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Metabolic Syndrome Risk Factors and Physical Activity in Middle-Aged Women

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Abstract

Aim: The purpose of this study was to explore the correlation between physical activity and metabolic syndrome risk factors middle-aged women.

Methods: A cross-sectional survey of 101 middle-aged women with metabolic syndrome risk factors were recruited from a regional teaching hospital in Taiwan. Surveys were conducted using a demographic questionnaire, and the Taiwanese version of the self-administered short version of the International Physical Activity Questionnaire.

Results: The research results indicate that (1) 69% of the Women with metabolic syndrome were mostly in postmenopause, and the most common risk factor for metabolic syndrome was abdominal obesity (80.2%). (2) Fasting blood glucose (FBG) ≥ 100mg/dl and the level of physical activity showed significantly differences (χ^2 = 6.1, $p < .05$). (3)The total metabolic equivalents (METs) of physical activities of having or no having metabolic syndrome women showed significantly different, no having metabolic syndrome women higher then metabolic syndrome women ($t = 2.23$, $p < .05$). (4) The predictor of waist circumference ≥ 80cm is basal metabolic index (BMI) (OR = 3.46; 95% CI = 1.61, 7.46) ($p < .05$), the predictor of FBG ≥ 100mg/dl is insufficient physical activity (OR = 11.29; 95% CI = 1.72, 73.82) ($p < .05$), and the predictors of metabolic syndrome are BMI (OR = 1.68; 95% CI = 1.33, 2.08), menopause (OR = 12.3; 95% CI = 1.25, 120.68), and postmenopause (OR = 42.97; 95% CI = 2.22, 831.41) ($p < .05$).

Conclusions: This study recommends that to prevent metabolic syndrome, middle-aged women should adopt an active lifestyle, actively control their weight, and a minimum of 150 min of moderate-intensity physical activity per week or 75 min of high-intensity physical activity. This result is a potentially crucial reference for healthcare professionals in their care of patients with metabolic syndrome.

Keywords: metabolic syndrome, physical activities, middle-aged women

1. Introduction

According to Taiwan's Ministry of Health and Welfare (2019), among the ten major causes of death in women, four diseases (heart disease, cerebrovascular disease, diabetes, and hypertensive diseases) were related to metabolic syndrome. Wang, Wu, Su, Lin, and Lee (2019) noted that diseases caused by metabolic abnormality are a threat to public health and a great burden to families and society.

Metabolic syndrome is a term encompassing traits that increase the risk of diseases (Samson & Garber, 2014). Research has shown that compared with those with no metabolic syndrome, people with metabolic syndrome are 2.35, 2.27, and 2.4 times more likely to develop cardiovascular disease (CVD), stroke, and CVD mortality, respectively (Mottillo et al., 2010). The risk factors include abdominal obesity, dyslipidemia (elevated triglycerides, low high-density lipoprotein [HDL]), high blood glucose, and hypertension (Kaaja, 2008). Grundy et al. (2005) noted that the US National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) defines metabolic syndrome as conformance to three or more of the abnormalities in the NCEP ATP III's guidelines. The guidelines pertain to (1) abdominal obesity (a waist circumference (WC) ≥102 cm and ≥88 cm for men and women, respectively), (2) blood pressure (a systolic blood pressure (SBP) ≥130 mmHg, diastolic blood pressure (DBP) ≥85 mmHg, or the receiving hypertension medication and history of hypertension), (3) blood glucose (a fasting blood glucose (FBG) ≥100mg/dl or the taking of diabetes medication), (4) triglycerides (≥150 mg/dl or the taking of triglycerides medication), (5) HDL (<40mg/dl and <50 mg/dl in men and women, respectively).

Middle-aged women tend to gain weight and have an increasing waistline due to decreased basal metabolism and physical activity; these increase their risk of metabolic syndrome (Lin, 2012). Yeh, Chang, and Pan (2011) conducted a survey on metabolic syndrome in Taiwan and observed a 15.1% prevalence rate for metabolic syndrome in women aged 31–44 years, which increased to 48.4% for those aged 45–64 years. Cho et al. (2008) noted that first, women had the highest risk of developing hypertension at 5–9 years after menopause, second, women who have stopped menstruating for less than 5 years had an increased risk of abdominal obesity and high blood glucose, and third, women who have stopped menstruating for 10–14 years had an increased risk of high triglycerides. Thus, the prevalence rate for metabolic syndrome in women generally increases with age (Prasad, Kabir, Dash, & Das, 2012).

