
Total Cholesterol(mg/dl)		1.01	1.01	1.01	<0.001

*Group-I: General sedentary-related occupations
†Group-II: non sedentary-related occupations ‡Group-III: sedentary-related occupations with high-SES

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FOOTNOTES

Contributors

M.-S.C. (Ming-Shu Chen) conceived and designed the experiments; M.-S.C. and C.-H.C. (Chi-Hao Chiu) performed the experiments; C.-H.C., and S.-H.C. (Shih-Hsin Chen) analyzed the data; M.-S.C. were supervised the study; M.-S.C. contributed investigation material; M.-S.C., C.-H.C., and S.-H.C. wrote this paper together. S.-H.C. submitted this paper.

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COMPETING INTERESTS

The authors declare no conflicts of interest concerning this study.

Ethics approval

Ethical approval was obtained from the Research Ethics Review Committee at the Far Eastern Memorial Hospital in New Taipei City, Taiwan (Institutional Review Board approval number: FEMH-IRB-107126-E, v.02; board meeting and approval date: September 10, 2018). The MJ Health Research Foundation also approved this study. This study also has a PPS receipt (ClinicalTrials.gov ID: NCT04142593, Date: October 25, 2019)

Data sharing statement

The first dataset was restricted by the Research Ethics Review Committee of the Far Eastern Memorial Hospital (FEMH-IRB-107126-E, v.02) in order to protect participant privacy. The second dataset, MJPD, is accessible to researchers upon request. Please contact Dr. Ming-Shu Chen (email: tree1013@gmail.com) to obtain further information.

Consent to patient and public involvement statement

No patient involved.

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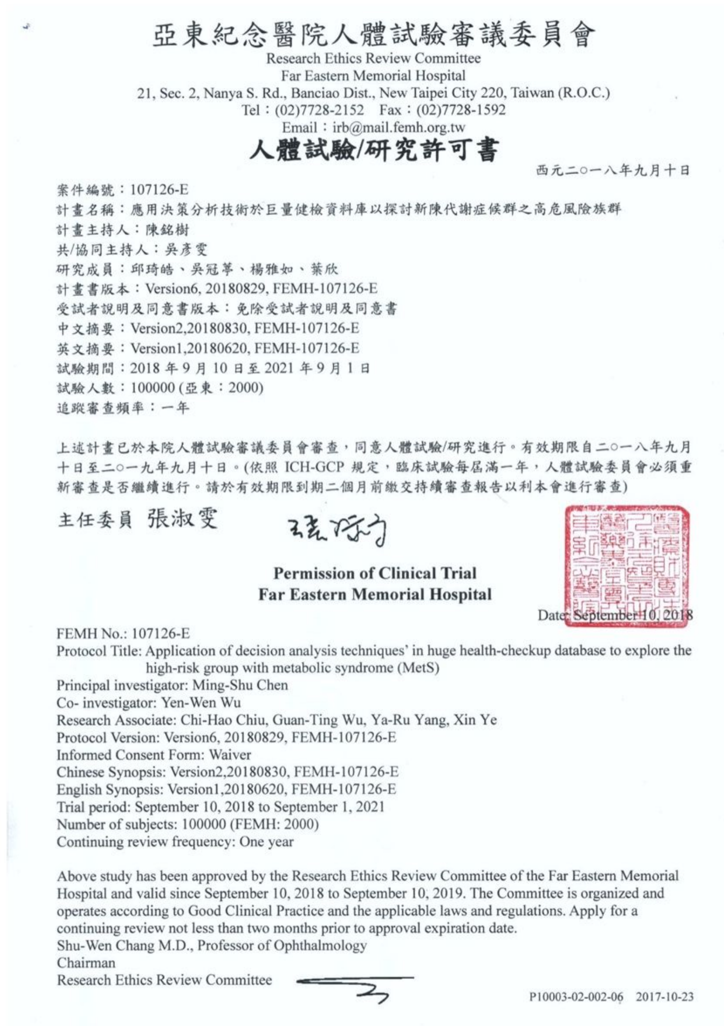
IRB CERTIFICATE



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人體試驗/研究許可書

西元二○一八年九月十日

案件編號：107126-E
計畫名稱：應用決策分析技術於巨量健檢資料庫以探討新陳代謝症候群之高危風險族群
計畫主持人：陳銘樹
共/協同主持人：吳彥雯
研究成員：邱琦皓、吳冠箏、楊雅如、葉欣
計畫書版本：Version6, 20180829, FEMH-107126-E
受試者說明及同意書版本：免除受試者說明及同意書
中文摘要：Version2,20180830, FEMH-107126-E
英文摘要：Version1,20180620, FEMH-107126-E
試驗期間：2018 年 9 月 10 日至 2021 年 9 月 1 日
試驗人數：100000 (亞東：2000)
追蹤審查頻率：一年

上述計畫已於本院人體試驗審議委員會審查，同意人體試驗/研究進行。有效期限自二○一八年九月十日至二○一九年九月十日。(依照 ICH-GCP 規定，臨床試驗每屆滿一年，人體試驗委員會必須重新審查是否繼續進行。請於有效期限到期二個月前繳交持續審查報告以利本會進行審查)

主任委員 張淑雯

Permission of Clinical Trial
Far Eastern Memorial Hospital

Date: September 10, 2018

FEMH No.: 107126-E
Protocol Title: Application of decision analysis techniques' in huge health-checkup database to explore the high-risk group with metabolic syndrome (MetS)
Principal investigator: Ming-Shu Chen
Co- investigator: Yen-Wen Wu
Research Associate: Chi-Hao Chiu, Guan-Ting Wu, Ya-Ru Yang, Xin Ye
Protocol Version: Version6, 20180829, FEMH-107126-E
Informed Consent Form: Waiver
Chinese Synopsis: Version2,20180830, FEMH-107126-E
English Synopsis: Version1,20180620, FEMH-107126-E
Trial period: September 10, 2018 to September 1, 2021
Number of subjects: 100000 (FEMH: 2000)
Continuing review frequency: One year

Above study has been approved by the Research Ethics Review Committee of the Far Eastern Memorial Hospital and valid since September 10, 2018 to September 10, 2019. The Committee is organized and operates according to Good Clinical Practice and the applicable laws and regulations. Apply for a continuing review not less than two months prior to approval expiration date.
Shu-Wen Chang M.D., Professor of Ophthalmology
Chairman
Research Ethics Review Committee

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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ABSTRACT

Objectives: To determine the association between metabolic syndrome (MetS) prevalence and occupation—distinguished by being sedentary and non-sedentary and by socioeconomic status (SES). Eight occupation categories are extensively considered. Numerous occupations, lawyers, teachers, engineers, senior section chiefs of enterprises, taxi driving, and so on are considered.

Methods: We analyzed two data sets with 73,506 cases. MetS was identified according to the criteria of the modified Adult Treatment Panel III. A multiple logistic regression algorithm was used to test factors for three age segments. We employed R for Windows (version 3.5.1) for all statistical analyses.

Results: MetS prevalence rate is increasing according to the age growth. Furthermore, When the age is above 60, MetS was significantly more likely for sedentary high-SES occupations (OR = 1.39, p < 0.0247) than those working in general sedentary occupations associated with no particular SES and non-sedentary job.

Conclusions: Because high-SES and sedentary occupations in the age above 60 increased the MetS risk, we suggest for the authorities to focus them, specif

Keywords: Sedentary occupation, Metabolic Syndrome, Risk assessment, Regression Model

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Strengths and limitations of this study

- We might be the first one to evaluate sedentary/non-sedentary occupations and by SES extensively.
- Two data sets with 73,506 cases were employed.
- Three occupation groups include general sedentary-related, non-sedentary related, and sedentary-related with high-SES.
- Chi-square test are used to evaluate the categorical factors of in three age groups and occupations, and multiple logistic regression tests the risk-factor associations
- The main limitations of this study is that the data was only collected in Taiwan, which might be not the same for other countries.

INTRODUCTION

MetS has been established as a public health concern in Western countries and is an increasingly severe public health problem in numerous countries. In the United States, 34% of adults satisfy the MetS criteria, which was formulated in the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III); in particular, US adults aged more than 60 years are more prone to having MetS [1]. The health status of the Taiwanese population was estimated in 2002 using the data of 7566 participants in a nationwide cross-sectional population-based survey, named the Taiwanese Survey on

Prevalence of Hyperglycemia, Hyperlipidemia, and Hypertension (TwSHHH). Hwang et al. [2] reported that the prevalence of MetS in women increases rapidly after the menopausal period to become higher than that in men; they also noted MetS' high correlations with age as well as overweight and obesity. In other Asian countries, MetS is also an important health issue, and studies on MetS have been conducted in Thailand [3], Malaysia [4], South Korea [5], and Japan [6] in addition to studies in Taiwan [2, 7, 8].

MetS is highly correlated with overweight and obesity [2, 9], and it comprises a constellation of interrelated metabolic disorders—including hypertension [10], type 2 diabetes mellitus (T2DM) [11, 12, 13], cardiovascular disease (CVD) [13, 14], and stroke [15]. In addition, people with MetS have five-fold diabetes[16]. The scholarly evidence has also preponderantly indicated that individuals with MetS or a sedentary occupation had increased the incidence of T2DM and coronary heart disease, as well as increased mortality due to CVD [11, 12, 13, 14, 17]. The other study also pointed out the reduced muscular strength is also associated with increased CVD and CVD-related mortality [18].

As a result, the reasons causing MetS must be investigated. The risk factors for MetS include aging, sedentary, long working hours, physical inactivity, Western diet, sleep duration greater than 7 hours [19], and high occupational stress [20]. Socioeconomic status (SES) and lifestyle are the possible risk factors for MetS [21, 22]. Of these factors, prolonged sitting is an apparent risk factor for negative health outcomes across all ages due to the rapid automation of the workplace [23, 24]. More recent studies have begun discussing the correlation of sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 28, 29, 30].

Bakrania et al. [26] demonstrated that sedentary behavior affects not only physical but also cognitive health. Leischik et al. [31] compared the 97 firefighters, 55 police officers, and 46 sedentary office workers in German. Sedentary occupations show to be associated with obesity and metabolic syndrome in middle-aged men. The other study on workers in a petroleum company reported that sedentary behavior—specifically for ten h/day with two-thirds of those ten h spent sitting at work—was significantly associated with cardiometabolic risk factors [32]. An individual having a sedentary occupation is substantially more likely to be obese. Strauß et al. [9] found that office workers had a significantly greater abdominal waist circumference (WC) than do firefighters and that 33% of sedentary German office workers had MetS. Later on, Strauß et al. [33] further evaluated the 10-year cardiovascular risk for 46 office workers in German by using the Framingham score. The office workers have a tendency cardiovascular risk and a higher rate of MetS.

However, its risk association must be replicated concerning the occupational condition or SES [22, 32, 34, 35]. SES is a combination of salary, social status, and education and can be evaluated by occupation or work status [36]. Al-Thani et al. [34] shown that no statistically significant association was founded for occupation. Mehrdad et al. [22] found the association between MetS and three job ranks in a company didn't cause a significant difference. Therefore, this study focused on MetS prevalence—and the related chronic disease biochemical test indexes— concerning occupation among adults in Taiwan. The current study focused on sedentary occupations and occupations associated with different SES conditions.

Finally, although numerous studies include some occupations or SES condition [22, 32, 34, 35], this research might be the first one to study those in sedentary or more high-SES-associated occupations, especially occupations that increase MetS risk, which hasn't explored yet by prior researches. There are eight major occupations and then allocated into three groups: general sedentary occupation, non-sedentary occupation, and sedentary occupations with high-SES. Our hypothesis includes a difference between the sedentary occupation and high-SES would cause higher MetS prevalence. The following section explains the methods used in this paper.

