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■ Original Article

Comparing Mobile-Based to Group-Based Education for Weight Reduction in a Developing Country: A Randomized Study

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Background: This study compared the impact of Short Message Service (SMS)-based education with traditional group-based education and the control group on body mass index, weight, and lifestyle in obese and overweight patients in a limited-resource country. It also compared the direct financial costs between the two intervention groups.

Methods: In this controlled randomized educational study, 90 overweight or obese adults from four family physician clinics in Shiraz, Iran were randomly allocated to three training groups: SMS-based education, group-based education, and a control group. The participants' weight, body mass index (BMI), and waist circumference were measured at baseline, and the Physical Activity Scale questionnaire was completed. Group-based training was conducted in 1-hour weekly sessions. The SMS group received a text message each morning. The control group received routine care from a family physician. The intervention lasted 12 weeks. All participants were re-examined for the studied variables. Additionally, the direct costs were estimated, calculated, and compared.

Results: The mean weight, BMI, and waist circumference changed significantly after 3 months compared to baseline in each group. The mean weight change differed significantly among the three groups (P-value=0.04), and the mean BMI changes were near significant (P-value=0.06). A post hoc comparison of changes in weight and BMI showed a significant difference between the control and SMS groups. SMS education incurred much lower costs for patients and healthcare services than group-based education.

Conclusion: The study showed that SMS is an effective and cost-saving educational method for weight loss compared to group-based education, especially in developing countries.

Keywords: Telemedicine; Overweight; Obesity; Text Messaging; Health Education; Weight Loss

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INTRODUCTION

Obesity is a chronic disease with increasing prevalence worldwide and is a major cause of noncommunicable diseases in most societies. In 2015, approximately 108 million children and 604 million adults worldwide were obese,[1] and the global prevalence of overweight and obesity was 39%. It has been estimated that the obesity/overweight rate would increase to 57.8% by 2030 if there were no changes to the status quo.[2]

The prevalence of obesity in developed countries appears stable but is undergoing an explosive process in developing countries. The prevalence in developing countries was less than 2% in 1980; however, this low rate was reported in only one of the nine countries studied in 2013. This problem is due to sedentary lifestyle, increased high-energy diets and fast food use, and rapid socioeconomic changes in developing countries.[3] The prevalence of obesity/overweight in the Iranian population in 2016 was 59.3%.[4]

Body mass index (BMI) is usually the first measurement in determining the degree of overweight. It is calculated by dividing the body weight (kg) by the square of the height (m). This measurement is convenient, reliable, and correlates with body fat percentage and body fat mass. This provides a better estimate of total body fat than body weight alone. It is associated with an increase in all-cause and cardiovascular disease (CVD) deaths.[5]

The treatment of obesity and overweight aims to prevent, treat, or reverse the complications of obesity and improve the quality of life.[6] Weight loss of only 5% of body weight is associated with health benefits.[7]

The increasing prevalence of obesity has created the need for access to broader education to promote lifestyle modifications. However, it appears necessary to use educational methods with high accessibility and low cost, especially in societies with limited resources.

Wide-access, non-face-to-face methods, such as telephone, social networking, the Internet, and email have been increasingly used in various treatment modalities to increase patient access.[8] With the almost universal ownership of mobile phones, short messages can potentially deliver text to a broad spectrum of the population.[9] Additionally, short messages are such that one can access them whenever it is convenient. This technology provides an interactive, inexpensive, convenient, and rapid communication environment.[9]

Short Message Service (SMS) interventions, such as weight loss programs, provide an appropriate delivery channel for health behavior changes. There is some evidence that SMS-delivered interventions have positive behavioral outcomes associated with weight loss,[9] diabetes self-control, decreased hemoglobin A1C levels,[10] and smoking cessation.[11] SMS-based prevention strategies can create alerts for individuals and their family members, and facilitate the implementation of preventive lifestyle strategies. A systematic review found that a few investigations indicated that text messaging interventions could promote weight loss. However, the lack of long-term results suggests that further studies of its efficacy are required. This study recommends that future research focus on determining relevant factors, such as the duration of intervention, frequency of text messages, and level of interaction, that lead to maximum success, as well as the cost of interventions.[12] However, most of these studies have been conducted in developed societies. A systematic review in 2022 that evaluated the effect of SMS intervention on obesity in developing countries found that only 12 randomized trials were conducted in developing countries compared to 84 studies in developed countries. This study concluded that evidence of low socioeconomic status is limited, even in developed countries, and recommended that more studies be conducted in these settings.[9]

