Journal of Epidemiology 27 (2017) 130–134

Contents lists available at ScienceDirect

Journal of Epidemiology

journal homepage: http://www.journals.elsevier.com/journal-of-epidemiology/

Short Communication

Metabolic syndrome among non-obese adults in the teaching profession in Melaka, Malaysia

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ARTICLE INFO

Article history:
Received 31 January 2016
Accepted 9 April 2016
Available online 26 December 2016

Keywords:
Metabolically obese
Non-obese
Metabolic syndrome
Body mass index

ABSTRACT

Background: Non-obese individuals could have metabolic disorders that are typically associated with elevated body mass index (BMI), placing them at elevated risk for chronic diseases. This study aimed to describe the prevalence and distribution of metabolically obese, non-obese (MONO) individuals in Malaysia.

Methods: We conducted a cross-sectional study involving teachers recruited via multi-stage sampling from the state of Melaka, Malaysia. MONO was defined as individuals with BMI 18.5–29.9 kg/m^2 and metabolic syndrome. Metabolic syndrome was diagnosed based on the Harmonization criteria. Participants completed self-reported questionnaires that assessed alcohol intake, sleep duration, smoking, physical activity, and fruit and vegetable consumption.

Results: A total of 1168 teachers were included in the analysis. The prevalence of MONO was 17.7% (95% confidence interval [CI], 15.3–20.4). Prevalence of metabolic syndrome among the normal weight and overweight participants was 8.3% (95% CI, 5.8–11.8) and 29.9% (95% CI, 26.3–33.7), respectively. MONO prevalence was higher among males, Indians, and older participants and inversely associated with sleep duration. Metabolic syndrome was also more prevalent among those with central obesity, regardless of whether they were normal or overweight. The odds of metabolic syndrome increased exponentially from 1.9 (for those with BMI 23.0–24.9 kg/m^2) to 11.5 (for those with BMI 27.5–29.9 kg/m^2) compared to those with BMI 18.5–22.9 kg/m^2 after adjustment for confounders.

Conclusions: The prevalence of MONO was high, and participants with BMI ≥23.0 kg/m^2 had significantly higher odds of metabolic syndrome. Healthcare professionals and physicians should start to screen non-obese individuals for metabolic risk factors to facilitate early targeted intervention.

1. Introduction

The prevalence of metabolic syndrome in Malaysia is higher than in other Asian countries,[1] mainly due to the high prevalence of obesity.[2] However, there are many individuals who are not categorized as obese based on body mass index (BMI) but are predisposed to metabolic disorders.[3] Screening for metabolic disorders among these non-obese individuals is often ignored, as they are assumed to be healthy. The literature shows that normal weight individuals could have metabolic disorders, placing them at elevated risk for chronic diseases that are typically associated with elevated BMI.[4] Evidence also suggests that an abnormal metabolic profile, rather than high BMI, is associated with higher risk of diabetes and cardiovascular disease.[5]

Individuals who are normal-to over-weight with metabolic syndrome have been broadly classified as metabolically obese, non-obese (MONO).[6–8] However, the classification of MONO was complicated by the limitations associated with utilizing BMI in the definition. MONO was previously defined as individuals with BMI <27.0 kg/m^2 [6, 7] or <25.0 kg/m^2 [8] who have metabolic syndrome. However, based on World Health Organization (WHO) classification, the definition of non-obese is BMI 18.5–29.9 kg/m^2.[9] Malaysia has the highest prevalence of overweight population in the Southeast Asia,[10] so knowing the metabolic risk among this group is crucial for public health action and clinical practice.

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Peer review under responsibility of the Japan Epidemiological Association.

http://dx.doi.org/10.1016/j.je.2016.10.006

MONO offers insight into the risks of metabolic syndrome independent of obesity. Several studies have reported that non-obese individuals with metabolic risk factors display characteristic such as insulin resistance and higher visceral adiposity and plasma triglyceride, which together may confer an increased risk of cardiometabolic disease.[11] Moreover, identifying MONO may be more important among Asians, who are generally less obese but have relatively higher body fat than Westerners with the same BMI.[9,12]

Therefore, the aim of this study was to describe the prevalence and distribution of MONO using a BMI criterion of 18.5–29.9 kg/m^2 among the adult population in the state of Melaka, Malaysia.

