



Employees' Behaviors Concerning Metabolic Syndrome Prevention: A Cellphone-Based Text Message Education Intervention

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Abstract

Background: The prevalence of metabolic syndrome (MetSyn) is increasing in Iran. This study was an attempt to determine the effects of a short message service (SMS)-based education intervention on knowledge, attitude, and the adoption of preventive behaviors concerning MetSyn among a sample of employees of Iran University of Medical Sciences (IUMS).

Methods: In this randomized controlled trial, conducted from January through April 2021, 144 IUMS staff members were assigned either to the intervention group (n=72) or to the control group (n=72). Thirty-two text messages were designed, pretested, and sent to the participants' phones in the intervention group in 32 days. Knowledge, attitude, and the adoption of preventive behaviors vis-à-vis MetSyn were measured in the intervention group before and 1 month after the intervention and compared with those in the control group at the same time points. The data were analyzed using paired t tests and ANCOVA.

Results: The mean age of the employees in the intervention and control groups was 42.97±8.80 and 40.81±9.58 years, respectively. The results showed that the mean scores of knowledge (P<0.001), attitude (P<0.001), and the adoption of preventive behaviors regarding MetSyn (P=0.009) were significantly different between the intervention and control groups after the intervention was done via SMS.

Conclusion: The results of the present study showed that SMS-based interventions might improve knowledge, attitude, and the adoption of preventive behaviors pertaining to MetSyn among employees.

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Keywords: Metabolic syndrome; Knowledge; Attitude; Behavior; Text messaging

Introduction

Metabolic syndrome (MetSyn) is a growing public health problem worldwide.¹ This syndrome is highly prevalent

among the Iranian adult population. A study showed that one-third of Iranian adults suffered from MetSyn.² Individuals with MetSyn are at high risk of developing atherosclerosis and adverse cardiac outcomes.² The syndrome is characterized

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by the clustering of several cardiovascular risk factors such as hypertension, high triglycerides, low high-density lipoprotein cholesterol (HDL), and glucose intolerance.³ Lifestyle modifications may improve all components of MetSyn and reduce the prevalence of the syndrome.^{4, 5} Orchard et al⁶ showed that conducting intensive lifestyle interventions lessened the incidence of MetSyn by 41% in participants with impaired glucose tolerance. Overall, it is recommended that lifestyle modifications be implemented in the primary prevention of MetSyn.⁷ There is evidence that individuals' knowledge and attitude influence their adherence to a lifestyle directed toward MetSyn prevention, which underscores the importance of interventions on these 2 parameters.⁸

In recent years, researchers have used new strategies such as cellphone text messages to improve individuals' adherence to lifestyle modifications directed toward the prevention of MetSyn.⁴ The effectiveness of interventions developed based on the short message service (SMS) system has been revealed in studies in different countries.^{9, 10} For example, Kim et al¹¹ found that cellphone text messages might help individuals with targeted lifestyle modifications aimed at MetSyn prevention. Overall, cellphone-based health interventions may modify 1 or more MetSyn components.¹² These interventions could be used for health care delivery, especially in low-resource settings.¹³ Given that individuals have different behaviors when using the cellphone and its services based on their social, economic, and cultural differences,¹⁴ an assessment of the impact of these variables in cellphone based-interventions on different individuals is needed.

Considering the high prevalence of MetSyn in Iran,² the association between occupation status and MetSyn development,¹⁵ and the necessity of informing individuals to adopt a healthy lifestyle to prevent the syndrome, the present study was conducted to examine the effects of an SMS-based education intervention on knowledge, attitude, and the adoption of preventive behaviors vis-à-vis MetSyn in a sample of employees of Iran University of Medical Sciences (IUMS).

Methods

This randomized controlled trial (No. IRCT20110727007132N20) was conducted from January through April 2021. The study participants were randomly selected from the list of administrative employees of the Hemmat Campus of IUMS (excluding the faculty members). First, 144 employees were randomly selected and then randomized into an intervention group (n=72) and a control group (n=72) via the balanced block randomization method. The inclusion criteria in the present study were: 1) employment in the administrative departments of

IUMS, 2) possession of a personal cellphone, 3) no history of diagnosed atherosclerosis and serious comorbidity, 4) a history of at least 1 of 5 components of MetSyn (hypertension, high triglycerides, low HDL, and glucose intolerance) in the employee or first-degree family members, and 5) no university degree in biomedical sciences. The study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Ethics Committee of IUMS (No. IR.IUMS.REC.1398.925). The employees were informed about the objectives of the study, and written informed consent was obtained from each participant. After the participants' cellphone numbers were obtained, the data were registered in the cellphone of one of the researchers. Due to the COVID-19 pandemic and teleworking of the employees on some days of the week, the participants were asked to fill out online self-administered questionnaires.