METHODS

Definition of a sedentary occupation and SES

According to the US Department of Labor's Dictionary of Occupational Titles, sedentary work is the occasional exertion of >10 lbs of force and/or a frequent exertion of a negligible amount of force. In this definition, "occasional" and "frequent" are defined as being present <1/3 and 1/3–2/3 of the time, respectively. Such force can be used to lift, carry, push, pull, or move objects—including the human body. Sedentary work involves sitting most of the time, but it may involve walking or standing for brief periods [1]. Thus, a job was defined to be sedentary if walking and standing are required only occasionally, and all other sedentary criteria are met [37]. In this research, we select the taxi drivers, clerical, and administrative jobs as the representative belonged to the sedentary-related occupations in comparison with other non-sedentary-related, and sedentary-related high-SES jobs in the analysis to compare three categories of occupations. The rationale and hypothesis of this study are based on the previous studies to determine whether sedentary-related careers have a higher risk of developing MetS, and at the same time, compare the differences between high-SES and non-SES in sedentary

[1] https://www.thehortongroup.com/resources/the-strength-test-levels

occupations.

We employed eight occupational categories: Professional-1, Technical-2, Managerial-3, Sales-4, Service-5, Clerical and Administrative-6, Manual Labor-7, and Taxi Driving-8. The detailed occupations of the Professional-1, Technical-2, and Managerial-3 categories are shown in Table 1. According to Jans et al. [38], there are differences in sitting time among occupational groups and business sectors in Dutch. We put the occupation categories into three groups: general sedentary-related (Group-I), non-sedentary (Group-II), and sedentary-related and high-SES (Group-III), based on occupational environment and social-economic status (SES) of occupations. The arrangement of the eight works is illustrated in Table 2.

Definition of MetS

MetS was defined in this study according to guidelines from the Health Promotion Administration of Taiwan's Ministry of Health and Welfare. MetS prevalence was evaluated using the definitions of the modified ATP III and the MetS criteria for Taiwanese (MetS-TW). Five major factors were used to determine whether a person had MetS: WC, high blood pressure, fasting blood sugar (BS), triglyceride (TG) level, and HDL-C level. High blood pressure included the rates of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically, a Taiwanese person is defined as having MetS if they have three or more of the following five conditions in the ATP III: abdominal obesity, high TG, low HDL-C, hypertension, and hyperglycemia; the rules are detailed in Table 3.

Data resource and data collection

We obtained two datasets from the New Taipei City Government Annual Taxi Health Examination Survey and MJ Health Check-Up–Based Population Database (MJPD). The duration of the first dataset covered the 2012–2016 period and was conducted by Far Eastern Memorial Hospital (FEMH)[2]. The second dataset MJPD was collected from four MJ clinics, which provide periodic health examinations to their members, which is accessible to researchers upon request[3].

All of the data sets used in this study were authorized and given to this study's researchers by the MJPD Health Research Foundation with FEMH IRB approval. The laboratory data of the two databases were obtained from the same biochemical examination apparatus (Hitachi-7600). The two datasets conform to the ISO-15189 guidelines. Regarding ethical data use, the protocol of this study was approved by the Research Ethics Review Committee at FEMH (FEMH-IRB-107126-E and) and the MJ Health Research Foundation.

[2] FEMH is one of the only hospitals that mainly undertakes the annual health check-up of taxi drivers in New Taipei City, and it is also the hospital with the most significant number of services and the largest hospital in New Taipei City

[3] http://www.mjhrf.org/main/page/release1/en/release01

Data preprocessing

In the beginning, any personal information of all individuals was removed to protect their privacy from the two datasets. The MJPD database had 71,212 cases (41,600 male and 29,612 female) after we excluded the data entries with the occupational category "Others" and "missing values" for data analysis. The FEMH database had 2,294 cases of taxi drivers (2,182 male and 112 female). After combining the two databases, there are 73,506 records in total. MetS was identified based on the NCEP ATP III MetS criteria, and MetS prevalence was calculated.

Because age has been demonstrated to be an essential influence on MetS risk, we stratified the data into ≤40, 40 to 60, and ≥60-year-old groups. We focused on the effect on MetS risk from occupation—distinguished first by whether the field is sedentary versus or non-sedentary and second by the occupation's association with SES.

Statistical analysis

This study's statistical analysis and graphs were performed using an R (v3.5.1) package for multiple logistic regression. A p-value of <0.05 indicated statistical significance between the two test populations. In the univariate analysis, a two-sample independent *t* test was adopted to analyze the difference in the mean value of continuous variables between participants with and without MetS. An exact chi-square test was used to define the differences between categorical variables. Multiple logistic regression was used to determine the effect of all influential variables.

RESULTS

We analyzed the dataset by gender, height, weight, WC, blood pressure, TG level, HDL-C, SBP, DBP, and fasting BS. We computed the BMI from the height and weight data. In the next sub-sections, we present the descriptive statistics and the correlations among factors.

Descriptive Statistics

Of these 73,506 cases, 57,932 did not have MetS and 15,574 had MetS. MetS prevalence in this study thus was 21.19%. We conducted comparisons for the various physiological parameters, such as weight, SBP, and DBP for males and females in

Table 1 Detail Occupation groups in the Professional-1, Technical-2, and Managerial-3 categories

Categories	Occupations
Professional-1	Lawyers, teachers, accountants, and nurses
Technical-2	Engineers, architects, and programmers
Managerial-3	Senior executives of government departments or section chiefs of enterprises

Table 2 Sedentary versus non-sedentary occupation categories association with SES

Group number	Type	Categories
Group-I	General sedentary-related	Service-5, ClericalandAdministrative-6, andTaxi Driver-8
Group-II	Non sedentary-related	Sales-4, and Manual Labor-7
Group-III	Sedentary-related and high-SES	Professional-1, Technical-2, and Managerial-3

Table 3 MetS criteria

No.	Factors	Abnormal Condition
1	Fasting Plasma Glucose (FPG)	FPG ≥ 100mg/dL
2	High Density Lipoprotein Cholesterol (HDL-C)	Male < 40mg/dL or Female < 50mg/dL
3	High Blood Pressure	SBP ≥ 130mmHg or DBP ≥ 85mmHg
4	Triglyceride (TG)	TG ≥ 150mg/dL
5	Waist Circumference (WC)	Male ≥ 90 cm or Female ≥ 80 cm

Table 4 and Table 5, respectively. Compared with MetS, individuals without MetS were healthier: their weight, SBP, WC, TG level, and BMI were lower, and their HDL-C level was greater. All characteristics were significantly related to MetS ($p < 0.001$).

We further stratified the cases into three age groups, including the younger age group (≤40 years old), the middle-aged group (40–60 years old), and the older age group (>60 years old). Table 6 and Table 7 detail the age-stratified data of male and female, respectively. MetS prevalence of males was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. The prevalence rates of the female are 6.23%, 15.68%, and 32.07% for the younger, middle-aged, and older age groups, respectively. The result is consistent with studies reporting that MetS becomes more likely with age [1, 15]. Furthermore, as noted in Table 6 and Table 7, most factors—such as weight, SBP, DBP, and WC—were significantly related ($p < 0.001$) to MetS prevalence for all age groups, identical to the findings for the unstratified data in Table 4 and Table 5.

Chi-square exact test and multiple logistic regression analysis

Because some variables for characteristics were categorical, we used a chi-square test to analyze the relationships among them for males and females in Table 8 and Table 9, respectively. We marked some important information in bold. Age and occupation were significantly associated with MetS ($p < 0.001$). To explore the public perception of risk indicators of MetS, we further analyzed the eight aforementioned occupational categories. All occupation categories were significantly associated with MetS ($p < 0.001$). Among the occupations, taxi driving had the highest MetS prevalence rate (e.g., 33.41% and 60.71% for male and female, respectively) even though the number of female taxi driving was only 44, which was much higher than the average prevalence rate (28.16% and 10.92% for male and female, respectively) in the unstratified data. The occupational categories with the second and the third highest MetS prevalence of males were Managerial-3 and Sales-4 at 32.52%, and 29.53%, respectively. On the other hand, the second and the third highest MetS prevalence of females were Manual Labor-7 and Managerial-3 at 18.97%, and 12.41%, respectively.

According to Table 8 and Table 9, the prevalence rates of both males and females were high when age is greater than or equal to 60; we focus on this age group. We analyzed the associations between major factors in a multiple logistic regression model in Table 10. BMI (%), body weight (kg), body

Table 4 Comparison of MetS characteristics of male

	Total		Without (n=31,454)		With (n=12,328)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	72.8	11.3	69.7	9.3	80.9	12.1	<0.001
SBP(mmHg	120.6	15.0	116.8	13.0	130.3	15.4	<0.001
DBP(mmHg	77.4	10.5	74.8	9.2	84.0	10.6	<0.001
WC(cm)	84.1	8.7	81.2	7.0	91.5	(8.3	<0.001
Body Fat (%	24.3	5.5	22.8	4.8	28.0	5.3	<0.001
FPG(mg/dl)	103.2	18.7	99.5	12.6	112.6	26.8	<0.001
TG(mg/dl	136.8	103.5	113.6	74.7	196.0	137.7	<0.001
CHOL	197.5	34.2	195.4	33.1	202.8	36.1	<0.001
HDL-C(mg/dl)	52.0	11.4	54.3	11.3	46.0	9.3	<0.001
LDL-C(mg/dl)	124.8	32.1	122.9	31.1	129.6	33.9	<0.001
BMI(Kg/m2)	24.8	3.4	23.7	2.7	27.4	3.5	<0.001

Table 5 Comparison of MetS characteristics of female

	Total		Without (n=26,478)		With (n=3,246)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	55.78	9.35	54.32	7.76	67.70	12.28	<0.001
SBP(mmHg)	107.49	14.89	105.48	13.15	123.88	17.81	<0.001
DBP(mmHg)	68.44	10.06	67.32	9.22	77.65	11.76	<0.001
WC(cm)	71.08	7.91	69.71	6.49	82.22	9.52	<0.001
Body Fat (%)	29.03	6.75	27.97	5.83	37.76	7.44	<0.001
FPG(mg/dl)	97.02	14.39	95.04	9.38	113.20	29.78	<0.001
TG(mg/dl)	86.99	58.01	78.01	43.40	160.16	97.19	<0.001
CHOL	190.61	32.57	189.36	31.96	200.81	35.56	<0.001
HDL-C(mg/dl)	65.33	14.78	67.12	14.21	50.80	10.78	<0.001
LDL-C(mg/dl)3	109.23	29.83	107.12	28.84	126.33	32.18	<0.001
BMI(Kg/m2)4	22.03	3.48	21.43	2.83	26.93	4.31	<0.001

Table 6 Comparisons of MetS characteristics of male stratified by age

	Age≤40 (n=21,410)			40<Age≤60 (n=20,565)			Age>60 (n=1,807)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	70.8(9.7)	85.1(12.5)	<0.001	68.7(8.5)	78.6(11.0)	<0.001	64.9(8.5)	73.5(9.6)	<0.001
SBP(mmHg)	115.9(11.7)	128.9(14.7)	<0.001	117.1(13.7)	130.5(15.6)	<0.001	125.8(17.2)	139.2(16.2)	<0.001
DBP(mmHg)	73.4(8.6)	82.4(10.6)	<0.001	76.1(9.5)	85.0(10.5)	<0.001	77.8(10.5)	85.0(10.0)	<0.001
WC(cm)	80.8(7.2)	92.6(8.6)	<0.001	81.6(6.7)	90.6(8.1)	<0.001	83.0(7.4)	91.5(8.0)	<0.001
Body Fat (%)	23.3(5.0)	29.6(5.3)	<0.001	22.3(4.5)	27.0(5.0)	<0.001	21.3(4.8)	25.8(5.4)	<0.001
FPG(mg/dl)	97.8(9.3)	108.5(22.8)	<0.001	101.2(14.7)	114.6(27.7)	<0.001	103.3(21.0)	122.0(37.6)	<0.001
TG(mg/dl)	109.1(74.0)	198.9(148.4)	<0.001	120.1(77.0)	196.0(132.2)	<0.001	101.1(47.2)	173.7(103.5)	<0.001
CHOL	192.1(32.8)	203.5(36.2)	<0.001	199.6(33.0)	203.1(36.0)	<0.001	192.0(34.0)	194.6(35.3)	<0.001
HDL-C(mg/dl)	54.4(11.2)	45.4(8.9)	<0.001	54.2(11.3)	46.3(9.5)	<0.001	55.3(11.8)	46.3(10.5)	<0.001
LDL-C(mg/dl)	120.6(31.1)	131.9(33.9)	<0.001	125.8(30.9)	128.7(34.0)	<0.001	120.2(31.3)	122.0(32.0)	<0.001
BMI(Kg/m2)	23.7(2.9)	28.2(3.7)	<0.001	23.7(2.5)	27.0(3.2)	<0.001	23.8(2.8)	26.6(3.3)	<0.001

fat percentage (%) and total cholesterol (mg/dL) were revealed to be the important risk factors for MetS ($p < 0.001$). As for the three occupational groups that the eight occupational categories fell under, those in group-III (i.e., sedentary-related occupations with high-SES) occupations were likely to develop MetS (OR = 1.39, CI: 1.04-1.85, p = 0.0247) compared with