2. Methods

This was a cross-sectional study carried out using multi-stage sampling in a school setting. A total of 51 public secondary schools were randomly selected. All permanent school teachers from the selected schools were invited to participate. Teachers who had psychiatric illnesses, were pregnant, or had a BMI <18.5 or ≥30.0 kg/m^2 were excluded. Data collection was carried out from October 2013 until February 2014. Information on socio-demographic characteristics and lifestyle behaviours were enquired using self-administered questionnaires. Anthropometric measurements and metabolic risk assessments were conducted by trained research assistants as per protocol.[13] This study is part of a cohort study on clustering of lifestyle risk factors and understanding its association with stress on health and wellbeing among school teachers in Malaysia (CLUSTer).[13]

This study was approved by the University Malaya Medical Ethics Committee (Ref No. 950.1) and written permission was granted from the Ministry of Education, the Education Department, and the school principals. Informed consent was obtained from all participants.

2.1. Definition of metabolic syndrome

Metabolic syndrome was defined using the Harmonization criteria as having any three or more of the following risk factors: (1) central obesity (waist circumference [WC] ≥80 cm in women or ≥90 cm in men); (2) elevated triglyceride (TG; ≥1.7 mmol/L); (3) low high-density lipoprotein cholesterol (HDL-C; ≤1.3 mmol/L in women or ≤1.0 mmol/L in men); (4) high blood pressure (BP; ≥130/85 mm Hg or on antihypertensive treatment); and (5) high fasting blood glucose (FBG; ≥5.6 mmol/L or on treatment for elevated glucose).[14]

2.2. Definition of MONO

MONO was defined as individuals with BMI 18.5–29.9 kg/m^2 with metabolic syndrome. These individuals were subdivided into four BMI categories (18.5–22.99, 23.00–24.99, 25.00–27.49, and 27.50–29.99 kg/m^2) according to the BMI cut-off points as defined by WHO.[9]

2.3. Statistical analyses

Data entry and analysis were undertaken using the IBM SPSS Statistic version 21.0 (IBM Corp, Armonk, NY, USA). Samples were weighted to account for unequal probabilities of selection and non-response rate. Complex sample multivariate logistic regression

Table 1
Socio-demographic characteristics and lifestyle risk factors of participants.

	Total n	MONO		*P* value
		Yes (n = 218) n (weighted %)	No (n = 950) n (weighted %)	
Age group, years				
20–29	113	6 (5.6)	107 (94.4)	<0.001
30–39	319	32 (10.5)	287 (89.5)	
40–49	430	87 (17.5)	343 (82.5)	
50–59	306	92 (29.4)	214 (70.6)	
Gender				
Male	280	72 (25.9)	208 (74.1)	0.004
Female	888	146 (15.2)	742 (84.8)	
Ethnicity				
Malay	897	165 (17.7)	732 (82.3)	0.005
Chinese	216	34 (14.9)	182 (85.1)	
Indian	40	16 (39.3)	24 (60.7)	
Others	15	2 (7.8)	13 (92.2)	
Level of education				
Diploma	37	5 (19.1)	32 (80.9)	0.451
Degree	1035	1868 (17.2)	847 (82.8)	
Master/PhD	96	25 (23.3)	71 (76.7)	
Level of physical activity				
Low	103	21 (15.2)	82 (84.8)	0.617
Moderate	453	84 (18.6)	369 (81.4)	
High	275	59 (20.0)	216 (80.0)	
Smoking status				
Current	28	7 (21.5)	21 (78.5)	0.870
Former	43	9 (19.2)	34 (80.8)	
Never	955	177 (17.6)	778 (82.4)	
Alcohol consumption				
Yes	34	10 (25.7)	24 (74.3)	0.219
No	1020	186 (17.2)	834 (82.8)	
	Mean (SE)	Mean (SE)	Mean (SE)	*P* value
Age, years	42.51 (0.49)	46.72 (0.72)	41.60 (0.50)	<0.001
Servings of fruits and vegetables/day	2.35 (0.04)	2.39 (0.10)	2.34 (0.05)	0.644
Sleep, hours per day	6.26 (0.05)	5.97 (0.08)	6.32 (0.06)	0.001

MONO, metabolically obese, non-obese; SE, standard error.