In this study, data were collected with the aid of 4 instruments. To assess knowledge and preventive behaviors regarding MetSyn, we employed measurement tools developed by Isiktekin et al (Isiktekin B, Emiral GO, Tozun M, Goktas S, Dagtekin G, Aygar H, Arslantas D, Unsal A. Development of "Metabolic Syndrome Knowledge Level Scale (Mets-KS)" and its validity and reliability study for Turkey. *Paripex Indian J Res* 2018;7:161-165.) and Kang (Kang SW. The validity and reliability of a lifestyle evaluation tool for patients with metabolic syndrome. *J Korean Acad Fundam Nurs* 2010;17:487-497), respectively. In addition, a researcher-made instrument was developed to determine the participants' attitude toward MetSyn. The forward-backward procedure was used to translate the first 2 instruments. Then, the validity and reliability of the 3 instruments were evaluated. An expert panel of 10 specialists in cardiology, health education, and nutrition judged the relevance of the items of the 3 instruments for assessing quantitative content validity. According to their reflections, the content validity index (CVI) and the content validity ratio (CVR) of the items in the 3 instruments were measured. In the current study, items with a CVR less than 0.62 (Lawshe CH. A quantitative approach to content validity. *Pers Psychol* 1975;28:563-575) and a CVI less than 0.80 were omitted.¹⁶ The initial instrument used to measure knowledge contained 25 items. At this stage, 6 items of this instrument were deleted, and 4 items were revised. No item was deleted from the attitude instrument. The initial instrument utilized to measure the impact of lifestyle on MetSyn featured 36 items. Seven items of the lifestyle evaluation on MetSyn tool were deleted, 8 items were revised, and 1 was divided into 2 items. Additionally, 2 new items were generated. In the next stage, the qualitative and quantitative face validities of the items of the 3 instruments were evaluated. For the evaluation of face validity, 10 IUMS employees with characteristics similar to those of the target population of the study judged the

relevance, ambiguity, and difficulty of the items. Based on their reflections, the impact score of the items was assessed, and items that scored 1.5 or higher were kept in the instrument.¹⁷ In this stage, no item was deleted from the scales. Finally, the reliability of the 3 instruments was determined by measuring the intraclass correlation coefficient (ICC) (with a 2-week interval between the tests) in another 20 IUMS employees with characteristics similar to those of the target population of the study. An ICC estimate of 0.70 or higher was considered satisfactory.¹⁸ No items of the instruments were deleted at this stage. In the study, information regarding the participants' demographic characteristics, including age, marital status, and education level, was collected. The scale for assessing knowledge had 19 items, with the items measured using "Yes/No/I don't know." The ICC for this scale was 0.931. Apropos of attitude about MetSyn, the scale had 5 items measured on a Likert scale, ranging from 0, denoting "strongly disagree," to 7, indicating "strongly agree." The ICC for this scale was 0.710. With respect to preventive behaviors toward MetSyn, the scale featured 32 items and measured 6 subscales: physical activity and weight control, eating habits, alcohol consumption and smoking, sleep and rest, stress, drug use, and health management. The items were measured on a Likert scale ranging from 4, indicating "always," to 1, denoting "never." The ICC for this scale was 0.936.

