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THE CARDIOVASCULAR FACTORS AND METABOLIC SYNDROME IN AN ELDERLY MALE CHINESE OCCUPATIONAL POPULATION

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ABSTRACT

Purpose
This study was conducted to explore the prevalence of metabolic syndrome and identify associated risk factors in an elderly male occupational population in Taipei, Taiwan.

Methods
A total of 2734 healthy subjects over age 65 voluntarily presented to a teaching hospital for a physical check-up in 2010. Demographic data and blood test results were collected. Metabolic syndrome was diagnosed according to NCEP ATP III criteria.

Results
The mean age of study participants was 74.4±6.6 years. The prevalence of metabolic syndrome was estimated at 29.9% (95%CI: 28.2%-31.6%). After adjustment for confounding factors, higher body-mass index (OR=1.50, 95%CI 1.41–1.62), higher mean body fat (% of total mass, OR=1.11, 95%CI: 1.04–1.20), elevated serum uric acid (OR=1.13, 95%CI: 1.02–1.26), and elevated alanine aminotransferase (OR=1.01, 95%CI: 1.00–1.02), and sedentary lifestyle (yes vs. no, OR=1.22, 95%CI: 1.09–1.37) were identified as the most significant risk factors associated with metabolic syndrome.

Conclusion
The prevalence of metabolic syndrome is related to several cardiovascular risk factors. Health initiatives directed towards preventing and treating metabolic syndrome could significantly reduce the prevalence of diabetes and cardiovascular disease in this older population.

Key Words: *male, metabolic syndrome, occupational population, elderly*

Metabolic syndrome (MetS), a consequence of of obesity and sedentary lifestyle, significantly increases the risk of cardiovascular disease (CVD) and diabetes.[1–3] The prevalence of MetS increases with age. It is estimated that 40% of individuals over age 60, and 10% of individuals ages 20–60 have MeS.[4] Early detection and treatment of this syndrome would significantly reduce the prevalence of associated poor health outcomes, including diabetes and CVD.

In Taiwan, the number of people entering the sector was estimated between 23,000 and 33,000 in 2002 by the Council of Agriculture. The agricultural population as a ratio of Taiwan's total employed workforce dropped from 10.1% in 1996 to 7.5% in 2002, with the average age of farm workers rising slightly from aged 49 to 50. Those over age 60 accounted for over 25%, a mild increase from the preceding year and an indication that Taiwan's agricultural population is relatively elderly. In addition, the rise of the tourism industry in Taiwan has increased the country's commercial fishing population, which is turning to recreational fishing for an economic turnaround. The generally low esteem of fishermen and the perceived lack of public respect for their occupation makes it difficult for the aging generation.[5] Little is known about the prevalence of MetS, especially among elderly males.

From the preventive medicine viewpoint, it is not only essential to be cognizant of the prevalence of MetS regionally, but to explore the spectrum of demographic and biological markers which may be related to MetS levels. Regarding the uncertainty on whether the prevalence of and the associated risk factors with MetS amongst a male elderly occupational population. This study was conducted to identify the prevalence of and associated factors for a MetS, among an elderly male agricultural and fishing population in Taipei, Taiwan.

METHODS

Study Design and Data Collection

In this cross-sectional study a total of 2,734 elder males from agricultural and fishing occupations voluntarily presented to one teaching hospital in Northern Taiwan for an annual physical check-up between January, 1, 2010 and December, 31, 2010. All procedures were performed in accordance with the guidelines of our institutional ethics committee and adhered to the tenets of the Declaration of Helsinki. All patients' information remained anonymous.

The medical histories and measurements of the participants were obtained by well-trained nurses. Personal and family histories of hypertension, type 2 diabetes, CVDs, and other chronic diseases were obtained by a questionnaire. The participants were asked to remove their shoes and any other belongings that could possibly add weight when they were weighed. Body-mass index (BMI) were evaluated based on height and weight. Waist circumference was measured at the level of the iliac processes and the umbilicus with a soft tape measure to evaluate abdominal obesity. Blood pressures were measured twice in the sitting position with an interval of 15 minutes between the measurements, by means of standard sphygmomanometers of appropriate width, after a rest period for 30 minutes. Those taking antihypertensive therapy were considered to be hypertensive.