Table 7 Comparisons of MetS characteristics of female stratified by age

	Age≤40 (n=15,972)			40<Age≤60 (n=13,172)			Age>60 (n=580)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	54.06	72.86	<0.001	54.69	65.80	<0.001	63.56	64.47	<0.001
SBP(mmHg)	103.10	120.02	<0.001	108.20	125.09	<0.001	53.50	61.22	<0.001
DBP(mmHg)	66.30	76.32	<0.001	68.54	78.43	<0.001	118.69	131.14	<0.001
WC(cm)	68.78	84.36	<0.001	70.85	81.28	<0.001	71.42	76.18	<0.001
Body Fat (%)	27.51	40.42	<0.001	28.54	36.70	<0.001	73.05	81.20	<0.001
FPG(mg/dl)	93.45	109.35	<0.001	96.89	114.45	<0.001	29.12	35.18	<0.001
TG(mg/dl)	73.05	149.66	<0.001	84.23	165.27	<0.001	91.55	159.60	<0.001
CHOL	183.75	192.51	<0.001	196.28	203.75	<0.001	207.74	212.53	0.1437
HDL-C(mg/dl)	67.05	49.48	<0.001	67.18	51.13	<0.001	67.84	54.21	<0.001
LDL-C(mg/dl)	102.60	123.23	<0.001	112.66	127.47	<0.001	121.36	129.99	0.0047
BMI(Kg/m2)	21.08	28.26	<0.001	21.87	26.39	<0.001	22.49	25.71	<0.001

Table 8 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables of male

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	16,483	76.99	4,927	23.01	<0.001
	40<Age≤60	13,813	67.17	6,752	32.83	
	Age>60	1,158	64.08	649	35.92	
Occupation	Professional-1	1,936	74.18	674	25.82	<0.001
	Technical-2	12,603	74.5	4,314	25.5	
	Managerial-3	5,704	67.48	2,749	32.52	
	Sales-4	4,516	70.47	1,892	29.53	
	Service-5	1,557	71.32	626	28.68	
	Clerical and Administrative-6	1,558	73.94	549	26.06	
	Manual Labor-7	2,127	72.79	795	27.21	
	Taxi Driver-8	1,453	66.59	729	33.41	

Table 9 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables of female

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	14,977	93.77	995	6.23	<0.001
	40<Age≤60	11,107	84.32	2,065	15.68	
	Age>60	394	67.93	186	32.07	
Occupation	Professional-1	3,410	91.23	328	8.77	<0.001
	Technical-2	2,313	91.06	227	8.94	
	Managerial-3	2,809	87.59	398	12.41	
	Sales-4	4,738	89.87	534	10.13	
	Service-5	2,655	88.15	357	11.85	
	Clerical and Administrative-6	9,334	89.81	1,059	10.19	
	Manual Labor-7	1,175	81.03	275	18.97	
	Taxi Driver-8	44	39.29	68	60.71	

the two other groups.

DISCUSSION

Owen et al. [24] reported that the average person spends (1) 71% of their daily waking hours in an inactive state and

Table 10 Multiple logistic regression results for risk-factor associations when age ≥ 60

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I*	1.00			
	Group-II†	1.16	0.89	1.53	0.2708
	Group-III‡	1.39	1.04	1.85	0.0247
Gender	Male	1.00			
	Female	0.99	0.65	1.50	0.9657
Weight(Kg)		1.06	1.04	1.08	<0.001
BMI		1.10	1.03	1.18	0.0059
Body Fat Percentage(%)		1.08	1.05	1.11	<0.001
LDL-C(mg/dl)		1.00	0.99	1.00	0.1646
Total Cholesterol(mg/dl)		1.00	1.00	1.01	0.1900

*Group-I: General sedentary-related occupations
†Group-II: non sedentary-related occupations ‡Group-III: sedentary-related occupations with high-SES

(2) only 30 min daily on moderate-intensity physical activity on most days of a week. As noted in the literature review in the introduction section, MetS likelihood significantly increases with sedentary time, and sedentary behavior [24, 39, 40]. Being sedentary also makes one significantly more likely to be obese [9], have poor cardiometabolic health [17, 32], and have poor cognitive health [26]. An increasing number of researchers are beginning to investigate the correlation of a sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 29, 30].

However, most MetS risk factors have focused on lack of physical activity rather than sedentary occupation. These studies have noted that spending more time being passive increases metabolic risk [41, 42]. Recent research has also demonstrated that lifestyle and SES are significant risk factors for MetS [21, 22] and CVD [21, 43, 44]. Nonetheless, Kim et al. [45] argued that a causal relationship of SES with MetS and CVD risks—as indicated by the Framingham risk score— cannot be established by the current body of cross-sectional evidence. Furthermore, scholars have yet to investigate the role of occupation in MetS risk, with occupation further dis- tinguished by sedentary status and SES associations. In particular, MetS risk is likely to differ between those working in typically sedentary white-collar occupations (such as doc- tors, professors, managers, and engineers) and those working in sedentary blue-collar occupations (such as administrative staff, service staff, and even taxi drivers).

We confirmed the importance of age and occupations as MetS risk factors for males and females in Table 8 and Table 9, respectively. Both aspects significantly influence the prevalence rate of MetS. We further stratified the cases into three age groups and eight occupation groups. Regarding the eight occupations, both Manager-3 and Taxi Driver-8 consistently get MetS for males and females. However, Sales-4 of males came to third place, represented a high prevalence rate even though they belong to the non-sedentary group. It might be interesting for future research to discover the risk factor for Sale-4.

Due to the older age group having the highest prevalence of MetS, this study compared the three occupation categories for this age group. There is no difference between the general sedentary group and the non-sedentary group. The reason might be the Sales-4 of males represented a high prevalence rate which influenced the comparisons. However, those working in sedentary and high-SES-associated occupations of the older age group are at a higher risk of MetS than general sedentary and non-sedentary occupations. Hence, the people who are belonged this sedentary High-SES category should avoid prolonged sitting all day long.

CONCLUSIONS

Although prolonged sitting is an ostensibly novel risk factor for health outcomes across all ages, its association must be replicated in occupational conditions [32]. In this study, we noted that age and occupation categories were risk factors for MetS. The study found that lawyers, teachers, accountants, doctors, nurses, engineers, managers, and taxi drivers, were high-risk groups for MetS, where taxi driving had the highest MetS prevalence. After the eight categories were grouped into three groups when the age is above 60, there is a significant difference. The sedentary and high-SES occupations (group-III) are likely to have MetS than the general sedentary occupations (group-I) and non-sedentary occupations (group-II). We recommend for government authorities to focus on sedentary high-SES workers in their policies, particularly in tailoring health promotion programs to these groups, such as aerobic exercise [46] or physical activities [28, 47].

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FOOTNOTES

Contributors

M.-S.C. (Ming-Shu Chen) conceived and designed the experiments; M.-S.C. and C.-H.C. (Chi-Hao Chiu) performed the experiments; C.-H.C., and S.-H.C. (Shih-Hsin Chen) analyzed the data; M.-S.C. were supervised the study; M.-S.C. contributed investigation material; M.-S.C., C.-H.C., and S.-H.C. wrote this paper together. S.-H.C. submitted this paper.

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COMPETING INTERESTS

The authors declare no conflicts of interest concerning this study.

Ethics approval

Ethical approval was obtained from the Research Ethics Review Committee at the Far Eastern Memorial Hospital in New Taipei City, Taiwan (Institutional Review Board approval number: FEMH-IRB-107126-E, v.02; board meeting and approval date: September 10, 2018). The MJ Health Research Foundation also approved this study. This study also has a PPS receipt (ClinicalTrials.gov ID: NCT04142593, Date: October 25, 2019)

Data sharing statement

We aggregate two databases from New Taipei City Government Annual Taxi Health Examination Survey by Far Eastern Memorial Hospital (FEMH), and the the MJ Health Check-Up--Based Population Database (MJPD) (2012--2016). The first dataset used in this study was restricted by the Research Ethics Review Committee of the Far Eastern Memorial Hospital (FEMH-IRB-107126-E, v.02) in order to protect participant privacy. The second dataset, MJPD, is accessible to researchers upon request. Please contact Dr. Ming-Shu Chen (email: tree1013@gmail.com) to obtain further information.

Consent to patient and public involvement statement

No patient involved.

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STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

Item	No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 1-2
Methods			
Study design	4	Present key elements of study design early in the paper	Page 2-3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	Page 3
		(*b*) For matched studies, give matching criteria and the number of controls per case	Page 2-3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	NA
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 2-3
Bias	9	Describe any efforts to address potential sources of bias	Page 1 and 7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 2-3
		(*b*) Describe any methods used to examine subgroups and interactions	Page 2-3
		(*c*) Explain how missing data were addressed	Page 2-3
		(*d*) If applicable, explain how matching of cases and controls was addressed	Page 2-3
		(*e*) Describe any sensitivity analyses	Page 2-3
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 4-7
		(b) Give reasons for non-participation at each stage	Page 4-7
		(c) Consider use of a flow diagram	Page 4-7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 4-7

		(b) Indicate number of participants with missing data for each variable of interest	Page 4-7
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	Page 4-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 4-9
		(*b*) Report category boundaries when continuous variables were categorized	Table 4-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Table 4-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 4-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 1 and Page 7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 1 and 7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 1 and 7
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 7-8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 8

*Give information separately for cases and controls.

Responding: This study is not a typical "case-control studies" and research design, we only on the major study subjects to select the appropriate study objects to compare in this study.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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ABSTRACT

Objectives: To determine the association between metabolic syndrome (MetS) prevalence and occupation—distinguished by being sedentary and non-sedentary and by socioeconomic status (SES). Eight occupation categories are extensively considered. Numerous occupations, lawyers, teachers, engineers, senior section chiefs of enterprises, taxi driving, and so on are considered.

Methods: We analyzed two data sets with 73,506 cases. MetS was identified according to the criteria of the modified Adult Treatment Panel III. A multiple logistic regression algorithm was used to test factors for three age segments. We employed R for Windows (version 3.5.1) for all statistical analyses.

Results: MetS prevalence rate is increasing according to age growth. In addition, even though the prevalence rate of age ≤ 40 is only 6.23%, the non-sedentary-related occupations (OR = 0.88, $p < 0.0295$) are significantly lower than the ones of general sedentary-related occupations and sedentary-related occupations with high-SES. If the age is above 60, MetS was substantially more likely for sedentary high-SES occupations (OR = 1.39, $p < 0.0247$) than those working in general sedentary fields associated with no particular SES and non-sedentary job.

Conclusions: The occupational sedentary behavior might influence the MetS in different age groups. Non-sedentary occupations have less risk of having MetS for the younger generation. High-SES and sedentary occupations above 60 increased the MetS risk significantly. We suggest that the authorities focus on the high-SES and sedentary occupations.

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Keywords: Sedentary occupation, Metabolic Syndrome, Risk assessment, Regression Model

Strengths and limitations of this study

- We might be the first one to evaluate sedentary/non-sedentary occupations and by SES extensively.
- Two data sets with 64,578 cases were employed.
- Three occupation groups include general sedentary-related, non-sedentary related, and sedentary-related with high-SES.
- Chi-square test are used to evaluate the categorical factors of in three age groups and occupations, and multiple logistic regression tests the risk-factor associations
- The main limitations of this study is that the data was only collected in Taiwan, which might be not the same for other countries.