After the development of the instruments, the participants in the 2 groups filled them out online (the pretest). Based on the pretest findings, the researchers developed 32 text messages and then pretested them. In order to respond to the research question of the study, we enrolled 10 employees of IUMS to participate in a face-to-face interview aimed at determining how the participants responded to the messages developed. We used some semi-structured questions introduced by the AIDSCAP Behavior Change Communication Unit (eg, "Are there any words that you do not understand? What are they?") to guide the interviews and also test the messages in different materials.¹⁹ Moreover, 5 experts in the nutrition and food industry checked the messages and discussed their factual appropriateness to determine whether they were appropriate for use in the study. Accordingly, we revised 2 messages and, finally, confirmed 32 text messages (Table 1). Thereafter, one of the researchers sent 1 message each day to the employees' cellphones in the intervention group during the 32-day intervention period. The researcher arranged the time and frequency of sending the text messages with the employees. Before receiving the text messages, the participants were provided with 1 free-of-charge SIM card to call the researchers if they had any questions or concerns. To rectify the possible failure of the system, one of the researchers checked the delivery reports of the cellphones. With the aim of augmenting intervention

fidelity and diminishing between-group contamination, the employees were asked not to share the text messages. One of the researchers was assigned to record and describe any contact between the participants and the researchers. One month after the intervention, the participants were followed up, and they completed the questionnaires again (Figure 1).

The data were analyzed using SPSS (version 18.0, SPSS, Inc, Chicago, IL, USA). The normality of the data was tested using the Kolmogorov-Smirnov test. The homogeneity of the demographic variables of both groups was analyzed using the independent-samples *t* test and the χ^2 test. The differences in the total mean score of the variables of knowledge, attitude, and the adoption of preventive behaviors concerning MetSyn before and after the intervention in each group were tested using paired *t* tests. The efficacy of the intervention was measured using the analysis of covariance (ANCOVA) after statistical assumptions were checked. In all the analyses, knowledge, attitude, and behaviors were dependent variables. The effects of confounding variables, including demographic characteristics, and covariates, including the scores of knowledge, attitude, and behaviors, at baseline were controlled by ANCOVA. The data were reported as the mean \pm the standard deviation (SD). A *P* value equal to or less than 0.05 was considered significant.

Results

Three participants in each group were excluded due to personal reasons, including lack of interest. There was also a 4.1% loss to follow-up. The demographic characteristics of the participants in the 2 groups are presented in Table 2. The results of the independent samples *t* test showed no significant differences between the 2 groups in age ($P=0.170$, $t=1.38$), the number of children ($P=0.411$, $t=0.82$), and body mass index ($P=0.719$, $t=-0.36$). The results of the χ^2 test revealed that the 2 groups had no significant differences concerning the level of education ($P=0.686$) and marital status ($P=0.849$). Table 3 shows the mean \pm SD of the variables of knowledge, attitude, and the adoption of preventive behaviors regarding MetSyn before and 1 month after the intervention in the 2 groups. In the intervention group, 1 month after the intervention, the mean scores of the knowledge, attitude, and behaviors that help prevent MetSyn exhibited significant increases compared with before the intervention (Table 3). In the control group, the mean score of these 3 variables had no significant differences before and after the intervention (Table 3). The findings also showed that following the intervention, there was a significant improvement in the mean scores of knowledge, attitude, and the adoption of preventive behaviors regarding MetSyn in the intervention group by comparison with the control groups (Table 4).



Table 1. SMS messages delivered to the cellphones of the participants in the intervention group