Fasting blood samples were drawn via venipuncture from study participants by clinical nurses. Overnight-fasting serum and plasma samples (from whole blood preserved with EDTA and NaF) were kept frozen (−20°C) until ready for analysis. MetS was diagnosed according to NCEP ATP III criteria., At least 3 of the following 5 parameters were required for diagnosis: (1) abdominal obesity (waist circumference ≥ 90 cm), (2) hypertension (SBP>130 mm Hg and/or DBP>85 mm Hg) or history of antihypertensive medication, (3) hypertriglyceridemia (≥150 mg/dL) or treatment for this disorder, (4) low HDL-C (<40 mg/dL in males) or treatment for this disorder, and (5) elevated fasting plasma glucose (>100 mg/dL) or the diagnosis of type 2 diabetes.[6,7]

Physical activity was gauged as moderate (60 minutes or more per day in activities such as brisk walking/ domestic chores/carrying or moving loads up to 20 kg) and vigorous (running/cycling/swimming/carrying or moving loads above 20 kg). Anything short of moderate physical activity was considered sedentary.[8]

Statistical Analysis

Statistical analysis was performed using SPSS for Windows, (SPSS version 18.0; Chicago, IL, USA). The one-way ANOVA method was adopted to assess differences in the mean value of continuous variables. The χ^2-trend test was used to determine significant differences in proportions among categorical variables. Multinomial logistic regression is the extension for the (binary) logistic regression when the categorical dependent outcome has more than 2 levels.[9] This method was also performed to provide a set of coefficients for each of the 2 comparisons of MetS and to investigate the independence of factors associated with the prevalence of MetS.

A p-value of <0.05 was considered to represent a statistically significant difference between 2 test populations.

RESULTS

Table 1 indicates the demographic characteristics of the participants of the study. There were significant differences in SBP, DBP, BMI, waist circumference, triglycerides, total cholesterol, and alanine aminotransferase (ALT) among different age subgroups. In addition, the prevalence of sedentary lifestyle among

TABLE 1 Demographic Characteristic of Participants with and Without Metabolic Syndrome among Male Study Population (n=2734)

		Age				Metabolic Syndrome			
Variables	**General (n=2734) mean±SD**	**65–74 (n=1519) mean±SD**	**75–84 (n=1020) mean±SD**	**≥85 (n=195) mean±SD**	**p-value for F-test**	**No (n=473) mean±SD**	**One or two (n=1443) mean±SD**	**More than three (n=818) mean±SD**	**p-value for F-test**
Age	74.4±6.6	69.7±2.9	78.8±2.8	88.7±4.6	-	74.7±6.9	74.5±6.5	74.5±6.5	0.10
SBP (mm Hg)	137.0±22.1	135.9±22.1	138.2±22.0	138.8±22.3	0.01	115.5±12.2	139.1±21.0	139.1±21.0	<0.001
DBP (mm Hg)	78.6±12.1	88.6±12.0	76.6±11.7	73.9±12.8	<0.001	69.3±8.0	79.3±11.6	79.3±11.6	<0.001
BMI (kg/m²)	24.9±3.5	25.3±3.5	24.6±3.4	23.7±3.6	<0.01	22.1±2.5	24.5±3.1	24.5±3.1	<0.001
Waist circumference (cm)	88.5±10.2	89.1±10.1	88.1±10.1	85.8±11.7	0.04	79.4±6.4	87.1±9.1	87.1±9.1	<0.001
Fasting blood glucose (mg/dL)	99.5±27.0	100.6±29.0	98.6±25.3	95.0±15.3	0.65	86.3±6.5	95.1±18.7	95.1±18.7	<0.001
Triglycerides (mg/dL)	128.5±82.0	135.9±92.0	120.6±69.1	111.7±50.1	0.020	83.8±6.5	105.4±47.5	105.4±47.5	<0.001
HDL-C (mg/dL)	51.9±14.5	52.0±14.7	51.8±14.3	52.1±13.5	0.11	61.1±13.8	54.2±13.5	54.2±13.5	<0.001
Uric acid(mg/dL)	6.5±1.5	6.4±1.5	6.6±1.5	6.6±1.5	0.15	6.1±1.3	6.4±1.4	6.4±1.4	<0.001
ALT(U/L)	32.4±26.0	34.5±32.2	30.1±14.6	25.1±9.4	0.01	28.3±11.8	31.6±27.2	31.6±27.2	<0.001
Mean body fat (% of total mass)	24.1±7.4	24.5±8.5	23.7±5.0	22.9±8.0	0.17	30.0±4.4	23.6±6.6	23.6±6.6	<0.001

ALT = alanine aminotransferase; BMI = body-mass index; DBP = diastolic blood pressure; HDL = high-density lipoprotein; SBP = systolic blood pressure.

study subjects was33.1% (95%CI: 31.3–34.9%). The prevalence of sedentary lifestyle and no MetS criteria, one or 2 criteria, and 3 or more criteria were 29.6% (95%CI: 25.5–33.7%), 31.8% (95%CI: 29.4–34.2%), and 37.4% (95%CI: 34.1–40.7%), respectively (χ^2=53.04, p<0.001).