Table 2
The proportion of metabolic syndrome according to fatness categories.

Fatness categories	Metabolic syndrome		*P* value
	Yes	No	
	n (weighted %)	n (weighted %)	
Normal weight[b]	55 (8.3)	577 (91.7)	
Central obesity[a]	35 (24.6)	92 (75.4)	<0.001
Non-central obesity	20 (4.2)	485 (95.8)	
Overweight[c]	163 (29.9)	373 (70.1)	
Central obesity[b]	149 (40.7)	212 (59.3)	<0.001
Non-central obesity	14 (8.4)	161 (91.6)	
Total (MONO)[d]	218 (17.7)	950 (82.3)	
Central obesity[a]	184 (36.2)	304 (63.8)	<0.001
Non-central obesity	34 (5.3)	646 (94.7)	

MONO, metabolically obese, non-obese.
[a] Male ≥90 cm; female ≥80 cm.
[b] BMI 18.5–24.9 kg/m^2.
[c] BMI 25.0–29.9 kg/m^2.
[d] BMI 18.5–29.9 kg/m^2.

analysis was conducted to estimate the odds ratio (OR) with 95% confidence interval (CI) of metabolic syndrome among non-obese individuals (MONO) adjusted for modifiable and non-modifiable confounders.

3. Results

A total of 1511 teachers were recruited, yielding a response rate of 36.0%. After excluding the underweight and obese, 1168 participants (78.4%) were included in the analysis. The majority of participants were females, Malays, and had tertiary education, with a mean age of 42.5 years (Table 1). The prevalence of MONO was 17.7% (95% CI, 15.3–20.4), whereas the prevalence of metabolic syndrome among the normal weight and overweight participants was 8.3% (95% CI, 5.8–11.8) and 29.9% (95% CI, 26.3–33.7), respectively (Table 2). The prevalence of MONO was higher among males ($P = 0.004$) and Indians ($P = 0.006$) and increased with age ($P < 0.001$). Participants with metabolic syndrome were