Text messages	
1	What is metabolic syndrome? Have you ever heard about that? Metabolic syndrome is a disorder that involves a combination of these symptoms: high blood pressure, high blood sugar, increased abdominal circumference, and abnormalities in the blood fat (decreased good blood fats [HDL] and increased triglycerides).
2	Metabolic syndrome has no specific symptoms, and many people do not know they have it. It can only be detected by measuring the abdomen circumference, blood pressure, blood sugar, and blood lipids.
3	By measuring your abdominal circumference and checking the latest blood test, you can determine which symptoms you or other family members have: 1. Abdominal circumference: more than 88 cm in women and more than 102 cm in men 2. Fasting blood sugar: more than 100 3. Good blood fat (HDL): less than 50 in women and less than 40 in men 4. Triglyceride: more than 150
4	If you currently have at least 3 of these 5 symptoms, you actually have metabolic syndrome: A. Abdominal circumference: more than 88 cm in women and more than 102 cm in men B. Blood pressure: higher than 130/85 mmHg C. Fasting blood sugar: more than 100 D. Good blood fat (HDL): less than 50 in women and less than 40 in men E. Triglyceride: more than 150
5	If you have symptoms of metabolic syndrome, do not worry because metabolic syndrome is almost preventable and treatable.
6	Metabolic syndrome can occur at any age. Take care of yourself, and take this syndrome seriously.
7	In Iran, almost 1 out of 3 people has metabolic syndrome. Unfortunately, many people are unaware of their illness. People with a hereditary background are more likely to get the disorder.
8	Some risk factors that increase the chance of developing metabolic syndrome are overweight and obesity, a high-fat diet, sugar and starch, sedentary lifestyle, smoking, and aging.
9	Keep in mind that metabolic syndrome is a very dangerous disorder. Albeit unknown, it can increase the risk of cardiovascular disease, heart attack, and type 2 diabetes. Therefore, reducing the risk factors of this disorder to prevent it is very important for you and your family's health.
10	By changing your lifestyle and taking medications prescribed by your doctor, you can take steps to eliminate the risk factors of metabolic syndrome.
11	You may tell yourself that you do not have enough time to deal with yourself and change your lifestyle. It may seem difficult, but if you plan, you can do activities throughout the day that reduce the risk factors of metabolic syndrome.
12	Abdominal obesity is dangerous, even if you have normal weight. Abdominal circumference greater than 88 cm in women and more than 102 cm in men can be a warning sign of a high risk of a heart attack.
13	If you are obese, overweight, or have abdominal obesity, try to return your weight to a normal range in proportion to your height. At the campus clinic, nutritionists are ready to provide advice on weight control and reducing belly circumference. Make an appointment and visit them.
14	Start exercising, with at least 30 minutes of moderate-intensity physical activity such as brisk walking, and repeat it at least 5 times a week.
15	Gradually increase your physical activity. It is better to increase the time to 1 hour a day (5–7 days a week). Exercises such as swimming, basketball, running, weightlifting, ping-pong, and cycling can also be helpful.
16	Take some routes on foot. In the corona pandemic, you can use the yard, roof, balcony, and even the space of the house for walking. Try it.
17	Do not be lazy, and if you do not have a particular problem, use the stairs instead of the elevator. Do not sit behind the computer and in front of the TV continuously. Walk a few steps and exercise.
18	Be more careful in choosing the type of food you eat. Chew the food well and eat slowly. Avoid overeating. Prepare and consume your meals in smaller volumes. Avoid over-snacking between the main meals. Eat 3 main meals and 2 snacks daily.
19	Reduce food fats as much as you can. To do this, you can eat cooked or steamed (instead of fried) foods as much as possible. Use low-fat or fat-free products (eg, low-fat dairy).
20	Reduce the consumption of harmful oils with saturated fatty acids (eg, butter and animal oils, oil of Kermanshah, tallow and tail, cream, buttermilk, and solid oils) as much as possible.
21	To fulfill the body's need for essential fatty acids, use little oil with unsaturated fatty acids (eg, olive oil, sunflower, corn, sesame, colza, and canola) instead of animal oil, solid oil, and butter in daily meals. It should be noted that the oils mentioned are not suit for frying or exposure to high temperatures.
22	Foods such as offal (sheep's brain, heart, and liver) and kebab are popular in Iran. These foods contain saturated fat and cholesterol, and high-fat meats should be reduced as much as possible.
23	Try to use more white meat (eg, fish, chicken, and other poultry with white meat) instead of red meat. Avoid processed meats (including sausages) that are high in fat and salt.
24	Eat more low-salt and salt-free foods. You can use a little lemon juice or other permitted spices to compensate for the lack of salt in the food and improve its taste. Remove salt from the food table.
25	Avoid canned foods and industrial juices, as well as soft drinks that contain a lot of sugar. It is better to replace them with water, homemade compotes, fresh fruit juice, and low-salt homemade buttermilk. As much as possible, do not use sugar, jams, syrups, chocolate, candy, ice cream, and all kinds of sweets, especially cream sweets, which have a lot of sugar.
26	Increasing the fiber intake in the diet can help lower blood pressure and body weight. Fiber is found in fruits, vegetables, legumes, grains, and nuts. It is best to eat at least 3 to 5 servings of fruits and vegetables throughout the day.
27	Include legumes such as peas, beans, lentils, and whole grains such as whole-wheat bread, whole-grain bread, and whole grains in your daily diet.
28	When you are buying food, check the labels of their ingredients, so you can choose and buy foods with fewer calories and fat. You can get help from your family.
29	If you are a smoker, try to smoke as little as possible and quit over time. Also, try not to expose your family and friends to secondhand smoke.
30	Limit tea or coffee to less than 3 cups a day. Allow it to cool slightly before you drink it. Hot tea has many side effects on your body.
31	You may be wondering if it is possible to live without stress. The human body and soul are quite close to each other. By controlling stress and relaxation, you can help your body's health a lot. Try to sleep 6 to 8 hours at night. Learn anger management skills, and increase your resilience in the face of adversity. You can consult with a psychologist.
32	At least once every 6 months, do a general check-up (for blood lipids and blood sugar). Check your blood pressure and abdominal circumference regularly, and take your medications according to your doctor's prescription.