The proportion of Chinese elderly men with MetS is shown in Figure 1. The prevalence of MetS among the study participants was 29.9 % (95%CI: 28.2–31.6%). The prevalence of MetS revealed significant negative relationship with metabolic components when applying the $\chi 2$ trend test (p=0.04). Figure 2 demonstrated the age-specific prevalence of each metabolic component of MetS. The prevalence of each metabolic component also revealed significant negative relationship with increased age when applying the $\chi 2$ trend test (p<0.001). The most common component among the different age subgroups in this survey was elevated blood pressure, which involved 57.0% (95%CI: 55.1–58.9%) of all the participants. Hypertriglyceridemia (26.2%, 95%CI: 24.6–27.9%) and low HDL-C (21.9%, 95%CI: 20.3–23.4%) were relatively low. There were the same ranks in the 5 components for each age group.

The effect of independent associated risk factors upon MetS was examined using the multinomial logistic regression model. As is depicted in Table 2, subsequent to adjustment for confounding factors, higher BMI (OR=1.19, 95%CI: 1.12–1.27), higher mean body fat (% of total mass, OR=1.07, 95%CI: 1.02–1.14), higher ALT (OR=1.01, 95%CI: 1.00–1.02), and sedentary lifestyle (yes vs. no, OR=1.17, 95%CI: 1.02–1.33) appeared to be statistically significantly related to subjects with one or 2 metabolic factors. In addition, higher BMI (OR=1.50, 95%CI: 1.41–1.62), higher mean body fat (% of total mass, OR=1.11, 95%CI: 1.04-1.20), higher serum uric acid (OR=1.13, 95%CI: 1.02–1.26), higher ALT (OR=1.01, 95%CI: 1.00–1.02), and sedentary lifestyle (yes vs. no, OR=1.22, 95%CI: 1.09–1.37) appeared to be statistically significantly related to subjects with MetS.

DISCUSSION

Factors Associated with Metabolic Syndrome

Interestingly we observed that the prevalence of MetS diminished with age (see Figure 1). Previous studies have indicated that prevalence of MetS increases with age until after age 70 when it tends to decrease This may be related to a higher prevalence of chronic disorders and related complications such as malnutrition, dementia, etc. that increase with age.[10,11] Another possible explanation may be related to the healthy worker effect (self-selection bias), whereby healthier working individuals may be more likely to volunteer for a physical check-up compared with unhealthier individuals who cannot work. In addition, we observed a higher prevalence of MetS in the sedentary lifestyle group. The relationship between regular moderate-to vigorous physical activity and the prevention of chronic

FIG. 1 Age-specific prevalence of number of metabolic components in the study participants (n=2,734).

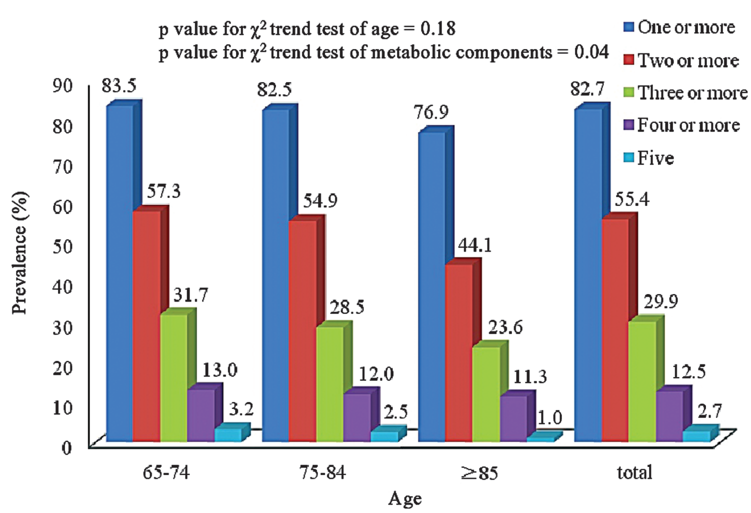

FIG. 2 Age-specific prevalence of each metabolic component in the study participants (n=2,734).