The pathogenesis of metabolic syndrome is closely related to dietary factors and a sedentary lifestyle (Kaaja, 2008). However, women in developed societies, having to juggle between work and family, often mistake work as exercise or use a lack of time to excuse a sedentary lifestyle (Lin, 2012). Zając-Gawlak et al. (2017) noted that sedentary physical behavior and low physical activity increase the incidence of metabolic syndrome, and that relative to low physical activity, high physical activity lowers the risk of metabolic syndrome by 4 times. Wu, Fisher-Hoch, Reininger, and McCormick (2016) observed that the weekly performance of 150 min of moderate- and high-intensity physical activity (≥600 metabolic equivalent [MET] adjusted minutes) reduced the risk of developing metabolic syndrome by 36%; performing more than 743 METs of moderate- and high-intensity physical activity per week reduced the risk of developing metabolic syndrome by 37%. Related studies have confirmed that the inclusion of aerobic exercises during exercise potentially improves metabolic syndrome risk factors (Ostman et al., 2017). Therefore, an active lifestyle is vital for the prevention and treatment of metabolic syndrome (Yoo et al., 2014).

Therefore, this study examined the correlation between metabolic syndrome risk factors and physical activity in middle-aged women (in addition to the predictors of metabolic syndrome), as a reference to better assist middle-aged women with metabolic syndrome risk factors through increasing their physical activity.

2. Method

2.1 Research Design

This cross-sectional study employed a self-administered questionnaire survey. The study recruited patients that met the inclusion criteria at a free adult health checkup clinic and outpatient clinic of the metabolism and endocrinology division of a regional teaching hospital in Northern Taiwan. As for the inclusion criteria, research participants had to be (1) a woman aged 40–60 years; (2) having one of the metabolic syndrome risk factors; (3) conscious and can read or communicate in Mandarin and Taiwanese; (4) willing to participate in the study; (5) free of hormone therapy, mental illness, thyroid disease, and menopause caused by hysterectomy and oophorectomy; (6) willing to answer the study's questionnaire. Convenience sampling was used for data collection; 101 participates were recruited.

2.2 Demographic Variables

The demographic data included those on age, level of education, BMI, and menopausal stage.

2.3 Metabolic Syndrome Risk Factors

The guidelines for metabolic syndrome in this study are based on the following metabolic syndrome guidelines stipulated by Taiwan's Health Promotion Administration, Ministry of Health and Welfare (2007):

1. Abdominal obesity (for women: WC ≥ 80 cm).
2. High Blood pressure (SBP ≥ 130 mmHg, DBP ≥ 85 mmHg, or the taking of hypertension medication).
3. High blood glucose (FBG ≥ 100 mg/dl or the taking of diabetes medication).
4. High triglycerides (triglycerides ≥ 150 mg/dl or the taking of hypolipidemic drugs).
5. Low HDL (for women: < 50 mg/dl).

In this study, a person has metabolic syndrome risk factors if they satisfy any one of these criteria.

2.4 International Physical Activity Questionnaires

This study used the Taiwanese version of the self-administered short version International Physical Activity

