



ORIGINAL ARTICLE

Improvements in the Metabolic Syndrome and Stages of Change for Lifestyle Behaviors in Korean Older Adults

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Abstract

Objectives: This study aims to examine the effectiveness of a 6-month lifestyle modification program on the improvement in metabolic syndrome (MetS) status and in stages of change for lifestyle behaviors associated with MetS among Korean older adults.

Methods: A lifestyle modification program was developed based on the trans-theoretical model. The program consisted of health counseling, education classes, a self-management handbook, newsletters and a health diary. Older adults aged ≥ 60 ($n = 480$) with MetS were randomly assigned to the intervention group (IG) or the comparison group (CG). The IG received a comprehensive 6-month lifestyle modification intervention, while the CG received minimal information on MetS and lifestyle modification. Health examination and self-administered survey were conducted before and after the intervention to determine the effectiveness of the program.

Results: After the intervention, the prevalence of MetS decreased to 38.1% in the IG and 52.4% in the CG ($p = 0.046$). The IG improved abdominal obesity ($p = 0.016$), blood pressure ($p = 0.030$), and triglyceride ($p = 0.005$) more than the CG did. The IG demonstrated significant improvements in the behavioral stages for portion control ($p = 0.021$), balanced diet ($p < 0.001$) and adequate intake of fruits and vegetables ($p = 0.012$). The IG reduced the prevalence of abdominal obesity (OR = 2.34) and improved MetS status (OR = 1.79) better than the CG. The IG were more likely to advance from preaction stages at baseline to action stage at post-intervention for portion control (OR = 3.29) and adequate intake of fruits and vegetables (OR = 2.06).

Conclusion: Lifestyle modification can improve the MetS status and behavioral stages in older adults.

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1. Introduction

Metabolic cardiovascular risk factors are significant predictors of cardiac events in old age [1,2], and concurrence of a number of metabolic cardiovascular risk factors is more common in older adults [3]. Metabolic syndrome (MetS) refers to a cluster of concurrent metabolic cardiovascular risk factors. According to the National Cholesterol Education Program's Adult Treatment Panel III (NCEP ATP III), MetS is defined as having three or more of the following: abdominal obesity, elevated blood pressure, impaired fasting glucose, elevated triglyceride, and decreased high-density lipoprotein (HDL) cholesterol level [4]. MetS is associated with increased risk of cardiovascular disease (CVD) and type 2 diabetes [5], particularly with an increased CVD-related morbidity and mortality even when CVD or diabetes does not exist clinically [6,7].

MetS is increasing worldwide including Asia [4,8]. Asians tend to have higher risk of type 2 diabetes and CVD even at lower body mass index (BMI) than Caucasians [9]. The age-adjusted prevalence of MetS in South Korea (Korea hereafter) among Korean adults aged ≥ 20 years, using the NCEP ATP III definition based on the Korean National Health and Nutrition Examination Surveys, increased consistently and significantly from 24.9% in 1998 to 31.3% in 2007 [8], compared to 34.0% in the USA, 2003-2006 [10]. The prevalence is greater in older adults [6,8].

Lifestyle modification intervention especially targeting diet and physical activity is instrumental and necessary for reducing the prevalence of MetS [4,11,12]. Healthy diet and regular physical activity are essential in the lifestyle modification for MetS management [13,14]. The transtheoretical model (TTM) has often been employed as a framework for interventions for healthy diet and physical activity [15]. However, application of TTM to improve diet and physical activity has been limited in MetS studies in Korea until recently [16,17]. The stages of change (SOC) construct in the TTM emphasizes behavioral change as a process that involves adopting the new behavior and acting on it. The SOC postulates behavior change as a dynamic process consisted of mutually exclusive stages of readiness: pre-contemplation (not considering change), contemplation (considering change), preparation (decided to take action in the next month), action (changed behavior in the past 6 months), and maintenance (maintained the changed behavior for longer than 6 months) [18]. The assessment of SOC can guide an intervention to identify behavioral readiness and intention for change and to develop effective processes for behavioral change [19]. SOC are, in fact, a predictor of actual behavior such as dietary intake [18]. This study aims to examine the changes in MetS status in Korean older adults after a 6-month health education intervention program along with

the improvement in behavioral stages from nonaction to action for lifestyle behaviors associated with MetS.