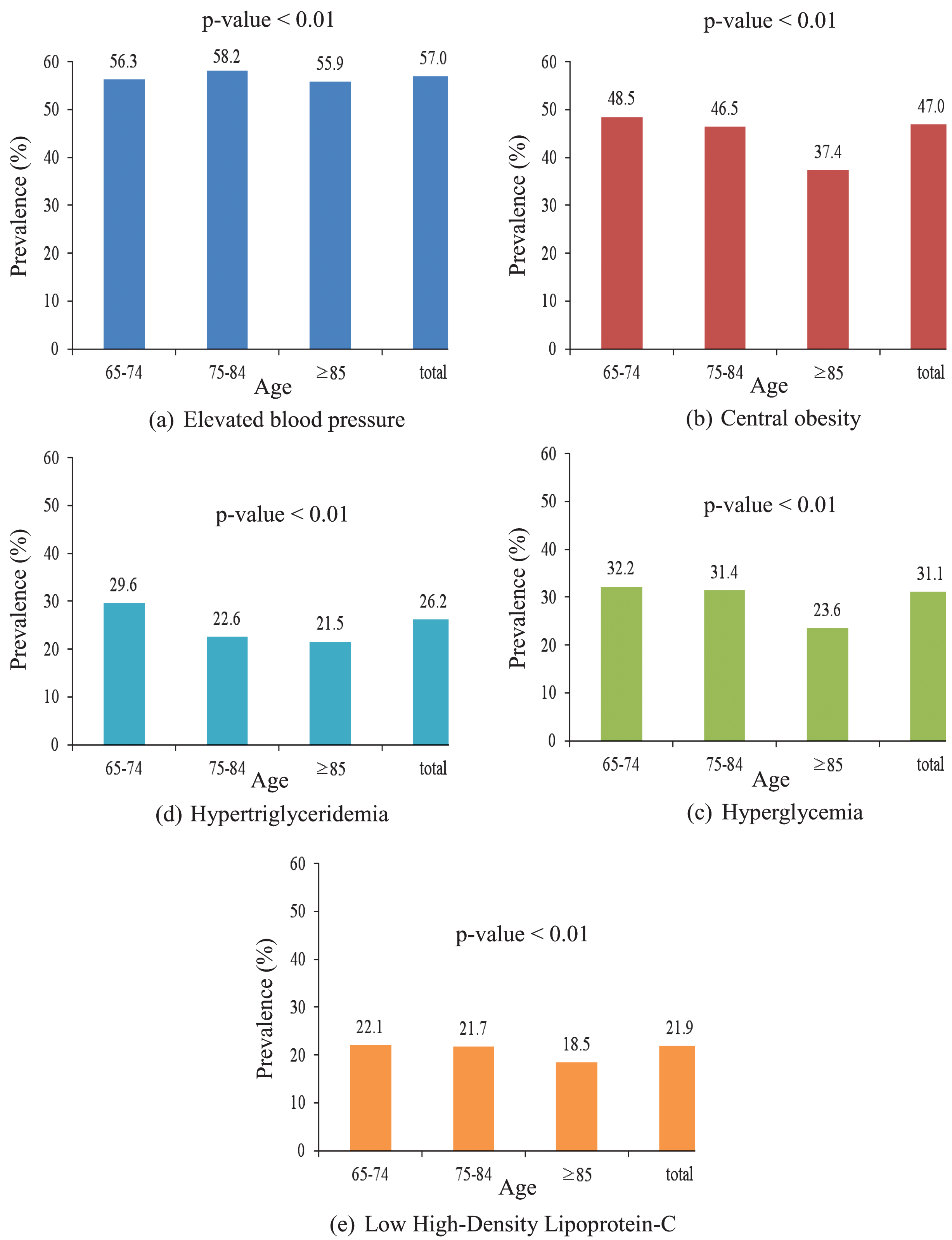

TABLE 2 Multinominal Logistic Regression of Associated Factors for Metabolic Syndrome Among Male Elderly Screened Subjects (n=2,734)