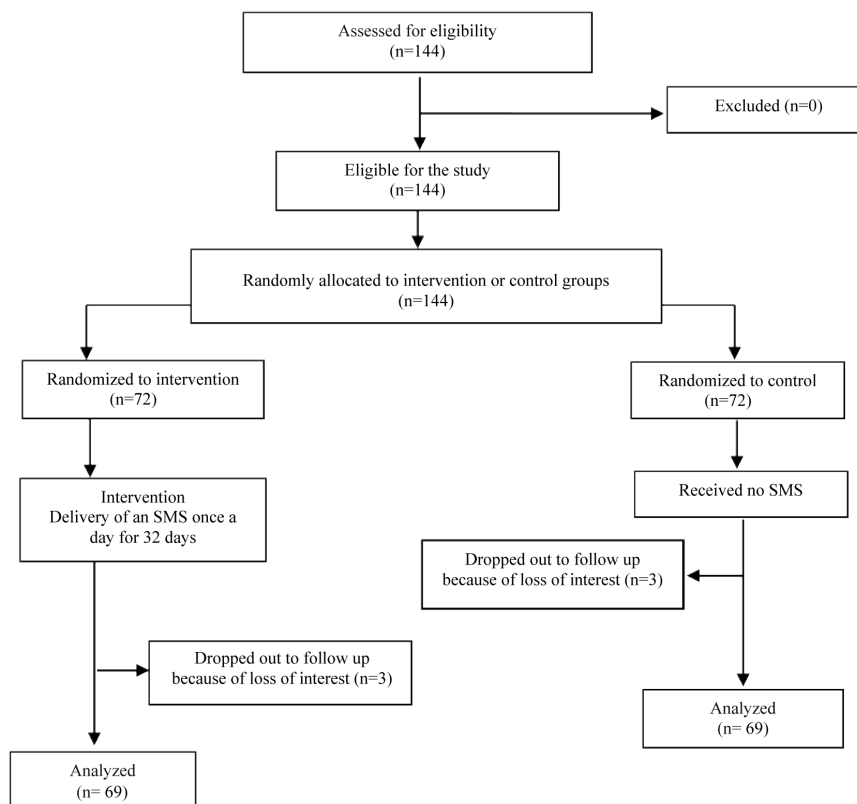


Figure 1. The chart depicts the enrolment process of the participants scheduled for SMS-based education intervention. SMS, Short message service

Table 2. Demographic characteristics of the participants

Variables	Intervention Group		Control Group	
	Mean±SD	n (%)	Mean±SD	n (%)
Age (y)	42.97±8.80	-	40.81±9.58	-
Number of children	0.97±0.93	-	0.84±0.91	-
Body Mass Index (kg/m ²)	25.72±4.02	-	26.25±3.83	-
Sex				
Female	-	52 (75.4)	-	48 (69.5)
Men	-	17 (24.6)	-	21 (30.4)
Education level				
<12th grade	-	1 (1.4)	-	3 (4.3)
≥12th grade	-	68 (98.6)	-	66 (95.6)
Marital Status				
Single	-	17 (24.6)	-	12 (17.4)
Married	-	48 (69.5)	-	52 (75.4)
Divorced or widow	-	4 (5.7)	-	5 (7.2)

Table 3. Effects of the cellphone-based text message education intervention on knowledge, attitude, and the adoption of preventive behaviors vis-à-vis MetSyn