INTRODUCTION

MetS has been established as a public health concern in Western countries and is an increasingly severe public health problem in numerous countries. In the United States, 34% of adults satisfy the MetS criteria, which was formulated in the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III); in particular, US adults aged more than 60 years are more prone to having MetS [1]. The health status of the Taiwanese population was estimated in 2002 using the data of 7566 participants in a nationwide cross-sectional population-based survey, named the Taiwanese Survey on Prevalence of Hyperglycemia, Hyperlipidemia, and Hypertension (TwSHHH). Hwang et al. [2] reported that the prevalence of MetS in women increases rapidly after the menopausal period to become higher than that in men; they also noted MetS' high correlations with age as well as overweight and obesity. In other Asian countries, MetS is also an important health issue, and studies on MetS have been conducted in Thailand [3], Malaysia [4], South Korea [5], and Japan [6] in addition to studies in Taiwan [2, 7, 8].

MetS is highly correlated with overweight and obesity [2, 9], and it comprises a constellation of interrelated metabolic disorders—including hypertension [10], type 2 diabetes mellitus (T2DM) [11, 12, 13], cardiovascular disease (CVD) [13, 14], and stroke [15]. In addition, people with MetS have fivefolddiabetes[16]. The scholarly evidence has also preponderantly indicated that individuals with MetS or a sedentary occupation had increased the incidence of T2DM and coro- nary heart disease, as well as increased mortality due to CVD [11, 12, 13, 14, 17]. The other study also pointed out the reduced muscular strength is also associated with increased CVD and CVD-related mortality [18].

As a result, the reasons causing MetS must be investigated. The risk factors for MetS include aging, sedentary, long working hours, physical inactivity, Western diet, sleep duration greater than 7 hours [19], and high occupational stress [20]. Socioeconomic status (SES) and lifestyle are the possible risk factors for MetS [21, 22]. Of these factors, prolonged sitting is an apparent risk factor for negative health outcomes across all ages due to the rapid automation of the workplace [23, 24]. More recent studies have begun discussing the correlation of sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 28, 29, 30].

Bakrania et al. [26] demonstrated that sedentary behavior affects not only physical but also cognitive health. Leischik et al. [31] compared the 97 firefighters, 55 police officers, and 46 sedentary office workers in German. Sedentary occupations show to be associated with obesity and metabolic syndrome in middle-aged men. The other study on workers in a petroleum company reported that sedentary behavior—specifically for ten h/day with two-thirds of those ten h spent sitting at work—was significantly associated with cardiometabolic risk factors [32]. An individual having a sedentary occupation is substantially more likely to be obese. Straußetal. [9]foundthatoffice workers had a significantly greater abdominal waist circum- ference (WC) than do firefighters and that 33% of sedentary German office workers had MetS. Later on, Strauß et al. [33] further evaluated the 10-year cardiovascular risk for 46 office workers in German by using the Framingham score. The office workers have a tendency cardiovascular risk and a higher rate of MetS.

However, its risk association must be replicated concerning the occupational condition or SES [22, 32, 34, 35]. SES is a combination of salary, social status, and education and can be evaluated by occupation or work status [36]. Al-Thani et al. [34] shown that no statistically significant association was founded for occupation. Mehrdad et al. [22] found the association between MetS and three job ranks in a company didn't cause a significant difference. Therefore, this study focused on MetS prevalence—and the related chronic disease biochemical test indexes— concerning occupation among adults in Taiwan. The current study focused on sedentary occupations and occupations associated with different SES conditions.

Finally, although numerous studies include some occupations or SES condition [22, 32, 34, 35], this research might be the first one to study those in sedentary or more high-SES-associated occupations, especially occupations that increase MetS risk, which hasn't explored yet by prior researches. There are eight major occupations and then allocated into three groups: general sedentary occupation, non-sedentary occupation, and sedentary occupations with high-SES. Our hypothesis includes a difference between the sedentary occupation and high-SES would cause higher MetS prevalence. The following section explains the methods used in this paper.

METHODS

Definition of a sedentary occupation and SES

According to the US Department of Labor's Dictionary of Occupational Titles, sedentary work is the occasional exertion of >10 lbs of force and/or a frequent exertion of a negligible amount of force. In this definition, "occasional" and "frequent" are defined as being present <1/3 and 1/3–2/3 of the time, respectively. Such force can be used to lift, carry, push, pull, or move objects—including the human body. Sedentary work involves sitting most of the time, but it may involve walking or standing for brief periods [1]. Thus, a job was defined to be sedentary if walking and standing are required only occasionally, and all other sedentary criteria are met [37]. In this research, we select the taxi drivers, clerical, and administrative jobs as the representative belonged to the sedentary-related occupations in comparison with other non-sedentary-related, and sedentary-related high-SES jobs in the ~~analysis to compare three~~ categories of occupations. The rationale and hypothesis of this study are based on the previous

[1] https://www.thehortongroup.com/resources/the-strength-test-levels

studies to determine whether sedentary-related careers have a higher risk of developing MetS, and at the same time, compare the differences between high-SES and non-SES in sedentary occupations.

We employed eight occupational categories: Professional-1, Technical-2, Managerial-3, Sales-4, Service-5, Clerical and Administrative-6, Manual Labor-7, and Taxi Driving-8. The detailed occupations of the Professional-1, Technical-2, and Managerial-3 categories are shown in Table 1. According to Jans et al. [38], there are differences in sitting time among occupational groups and business sectors in Dutch. We put the occupation categories into three groups: general sedentary-related (Group-I), non-sedentary (Group-II), and sedentary-related and high-SES (Group-III), based on occupational environment and social-economic status (SES) of occupations. The arrangement of the eight works is illustrated in Table 2.

Definition of MetS

MetS was defined in this study according to guidelines from the Health Promotion Administration of Taiwan's Ministry of Health and Welfare. MetS prevalence was evaluated using the definitions of the modified ATP III and the MetS criteria for Taiwanese (MetS-TW). Five major factors were used to determine whether a person had MetS: WC, high blood pressure, fasting blood sugar (BS), triglyceride (TG) level, and HDL-C level. High blood pressure included the rates of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically, a Taiwanese person is defined as having MetS if they have three or more of the following five conditions in the ATP III: abdominal obesity, high TG, low HDL-C, hypertension, and hyperglycemia; the rules are detailed in Table 3.

Data resource and data collection

We obtained two datasets from the New Taipei City Government Annual Taxi Health Examination Survey and MJ Health Check-Up–Based Population Database (MJPD). The duration of the first dataset covered the 2012–2016 period and was conducted by Far Eastern Memorial Hospital (FEMH)[2]. The second dataset MJPD was collected from four MJ clinics, which provide periodic health examinations to their members, which is accessible to researchers upon request[3].

All of the data sets used in this study were authorized and given to this study's researchers by the MJPD Health Research Foundation with FEMH IRB approval. The laboratory data of the two databases were obtained from the same biochemical examination apparatus (Hitachi-7600). The two datasets conform to the ISO-15189 guidelines. Regarding ethical data use, the protocol of this study was approved by the Research Ethics Review Committee at FEMH (FEMH-IRB-107126-E and) and the MJ Health Research Foundation.

Data preprocessing

In the beginning, any personal information of all individuals was removed to protect their privacy from the two datasets. The MJPD database had 71,212 cases (41,600 male and 29,612 female) after we excluded the data entries with the occupational category "Others" and "missing values" for data analysis. The FEMH database had 2,294 cases of taxi drivers (2,182 male and 112 female). After combining the two databases, there are 73,506 records in total. MetS was identified based on the NCEP ATP III MetS criteria, and MetS prevalence was calculated.

Because age has been demonstrated to be an essential influence on MetS risk, we stratified the data into ≤40, 40 to 60, and ≥60-year-old groups. We focused on the effect on MetS risk from occupation—distinguished first by whether the field is sedentary versus or non-sedentary and second by the occupation's association with SES.

Statistical analysis

This study's statistical analysis and graphs were performed using an R (v3.5.1) package for multiple logistic regression. A p-value of <0.05 indicated statistical significance between the two test populations. In the univariate analysis, a two-sample independent *t* test was adopted to analyze the difference in the mean value of continuous variables between participants with and without MetS. An exact chi-square test was used to define the differences between categorical variables. Multiple logistic regression was used to determine the effect of all influential variables.

RESULTS

We analyzed the dataset by gender, height, weight, WC, blood pressure, TG level, HDL-C, SBP, DBP, and fasting BS. We computed the BMI from the height and weight data. In the next sub-sections, we present the descriptive statistics and the correlations among factors.

[2]FEMH is one of the only hospitals that mainly undertakes the annual health check-up of taxi drivers in New Taipei City, and it is also the hospital with the most significant number of services and the largest hospital in New Taipei City

[3]http://www.mjhrf.org/main/page/release1/en/release01

Table 1 Detail Occupation groups in the Professional-1, Technical-2, and Managerial-3 categories

Categories	Occupations
Professional-1	Lawyers, teachers, accountants, and nurses
Technical-2	Engineers, architects, and programmers
Managerial-3	Senior executives of government departments or section chiefs of enterprises

Table 2 Sedentary versus non-sedentary occupation categories association with SES

Group number	Type	Categories
Group-I	General sedentary-related	Service-5, ClericalandAdministrative-6, andTaxi Driver-8
Group-II	Non sedentary-related	Sales-4, and Manual Labor-7
Group-III	Sedentary-related and high-SES	Professional-1, Technical-2, and Managerial-3

Table 3 MetS criteria

No.	Factors	Abnormal Condition
1	Fasting Plasma Glucose (FPG)	FPG ≥ 100mg/dL
2	High Density Lipoprotein Cholesterol (HDL-C)	Male < 40mg/dL or Female < 50mg/dL
3	High Blood Pressure	SBP ≥ 130mmHg or DBP ≥ 85mmHg
4	Triglyceride (TG)	TG ≥ 150mg/dL
5	Waist Circumference (WC)	Male ≥ 90 cm or Female ≥ 80 cm

Descriptive Statistics

Of these 73,506 cases, 57,932 did not have MetS and 15,574 had MetS. MetS prevalence in this study thus was 21.19%. We conducted comparisons for the various physiological parameters, such as weight, SBP, and DBP for males and females in Table 4 and Table 5, respectively. Compared with MetS, individuals without MetS were healthier: their weight, SBP, WC, TG level, and BMI were lower, and their HDL-C level was greater. All characteristics were significantly related to MetS ($p < 0.001$).

We further stratified the cases into three age groups, including the younger age group (≤40 years old), the middle-aged group (40–60 years old), and the older age group (>60 years old). Table 6 and Table 7 detail the age-stratified data of male and female, respectively. MetS prevalence of males was 23.01%, 32.83%, and 35.92% for the younger, middle-aged, and older age groups, respectively. The prevalence rates of the female are 6.23%, 15.68%, and 32.07% for the younger, middle-aged, and older age groups, respectively. The result is consistent with studies reporting that MetS becomes more likely with age [1, 15]. Furthermore, as noted in Table 6 and Table 7, most factors—such as weight, SBP, DBP, and WC—were significantly related ($p < 0.001$) to MetS prevalence for all age groups, identical to the findings for the unstratified data in Table 4 and Table 5.

Chi-square exact test and multiple logistic regression analysis

Because some variables for characteristics were categorical, we used a chi-square test to analyze the relationships among them for males and females in Table 8 and Table 9, respectively. We marked some important information in bold. Age and occupation were significantly associated with MetS ($p < 0.001$). To explore the public perception of risk indicators of MetS, we further analyzed the eight aforementioned occupational categories. All occupation categories were significantly associated with MetS ($p < 0.001$). Among the occupations, taxi driving had the highest MetS prevalence rate (e.g., 33.41% and 60.71% for male and female, respectively) even though the number of female taxi driving was only 44, which was much higher than the average prevalence rate (28.16% and 10.92% for male and female, respectively) in the unstratified data. The occupational categories with the second and the third highest MetS prevalence of males were Managerial-3 and Sales-4 at 32.52%, and 29.53%, respectively. On the other hand, the second and the third highest MetS prevalence of females were Manual Labor-7 and Managerial-3 at 18.97%, and 12.41%, respectively.