	One or two metabolic factors vs. no metabolic factors		**Three or more metabolic factors vs. no metabolic factors**	
	OR	95%CI	OR	95%CI
Age (yrs)	1.01	0.97–1.07	1.01	0.99–1.04
BMI (Kg/m^2)	1.19	1.12–1.27	1.50	1.41–1.62
Mean body fat (% of total mass)	1.07	1.02–1.14	1.11	1.04–1.20
Uric acid (mg/dl)	1.07	0.98–1.16	1.13	1.02–1.26
ALT (U/L)	1.01	1.00–1.02	1.01	1.00–1.02
Irregular physical activity (yes vs. no)	1.17	1.02–1.33	1.22	1.09–1.37

diseases is well accepted.[12] Evidence-based studies also have demonstrated -that sporadic physical activity contributes to total daily energy expenditure significantly and therefore had the potential to play an important role in MetS patient who want to improve obesity.[13,14]

In this study, higher serum uric acid was independently associated with MetS. Serum uric acid is the final oxidation product of purine metabolism in humans. Hyperuricemia is usually caused by inadequate renal excretion of uric acid.[15] Epidemiologic studies have shown an association between serum uric acid levels and the components of MetS, suggesting that hyperuricemia could be an additional component of MetS.[15–17] The association between serum uric acid levels and CVDs might be partially due to attributable cardiovascular risk factors clustering in subjects with MetS, especially those strongly associated with waist circumference, which are also relevant in relation to MetS index – obesity.[16] Underlying mechanisms which may explain why hyperuricemia is more commonly associated with MetS include: (1) Insulin resistance is widely recognized as a major risk factor for kidney disease and is also common in subjects with hyperuricemia and MetS. (2) Fructose is known to increase uric acid concentrations in humans, and uric acid may in turn increase the risk of MetS.[15,18,19] However, strong intercorrelations among serum uric acid levels and the diagnostic criteria of MetS the make it difficult to determine if an elevated serum uric acid level is an additional active component of MetS or just an associated link to MetS and its components.[16]

Our results revealed that both higher BMI and higher mean body fat are strongly associated with MetS. MetS and obesity have been associated with an increased risk of diabetes and CVD morbidity and mortality, resulting in an enormous economic burden to society.[20] Obesity adversely affects processes controlling blood glucose, blood pressure, and lipids.[2] In addition, several investigators have shown that body fat is higher in Asian compared with white Caucasians for the similar level of BMI.[2,21] Higher body fat composition, contributes to insulin resistance, dyslipidemia, hyperglycemia, and hypercoagulability seen commonly in South Asians.[2,21–23] From the primary prevention viewpoint, obesity and sedentary lifestyle are responsible for the MetS epidemic behavioral modification to reduce weight and increase physical activity therefore should be the cornerstone of treatment.[24,25]

Serum ALT was identified an important modifiable risk factor for MetS in this study. Elevated serum ALT is most closely related to liver fat accumulation, and is often used in epidemiological studies as a surrogate marker for nonalcoholic fatty liver disease.[26,27] Previous studies demonstrated that serum ALT concentrations were related to hepatic insulin resistance and fatty changes in the liver.[28] Therefore, conducting the better quality of liver function in order to prevent MetS is essential in elderly sub-population. Besides this fact, an early detection of MetS might be beneficial if accompanied with an early intervention, such as suppressing pathways for complications

Prevalence of Metabolic Syndrome

The MetS is viewed as a constellation of cardiovascular risk factors. Table 3 presents the prevalence

TABLE 3 Prevalence of Metabolic Syndrome by ATP III Criteria in Various Populations

Author	Study year	Screened number	Setting	Study age (years)	Prevalence of metabolic syndrome (%)	Associated factors
Shin MH, et al.[33]	2013	9260	Korea	Older than 50	40.4% (male), 53.9% (female)	Alcohol intake
Gundogan K, et al.[10]	2013	4309	Turkey	47 ± 14	36.6%	Age, body-mass index, obesity
Carriere I, et al.[34]	2013	6141	France	Older than 65		Central obesity, high triglycerides, and elevated fasting glucose and incidence of limitations in mobility and instrumental activities of daily living.
Li JB, et al.[35]	2010	1206	China	59 ± 15	38.0%	Hypertension, diabetes, abdominal obesity, elevated blood glucose, life stress and anxiety
Chiou WK, et al.[36]	2010	5896	Taiwan	53 ± 12	50.0% (male), 59.4% (female)	Age, cardiovascular risk factor, hyperuricemia
Zuo h, et al.[37]	2009	3914	China	53 ± 10	45.2%	Body-mass index, hypertension, education, tea drinking, age, triglycerides
Erem C, et al.[11]	2008	4809	Turkey	Older than 20	26.9% (female), 21.7% (male)	Age, marital status, parity, cessation of cigarette smoking, and negatively with the level of education, alcohol consumption, current cigarette use, household income, and physical activity
Rho YH, et al.[38]	2008	1686	Korea	Older than 20	4.4% (male), 6.8% (female)	Uric acid
Gu D, et al.[20]	2005	15540	China	35–74	9.8% (male), 17.8% (female)	Age, body-mass index, overweight