In some studies, the effect of SMS-based education has been compared with that of other health education methods. In one study, the impact in students of daily SMS on improving nutritional status and reducing osteoporosis was compared with weekly 60-minute lectures. The results showed that text messages enhanced students' nutritional status more than lectures.[13]

Another study compared the effect of three education groups (SMS, group education, and routine care) on blood sugar reduction in the family doctor system. The results showed that both the SMS and group training groups achieved better results in controlling blood sugar than the control group, and the SMS group performed better in controlling blood sugar 2 hours after a meal.[10]

In a study conducted in Bangladesh, mobile education was compared with traditional education. In this study, a mobile phone was used for monthly voice call reminders, and this method was compared with traditional home and personal visits. It has been shown that mobile health education has better results in improving knowledge, adherence to treatment, and disease outcomes. In this study, it was recommended that traditional education be replaced with mobile phone education to improve noncommunicable disease management in developing countries.[14]

To date, most studies have compared mobile phone methods with face-to-face interventions for weight loss in obese patients, and no evidence has been found to compare them with group-based education in limited-resource countries. Therefore, we utilized a randomized, controlled educational program to pursue the four aims of this study. The first aim compared the effects of group-based training, SMS-based training, and routine intervention (control group) in reducing the BMI of overweight and obese patients. The second aim compared lifestyle changes, including physical activity and consumption of sweet beverages, fast food, and candy, among the three groups. Third, a pre-post analysis was conducted to investigate the effect size in each group separately. The fourth aim compared the costs of group-based education with SMS-based education.

METHODS

This randomized controlled educational study was conducted in Shiraz, a large city in southern Iran, and was approved by the Ethics Committee of Shiraz University of Medical Sciences with the ethical code

I.R.SUMS.MED.REC.1397.462. Participants were enrolled from four family medicine clinics located in four different marginal areas of the city with low socioeconomic status.

The sample size was calculated using the PASS ver. 11.0 software (NCSS Statistical Software, Kaysville, UT, USA) to determine the sample size in the analysis of variance (ANOVA) analysis for the three groups. Based on the initial pilot study, the standard deviation (SD) was 1.3, and the difference between the BMI means was considered 2 (d=2), with alpha=0.05, beta=0.80, and R=1. The required sample size was calculated on this basis and included 69 participants. Considering 20% missing data, the total sample size was 90.

1. Participants

Ninety overweight or obese adult patients from four Shiraz family physician clinics who met the inclusion criteria were included in the study. To select participants, we extracted the names of overweight or obese patients from the electronic health records of these clinics. A healthcare provider called on these patients to undergo examinations. After the researcher explained the research aim, eligible individuals willing to participate were identified. Recruitment continued until the calculated sample size was reached.

The inclusion criteria were: age 18–60 years; BMI 25.0–35.0 kg/m^2, adequate health to participate in physical activity, weight loss as determined by an internal medicine physician and a family physician resident who were responsible for the study, ability to use a mobile phone and read SMS, and willingness to participate in the study.

Exclusion criteria were: people who currently used or planned to use any weight loss medication or other weight loss strategies; those with psychological problems such as severe anxiety, major depression, or panic disorder that were not stable for at least 6 months; pregnancy, lactation, or planning for pregnancy during the study; eating disorders; and other comorbid conditions such as diabetes and CVD.

2. Recruitment

After completing the informed consent form, a family physician examined all patients to confirm their health to participate in the program. Demographic information including height, weight, BMI, and waist circumference were recorded. The participants completed the Physical Activity Scale (PAS) questionnaire. Three other questions were asked to investigate the role of fast food, sweet beverages, and cookies in overweight participants and the effect of education on these food behaviors in the studied population. These questions concerned the frequency of fast food and cookies in a typical week and sweet drinks on a typical day. Another question concerned bedtime snoring, a common complaint in overweight and obese patients and a significant risk factor for other diseases such as hypertension. Eligible individuals were randomly divided into three training groups using a sealed envelope randomization method. The three groups were SMS-based education, group-based education, and a control group that received routine care. Randomization was performed on a relevant website using a block randomization technique with a block size of six.