2. Materials and Methods

2.1. Intervention

A 6-month lifestyle change program was developed to control MetS through increasing physical activity, improving diet, and reducing weight. TTM is applied to our program to provide different intervention strategies to the older adults according to their SOC (pre-contemplation, contemplation or preparation, and action or maintenance [20]). Participants were encouraged to enhance MetS-related knowledge (definition, prevalence and trends, causes, and consequences of MetS) and life skills for hypocaloric, balanced diet, moderate drinking, and adequate level of physical activity [21]. Cognitive and behavioral strategies included consciousness raising, enhancing pros of lifestyle change and self efficacy, goal setting for behavior change, regular self-monitoring of progress, and providing rewards to promote the movement from stage to stage and to reinforce healthy lifestyle (Table 1).

The intervention composed of individual counseling sessions with registered dietitians, health education classes, educational newsletters and booklets, and keeping a health diary. One-on-one health counseling was provided every other week, by telephone when face-to-face counseling was not possible. A booklet and a health diary were provided to those in the intervention group as health education material and also as a self-monitoring tool. In addition to individual counseling, the intervention group members were invited to two health classes on prevention and management of hypertension, diabetes, obesity, and MetS. Monthly newsletters on healthy lifestyle were sent to the intervention group members (Figure 2). The comparison group, in contrast, was provided with their MetS status and a one-page health information sheet on MetS at baseline.

2.2. Participants and recruitment

The participants were 430 adults aged 60 and older who were diagnosed with MetS after completing health examinations at one of 15 regional branch medical facilities of the Korea Association of Health Promotion (KAHP) between June 1, 2008 and April 30, 2009. MetS is defined by the NCEP ATP III criteria for MetS [4] and the Asia-Pacific standard for abdominal obesity [22]. That is, older adults who meet three or more of the following five conditions are classified as having MetS: (1) waist circumference >90 cm for men or >80 cm for women; (2) HDL cholesterol <40 mg/dL for men or <50 mg/dL for women; (3) triglyceride ≥ 150 mg/dL; (4) systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg; and (5) fasting glucose

Table 1. TTM-based cognitive and behavioral intervention strategies

SOC	Methods	Strategies
PC	Consciousness raising	- Determine participants' perceptions of the severity of MetS
	Outcome expectation	- Provide personal feedback on the severity of MetS and related health behavior problems
		- Provide MetS related knowledge
		- Provide information on the benefits of changing health behavior patterns to manage MetS
C/PR	Decisional balance (pros and cons)	- Explain the benefits of changing health behaviors in details
	Modeling	- Counteract barriers to change with salient benefits
	Self-efficacy	- Provide observational learning opportunity through modeling
	Self-liberation	- Teach how-to information and skills for health behavior change
	Goal setting	- Sign commitment form - Set the reasonable and specific goals
A/M	Self-monitoring	- Self-monitor diet, activity and other health behaviors
	Stimulus control	- Provide relapse prevention strategies
	Reinforcement management	- Provide reminders to engage healthy behaviors - Modify undesirable attribution
		- Provide rewards for the completion of the study

TTM = transtheoretical model; SOC = stages of change; MetS = metabolic syndrome; PC = precontemplation stage; C/PR = contemplation or preparation stage; A/M = action or maintenance stage.

≥100 mg/dL. Exclusion criteria for the study were: being on medication for weight control; having been diagnosed with diabetes or hypertension; being on treatment for MetS; and not providing signed consent form for participation in the study.

Of 5156 older adults identified with MetS, 821 met the eligibility criteria. Among those, 391 refused to participate in the study. The remaining 430 older adults who agreed with and were eligible for the intervention were randomly assigned to either the intervention group (IG) or the comparison group (CG). Participants in the IG received the aforementioned comprehensive 6-month lifestyle change intervention and the CG received minimal information on the MetS and lifestyle modification. During the study, 100 and 118 participants dropped out from IG and CG, respectively. The reasons for dropping out were described in Figure 1. The final analyses included 113 participants in IG and 82 in CG (Figure 1). This study was reviewed and approved by Institutional Review Board of the KAHP (# 09-B-04).