TABLE 3 Prevalence of Metabolic Syndrome by ATP III Criteria in Various Populations (*Continued*)

Author	Study year	Screened number	Setting	Study age (years)	Prevalence of metabolic syndrome (%)	Associated factors
Ford ES, et al.[39]	2005	3601	United States	Older than 20	34.5±0.9%	Waist circumference
Park, et al.[40]	2004	3937(male) 4713(female)	Korea	43 ± 15	14.2%(male), 17.7%(female)	Obesity, body-mass index, current smoking
Gupta, et al.[41]	2003	532(male) 559(female)	North India	Older than 20	9.8%(male), 20.4%(female)	Obesity, central obesity, hypertension, low high-density lipoprotein, hypertriglyceridemia
Azizi, et al.[43]	2003	4397(male) 5971(female)	Tehran, Iran(urban)	Older than 20	24.0%(male), 42.0%(female)	Age
Al-Lawati, et al.[43]	2003	4723	Oman	38 ± 15	19.5%(male), 23.0%(female)	Obesity, age, low high-density lipoprotein, cholesterol
Ford ES, et al.[44]	2002	8814	United States	Older than 20	21.8%(male), 23.7%(female)	Age
Misra, et al.[45]	2001	170(male) 362(female)	North India	35 ± 12	13.3%(male), 15.6%(female)	Obesity, dyslipidaemia, diabetes

and factors related to MetS in various populations. The prevalence of MetS seems to vary among different screened populations based on the results of different studies conducted in different countries.

Changes in lifestyle and diet have led to an increase in the prevalence of MetS in many parts of the world including Asia.[29] Sixty-four million people are estimated to have MetS in China alone.[20] The results provide an opportunity to elucidate the associations between putative factors and the early stage of MetS. The significant associated factors in our study are congruent with the biological plausibility that the impact of factors on the development or progression of MetS. The prevalence of MetS amongst different screened populations appears to vary according to the results of different studies conducted in different countries.[2] This disparity would likely be largely due to differences between different populations in addition to differences in the specifics of diagnostic criteria for MetS. The prevalence of MetS for our study population (29.9%) was higher than the corresponding prevalence presented in a previous population-based study conducted in general Chinese populations.[20,30–32] This might partially explain the apparently high prevalence of MetS observed in our study due to the agricultural and fishing population always face to the physical work, job stress, and reversed working and resting time. Irregular lifestyle and carelessness with their own health can result in MetS.[5] Another possible reason for such difference between the results of the general population-based studies and our results may simply have been related to the different study populations.

Limitations of This Study

Admittedly, there were several limitations in this study. Firstly, the MetS measurements were done only at a single point in time and would not be able to be used to reflect long-term exposure to various demographic or biochemical aspects or factors, which might be important influencers of MetS status. The better solution to such a quandary is to conduct a number of prospective analogous studies which would be expected to complement the cross-sectional results of this study. Secondly, the potential selection bias due to the hospital-based study design, is not representative of the whole general population. The present study only included male subjects who were aged ≥65 years and may have different characteristics compared with whole population. This study's sub-population was more susceptible to be implemented with MetS. Furthermore, it can be beneficial to predict pathogenic trends and take early prevention strategies.

CONCLUSIONS

The prevalence of MetS is related to several cardiovascular risk factors. Promoting good health practices among this elderly male population is extremely important. Further studies are also needed to elucidate the temporal sequence of events that typically lead to MetS among male elderly sub-population.

CONFLICTS OF INTEREST

We certify that all the affiliations with or financial involvement in, within the past 5 years and foreseeable future, any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript are completely disclosed (e.g., employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, royalties).

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