Questionnaires (IPAQ), authorized by the Health Promotion Administration, Ministry of Health and Welfare, Executive Yuan. Liu (2004) formulated this version of the IPAQ: they translated the original IPAQ to Chinese and classified its items according to the everyday activities of Taiwanese people. A reliability and validity test was conducted for the questionnaire, using 141 participants aged 18–65 years. The content validity score of the Chinese and English version of the IPAQ was greater than 98%. The intrinsic correlation of the goodness of fit values for the language and similarity of meaning were 0.71-0.86, indicating that this version of the IPAQ has excellent stability. In a Spearman's rho correlation test, the test-retest reliability was 0.67. The IPAQ has seven questions, including two questions on the time spent daily on high-intensity physical activities in the last 7 days, two questions on moderate-intensity physical activities, two questions on walking, and one question on the time spent sitting daily. In this study, the method of calculation was to first take, for each participant, the values for the time spent on high-intensity physical activity, moderate-intensity physical activity, and walking (in the last 7 days). Subsequently, to calculate the total physical activity (METs in min/wk) for the last 7 days, the MET value for each type of physical activity (the MET values for high-intensity activity, moderate-intensity activity, and walking are 8.0, 4.0, and 3.3, respectively) was multiplied by the time spent on the respective physical activity. Subsequently, each person's quantity of physical activity was obtained by summing across the three activity types; each person was then classified according to those who engaged in high physical activity, sufficient physical activity, and insufficient physical activity.

2.5 Data Analysis

The study used SPSS17.0 for statistical analysis. The descriptive statistics used in the study were the frequency, percentage, mean, and standard deviation. A Chi-square test and t test were used to determine the extent of each metabolic syndrome in the middle-aged women and the difference between women with respect to metabolic syndrome and physical activity. Logistic regression was used to analyze the predictors of metabolic syndrome and metabolic syndrome risk factors. A p value $< .05$ was considered statistically significant.

2.6 Ethical Considerations

This study was approved by the institutional review board of a regional hospital in Taiwan (No. 099-E-14). The content of the consent form was explained verbally to the research subject prior to recruitment. The purpose and process of this study were explained in detail, and informed consent was obtained from the subject. The subject could withdraw at any time during the course of the study.

3. Results

3.1 Demographics of Research Subjects and the Distribution of Metabolic Syndrome Risk Factors

As displayed in Table 1, the average age of participants was 52.3 ± 6.2 years, most participants were in the postmenopausal stage (57 participants, 56.4%), and the number of women with metabolic syndrome was 56 (55.4%).

Table 1. Demographics of research subjects n=101

Variables	n (%)	Mean ± SD
Age		52.3±6.2
≤ 44 year	17(16.8)	
45-50 year	21(20.8)	
51-55 year	17(16.8)	
56-60 year	46(45.5)	
Educational degree		
Junior high school	21(20.8)	
High school	27(26.7)	
University	53(52.5)	
BMI		25.9±3.9
Normal 18.5 ≤ BMI <24	29(28.7)	
Overweight 24 ≤ BMI < 27	33(32.7)	
Obesity BMI ≥ 27	39(38.6)	

Menopause stage	
Premenopausal	25(24.8)
Menopause	19(18.8)
Postmenopause	57(56.4)
Number of Metabolic Syndrome risk factors	
One	10(9.9)
Two	35(34.7)
Three	26(25.7)
Four	20(19.8)
Five	10(9.9)
Metabolic Syndrome	
≥ three	56(55.4)
< two	45(44.6)

Abbreviation: SD, standard deviation

As displayed in Table 2, the numbers of women with abdominal obesity (WC ≥ 80 cm), an FBG ≥ 100 mg/dl, a HDL < 50mg/dl, triglycerides (≥ 150mg/dl), an SBP ≥ 130mmHg, and a DBP ≥ 85mmHg were 81 (80.2%), 75 (74.3%), 39 (38.6%), 32 (31.75%), 56 (55.4%), and 24 (23.8%), respectively.

Table 2. The distribution of metabolic syndrome risk factors n=101

Variables	**n (%)**			**Mean ± *SD***
	Normal	**Anomaly**	**Not taking blood**	
Abdominal obesity				
Waistline<79 cm	20(19.8)			71.5±6.1
Waistline ≥ 80cm		81(80.2)		88.8±7.6
Triglyceride				
<149mg/dl	64(63.4)			88.9±32.8
≥150mg/dl		32(31.7)		231.4±102.1
			5(5)	
Fasting blood sugar				
<99mg/dl	20(19.8)			87.2±7.9
≥100mg/dl		75(74.3)		156.1±49.2
			6(5.9)	
HDL-C				
<50mg/dl		39(38.6)		41.6±4.7
>50 mg/dl	33(32.7)			62.2±14.4
			29(28.7)	
Systolic blood pressure				
<129mmHg	45(44.6)			120.4±6.9
≥130mmHg		56(55.4)		139.8±6.9
Diastolic blood pressure				
<84mmHg	77(76.2)			74.1±6.2
≥85mmHg		24(23.8)		89.4±3.7