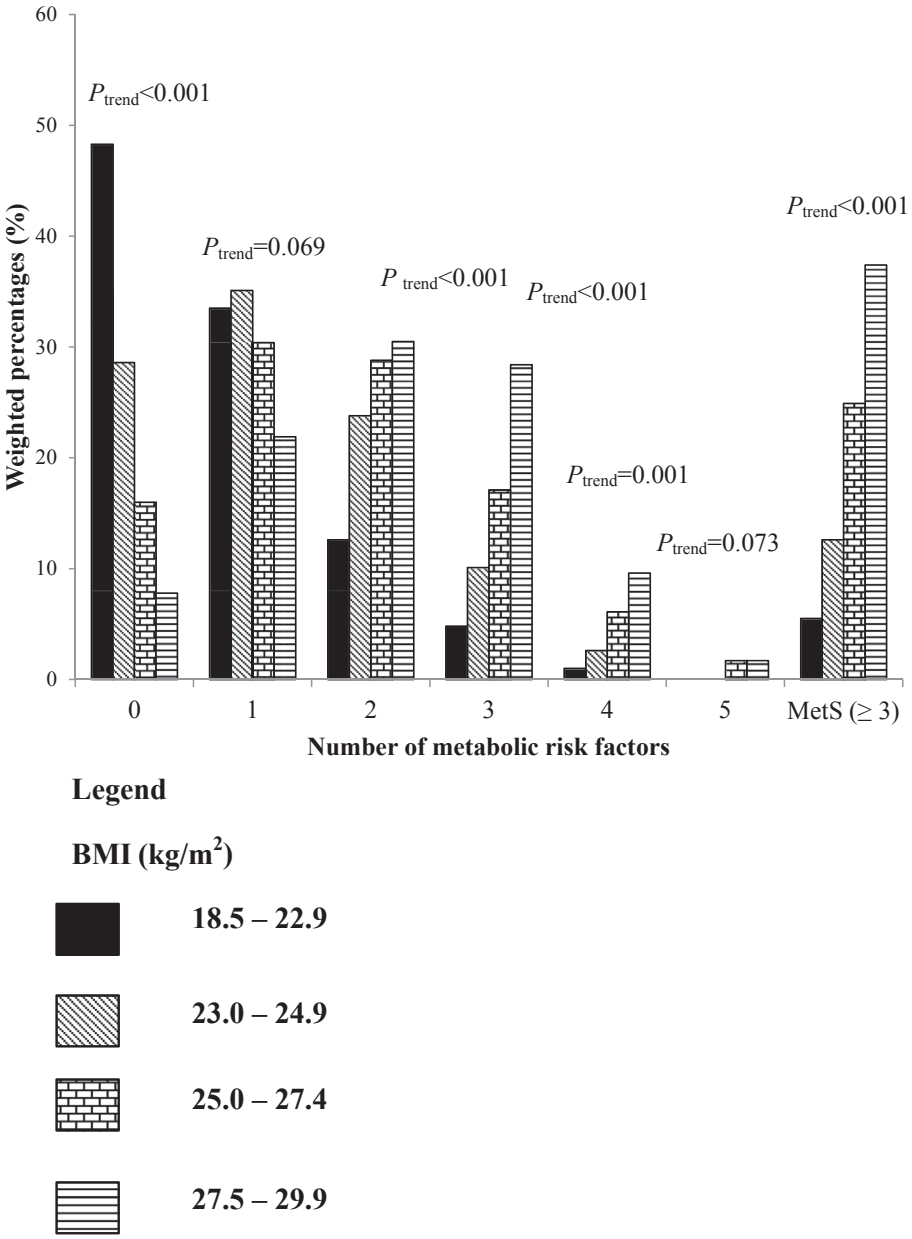

Fig. 1. The proportion of number of metabolic risk factors according to BMI categories. MetS, metabolic syndrome.

Table 3
The odds ratios of metabolic syndrome according to BMI categories.

BMI categories, kg/m^2	n	Unadjusted		Model 1		Model 2	
		OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
18.5 to 22.9	376	1		1		1	
23.0 to 24.9	256	2.49 (1.46, 4.25)	0.001	2.22 (1.23, 4.01)	0.009	1.94 (1.06, 3.55)	0.032
25.0 to 27.4	312	5.714 (3.48, 9.39)	<0.001	5.66 (3.43, 9.34)	<0.001	6.47 (3.53, 11.88)	<0.001
27.5 to 29.9	224	10.32 (5.64, 18.89)	<0.001	10.95 (3.43, 9.34)	<0.001	11.47 (5.11, 25.75)	<0.001

BMI, body mass index; CI, confidence interval; OR, odds ratio.
Model 1: Adjusted for non-modifiable confounders: age, gender, ethnicity.
Model 2: Adjusted for all factors in Model 1 and modifiable confounders: education, physical activity, smoking, alcohol consumption, fruit and vegetable consumption, and sleep duration.

significantly older (by approximately five years) and had shorter sleep duration (by approximately half an hour). There was no significant difference in the prevalence of metabolic syndrome according to the levels of education, physical activity, smoking status, alcohol consumption, or fruits and vegetables intake (Table 1).

Regardless of BMI status (normal and/or overweight), participants with central obesity were more likely to have metabolic syndrome compared to those without central obesity ($P < 0.001$), whereas, among participants without central obesity, only 4–8% were diagnosed with metabolic syndrome (Table 2).

The number of metabolic risk factors according to BMI categories is shown in Fig. 1. The proportion of participants with no metabolic risk factors reduced with BMI ($P_{trend} < 0.001$), while the proportion of participants with two to four metabolic risk factors increased significantly with BMI. There were no participants with five metabolic risk factors in the normal BMI categories. The proportion of participants with metabolic syndrome increased with BMI ($P_{trend} < 0.001$).

The associations between BMI categories and metabolic syndrome are presented in Table 3. Higher BMI categories conferred higher crude and adjusted OR for metabolic syndrome. The unadjusted odds of metabolic syndrome increased exponentially from 2.5 (at BMI 23.0–24.9 kg/m^2) to 10.3 (at BMI 27.5–29.9 kg/m^2) compared to those with BMI 18.5–22.9 kg/m^2. The adjusted odds of metabolic syndrome in models 1 and 2 were comparable those in the unadjusted model.