2.3. Data collection

Height, weight, BMI and five components of MetS of all study participants were measured at baseline and postintervention (6 months from the baseline). Both height and weight were measured using the Fatness Measuring System (DS-102, Dong Sahn Jenix, Seoul, Korea). Weight was measured in the morning before breakfast, with participants in a T-shirt and shorts without shoes. BMI was calculated as the weight in kilograms divided by the square of height in meters. Waist circumference was measured at a level midway between the lowest rib and the iliac crest. Fasting blood samples were

drawn before and after the intervention. The blood was separated by centrifugation and analyzed at the KAHP laboratories. Triglycerides, HDL cholesterol and fasting glucose levels were measured using HITACHI 7600-110 (HITACHI, Tokyo, Japan). Blood pressure was measured with an automatic digital sphygmomanometer (TM-2655P; A&D, Tokyo, Japan). Measurements were made after participants had been seated quietly for at least 5 min in a chair with feet on the floor and arm supported at heart level. Classification of blood pressure is based upon the average of two or more readings on two or more occasions separated by at least 2 min.

SOC of the participants for health behaviors related to MetS were assessed through a self-administered questionnaire. The questionnaire was based on the multi-item algorithm of SOC (M-SOC) developed by Sutton et al [23]. It included four categories of dietary behavior: decreasing portion size, eating balanced diet and adequate amount of fruits and vegetables, and lowering fat consumption, and also included an item on daily physical activities. Cronbach α ranged from 0.686 for physical activity to 0.795 for portion control.

2.4. Analysis

Using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA), independent-samples *t* test and chi-square test were performed to examine differences between the IG and CG at baseline. McNemar and Pearson chi-square tests were applied to analyze within-group and between-group differences in SOC distribution of health behaviors and prevalence data at baseline and 6 months. The odds ratio effect sizes were calculated to investigate