Variables	Intervention Group				Control Group			
	T ₁	T ₂	Paired t	P	T ₁	T ₂	Paired t	P
Knowledge	11.35±6.43	16.97±2.05	7.42	<0.001	8.84±6.82	9.28±6.72	1.19	0.235
Attitude	26.17±4.85	29.00±3.70	5.58	<0.001	26.54±5.09	25.74±5.02	1.87	0.065
Adoption of preventive behaviors vis-à-vis MetSyn	87.84±13.02	89.64±13.16	2.04	0.045	86.32±11.51	85.58±10.74	1.13	0.262

T1, Pre-intervention scores; T2, Post-intervention scores; MetSyn, Metabolic syndrome



Table 4. Comparison of the effects of the cellphone-based text message education intervention on knowledge, attitude, and the adoption of preventive behaviors vis-à-vis MetSyn

Variables	F (ANCOVA)	P	Eta squared
Knowledge	101.19	<0.001	0.42
Attitude	38.00	<0.001	0.22
Adoption of preventive behaviors vis-à-vis MetSyn	7.00	0.009	0.04

T₁, Pre-intervention scores; T₂, Post-intervention scores; ANCOVA, Analysis of covariance; MetSyn, Metabolic syndrome

Discussion

The results of the present study showed that following an SMS-based education intervention, the mean score of the participants' knowledge in the intervention group about MetSyn increased significantly compared with the control group. This finding is consistent with those of some similar previous studies. For instance, Goodarzi et al²⁰ indicated that education via cellphone text messages could improve knowledge regarding type 2 diabetes mellitus in patients. Haricharan et al²¹ also concluded that text messages were effective in improving knowledge about hypertension among their sample of hearing-impaired South Africans. According to a previous investigation, notwithstanding the significant role of awareness in MetSyn risk factor prevention and management, individuals' access to such information as provided by healthcare workers was limited.²² Alali et al²³ suggested that there was a need to raise awareness about MetSyn among primary care physicians in Al-Asha, Saudi Arabia. Professionals in primary healthcare should pay more attention to the use of affordable and cost-effective communication channels (eg, SMS-based programs) to educate a wide range of people in the community about the risk factors and targeted healthy lifestyles related to MetSyn.

We found a significant difference between our intervention and control groups in the mean score of attitude toward MetSyn after the SMS-based intervention. In other words, the developed intervention had positive effects on the participants' attitude after they received the text messages. To the best of our knowledge, few studies have assessed the effects of SMS-based interventions on the attitude of individuals toward MetSyn. Gatwood et al²⁴ indicated that cellphone text messaging was a novel way to address medication adherence, health beliefs, and attitude among adults with diabetes. Moreover, Goodarzi et al²⁰ showed that SMS-based programs could improve the attitude of patients with type 2 diabetes mellitus. Frisman and Berterö²⁵ revealed a neglectful attitude toward MetSyn among Swedish adults. From their perspectives, a life with the recurrence of unhealthy behaviors seemed easy as the risk factors are supposed to be caused genetically. The thoughts of such individuals with respect to the genetic causes of the syndrome endorsed their behavior, and they saw no reason to make any changes. The authors suggested that individuals' attitude toward MetSyn should be determined when they try

to modify their lifestyles. Individuals with healthy attitude are more likely to embrace lifestyle changes toward MetSyn prevention.²⁶

Although the intervention conducted in the present study succeeded in raising the mean score of adopting preventive behaviors concerning MetSyn only by about 1.80 points (87.84–89.64) in the intervention group, this increase was significant compared with the control group. The effects of the present intervention on the participants' knowledge and attitude were greater than those on behavior modification. A possible reason for the slight improvement in behavior in the intervention group may be the participants needed more time to change their unhealthy lifestyle habits. The time constraints of 1 member of the research team (thesis presentation) precluded us from following up the participants for a sufficient length of time. The assessment of the long-term impact of similar studies on individuals' lifestyle modification or behavioral habits is recommended. Consistent with our finding, Moradi et al²⁷ demonstrated that an educational intervention based on SMS might improve knowledge regarding foot care and foot care practices in patients with type 2 diabetes. Joo and Kim²⁸ showed that an anti-obesity program with cellphone short messages might effectively modify individuals' behaviors toward weight control in Korea. Adopting healthy behaviors may reduce the risk of MetSyn development. In a prior study, the risk of MetSyn was substantially lower in individuals who were physically active, did not smoke, had a relatively low carbohydrate intake, and maintained their body mass index within the nonobese range.²⁹ According to the results of the present study, it seems that the implementation of SMS-based interventions alone cannot modify behaviors in terms of MetSyn prevention significantly; we, therefore, recommend the use of other strategies such as one-on-one counseling along with SMS. In addition, the assessment of the long-term effects of developed interventions on biochemical indicators of MetSyn is needed.