Table 4 Comparison of MetS characteristics of male

	Total		Without (n=31,454)		With (n=12,328)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	72.8	11.3	69.7	9.3	80.9	12.1	<0.001
SBP(mmHg	120.6	15.0	116.8	13.0	130.3	15.4	<0.001
DBP(mmHg	77.4	10.5	74.8	9.2	84.0	10.6	<0.001
WC(cm)	84.1	8.7	81.2	7.0	91.5	(8.3	<0.001
Body Fat (%	24.3	5.5	22.8	4.8	28.0	5.3	<0.001
FPG(mg/dl)	103.2	18.7	99.5	12.6	112.6	26.8	<0.001
TG(mg/dl	136.8	103.5	113.6	74.7	196.0	137.7	<0.001
CHOL	197.5	34.2	195.4	33.1	202.8	36.1	<0.001
HDL-C(mg/dl)	52.0	11.4	54.3	11.3	46.0	9.3	<0.001
LDL-C(mg/dl)	124.8	32.1	122.9	31.1	129.6	33.9	<0.001
BMI(Kg/m2)	24.8	3.4	23.7	2.7	27.4	3.5	<0.001

Table 5 Comparison of MetS characteristics of female

	Total		Without (n=26,478)		With (n=3,246)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	55.78	9.35	54.32	7.76	67.70	12.28	<0.001
SBP(mmHg)	107.49	14.89	105.48	13.15	123.88	17.81	<0.001
DBP(mmHg)	68.44	10.06	67.32	9.22	77.65	11.76	<0.001
WC(cm)	71.08	7.91	69.71	6.49	82.22	9.52	<0.001
Body Fat (%)	29.03	6.75	27.97	5.83	37.76	7.44	<0.001
FPG(mg/dl)	97.02	14.39	95.04	9.38	113.20	29.78	<0.001
TG(mg/dl)	86.99	58.01	78.01	43.40	160.16	97.19	<0.001
CHOL	190.61	32.57	189.36	31.96	200.81	35.56	<0.001
HDL-C(mg/dl)	65.33	14.78	67.12	14.21	50.80	10.78	<0.001
LDL-C(mg/dl)3	109.23	29.83	107.12	28.84	126.33	32.18	<0.001
BMI(Kg/m2)4	22.03	3.48	21.43	2.83	26.93	4.31	<0.001

Table 6 Comparisons of MetS characteristics of male stratified by age

	Age≤40 (n=21,410)			40<Age≤60 (n=20,565)			Age>60 (n=1,807)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	70.8(9.7)	85.1(12.5)	<0.001	68.7(8.5)	78.6(11.0)	<0.001	64.9(8.5)	73.5(9.6)	<0.001
SBP(mmHg)	115.9(11.7)	128.9(14.7)	<0.001	117.1(13.7)	130.5(15.6)	<0.001	125.8(17.2)	139.2(16.2)	<0.001
DBP(mmHg)	73.4(8.6)	82.4(10.6)	<0.001	76.1(9.5)	85.0(10.5)	<0.001	77.8(10.5)	85.0(10.0)	<0.001
WC(cm)	80.8(7.2)	92.6(8.6)	<0.001	81.6(6.7)	90.6(8.1)	<0.001	83.0(7.4)	91.5(8.0)	<0.001
Body Fat (%)	23.3(5.0)	29.6(5.3)	<0.001	22.3(4.5)	27.0(5.0)	<0.001	21.3(4.8)	25.8(5.4)	<0.001
FPG(mg/dl)	97.8(9.3)	108.5(22.8)	<0.001	101.2(14.7)	114.6(27.7)	<0.001	103.3(21.0)	122.0(37.6)	<0.001
TG(mg/dl)	109.1(74.0)	198.9(148.4)	<0.001	120.1(77.0)	196.0(132.2)	<0.001	101.1(47.2)	173.7(103.5)	<0.001
CHOL	192.1(32.8)	203.5(36.2)	<0.001	199.6(33.0)	203.1(36.0)	<0.001	192.0(34.0)	194.6(35.3)	<0.001
HDL-C(mg/dl)	54.4(11.2)	45.4(8.9)	<0.001	54.2(11.3)	46.3(9.5)	<0.001	55.3(11.8)	46.3(10.5)	<0.001
LDL-C(mg/dl)	120.6(31.1)	131.9(33.9)	<0.001	125.8(30.9)	128.7(34.0)	<0.001	120.2(31.3)	122.0(32.0)	<0.001
BMI(Kg/m2)	23.7(2.9)	28.2(3.7)	<0.001	23.7(2.5)	27.0(3.2)	<0.001	23.8(2.8)	26.6(3.3)	<0.001

We analyzed the associations between major factors of the three age groups in a multiple logistic regression model in Table 10 to Table 12. BMI (%), body weight (kg), body fat percentage (%) and total cholesterol (mg/dL) were revealed to be the important risk factors for MetS ($p < 0.01$ or even $p < 0.001$). There are significant differences in gender between

Table 7 Comparisons of MetS characteristics of female stratified by age

	Age≤40 (n=15,972)			40<Age≤60 (n=13,172)			Age>60 (n=580)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	54.06	72.86	<0.001	54.69	65.80	<0.001	63.56	64.47	<0.001
SBP(mmHg)	103.10	120.02	<0.001	108.20	125.09	<0.001	53.50	61.22	<0.001
DBP(mmHg)	66.30	76.32	<0.001	68.54	78.43	<0.001	118.69	131.14	<0.001
WC(cm)	68.78	84.36	<0.001	70.85	81.28	<0.001	71.42	76.18	<0.001
Body Fat (%)	27.51	40.42	<0.001	28.54	36.70	<0.001	73.05	81.20	<0.001
FPG(mg/dl)	93.45	109.35	<0.001	96.89	114.45	<0.001	29.12	35.18	<0.001
TG(mg/dl)	73.05	149.66	<0.001	84.23	165.27	<0.001	91.55	159.60	<0.001
CHOL	183.75	192.51	<0.001	196.28	203.75	<0.001	207.74	212.53	0.1437
HDL-C(mg/dl)	67.05	49.48	<0.001	67.18	51.13	<0.001	67.84	54.21	<0.001
LDL-C(mg/dl)	102.60	123.23	<0.001	112.66	127.47	<0.001	121.36	129.99	0.0047
BMI(Kg/m2)	21.08	28.26	<0.001	21.87	26.39	<0.001	22.49	25.71	<0.001

Table 8 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables of male

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	16,483	76.99	4,927	23.01	<0.001
	40<Age≤60	13,813	67.17	6,752	32.83	
	Age>60	1,158	64.08	649	35.92	
Occupation	Professional-1	1,936	74.18	674	25.82	<0.001
	Technical-2	12,603	74.5	4,314	25.5	
	Managerial-3	5,704	67.48	2,749	32.52	
	Sales-4	4,516	70.47	1,892	29.53	
	Service-5	1,557	71.32	626	28.68	
	Clerical and Administrative-6	1,558	73.94	549	26.06	
	Manual Labor-7	2,127	72.79	795	27.21	
	Taxi Driver-8	1,453	66.59	729	33.41	

Table 9 Chi-square test results of categorical variables for characteristics as well as MetS criteria variables of female

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	14,977	93.77	995	6.23	<0.001
	40<Age≤60	11,107	84.32	2,065	15.68	
	Age>60	394	67.93	186	32.07	
Occupation	Professional-1	3,410	91.23	328	8.77	<0.001
	Technical-2	2,313	91.06	227	8.94	
	Managerial-3	2,809	87.59	398	12.41	
	Sales-4	4,738	89.87	534	10.13	
	Service-5	2,655	88.15	357	11.85	
	Clerical and Administrative-6	9,334	89.81	1,059	10.19	
	Manual Labor-7	1,175	81.03	275	18.97	
	Taxi Driver-8	44	39.29	68	60.71	

the young and middle-aged groups. That is, male runs a higher risk to have MetS. However, there is no difference between the male and female when age > 60.

As for the three occupational groups that the eight occupational categories fell under in Table 10, the non-sedentary-related occupations in Group-II significantly have less prevalence rate of MetS (OR = 0.88, CI: 0.78-0.99, p = 0.0295) than the other groups if age ≤ 40. There is no difference among the three occupation groups in the middle age group. The proportion of men with MetS is still significantly higher than that of women by the age 60. Finally, those in group-III (i.e., sedentary-related occupations with high-SES) occupations were likely to develop MetS (OR = 1.39, CI: 1.04-1.85, p = 0.0247) compared with the two other groups if age > 60. There is no difference between male and female in terms of the MetS prevalence.

DISCUSSION

Owen et al. [24] reported that the average person spends (1) 71% of their daily waking hours in an inactive state and (2) only 30 min daily on moderate-intensity physical activity on most days of a week. As noted in the literature review in the introduction section, MetS likelihood significantly increases with sedentary time, and sedentary behavior [24, 39, 40]. Being sedentary also makes one significantly more likely to be obese [9], have poor cardiometabolic health [17, 32], and have poor cognitive health [26]. An increasing number of researchers are beginning to investigate the correlation of a sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 29, 30].

However, most MetS risk factors have focused on lack of physical activity rather than sedentary occupation. These studies have noted that spending moretimebeing passive increases metabolic risk [41, 42]. Recent research has also demonstrated that lifestyle and SES are significant risk factors for MetS [21, 22] and CVD [21, 43, 44]. Nonetheless, Kim et al. [45] argued that a causal relationship of SES with MetS and CVD risks—as indicated by the Framingham risk score—cannot be established by the current body of cross-sectional evidence. Furthermore, scholars have yet to investigate the role of occupation in MetS risk, with occupation further distinguished by sedentary status and SES associations. In particular, MetS risk is likely to differ between those working in typically sedentary white-collar occupations (such as doctors, professors, managers, and engineers) and those working in sedentary blue-collar occupations (such as administrative staff, service staff, and even taxi drivers).

We confirmed the importance of age and occupations as MetS risk factors for males and females in Table 8 and Table 9, respectively. Both aspects significantly influence the prevalence rate of MetS. We further stratified the cases into three age groups and eight occupation groups. Regarding the eight occupations, both Manager-3 and Taxi Driver-8 consistently get MetS for males and females. However, Sales-4 of males came to third place, represented a high prevalence rate even though they belong to the non-sedentary group. It might be interesting for future research to discover the risk factor for Sale-4. According to Table 8 and Table 9, the prevalence rate of female is low when age is less than and equal to 60. However, the prevalence rate of female is increased dramatically to 32.07% when age is above 60. This result was due to the female hormones was reduced when they step into the menopause [46]. Hence, the difference in the prevalence rate between males and females is not many.

Due to the age group influencing the highest prevalence of MetS, this study compared the three occupation categories under different age groups. In Table 10, we found the non-sedentary occupation group has less chance to have MetS. In Table 11, there is no difference among the three occupational groups which implies occupational effects might not be the key factor for MetS. However, high-SES-associated occupations of the older age group are at a higher risk of MetS than general sedentary and non-sedentary occupations shown in Table 12. Hence, the people who are belonged this sedentary and high-SES occupations should avoid prolonged sitting all day long. In addition, there is no difference between the male and female due to MetS was more prevalent among post-menopausal female [46].

CONCLUSIONS

Although prolonged sitting is an ostensibly novel risk factor for health outcomes across all ages, its association must be replicated in occupational conditions [32]. In this study, we noted that age and occupation categories were risk factors for MetS. The study found that lawyer, teacher, accountant, doctor, nurse, engineer, manager, and taxi driver, were high-risk groups for MetS. After the eight categories were grouped into three groups when the age is under 40, the non-sedentary occupation groups yield less prevalence rate than those in the general sedentary, and sedentary and high-SES occupations. Besides, when the age is above 60, there is a significant difference. The sedentary and high-SES occupations (group-III) are likely to have MetS than the general sedentary occupations (group-I) and non-sedentary occupations (group-II). We recommend for government authorities to focus on sedentary high-SES workers in their policies, particularly in tailoring health promotion programs to these groups, such as aerobic exercise [47] or physical activities [28, 48].