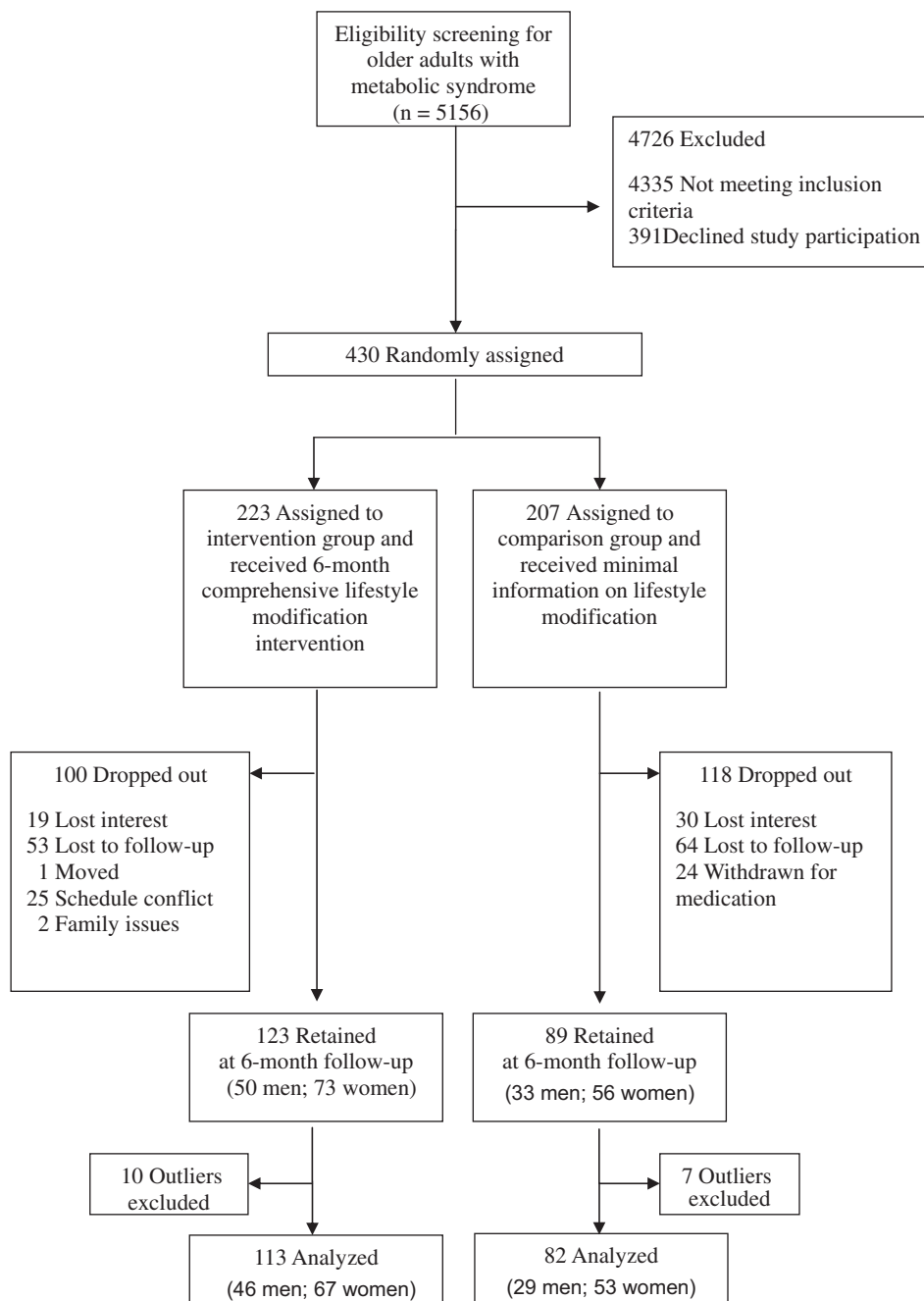


Figure 1. Flow of participants through the 6-month intervention.

improvement in health behaviors and prevalence of MetS in the IG relative to the CG.

3. Results

3.1. Baseline characteristics

The IG and CG were similar in demographic composition, health status, and health behaviors overall at baseline (Table 2). More than a third of the participants were male, and the mean \pm SD age of the

participants was 65.68 ± 3.38 years for the IG and 65.73 ± 4.07 years for the CG. All patients in both groups had MetS at baseline, with BMI of 25.87 ± 2.36 kg/m² in the IG and 26.12 ± 2.36 kg/m² in the CG. In both IG and CG, more than half of the participants practiced balanced diet, but the prevalence of other health behaviors such as portion control, low fat diet, adequate intake of fruits and vegetables, and physical activity was relatively lower, respectively. Meanwhile, behavioral stages at baseline differed between the groups in low fat diet and physical

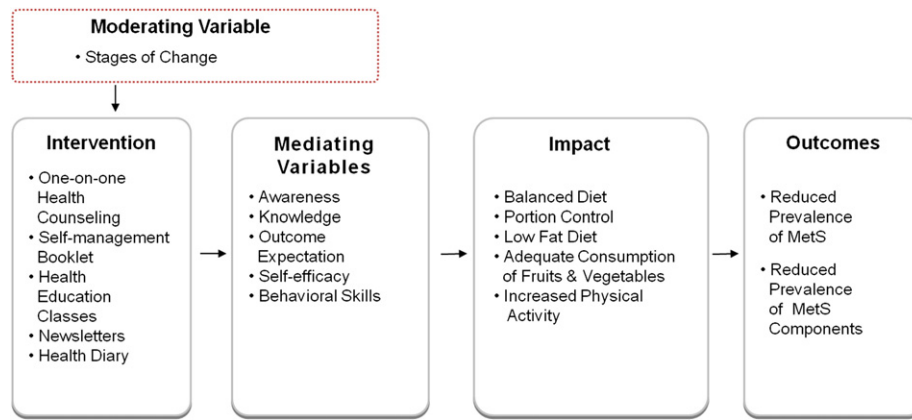


Figure 2. Logic model of the lifestyle change program.

activity: more in the IG were in the contemplation and preparation stages and fewer were in the pre-contemplation stage for both behaviors, compared to the CG group (Table 3).