4. Discussion

The prevalence of MONO among our participants was about 18%, with male predominance. Previous studies have shown that the prevalence of metabolic syndrome among Taiwanese with BMI <27.0 kg/m^2 was 18.7%[6] and that the prevalence among South Indians with BMI <25.0 kg/m^2 was 15.1%.[8]

MONO was most prevalent among our participants of Indian ethnicity, as they had higher tendency to develop central obesity, hypertension, dyslipidaemia, hyperinsulinemia, and glucose intolerance, as has been reported elsewhere.[15,16] Older age participants also had higher prevalence of MONO, so it is important to screen the older population for metabolic risk factors even if they are non-obese. Lifestyle risk factors, such as physical activity, smoking, alcohol, fruit and vegetable consumption, and sleep duration were reported to contribute to metabolic syndrome.[17,18] However, in our study, only sleep duration was found to be significantly associated with MONO; an inverse relationship between sleep and metabolic syndrome has also been reported in a recent meta-analysis.[19]

Central obesity is not compulsory in diagnosing metabolic syndrome using the Harmonization criteria. However, our results showed that those with central obesity had higher risk of metabolic syndrome regardless of being normal weight or overweight. One possible explanation might be because central obesity was the most frequently reported metabolic risk factor among our participants (data not shown), and central obesity could be a proxy for insulin resistance, which would increase the risk of developing metabolic syndrome.[20,21]

Our study showed that the prevalence of metabolic syndrome and the number of metabolic risk factors increased with BMI, findings that have been similarly reported by others.[6,22–24] These findings support the notion that weight gain is detrimental to metabolic health. We found that the adjusted odds of metabolic syndrome increased exponentially from a BMI of 23.0 kg/m^2, in agreement with the recommendations,[9] where BMI 23.0 kg/m^2 was identified as an additional trigger point for public health action among Asians.

There were several limitations in our study that need to be addressed. First, the prevalence of MONO is difficult to quantify, as there is presently no standardized definition for MONO, resulting in a wide variation in its prevalence. Our results may not be generalizable to the general population, as the majority of our participants were females, Malays, and had tertiary education, representing the characteristics of the secondary school teachers in our country. In addition, the cross-sectional design does not allow us to establish causal relationships. Finally, recall bias could not be ruled out, as lifestyle behaviours were self-reported.

However, to the best of our knowledge, this is the first study to investigate the prevalence of MONO in Malaysia. In addition, the BMI categories were based on WHO cut-off points,[9] unlike other studies where cut-off points were chosen arbitrarily.[6–8] It is now clear that MONO is prevalent among our participants and they are susceptible to developing diabetes and cardiovascular disease, which may lead to cardiovascular or all-cause mortality.[5,25–29] Detection of MONO individuals might be particularly noteworthy, since they might be more responsive to dietary and lifestyle interventions, which may reduce their subsequent risk of cardiovascular complications.[3,30] Furthermore, it is practical, cost-effective, and feasible to identify MONO individuals in a large population using our already established health care system.

In conclusion, the prevalence of MONO was high and increased with BMI among our participants. Participants with BMI ≥23.0 kg/m^2 had significantly higher odds of metabolic syndrome after adjustment. MONO was more prevalent among males, Indians, and those of older age, and was inversely associated with sleep duration. Healthcare professionals should start screening normal weight and overweight individuals for metabolic risk factors. Health promotion programs should be targeted on MONO individuals to increase their awareness of cardiometabolic risks and gear them towards taking preventive measures. Future studies should be conducted among populations from more diverse occupations, with a more nationally representative ethnic and gender distribution. Longitudinal studies should also be carried out to establish causal relationship between metabolic syndrome and its risk factors.

Funding

This project was funded by the Ministry of Education High Impact Research Grant, Malaysia (H-20001-00-E000069).

Conflicts of interest

None declared.

Acknowledgements

The approval from the Ministry of Education, Malaysia (reference no: KP(BPPDP) 603/5/JLD.12(24)) and the Department of Education in Melaka (reference no: JPM.SPS.UPP.100 - 2/5/2 Jid 10(84)) for this study is acknowledged. We would like to thank all the schools and teachers who participated in this study.

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