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Table 10 Multiple logistic regression results for risk-factor associations when if ≤ 40

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I*	1.00			
	Group-II †	0.88	0.78	0.99	0.0295
	Group-III ‡	1.03	0.95	1.12	0.4825
Gender	Male	1.00			
	Female	0.43	0.37	0.51	<0.001
Weight(Kg)		1.04	1.03	1.05	<0.001
BMI		1.26	1.22	1.29	<0.001
Body Fat Percentage(%)		1.07	1.06	1.08	<0.001
LDL-C(mg/dl)		1.00	1.00	1.01	0.0012
Total Cholesterol(mg/dl)		1.00	1.00	1.00	0.0406

*Group-I: General sedentary-related occupations
†Group-II: non sedentary-related occupations ‡Group-III: sedentary-related occupations with high-SES

Table 11 Multiple logistic regression results for risk-factor associations when 40 < age ≤ 60

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I	1.00			
	Group-II	1.01	0.93	1.10	0.8170
	Group-III	0.98	0.91	1.05	0.5618
Gender	Male	1.00			
	Female	0.46	0.40	0.52	<0.001
Weight(Kg)		1.03	1.02	1.03	<0.001
BMI		1.30	1.27	1.33	<0.001
Body Fat Percentage(%)		1.07	1.06	1.08	<0.001
LDL-C(mg/dl)		1.00	1.00	1.00	0.2922
Total Cholesterol(mg/dl)		1.00	1.00	1.00	<0.001

Table 12 Multiple logistic regression results for risk-factor associations when age > 60

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I	1.00			
	Group-II	1.16	0.89	1.53	0.2708
	Group-III	1.39	1.04	1.85	0.0247
Gender	Male	1.00			
	Female	0.99	0.65	1.50	0.9657
Weight(Kg)		1.06	1.04	1.08	<0.001
BMI		1.10	1.03	1.18	0.0059
Body Fat Percentage(%)		1.08	1.05	1.11	<0.001
LDL-C(mg/dl)		1.00	0.99	1.00	0.1646
Total Cholesterol(mg/dl)		1.00	1.00	1.01	0.1900

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FOOTNOTES

Contributors

M.-S.C. (Ming-Shu Chen) conceived and designed the experiments; M.-S.C. and C.-H.C. (Chi-Hao Chiu) performed the experiments; C.-H.C., and S.-H.C. (Shih-Hsin Chen) analyzed the data; M.-S.C. were supervised the study; M.-S.C. contributed investigation material; M.-S.C., C.-H.C., and S.-H.C. wrote this paper together. S.-H.C. submitted this paper.

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COMPETING INTERESTS

The authors declare no conflicts of interest concerning this study.

Ethics approval

Ethical approval was obtained from the Research Ethics Review Committee at the Far Eastern Memorial Hospital in New Taipei City, Taiwan (Institutional Review Board approval number: FEMH-IRB-107126-E, v.02; board meeting and approval date: September 10, 2018). The MJ Health Research Foundation also approved this study. This study also has a PPS receipt (ClinicalTrials.gov ID: NCT04142593, Date: October 25, 2019)

Data sharing statement

We aggregate two databases from New Taipei City Government Annual Taxi Health Examination Survey by Far Eastern Memorial Hospital (FEMH), and the the MJ Health Check-Up–Based Population Database (MJPD) (2012–2016). The first dataset used in this study was restricted by the Research Ethics Review Committee of the Far Eastern Memorial Hospital (FEMH-IRB-107126-E, v.02) in order to protect participant privacy. The second dataset, MJPD, is accessible to researchers upon request. Please contact Dr. Ming-Shu Chen (email: tree1013@gmail.com) to obtain further information.

Consent to patient and public involvement statement

No patient involved.

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STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

Item	No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 1-2
Methods			
Study design	4	Present key elements of study design early in the paper	Page 2-3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	Page 3
		(*b*) For matched studies, give matching criteria and the number of controls per case	Page 2-3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	NA
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 2-3
Bias	9	Describe any efforts to address potential sources of bias	Page 1 and 7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 2-3
		(*b*) Describe any methods used to examine subgroups and interactions	Page 2-3
		(*c*) Explain how missing data were addressed	Page 2-3
		(*d*) If applicable, explain how matching of cases and controls was addressed	Page 2-3
		(*e*) Describe any sensitivity analyses	Page 2-3
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 4-7
		(b) Give reasons for non-participation at each stage	Page 4-7
		(c) Consider use of a flow diagram	Page 4-7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 4-7

		(b) Indicate number of participants with missing data for each variable of interest	Page 4-7
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	Page 4-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 4-9
		(*b*) Report category boundaries when continuous variables were categorized	Table 4-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Table 4-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 4-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 1 and Page 7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 1 and 7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 1 and 7
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 7-8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 8

*Give information separately for cases and controls.

Responding: This study is not a typical "case-control studies" and research design, we only on the major study subjects to select the appropriate study objects to compare in this study.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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Keywords:	Other metabolic, e.g. iron, porphyria < DIABETES & ENDOCRINOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS

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Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status

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ABSTRACT

Objectives: To determine whether occupation type, distinguished by socioeconomic status (SES) and sedentary status, is associated with metabolic syndrome (MetS) risk.

Methods: We analyzed two data sets covering 73,506 individuals. MetS was identified according to the criteria of the modified Adult Treatment Panel III. Eight occupational categories were considered: professionals, technical workers, managers, salespeople, service staff, administrative staff, manual laborers, and taxi drivers; occupations were grouped into nonsedentary; sedentary, high-SES; and sedentary, non-high-SES occupations. A multiple logistic regression was used to determine significant risk factors for MetS in three age-stratified subgroups. R software for Windows (version 3.5.1) was used for all statistical analyses.

Results: MetS prevalence increased with age. Among participants aged ≤ 40 years, where MetS prevalence was low at 6.23%, having a nonsedentary occupation reduced the MetS risk (odds ratio [OR] = 0.88, $p < 0.0295$). Among participants aged > 60 years, having a sedentary, high-SES occupation significantly increased (OR = 1.39, $p < 0.0247$) MetS risk.

Conclusions: The influence of occupation type on MetS risk differs among age groups. Nonsedentary occupations and sedentary, high-SES occupations decrease and increase MetS risk, respectively, among younger and older adults, respectively. Authorities should focus on individuals in sedentary, high-SES occupations.

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Keywords: Sedentary occupation, Metabolic Syndrome, Risk assessment, Regression Model

Strengths and limitations of this study

- We are the first to analyze the effects of a sedentary occupation and SES on metabolic syndrome.
- Two large data sets, covering 64,578 individuals, were employed.
- Occupations were segmented into the following categories: nonsedentary, sedentary and associated with high SES, and sedentary and not associated with high SES.
- A chi-square test was used for the categorical variables of age (in terms of three age groups) and type of occupation; a multiple logistic regression was used to determine significant factors for metabolic syndrome risk.
- The study's findings may not be applicable outside Taiwan.

INTRODUCTION

Metabolic syndrome (MetS) is a public health concern in many countries, particularly those in the West. In the United States, 34% of the population has MetS, according to criteria formulated in the National Cholesterol Education Program Adult Treatment Panel (ATP) III; in particular, US adults older than 60 years of age are more prone to having MetS [1]. The health status of the Taiwanese population was estimated in 2002 using the data of 7566 participants in a nationwide cross-sectional population-based survey: the Taiwanese Survey on Prevalence of Hyperglycemia, Hyperlipidemia, and Hypertension. (TwSHHH). Hwang et al. [2] reported that the prevalence of MetS in women increases rapidly after menopause to a level higher than that in their male counterparts; they also noted MetS' high correlations with age and overweight and obesity. MetS is also a public health problem in other Asian countries, and studies on MetS have been conducted in Thailand [3], Malaysia [4], South Korea [5], and Japan [6] as well as Taiwan [2, 7, 8].

MetS is highly correlated with overweight and obesity [2, 9], and it comprises a constellation of interrelated metabolic disorders—including hypertension [10], type 2 diabetes mellitus (T2DM) [11, 12, 13], cardiovascular disease (CVD) [13, 14], and stroke [15]. In addition, having MetS increases the risk of having diabetes by five-fold [16]. Studies have overwhelmingly indicated that individuals with MetS or a sedentary occupation have an increased risk of T2DM and coronary heart disease and increased mortality due to CVD [11, 12, 13, 14, 17]. A study also reported that reduced muscular strength is associated with increased risk of CVD and CVD-related mortality [18].

The causes for MetS should thus be investigated. The risk factors for MetS include aging, a sedentary lifestyle, long working hours, physical inactivity, a Western diet, sleep duration greater than 7 hours [19], and high occupational stress [20]. Socioeconomic status (SES) and lifestyle are the possible risk factors for MetS [21, 22]. Among these factors, prolonged sitting is notable because it affects people of all ages and is becoming increasingly common because of the rapid automation of the workplace [23, 24]. Scholars have recently investigated the relationship of a sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 28, 29, 30].

Bakrania et al. [26] demonstrated that sedentary behavior affects not only physical but also cognitive health. Leischik et al. [31] compared the health of 97 firefighters, 55 police officers, and 46 sedentary office workers in Germany, and they reported that having a sedentary occupation increased the likelihood of being obese and having MetS in their middle-aged sample . Another study on workers in a petroleum company reported that a sedentary lifestyle—specifically, being sedentary for 10 h/day with two-thirds of those 10 h spent sitting at work—was significantly associated with cardiometabolic risk factors [32]. An individual having a sedentary occupation is substantially more likely to be obese. Strauß et al. [9] reported that office workers had a significantly greater abdominal waist circumference (WC) than did firefighters and that 33% of sedentary German office workers had MetS. In a subsequent study, Strauß et al. [33] evaluated the 10-year cardiovascular risk of 46 office workers in Germany using the Framingham score and observed that office workers had a higher risk of CVD and MetS.

However, the association of MetS risk with not only occupation type but also SES must be determined [22, 32, 34, 35]. SES is a concept encompassing salary, social status, and education and can be indicated by an individual's occupation [36]. Al-Thani et al. [34] and Mehrdad et al. [22] reported that occupation type and seniority in a company, respectively, are not significantly associated with MetS risk. Therefore, this study conducted in Taiwan focused on the relationship of type of occupation with MetS prevalence as well as with the biochemical indexes of related chronic diseases. Specifically, this study focused on sedentary occupations and occupations associated with different SESs.

Finally, although numerous studies have analyzed several occupations or SESs in relation to MetS risk [22, 32, 34, 35], this study is the first to focus on occupations that are sedentary or associated with a high SES . Occupations were segmented into 1) nonsedentary, 2) sedentary and associated with high SES (sedentary, high-SES), and 3) sedentary and not associated with high SES (sedentary, non-high-SES) occupations. We hypothesized that sedentary, high-SES occupations differ from sedentary, non-high-SES occupations in the magnitude of their positive correlation with MetS prevalence and that both types of occupations are associated with increased MetS risk.

METHODS

Definition of a sedentary occupation and SES

According to the US Department of Labor's Dictionary of Occupational Titles, sedentary work is the occasional exertion of >10 lbs of force and/or a frequent exertion of a negligible amount of force. In this definition, "occasional" and "frequent" are defined as being present <1/3 and 1/3–2/3 of the time, respectively. Such force can be used to lift, carry, push, pull, or move objects—including the human body. Sedentary work involves sitting most of the time, but it may involve walking or standing for brief periods[1]. Thus, a job was defined to be sedentary if walking and standing are required only occasionally, and all other sedentary criteria are met [37]. In this study, we selected taxi drivers, clerical jobs, and administrative jobs as representative of sedentary, non-high-SES occupations.

We focused on eight types of workers : professionals, tech-

[1]https://www.thehortongroup.com/resources/the-strength-test-levels

nical workers, managers, salespeople, service staff, administrativestaff, manuallaborers, andtaxidrivers. Table1presents the occupations in the professional, technical, and managerial categories. Jans et al. [38] reported that occupations in the Netherlands differed with respect to the time a worker spends sitting. We put the occupation categories into three groups: general sedentary-related (Group-I), non-sedentary (Group-II), and sedentary-related and high-SES (Group-III), based on occupational environment and social-economic status (SES) of occupations. The arrangement of the eight works is illustrated in Table 2.