3.2. Changes in the behavioral stages and metabolic syndrome prevalence

After the intervention, the prevalence of MetS decreased to 38.1% in IG and 52.4% in CG ($p = 0.046$). (Figure 3). More specifically, IG improved abdominal

obesity (-22.1%), blood pressure (-28.3%), triglyceride (-35.4%) more than CG did. Along with the changes in MetS status, significant improvements in the behavioral change stages were observed in the IG versus CG in 6 months for portion control, balanced diet, and adequate intake of fruits and vegetables. The number of participants in the IG increased significantly in the action/maintenance stages from baseline to postintervention for portion control ($+21.2\%$, $p = 0.003$), low fat diet ($+19.7\%$, $p = 0.003$), adequate intake of fruits and vegetables

Table 2. Baseline characteristics of the 6-month participants

Characteristics	Intervention Group ($n = 113$)	Comparison Group ($n = 82$)	p^a
Demographics			
Male, n (%)	46 (40.7)	29 (35.4)	0.449
Age, yrs, mean(SD)	65.68 (3.38)	65.73 (4.07)	0.839
60-64, yrs, n (%)	42 (37.2)	36 (43.9)	0.068
65-69, yrs, n (%)	61 (54.0)	32 (39.0)	
+ 70, yrs, n (%)	10 (8.8)	14 (17.1)	
Health outcomes			
Weight, kg, mean(SD)	65.68 (9.71)	65.17 (9.28)	0.712
BMI, kg/m^2 , mean(SD)	25.87 (2.36)	26.12 (2.36)	0.474
Abdominal obesity, n (%)	94 (83.2)	69 (84.1)	0.858
High SBP, n (%)	75 (66.4)	56 (68.3)	0.778
High DBP, n (%)	45 (39.8)	21 (25.6)	0.038
High Blood pressure, n (%)	84 (74.3)	58 (70.7)	0.576
High TG, n (%)	86 (76.1)	61 (74.4)	0.784
Low HDL-C, n (%)	69 (61.1)	49 (59.8)	0.854
High FBG, n (%)	57 (50.4)	51 (62.7)	0.103
Health Behaviors			
Portion control, n (%)	16 (14.5)	11 (13.6)	0.850
Balanced diet, n (%)	61 (55.5)	43 (53.8)	0.816
Low fat diet, n (%)	13 (11.9)	10 (12.5)	0.905
Fruit and vegetable intake, n (%)	20 (18.0)	18 (22.0)	0.497
Physical activity, n (%)	10 (8.9)	3 (3.7)	0.147

^aChi-square test or independent t test.

BMI = body mass index; WC = waist circumference; SBP = systolic blood pressure; DBP = diastolic blood pressure; TG = triglyceride; HDL-C = high-density lipoprotein cholesterol; FBG = fasting blood glucose; MetS = metabolic syndrome.

Table 3. Distributions of participants across the three stages of health behavior change before and after the intervention