The main strength of our study is that it is the first research to evaluate the effectiveness of SMS-delivered education interventions on individuals' knowledge, attitude, and adoption of preventive behaviors apropos of MetSyn. One of the limitations of this study, however, is its short follow-up period. In addition, the results were based on a small convenience sample of employees at IUMS, Tehran, Iran, precluding the generalizability of the findings.

Conclusion

The results of the current study revealed the effectiveness of a cellphone-based SMS intervention in increasing knowledge, attitude, and the adoption of preventive behaviors vis-à-vis MetSyn in a sample of Iranian employees. Given that this intervention proved effective, it could be applied to other population groups in Iran.

Acknowledgments

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References

1. Saklayen MG. The global epidemic of the metabolic syndrome. *Curr Hypertens Rep* 2018;20:12.
2. Kalan Farmanfarma K, Kaykhaei MA, Adineh HA, Mohammadi M, Dabiri S, Ansari-Moghaddam A. Prevalence of metabolic syndrome in Iran: a meta-analysis of 69 studies. *Diabetes Metab Syndr* 2019;13:792-799.
3. Bonora E. The metabolic syndrome and cardiovascular disease. *Ann Me*. 2006;38:64-80.
4. Bassi N, Karagodin I, Wang S, Vassallo P, Priyanath A, Massaro E, Stone NJ. Lifestyle modification for metabolic syndrome: a systematic review. *Am J Med* 2014;127:1242.e1-10.
5. van Namen M, Prendergast L, Peiris C. Supervised lifestyle intervention for people with metabolic syndrome improves outcomes and reduces individual risk factors of metabolic syndrome: a systematic review and meta-analysis. *Metabolism* 2019;101:153988.
6. Orchard TJ, Temprosa M, Goldberg R, Haffner S, Ratner R, Marcovina S, Fowler S; Diabetes Prevention Program Research Group. The effect of metformin and intensive lifestyle intervention on the metabolic syndrome: the Diabetes Prevention Program randomized trial. *Ann Intern Med* 2005;142:611-619.
7. Nyenwe EA, Dagogo-Jack S. Metabolic syndrome, prediabetes and the science of primary prevention. *Minerva Endocrinol* 2011;36:129-145.
8. Alefishat EA, Abu Farha RK, Al-Debei MM. Self-reported adherence among individuals at high risk of metabolic syndrome: effect of knowledge and attitude. *Med Princ Pract* 2017;26:157-163.
9. Wu Y, Liang Y, Zhou Q, Liu H, Lin G, Cai W, Li Y, Gu J. Effectiveness of a short message service intervention to motivate people with positive results in preliminary colorectal cancer screening to undergo colonoscopy: a randomized controlled trial. *Cancer* 2019;125:2252-2261.
10. Shapiro JR, Bauer S, Hamer RM, Kordy H, Ward D, Bulik CM. Use of text messaging for monitoring sugar-sweetened beverages, physical activity, and screen time in children: a pilot study. *J Nutr Educ Behav* 2008;40:385-391.
11. Kim CJ, Schlenk EA, Kang SW, Park JB. Effects of an internet-based lifestyle intervention on cardio-metabolic risks and stress in Korean workers with metabolic syndrome: a controlled trial. *Patient Educ Couns* 2015;98:111-119.
12. Akbari M, Lankarani KB, Naghibzadeh-Tahami A, Tabrizi R, Honarvar B, Kollahdoz F, Borhaninejad V, Asemi Z. The effects of mobile health interventions on lipid profiles among patients with metabolic syndrome and related disorders: a systematic review and meta-analysis of randomized controlled trials. *Diabetes Metab Syndr* 2019;13:1949-1955.
13. Bobrow K, Brennan T, Springer D, Levitt NS, Rayner B, Namane M, Yu LM, Tarassenko L, Farmer A. Efficacy of a text messaging (SMS) based intervention for adults with hypertension: protocol for the StAR (SMS Text-message Adherence support trial) randomised controlled trial. *BMC Public Health* 2014;14:28.