Definition of MetS

MetS was defined in this study according to guidelines from the Health Promotion Administration of Taiwan's Ministry of Health and Welfare.MetS prevalence was evaluated using the definitions of the modified ATP III and the MetS criteria for Taiwanese people. Five major factors were used to determine whether a person had MetS: WC, high blood pressure, fasting blood sugar (BS), triglyceride (TG) level, and high-density lipoprotein cholesterol (HDL-C) level. High blood pressure was determined in terms of systolic blood pressure (SBP) and diastolic blood pressure (DBP). A Taiwanese person is defined as having MetS if they have three or more of the following five conditions in the ATP III: abdominal obesity, high TG, low HDL-C, hypertension, and hyperglycemia; Table 3 presents the criteria for defining MetS.

Data resource and data collection

We obtained two data sets from the New Taipei City Government Annual Taxi Health Examination Survey and from the MJ Health Check-Up–Based Population Database (MJPD). The data in the first data set covered the 2012–2016 period and were collected by Far Eastern Memorial Hospital (FEMH)[2]. this data set shall be termed "the FEMH data set" in the remaining portion of the paper. The second MJPD data set was collected from four MJ clinics, which provide periodic health examinations to their members; this data set is accessible to any researcher upon request[3].

The data sets were authorized for use in this study and provided to us by the MJPD Health Research Foundation with FEMH Institutional Review Board (IRB) approval. The laboratory data of the two databases were obtained from the same biochemical examination apparatus (Hitachi-7600). The two data sets conform to the International Organization for Standardization 15189 guidelines. This study's protocol was approved by the Research Ethics Review Committee at FEMH (FEMH-IRB-107126-E) and the MJ Health Research Foundation.

Data preprocessing

Thedatasetswereanonymizedpriortoanyprocessingoranalysis. We enrolled 71,212 individuals (41,600 men and 29,612 women) in the MJPD data set after those whose occupation did not fall under our three categories and those with missing data were excluded. We also enrolled 2,294 taxi drivers (2,182 men and 112 women) from the FEMH database. Thus, the data of 73,506 individuals were subject to analysis.

Because age is a key factor influencing MetS risk, we stratified our sample into ≤40, 40 to 60, and ≥60-year-old subgroups, which we refer to as the "younger," "middle-aged," and "older" subgroups, respectively. We focused on the effect on MetS risk from occupation—distinguished first by whether the field is sedentary or non-sedentary and second by the occupation's association with SES.

Statistical analysis

Data analysis, including a multiple logistic regression with all variables, and data visualization were conducted in R (version 3.5.1) software. A p-value of <0.05 indicated a statistically significant difference between two groups. In a univariate analysis, a two-sample independent *t* test was used to determine the differences in the mean values of continuous variables between participants with and without MetS. An exact chi-square test was used to determine the differences in categorical variables between groups.

PATIENT AND PUBLIC INVOLVEMENT

This is second-hand de-identified data analysis, does not need patient and public direct involvement. This secondary data analysis was supported by the FEMH IRB and the MJ Health Research Foundation, the data is applied for and authorized to use (FEMHIRB-107126-E).

RESULTS

Gender, height, weight, WC, blood pressure, TG level, HDL-C, SBP, DBP, and fasting BS were used as covariates; Body Mess Index (BMI) was also computed from data on height and weight.

[2]FEMH is one of the only hospitals that mainly undertakes the annual health check-up of taxi drivers in New Taipei City, and it is also the hospital with the most significant number of services and the largest hospital in New Taipei City

[3]http://www.mjhrf.org/main/page/release1/en/release01

Table 1 Occupations belonging to the professional, technical, and managerial categories

Categories	Occupations
Professional-1	Lawyers, teachers, accountants, and nurses
Technical-2	Engineers, architects, and programmers
Managerial-3	Senior executives of government departments or section chiefs of enterprises

Table 2 Sedentary versus nonsedentary and high-SES versus non-high-SES occupations

Group number	Type	Categories
Group-I	General sedentary-related	Service-5, ClericalandAdministrative-6, andTaxi Driver-8
Group-II	Non sedentary-related	Sales-4, and Manual Labor-7
Group-III	Sedentary-related and high-SES	Professional-1, Technical-2, and Managerial-3

Table 3 MetS criteria

No.	Factors	Abnormal Condition
1	Fasting Plasma Glucose (FPG)	FPG ≥ 100mg/dL
2	High Density Lipoprotein Cholesterol (HDL-C)	Male < 40mg/dL or Female < 50mg/dL
3	High Blood Pressure	SBP ≥ 130mmHg or DBP ≥ 85mmHg
4	Triglyceride (TG)	TG ≥ 150mg/dL
5	Waist Circumference (WC)	Male ≥ 90 cm or Female ≥ 80 cm

Descriptive Statistics

Among the 73,506 participants, 57,932 did not have MetS, and 15,574 had MetS. The MetS prevalence in this study was thus 21.19%. Tables 4 and 5 present the descriptive statistics of physiological parameters, such as weight, SBP, and DBP, for the participants with different sex, respectively. Compared with participants with MetS, participants without MetS were healthier; their weight, SBP, WC, TG level, and BMI were lower, and their HDL-C level was higher. All physiological parameters were significantly related to MetS risk ($p < 0.001$).

Tables 6 and 7 detail the age-stratified data of male and female participants, respectively. Among men, the MetS prevalence was 23.01%, 32.83%, and 35.92% in the younger, middle-aged, and older subgroups, respectively. Among women, theMetSprevalence was 6.23%, 15.68%, and 32.07% for the younger, middle-aged, and older subgroups, respectively. These findings are consistent with the finding that MetS prevalence increases with age [1, 15]. Furthermore, as noted in Table 6 and 7, most factors (such as weight, SBP, DBP, and WC) were significantly related ($p < 0.001$) to MetS prevalence in all age-stratified subgroups, which was identical to the findings for the unstratified sample (Tables 4 and 5).

Chi-square exact test and multiple logistic regression analysis

We used a chi-square test to analyze the relationships that categorical variables had with MetS risk; Tables 8 and 9 present the findings for the male and female participants, respectively (key findings are marked in bold). Age and occupation were significantly associated with MetS risk ($p < 0.001$).

The eight occupational categories were significantly associated with MetS risk ($p < 0.001$), among which taxi driving had the highest MetS prevalence rate (33.41% and 60.71% among men and women, respectively). As an aside, the female taxi drivers in our study were underrepresented in this occupation (at only 44 individuals) and had a much higher MetS prevalence than either the average woman or man (28.16% and 10.92%, respectively) in our overall sample. Furthermore, managers and salespeople had the second- and third-highest MetS prevalence at 32.52% and 29.53%, respectively. Among female participants, manual laborers and managers had the second and the third-highest MetS prevalence at 18.97% and 12.41%, respectively.

Table 4 MetS characteristics of male participants

	Total		Without (n=31,454)		With (n=12,328)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	72.8	11.3	69.7	9.3	80.9	12.1	<0.001
SBP(mmHg	120.6	15.0	116.8	13.0	130.3	15.4	<0.001
DBP(mmHg	77.4	10.5	74.8	9.2	84.0	10.6	<0.001
WC(cm)	84.1	8.7	81.2	7.0	91.5	(8.3	<0.001
Body Fat (%	24.3	5.5	22.8	4.8	28.0	5.3	<0.001
FPG(mg/dl)	103.2	18.7	99.5	12.6	112.6	26.8	<0.001
TG(mg/dl	136.8	103.5	113.6	74.7	196.0	137.7	<0.001
CHOL	197.5	34.2	195.4	33.1	202.8	36.1	<0.001
HDL-C(mg/dl)	52.0	11.4	54.3	11.3	46.0	9.3	<0.001
LDL-C(mg/dl)	124.8	32.1	122.9	31.1	129.6	33.9	<0.001
BMI(Kg/m2)	24.8	3.4	23.7	2.7	27.4	3.5	<0.001

Table 5 MetS characteristics of female participants

	Total		Without (n=26,478)		With (n=3,246)		
Variables	Mean	SD	Mean	SD	Mean	SD	p-value
Weight(Kg)	55.78	9.35	54.32	7.76	67.70	12.28	<0.001
SBP(mmHg)	107.49	14.89	105.48	13.15	123.88	17.81	<0.001
DBP(mmHg)	68.44	10.06	67.32	9.22	77.65	11.76	<0.001
WC(cm)	71.08	7.91	69.71	6.49	82.22	9.52	<0.001
Body Fat (%)	29.03	6.75	27.97	5.83	37.76	7.44	<0.001
FPG(mg/dl)	97.02	14.39	95.04	9.38	113.20	29.78	<0.001
TG(mg/dl)	86.99	58.01	78.01	43.40	160.16	97.19	<0.001
CHOL	190.61	32.57	189.36	31.96	200.81	35.56	<0.001
HDL-C(mg/dl)	65.33	14.78	67.12	14.21	50.80	10.78	<0.001
LDL-C(mg/dl)3	109.23	29.83	107.12	28.84	126.33	32.18	<0.001
BMI(Kg/m2)4	22.03	3.48	21.43	2.83	26.93	4.31	<0.001

Table 6 MetS characteristics of male participants in age-stratified subgroups

	Age≤40 (n=21,410)			40<Age≤60 (n=20,565)			Age>60 (n=1,807)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	70.8(9.7)	85.1(12.5)	<0.001	68.7(8.5)	78.6(11.0)	<0.001	64.9(8.5)	73.5(9.6)	<0.001
SBP(mmHg)	115.9(11.7)	128.9(14.7)	<0.001	117.1(13.7)	130.5(15.6)	<0.001	125.8(17.2)	139.2(16.2)	<0.001
DBP(mmHg)	73.4(8.6)	82.4(10.6)	<0.001	76.1(9.5)	85.0(10.5)	<0.001	77.8(10.5)	85.0(10.0)	<0.001
WC(cm)	80.8(7.2)	92.6(8.6)	<0.001	81.6(6.7)	90.6(8.1)	<0.001	83.0(7.4)	91.5(8.0)	<0.001
Body Fat (%)	23.3(5.0)	29.6(5.3)	<0.001	22.3(4.5)	27.0(5.0)	<0.001	21.3(4.8)	25.8(5.4)	<0.001
FPG(mg/dl)	97.8(9.3)	108.5(22.8)	<0.001	101.2(14.7)	114.6(27.7)	<0.001	103.3(21.0)	122.0(37.6)	<0.001
TG(mg/dl)	109.1(74.0)	198.9(148.4)	<0.001	120.1(77.0)	196.0(132.2)	<0.001	101.1(47.2)	173.7(103.5)	<0.001
CHOL	192.1(32.8)	203.5(36.2)	<0.001	199.6(33.0)	203.1(36.0)	<0.001	192.0(34.0)	194.6(35.3)	<0.001
HDL-C(mg/dl)	54.4(11.2)	45.4(8.9)	<0.001	54.2(11.3)	46.3(9.5)	<0.001	55.3(11.8)	46.3(10.5)	<0.001
LDL-C(mg/dl)	120.6(31.1)	131.9(33.9)	<0.001	125.8(30.9)	128.7(34.0)	<0.001	120.2(31.3)	122.0(32.0)	<0.001
BMI(Kg/m2)	23.7(2.9)	28.2(3.7)	<0.001	23.7(2.5)	27.0(3.2)	<0.001	23.8(2.8)	26.6(3.3)	<0.001

We analyzed the associations between major factors of the three age groups in a multiple logistic regression model in Table 10 to Table 12. BMI (%), body weight (kg), body fat percentage (%) and total cholesterol (mg/dL) were revealed to be the important risk factors for MetS ($p < 0.01$ or even $p < 0.001$). There are significant differences in gender between