	Intervention Group				Comparison Group				Between group difference at baseline	Between group difference at 6 month
	Baseline <i>n</i> (%)	6 month <i>n</i> (%)	Change %	<i>p</i> ^a	Baseline <i>n</i> (%)	6 month <i>n</i> (%)	Change %	<i>p</i> ^a	<i>p</i> ^b	<i>p</i> ^b
Portion control									0.933	0.021
PC	8 (7.3)	7 (7.1)	-0.2	1.000	5 (6.2)	6 (7.4)	1.2	1.000		
C/PR	86 (78.2)	56 (57.1)	-21.1	<0.001	65 (80.2)	61 (75.3)	-4.9	0.523		
A/M	16 (14.5)	35 (35.7)	21.2	0.003	11 (13.6)	14 (17.3)	3.7	0.581	0.882 ^c	0.027 ^c
<i>n</i>	110 (100.0)	98 (100.0)			81 (100.0)	81 (100.0)				
Balanced diet									0.713	<0.001
PC	3 (2.7)	7 (7.1)	4.4	0.344	4 (5.0)	2 (2.4)	-2.6	0.687		
C/PR	46 (41.8)	19 (19.2)	-22.6	<0.001	33 (41.3)	41 (50.0)	8.7	0.280		
A/M	61 (55.5)	73 (73.7)	18.2	0.162	43 (53.8)	39 (47.6)	-6.2	0.643	0.831 ^c	0.018 ^c
<i>n</i>	110 (100.0)	99 (100.0)			80 (100.0)	82 (100.0)				
Low fat diet									<0.001	0.061
PC	5 (4.6)	16 (16.3)	11.7	0.027	25 (31.3)	20 (24.4)	-6.9	0.458		
C/PR	91 (83.5)	51 (52.0)	-31.5	<0.001	45 (56.3)	48 (58.5)	2.2	0.760		
A/M	13 (11.9)	31 (31.6)	19.7	0.003	10 (12.5)	14 (17.1)	4.6	0.481	0.883 ^c	0.090 ^c
<i>n</i>	109 (100.0)	98 (100.0)			80 (100.0)	82 (100.0)				
Fruit and vegetable intake									0.390	0.012
PC	0 (0.0)	9 (9.0)	9.0	0.004	1 (1.2)	10 (12.2)	11.0	0.012		
C/PR	91 (82.0)	36 (36.0)	-46.0	<0.001	63 (76.8)	45 (54.9)	-21.9	0.006		
A/M	20 (18.0)	55 (55.0)	37.0	<0.001	18 (22.0)	27 (32.9)	10.9	0.151	0.459 ^c	0.028 ^c
<i>n</i>	111 (100.0)	100 (100.0)			82 (100.0)	82 (100.0)				
Physical activity									<0.001	0.066
PC	14 (12.5)	12 (12.1)	-0.4	0.832	39 (47.6)	18 (22.0)	-25.6	<0.001		
C/PR	88 (78.6)	66 (66.7)	-11.9	0.002	40 (48.8)	55 (67.1)	18.3	0.025		
A/M	10 (8.9)	21 (21.2)	12.3	0.019	3 (3.7)	9 (11.0)	7.3	0.109	0.151 ^c	0.140 ^c
<i>n</i>	112 (100.0)	99 (100.0)			82 (100.0)	82 (100.0)				

^aMcNemar test; ^bChi-square test for overall differences; ^cChi-square test for between group differences in A/M stage.

PC = precontemplation stage; C/PR = contemplation and preparation stage; A/M = action and maintenance stage; MetS = metabolic syndrome.

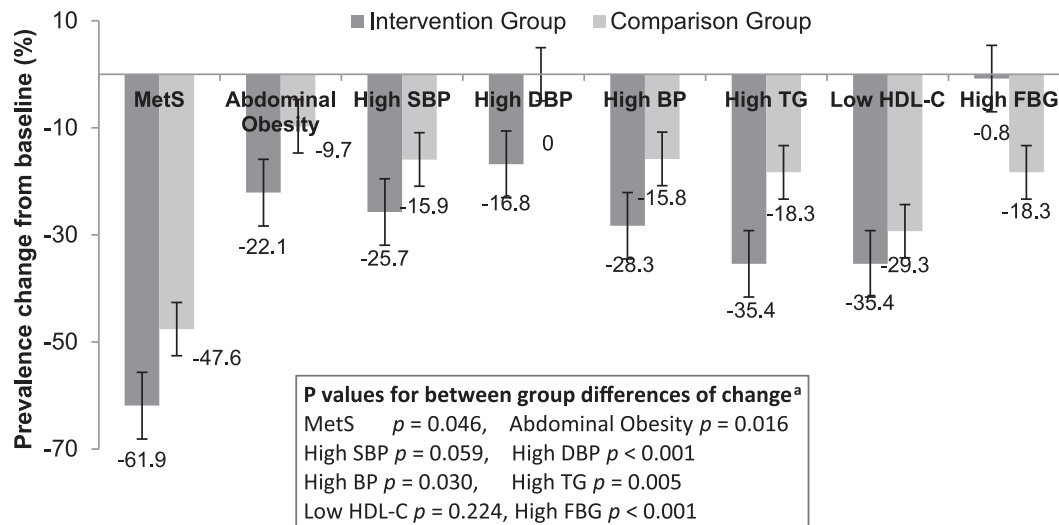


Figure 3. Changes in metabolic syndrome prevalence among participants. ^a Chi-square test.