Abbreviation: SD, standard deviation

3.2 Presence or Absence of Metabolic Syndrome Risk Factors, and the Association Between Metabolic Syndrome and Physical Activity

As detailed in Table 3, FBG was significantly associated with physical activity ($\chi2 = 6.1$, $p = .04$), with an FBG ≥100mg/dl mostly due to insufficient physical activity. The variables pertaining to WC, triglycerides, HDL, SBP, and DBP were not significantly associated with physical activity.

Table 3. Presence or absence of metabolic syndrome risk factors, and the association between metabolic syndrome and physical activity

Variables		waistline≧80cm		Triglyceride ≧150mg/dL		Fasting blood sugar≧100mg/dl		HDL-C<50mg/dl		Systolic blood pressure ≧ 130mmHg		Diastolic blood pressure ≧ 85mmHg		Metabolic Syndrome	
		Yes n=81	No n=20	Yes n=32	No n=64	Yes n=75	No n=20	Yes n=39	No n=33	Yes n=56	No n=45	Yes n=24	No n=77	Yes n=56	No n=45
Physical Activity	High/ sufficient	45 (56%)	13 (65%)	20 (62%)	36 (56%)	36 (48%)	15 (80%)	18 (47%)	21 (64%)	29 (52%)	29 (64%)	16 (66%)	43 (56%)	27 (48%)	34 (69%)
	insufficient	36 (44%)	7 (35%)	12 (38%)	28 (44%)	39 (52%)	5 (20%)	21 (53%)	12 (36%)	27 (48%)	16 (36%)	9 (34%)	34 (44%)	29 (52%)	14 (31%)
	χ^2 (*P*)	.58(.61)		.99(.60)		6.1(.04)		3.32(.19)		1.63(.22)		.33(.64)		4.36(.06)	

Note: n=101

3.3 The Presence and Absence of Metabolic Syndrome Differed According to the Total METs of Physical Activity

As presented in Table 4, the presence and absence of metabolic syndrome significantly differed according to the total METs of physical activity ($t = 2.23$, $p < .05$). Among participants, those who had no metabolic syndrome had higher total METs relative to those with metabolic syndrome (1216.14 ±1471.72 vs. 674.94 ±764.71).

Table 4. The presence and absence of metabolic syndrome differed according to the total METs of physical activity (N=101)

Variables	Metabolic Syndrome		*t*(*P*)
	Yes(n=56) M±*SD*	No(n=45) M±*SD*	
Total Physical Activity METs	674.94±764.71	1216.14±1471.72	2.23(.02)

Abbreviation: SD, standard deviation; M, mean

3.4 Predictors of Metabolic Syndrome Risk Factors

The study used the statistically significant predictors (“basic attributes” and “physical activity”) as independent variables and the metabolic syndrome risk factors (“presence or absence of WC ≥ 80cm,” “presence or absence of FBG ≥ 100mg/dl,” and “presence or absence of SBP ≥ 85mmHg”) as dependent variables in a logistic regression. In the regression results, a WC ≥ 80cm and the predictor variable of BMI was statistically significant ($p < .05$), with BMI having an OR value of 3.46--meaning that for every unit (kg/m2) increase in BMI, the risk ratio of those with WC ≥ 80cm increased by 3.46 times. A fasting blood glucose ≥100mg/dl and the predictor variable of insufficient physical activity were statistically significant ($p < .05$), with insufficient physical activity having an OR value of 11.29--meaning that comparing those who had sufficient physical activity, those with insufficient physical activity having an FBG ≥100mg/dl risk ratio was 11.29 times higher (Table 5).