Table 7 MetS characteristics of female participants in age-stratified subgroups

	Age≤40 (n=15,972)			40<Age≤60 (n=13,172)			Age>60 (n=580)		
	Non Mets	Mets		Non MetS	MetS		Non MetS	MetS	
Variables	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
Weight(Kg)	54.06	72.86	<0.001	54.69	65.80	<0.001	63.56	64.47	<0.001
SBP(mmHg)	103.10	120.02	<0.001	108.20	125.09	<0.001	53.50	61.22	<0.001
DBP(mmHg)	66.30	76.32	<0.001	68.54	78.43	<0.001	118.69	131.14	<0.001
WC(cm)	68.78	84.36	<0.001	70.85	81.28	<0.001	71.42	76.18	<0.001
Body Fat (%)	27.51	40.42	<0.001	28.54	36.70	<0.001	73.05	81.20	<0.001
FPG(mg/dl)	93.45	109.35	<0.001	96.89	114.45	<0.001	29.12	35.18	<0.001
TG(mg/dl)	73.05	149.66	<0.001	84.23	165.27	<0.001	91.55	159.60	<0.001
CHOL	183.75	192.51	<0.001	196.28	203.75	<0.001	207.74	212.53	0.1437
HDL-C(mg/dl)	67.05	49.48	<0.001	67.18	51.13	<0.001	67.84	54.21	<0.001
LDL-C(mg/dl)	102.60	123.23	<0.001	112.66	127.47	<0.001	121.36	129.99	0.0047
BMI(Kg/m2)	21.08	28.26	<0.001	21.87	26.39	<0.001	22.49	25.71	<0.001

Table 8 Chi-square test results of differences in categorical variables between ages and between occupations among men

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	16,483	76.99	4,927	23.01	<0.001
	40<Age≤60	13,813	67.17	6,752	32.83	
	Age>60	1,158	64.08	649	35.92	
Occupation	Professional-1	1,936	74.18	674	25.82	<0.001
	Technical-2	12,603	74.5	4,314	25.5	
	Managerial-3	5,704	67.48	2,749	32.52	
	Sales-4	4,516	70.47	1,892	29.53	
	Service-5	1,557	71.32	626	28.68	
	Clerical and Administrative-6	1,558	73.94	549	26.06	
	Manual Labor-7	2,127	72.79	795	27.21	
	Taxi Driver-8	1,453	66.59	729	33.41	

Table 9 Chi-square test results of differences in categorical variables between ages and between occupations among women

		Non-MetS		MetS		
Variables	Item	n	(%)	n	(%)	p-value
Age	Age≤40	14,977	93.77	995	6.23	<0.001
	40<Age≤60	11,107	84.32	2,065	15.68	
	Age>60	394	67.93	186	32.07	
Occupation	Professional-1	3,410	91.23	328	8.77	<0.001
	Technical-2	2,313	91.06	227	8.94	
	Managerial-3	2,809	87.59	398	12.41	
	Sales-4	4,738	89.87	534	10.13	
	Service-5	2,655	88.15	357	11.85	
	Clerical and Administrative-6	9,334	89.81	1,059	10.19	
	Manual Labor-7	1,175	81.03	275	18.97	
	Taxi Driver-8	44	39.29	68	60.71	

the young and middle-aged groups. That is, male runs a higher risk to have MetS. However, there is no difference between the male and female when age > 60.

Tables 10-12 present the multiple logistic regression results for the three age-stratified subgroups, respectively. BMI (%), body weight (kg), body fat percentage (%), and total cholesterol (mg/dL) were revealed to be the most significant risk factors for MetS (p < 0.01 or p < 0.001). Men were significantly more likely to have MetS than women in only the young and middle-aged subgroups.

With regard to the three occupational groups (Table 10), in the younger subgroup, individuals with a nonsedentary occupation were less likely to have MetS (odds ratio [OR] = 0.88, 95% confidence interval [CI]: 0.78–0.99, p = 0.0295) than were those in other occupations. The three occupational groups did not differ with respect to MetS prevalence in the middle age group. In the older subgroup, MetS prevalence was higher among individuals in sedentary, high-SES occupations (OR = 1.39, CI: 1.04–1.85, p = 0.0247) than among individuals in other occupations and higher among men than women. Men and women did not significantly different with respect to MetS prevalence.

DISCUSSION

Owen et al. [24] reported that the average person spends 1) 71% of their daily waking hours in an inactive state and 2) only 30 min daily on moderate-intensity physical activity on most days of a week. As noted in the literature review in the Introduction section, leading a sedentary lifestyle significantly increases the risk of MetS [24, 39, 40]. A sedentary lifestyle also increases the risk of obesity [9], poor cardiometabolic health [17, 32], and poor cognitive health [26]. An increasing number of researchers have begun to investigate the correlation of a sedentary occupation with MetS or CVD risk [9, 25, 26, 27, 29, 30].

However, most MetS risk factors have centered on a lack of physical activity rather than on a sedentary occupation [41, 42]. Studies have also demonstrated that lifestyle and SES are significant risk factors for MetS [21, 22] and CVD [21, 43, 44]. However, Kim et al. [45] argued that a causal relationship of SES with MetS and CVD risk, as indicated by theFraminghamriskscore, cannotbeinferredfromthecurrent body of cross-sectional evidence. Furthermore, scholars have yet to investigate the role of occupation in MetS risk, let alone in a fine-grained manner with occupation further distinguished by level of physical activity and association with SES. In particular, MetS risk is likely to differ between those working in typically sedentary, white-collar occupations (such as doctors, professors, managers, and engineers) and those working in sedentary blue-collar occupations (such as administrative staff, service staff, and taxi drivers).

Our findings indicate that age and occupation are significant MetS risk factors among men and women (Table 8 and 9, respectively). Managers and taxi drivers, regardless of gender, were more likely to have MetS than were those in other occupations. Notably, salesmen, despite having a relatively physically active job, had the third-highest (and still high) MetS prevalence rate. The reasons for this finding should be investigated in future research. Furthermore, MetS prevalence was low among women younger than 60 years old (Tables 8 and 9) but high (at 32.07%, similar to that of their male counterparts) among women older than 60 years old. This is attributable to a decrease in estrogen levels after menopause [46].

Due to the age group influencing the highest prevalence of MetS, this study compared the three occupation categories under different age groups. In Table 10, we found the non-sedentary occupation group has less chance to have MetS. In Table 11, there is no difference among the three occupational groups which implies occupational effects might not be the key factor for MetS. However, high-SES-associated occupations of the older age group are at a higher risk of MetS than general sedentary and non-sedentary occupations shown in Table 12. Hence, the people who are belonged this sedentary and high-SES occupations should avoid prolonged sitting all day long. In addition, there is no difference between the male and female due to MetS was more prevalent among post-menopausal female [46].

Individuals in a nonsedentary occupation were less likely to have MetS (Table 10). The three occupational groups did not differ with respect to MetS prevalence (Table 11), which implies that occupation is not a key factor for MetS. However, among participants in the older subgroup, having a sedentary, high-SES occupations was associated with a higher risk of MetS (Table 12). Thus, individuals in sedentary, high-SES occupations should avoid prolonged sitting [46].

CONCLUSIONS

Although prolonged sitting is a seemingly novel risk factor for health outcomes across all ages, its association must be determined under occupational conditions [32]. Our findings indicate that age and occupation type are risk factors for MetS. We found that lawyers, teachers, accountants, doctors, nurses, engineers, managers, and taxi drivers constitute high-risk groups for MetS. For individuals 40 years old, having a nonsedentary occupation lowers the risk of MetS. For individuals >60 years old, having a sedentary, high-SES occupation significantly increases the risk of MetS. Government authorities should focus on sedentary, high-SES workers by tailoring health promotion programs—involving, for example, aerobic exercise [47] or physical activity [28, 48]— to this group of workers.

Table 10 Multiple logistic regression results for factors associated with MetS risk among participants aged ≤ 40 years

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I*	1.00			
	Group-II †	0.88	0.78	0.99	0.0295
	Group-III ‡	1.03	0.95	1.12	0.4825
Gender	Male	1.00			
	Female	0.43	0.37	0.51	<0.001
Weight(Kg)		1.04	1.03	1.05	<0.001
BMI		1.26	1.22	1.29	<0.001
Body Fat Percentage(%)		1.07	1.06	1.08	<0.001
LDL-C(mg/dl)		1.00	1.00	1.01	0.0012
Total Cholesterol(mg/dl)		1.00	1.00	1.00	0.0406

*Group-I: General sedentary-related occupations †Group-II: non sedentary-related occupations ‡Group-III: sedentary-related occupations with high-SES

Table 11 Multiple logistic regression results for factors associated with MetS risk among participants aged 40–60 years

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I	1.00			
	Group-II	1.01	0.93	1.10	0.8170
	Group-III	0.98	0.91	1.05	0.5618
Gender	Male	1.00			
	Female	0.46	0.40	0.52	<0.001
Weight(Kg)		1.03	1.02	1.03	<0.001
BMI		1.30	1.27	1.33	<0.001
Body Fat Percentage(%)		1.07	1.06	1.08	<0.001
LDL-C(mg/dl)		1.00	1.00	1.00	0.2922
Total Cholesterol(mg/dl)		1.00	1.00	1.00	<0.001

Table 12 Multiple logistic regression results for factors associated with MetS risk among participants aged > 60 years

Variables	Condition	OR	95%CI		p-value
Occupation	Group-I	1.00			
	Group-II	1.16	0.89	1.53	0.2708
	Group-III	1.39	1.04	1.85	0.0247
Gender	Male	1.00			
	Female	0.99	0.65	1.50	0.9657
Weight(Kg)		1.06	1.04	1.08	<0.001
BMI		1.10	1.03	1.18	0.0059
Body Fat Percentage(%)		1.08	1.05	1.11	<0.001
LDL-C(mg/dl)		1.00	0.99	1.00	0.1646
Total Cholesterol(mg/dl)		1.00	1.00	1.01	0.1900

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FOOTNOTES

Contributors

M.-S.C. (Ming-Shu Chen) conceived and designed the experiments; M.-S.C. and C.-H.C. (Chi-Hao Chiu) performed the experiments; C.-H.C., and S.-H.C. (Shih-Hsin Chen) analyzed the data; M.-S.C. were supervised the study; M.-S.C. contributed material for investigation; M.-S.C., C.-H.C., and S.-H.C. wrote this paper together. S.-H.C. submitted this paper.

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COMPETING INTERESTS

The authors declare no conflicts of interest concerning this study.

Ethics approval

Ethical approval was obtained from the Research Ethics Review Committee at FEMH in New Taipei City, Taiwan (IRB approval number: FEMH-IRB-107126-E, v.02; board meeting and approval date: September 10, 2018). The MJ Health Research Foundation also approved this study. This study also has a PPS receipt (ClinicalTrials.gov ID: NCT04142593, Date: October 25, 2019).

Data sharing statement

We aggregated two databases from the New Taipei City Government Annual Taxi Health Examination Survey by FEMH and from the MJPD (for 2012–2016). Access to the first data set by the wider scholarly community is restricted by the Research Ethics Review Committee of FEMH (FEMH-IRB-107126-E, v.02) out of concern for participant privacy. The second data set is accessible to any researcher upon request. Please contact Dr. Ming-Shu Chen (email: tree1013@gmail.com) to obtain further information.

Consent to patient and public involvement statement

No patients were involved.

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STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

Item	No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 1-2
Methods			
Study design	4	Present key elements of study design early in the paper	Page 2-3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	Page 3
		(*b*) For matched studies, give matching criteria and the number of controls per case	Page 2-3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	NA
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 2-3
Bias	9	Describe any efforts to address potential sources of bias	Page 1 and 7
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 2-3
		(*b*) Describe any methods used to examine subgroups and interactions	Page 2-3
		(*c*) Explain how missing data were addressed	Page 2-3
		(*d*) If applicable, explain how matching of cases and controls was addressed	Page 2-3
		(*e*) Describe any sensitivity analyses	Page 2-3
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 4-7
		(b) Give reasons for non-participation at each stage	Page 4-7
		(c) Consider use of a flow diagram	Page 4-7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 4-7

		(b) Indicate number of participants with missing data for each variable of interest	Page 4-7
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	Page 4-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 4-9
		(*b*) Report category boundaries when continuous variables were categorized	Table 4-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Table 4-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 4-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 1 and Page 7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 1 and 7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 1 and 7
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 7-8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 8

*Give information separately for cases and controls.

Responding: This study is not a typical "case-control studies" and research design, we only on the major study subjects to select the appropriate study objects to compare in this study.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.