MetS = metabolic syndrome; SBP = systolic blood pressure; DBP = diastolic blood pressure; BP = blood pressure; TG = triglyceride; HDL-C = high density lipoprotein cholesterol; FBG = fasting blood glucose.

(+37.0%, $p < 0.001$), and physical activity (+12.3%, $p = 0.019$), respectively (Table 3). At the same time, the IG reduced the number of participants in the contemplation/preparation stage in 6 months for all 5 behavior categories. In contrast, significant improvement in behavioral stages in the CG was observed only for physical activity where the proportion of participants in the precontemplation stage decreased and those in the contemplation stage increased significantly. However, for adequate intake of fruits and vegetables, the number of participants in the CG increased in the precontemplation stage and decreased in the contemplation/preparation stage after the intervention.

3.3. Desirable changes in the health status and behaviors

Table 4 presents changes from abnormal health status or preaction stage for health behavior at baseline to normal health status or action stage for health behavior at postintervention. Compared to the CG, the IG reduced waist circumference significantly (OR effect size = 2.34, 95% CI = 1.12, 3.55), experienced marginal reduction of triglyceride (OR effect size = 1.86, 95% CI = 0.99, 2.72) and improved MetS status more than the CG (OR effect size = 1.79, 95% CI = 1.07, 2.52). Similarly for health behaviors, the IG improved portion control (OR effect size = 3.29, 95%

Table 4. Improvement in health outcomes and behaviors between groups

	Intervention Group		Comparison Group		p^a	Odds ratio effect size (95% CI)
	<i>n</i>	<i>n</i> (%)	<i>n</i>	<i>n</i> (%)		
<i>Health outcomes</i>	Abnormal	Normalized	Abnormal	Normalized		
WC	94	31 (33.0)	69	12 (17.4)	0.033	2.34 (1.12, 3.55)
SBP	75	38 (50.7)	56	21 (37.5)	0.229	1.71 (0.87, 2.55)
DBP	45	28 (62.2)	21	12 (57.1)	0.083	1.24 (0.37, 2.10)
Blood pressure	84	39 (46.4)	58	21 (36.2)	0.210	1.53 (0.80, 2.25)
TG	86	44 (51.2)	61	22 (36.1)	0.078	1.86 (0.99, 2.72)
HDL-C	69	41 (59.4)	49	29 (59.2)	0.895	1.01 (0.49, 1.53)
Fasting glucose	57	17 (29.8)	51	20 (39.2)	0.100	0.66 (0.29, 1.03)
Metabolic syndrome	113	70 (61.9)	82	39 (47.6)	0.046	1.79 (1.07, 2.52)
<i>Health Behaviors</i>	Preaction	Action	Preaction	Action		
Portion control	94	28 (29.8)	70	8 (11.4)	0.008	3.29 (1.36, 5.21)
Balanced diet	49	35 (71.4)	37	18 (48.6)	0.162	2.64 (0.97, 4.30)
Low fat diet	96	24 (25.0)	70	11 (15.7)	0.160	1.79 (0.81, 2.76)
Fruit & vegetable intake	91	44 (48.4)	64	20 (31.3)	0.033	2.06 (1.11, 3.01)
Physical activity	102	15 (14.7)	79	8 (10.1)	0.452	1.53 (0.56, 2.50)

^aChi-square test.

WC = waist circumference; SBP = systolic blood pressure; DBP = diastolic blood pressure; TG = triglyceride; HDL-C = high density lipoprotein cholesterol; FBG = fasting blood glucose; MetS = metabolic syndrome.

CI = 1.36, 5.21), and adequate intake of fruits and vegetables (OR effect size = 2.06, 95% CI = 1.11, 3.01) significantly more than the CG from preaction stage at baseline to action stage at postintervention.