Table 5. Predictors of metabolic syndrome risk factors

Variables(Baseline category)	B	OR(95%CI)	*P*
[a] Waistline≥80cm(No)			
Age	.10	1.11(.67, 1.83)	.68
BMI	1.24	3.46(1.61, 7.46)	.00
Menopause stage(Premenopausal)			
Menopause	-20.7	.00	.99
Postmenopause	-18.6	.00	.99
[b] Fasting blood sugar≥100mg/dl(No)			
Age	.09	1.10 (.79, 1.52)	.55
Menopause stage(Premenopausal)			
Menopause	2.03	7.67 (.38, 152.72)	.18
Postmenopause	2.50	12.24(.14, 003.69)	.26
Physical Activity(Enough)			
High	1.52	4.60 (.02, 950.23)	.57
Inadequate	2.42	11.29(1.72, 73.82)	.01
[c] Diastolic blood pressure≥85mmHg(No)			
Age	-.08	.91 (.77, 1.09)	.33
BMI	.14	1.15 (.98, 1.35)	.07
Menopause stage(Premenopausal)			
Menopause	.22	1.25 (.17, 9.09)	.82
Postmenopause	.31	1.37 (.10, 18.09)	.80
[a] Omnibus Tests: Chi-square=74.63, P.00			
[b] Omnibus Tests: Chi-square=47.69 , P.00			
[c] Omnibus Tests: Chi-square=22.83 , P.00			

a. 96 cases effective samples; b. 85 cases effective samples; c. 83 cases effective samples

3.5 Predictors of Metabolic Syndrome

According to Table 6, metabolic syndrome and the predictor variables of “BMI” “menopause,” and “postmenopause” were statistically significant ($p < .05$), which means that for every unit (kg/m2) increase in BMI, the metabolic syndrome risk ratio increased by 1.68 times. Compared with women in premenopause, the metabolic syndrome risk ratio for women in menopause was 12.3 times higher. Compared with women in premenopause, the metabolic syndrome risk ratio of those in postmenopause was 42.97 times higher.

Table 6. Predictors of metabolic syndrome

Variables(Baseline category)	**B**	**OR** (95%CI**)**	***P***
Age	-.00	.99(.82, 1.21)	.97
BMI	.51	1.68(1.33, 2.08)	.00
Menopause stage(Premenopausal)			
Menopause	2.51	12.3(1.25, 120.68)	.03
Postmenopause	3.76	42.97(2.22, 831.41)	.01
Total Physical Activity METs	.00	1.00(.99, 1.00)	.11
Omnibus Tests: Chi-square=54.37, p=.00			

81 cases effective samples

4. Discussion

The aim of this study was to discuss the correlation between metabolic syndrome risk factors and physical activity in middle-aged women. The study found that metabolic syndrome was most prevalent in postmenopausal women (69%); this result is similar to those of Heidari et al. (2010) and Pandey et al. (2010). Heidari et al. (2010) studied metabolic syndrome in postmenopausal women and found that postmenopausal women were more prone to developing metabolic syndrome than women in premenopause and the early stage of menopause. This implies that to reduce their risk of metabolic syndrome, postmenopausal women should make lifestyle changes to control their body weight, blood glucose, blood pressure, and blood lipid levels. Pandey et al. (2010) studied metabolic syndrome in menopausal women and found that more women developed metabolic syndrome during postmenopause. Therefore, it is recommended that postmenopausal women should actively adopt a healthier lifestyle to lower their risk of developing metabolic syndrome.

Regarding metabolic syndrome risk factors, studies have found that most factors were associated with abdominal obesity, a result consistent with those of Arai et al. (2010). Arai et al. (2010) studied the prevalence of metabolic syndrome in elderly and middle-aged people and discovered that abdominal obesity was the most crucial metabolic syndrome risk factor in women aged 40–64 years. Davies, Heaney, Recker, Barger, and Lappe (2001) observed that women in pre and postmenopause gained weight at a rate of 0.43% annually. Lovejoy, Champagne, Jonge, Xie, and Smith (2008) noted that the accumulation of abdominal fat in women in pre and postmenopause increased with time. Thus, these findings strongly suggest that abdominal obesity in women is a significant cause of metabolic syndrome.