14. Feroz AS, Ali NA, Saleem S. Assessing mobile phone access, usage, and willingness among women to receive voice message-based mobile health intervention to improve antenatal care attendance in district Thatta, Sindh, Pakistan. *Reprod Health* 2020;17:104.
15. Salaroli LB, Saliba RA, Zandonade E, Molina Mdel C, Bissoli NS. Prevalence of metabolic syndrome and related factors in bank employees according to different defining criteria, Vitória/ES, Brazil. *Clinics (Sao Paulo)* 2013;68:69-74.
16. Polit DF, Beck CT. Assessing data quality. In: Polit DF, Beck CT, eds. *Nursing Research: Principles and Methods*. 7th ed. Philadelphia /Baltimore/New York/London/ Buenos Aires/Hong Kong/Sydney/Tokyo: Lippincott Williams & Wilkins; 2004. p. 375- 397.
17. Abbasi A, Araban M, Heidari Z, Alidoosti M, Zamani-Alavijeh F. Development and psychometric evaluation of waste separation beliefs and behaviors scale among female students of medical sciences university based on the extended parallel process model. *Environ Health Prev Med* 2020;25:12.
18. Clark RA, Pua YH, Oliveira CC, Bower KJ, Thilarajah S, McGaw R, Hasanki K, Mentiplay BF. Reliability and concurrent validity of the Microsoft Xbox One Kinect for assessment of standing balance and postural control. *Gait Posture* 2015;42:210-213.
19. Flanagan D, Mahler H, Cohen S. How to conduct effective pretests: ensuring meaningful BCC messages and materials. <http://www.fhi360.org/resource/aidschap-how-conduct-effective-pretests-pdf-english-french> (16 December 2021).
20. Goodarzi M, Ebrahimzadeh I, Rabi A, Saedipour B, Jafarabadi MA. Impact of distance education via mobile phone text messaging on knowledge, attitude, practice and self efficacy of patients with type 2 diabetes mellitus in Iran. *J Diabetes Metab Disord* 2012;11:10.
21. Haricharan HJ, Heap M, Hacking D, Lau YK. Health promotion via SMS improves hypertension knowledge for deaf South Africans. *BMC Public Health* 2017;17:663.
22. Joshi A, Mehta S, Grover A, Talati K, Malhotra B, Puricelli Perin DM. Knowledge, attitude, and practices of individuals to prevent and manage metabolic syndrome in an Indian setting. *Diabetes Technol Ther* 2013;15:644-653.
23. Alali AA, Albagshi NM, Albin Alshaiikh SM, Almubarak AA. Primary care physicians' knowledge, attitudes and practices related to metabolic syndrome screening and management in Alahsa, Saudi Arabia. *Diabetes Metab Syndr* 2019;13:2689-2697.
24. Gatwood J, Balkrishnan R, Erickson SR, An LC, Piette JD, Farris KB. The impact of tailored text messages on health beliefs and medication adherence in adults with diabetes: a randomized pilot study. *Res Social Adm Pharm* 2016;12:130-140.
25. Frisman GH, Berterö C. Having knowledge of metabolic syndrome: does the meaning and consequences of the risk factors influence the life situation of Swedish adults? *Nurs Health Sci* 2008;10:300-305.
26. Lewis SJ, Rodbard HW, Fox KM, Grandy S; SHIELD Study Group. Self-reported prevalence and awareness of metabolic syndrome: findings from SHIELD. *Int J Clin Pract* 2008;62:1168-1176.
27. Moradi A, Alavi SM, Salimi M, Nouhjah S, Shahvali EA. The effect of short message service (SMS) on knowledge and preventive behaviors of diabetic foot ulcer in patients with diabetes type 2. *Diabetes Metab Syndr* 2019;13:1255-1260.
28. Joo NS, Kim BT. Mobile phone short message service messaging for behaviour modification in a community-based weight control programme in Korea. *J Telemed Telecare* 2007;13:416-420.
29. Zhu S, St-Onge MP, Heshka S, Heymsfield SB. Lifestyle behaviors associated with lower risk of having the metabolic syndrome. *Metabolism* 2004;53:1503-1511.