4. Discussion and Conclusion

This is one of few experimental studies on MetS intervention, to our knowledge, for Korean older adults in multiple regions in Korea that applied TTM constructs. Recent literature on MetS studies based on the TTM framework was a cross-sectional survey study with a focus on exercise behavior [16], or conducted with a smaller number of middle-aged Koreans with MetS and type 2 diabetes in a 16-week intervention [24]. Our study presents a case in which older adults could improve their MetS status by modifying lifestyle behaviors despite the belief that health behaviors in old age are so embedded in lifestyle that they are difficult to change [25]. In fact, Villareal et al [3] argued that older adults are sufficiently compliant with lifestyle modification intervention to accomplish lifestyle-induced weight loss that is comparable to young and middle-aged adults. It is of note that the older adults in our study demonstrated psychobehavioral changes and improvement in MetS prevalence without medical treatment. Recruited participants of this study were those in predisease stage for any of the MetS components, and none were taking medications or under treatment for cardiometabolic conditions.

Reduction of MetS prevalence was more prominent in IG in which fewer participants remained thinking about changing behaviors (contemplation/preparation stage) and significantly more participants advanced to the action/maintenance stage for dietary behaviors in 6 months. Although the CG also improved their MetS status and some lifestyle behaviors with minimal intervention by being informed about their MetS status and receiving a one-page health education leaflet on MetS, the amount of change in the MetS prevalence was smaller and the behavior change did not occur in the action/maintenance stage in the CG. Increase in the proportion of participants in the action/maintenance stage occurred only in the IG. For low fat diet and physical activity, respectively, more participants were in the contemplation/preparation stage in the IG at baseline; therefore they might have been more ready to practice the healthy behavior and to transition to the action/maintenance stage than those in CG. However, the number in the precontemplation subgroup decrease and the size of the contemplation/preparation subgroup did not increase in the CG for low fat diet, let alone transitioning to the action/maintenance stage. For physical activity, on the other hand, a significant number of older adults in the CG moved from the precontemplation to contemplation/preparation stages although not many advanced to the action/maintenance stage. Self-awareness of the MetS status might have influenced the intention of the older adults in the CG to be physically

active in everyday life. Johnson et al [26] maintain that pretest and post-test assessments of SOC and health status performed in interventions might inform and influence those in the CG to change. However, the dietary behavior changes may require more specific knowledge and skills, and the IG, who had regular encounters with and reinforcement from dietitians, demonstrated greater improvement in dietary behaviors and MetS prevalence.

The TTM and SOC postulate that behavioral change is a temporal dimension and thus occurs as a process [19]. The SOC in the TTM also indicate that action is not an event but a process in which regression can occur. Our results corroborate such a notion by showing that the number of participants increased in the precontemplation stage or decreased in the action/maintenance stage in certain behaviors in 6 months. It also draws attention to the need for follow-up lifestyle management and care to reinforce continued action and to prevent from relapsing to earlier behavior stages.

This study does not include socioeconomic status information of the participants, measurement of dietary caloric intake, or assessment of the types, intensity, and frequency of physical activity, and thus is limited in its explanative capacity. The volume of dropouts in this study calls for program monitoring. Another issue of discussion is that SOC is an essential but not the only construct of the TTM. This study is narrow in the TTM scope by leaving out other constructs of the TTM such as the processes of change, decisional balance, and self-efficacy [27]. However, SOC is a predictor of behavioral performance [18], and our findings shows changes in the composition of the SOC in participant groups and in actual health status in a randomized controlled trial with a lifestyle modification intervention.

Despite some limitations, our randomized controlled trial study demonstrated the effectiveness of a theory-based lifestyle modification program for MetS in reducing the prevalence of MetS in older adults. This study was conducted with a relatively larger sample from multiple regions compared to previous lifestyle intervention studies on MetS in Korea. This study presents that lifestyle modification alone can improve the MetS status in older adults. It also shows that significant differences occurred in the changes in behavioral stages between the IG and CG in 6 months: more in the IG moved to the action/maintenance stage in several behavior categories. Further research is warranted to investigate the effects of the intervention program in younger adults with MetS, and to incorporate other constructs of the TTM to explain the facilitation of behavioral changes by the intervention program for MetS management and control.

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