This study determined that FBG significantly differed in relation to physical activity; an FBG ≥ 100mg/dl was mostly due to insufficient physical activity ($p < .05$). This result is similar to that of Turi, Codogno, Fernandes, and Monteiro (2016). Turi et al. (2016) studied the association between low physical activity and metabolic syndrome, in people aged 50 years, and determined that the time spent on physical activities was negatively and significantly correlated with diabetes, hypercholesterolemia, and high prevalence of metabolic syndrome. Additionally, Lee et al. (2012) evaluated the effects of a lack of exercise on major chronic diseases globally; the study noted that instances of a lack exercise comprised 7% of diabetes cases, 6% of heart disease cases, in addition to a greater number of cases of increased mortality and decreased life expectancy. Numerous studies have confirmed that physical activity can prevent and reverse the risk factors of metabolic syndrome. Myers, Kokkinos, and Nyelin (2019) noted that a minimum of 150 min of moderate-intensity physical activity per week or 75 min of high-intensity physical activity per week can significantly reduce the risks of metabolic syndrome.

The results of the present study also indicated that metabolic syndrome significantly ($p < .05$) differed with respect to the total METs of physical activity: the total METs of those with no metabolic syndrome was higher than those with metabolic syndrome. This result is similar to those of Bilbeisi, Hosseini, and Djafarian (2017). Bilbeisi, Hosseini, and Djafarian (2017) found that women with metabolic syndrome averaged 710.6 ± 1 MET/wk of physical activity—which comprised mostly low physical activity (97%)—and women with no metabolic syndrome averaged 2293.2 ± 1 MET/wk of physical activity—which comprised mostly high physical activity (73.7%). Thus, these findings strongly suggest that low physical activity and increased metabolic syndrome are correlated.

According to the results of this study, insufficient physical activity was a predictor of FBG ≥ 100mg/dl (OR = 11.29; 95% CI = 1.72, 73.82) ($p < .05$). Orchard et al. (2005) conducted a randomized trial on the relationship between lifestyle intervention and metabolic syndrome. They found that 3 years after the intervention, the group with the lifestyle intervention (which comprised at least 150 min of physical activity weekly and a low calorie, low fat diet) significantly improved metabolic risk factors, such as FBG, relative to the group with no lifestyle intervention.

According to the results of this study, BMI was the predictor of WC ≥ 80cm (OR = 3.46; 95% CI = 1.61, 7.46) and metabolic syndrome (OR = 1.68; 95% CI = 1.33, 2.08) ($p < .05$), similar to the results of Yen et al. (2007). Yen et al. (2007) found that the BMI of those with a WC ≥ 80cm were mostly in the obese range, and further analysis indicated that for every 1 unit increase in BMI, the metabolic syndrome risk ratio increased by 1.41 times. Additionally, this study also determined that the predictors of metabolic syndrome include menopause (OR = 12.3; 95% CI = 1.25, 120.68) and postmenopause (OR = 42.97; 95% CI = 2.22, 831.41) ($p < .05$). Heidari et al. (2010) studied metabolic syndrome in 1596 menopausal women in Iran, they found that the metabolic syndrome significantly differed in relation to menopausal stage. Among the participants their study, there were 303 women in premenopausal, 233 women in early menopausal and 987 women in postmenopausal. 136(44.9%) were premenopausal women with metabolic syndrome, 135(57.9%) were menopausal women with metabolic syndrome, and 634(64.3%) were postmenopausal women with metabolic syndrome. These findings strongly suggest that, in comparison with premenopause, the risk of developing metabolic syndrome is higher during menopause and postmenopause. Drown (2006) determined that estrogen deficiency contributes to visceral fat distribution.

5. Conclusion and Recommendation

The purpose of this study was to investigate the correlation between metabolic syndrome risk factors and physical activity in middle-aged women (in addition to the predictors of metabolic syndrome). The results of the study indicate that an FBG ≥ 100mg/dl was mostly due to insufficient physical activity, the total METs of those with no metabolic syndrome was higher than those with metabolic syndrome. We recommend that middle-aged women should actively adopt a healthy lifestyle during menopause and postmenopause to actively control their weight. Specifically, a minimum of 150 min of moderate-intensity physical activity per week or 75 min of high-intensity physical activity to prevent metabolic syndrome. This finding serves as a potential reference for healthcare professionals in their care of patients with metabolic syndrome.

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