Participants who did not attend more than six sessions of group-based education and those who did not respond to more than 50% of the messages in the SMS-based education were excluded from the study.

3. Intervention Description

The training duration was 12 weeks. All educational content was extracted from patient education issues on UpToDate, an evidence-based site.[15,16] The topics of the educational content are listed in Table 1.

Training in group-based education was conducted in 1-hour sessions per week for 12 weeks, in which the family physician's resident taught the patients. Participants' height, weight, and waist circumference were measured at baseline and then weekly.

In SMS-based training, a text message was sent to people every morning for 12 weeks. Contents of the text messages were divided into two major categories: (1) informative or cognitive and (2) motivational, such as "always using stairs instead of elevators." Participants were asked to respond briefly to ensure that they received the text message, and were asked to respond to weekly text messages asking them to report their weight and waist circumference measures. In addition, a watch group, including a family physician resident, a professor of family medicine, and a Doctor of Nutrition, responded to the participants' questions by SMS for 2 hours every Wednesday.

The control group received routine family physician care (including a visit by their healthcare provider, a referral to a nutritionist for face-

Table 1. Contents of education for intervention groups (SMS-based and group-based groups)

	Educational content
Starting a weight loss program	
Setting a weight loss goal	
Lifestyle changes	• Setting goals and using rewards • Other factors that contribute to • Successful weight loss - Establish a "buddy" system - Learn to avoid temptations - Develop a support system - Positive thinking - Reduce stress
Changing your eating habits	
Healthy diet overview	
General recommendations for a healthy diet	• Low-fat diet • Low-carbohydrate diet • Mediterranean diet • Which diet is best?
Exercise and movement	• What are the benefits of movement? • What are the main types of exercise? • Should I talk to my doctor or nurse before I start exercising? • What should I do when I exercise? • How often should I exercise? • When should I call my doctor or nurse? • What if I don't have time to exercise? • What else should I do when I exercise?

SMS, Short Message Service.

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to-face counseling, and monthly follow-up for weight and BMI measurements). Two other groups were visited by their family physicians but were not referred to nutritionists.

After 3 months, all participants were re-examined for weight, BMI, and waist circumference at the clinics using the same scale as the baseline measurement. These objective measurements were used for the statistical analysis. In addition, the PAS questionnaire and questions related to sweet drink and fast food consumption were completed.

4. Outcome Measurement

Anthropometric measurements: Weight was measured using the Bardia Teb Salamat weight scale model 300 (Bardia Teb Salamat, Alborz, Iran), which was available in all four clinics in which the research was conducted. Height was measured using a tape measure while the patient stood against a wall without shoes. Waist circumference was measured in the horizontal plane between the lower rib and iliac crest using a soft tape measure. Patients were asked to come for weight measurement while fasting. The same healthcare provider measured the anthropometric variables at baseline and the end of the study period. The patients' shoes and extra clothes were removed, and their weight was measured with a blouse and pants, or similar. BMI was calculated using these data. At the end of the study, the measurement tools and style were the same as those used for the baseline measurement.

Physical activity was measured using a PAS questionnaire. This is a simple self-administered questionnaire. The validity and reliability of the original version were highly correlated with those of the Daily Activity Questionnaire (r=0.74). An interclass correlation of 0.55 showed acceptable reliability.[17] The validity of the Persian translation was proven by a correlation coefficient of 0.87.[18] The questionnaire categorized daily activities based on the metabolic equivalents of task (MET), a unit that estimates energy consumption. One MET is equal to the energy consumed by a person while sitting, which is approximately equivalent to the consumption of 3.5 liters of oxygen per minute per kilogram of body weight. The questionnaire rated activity intensity into nine groups, from low (0.9) to high (>6). The patients were asked to report the duration of each activity category within a typical 24 hours of their everyday life. MET time was calculated as MET×duration of activity. The MET time multiplied by weight indicates the amount of energy consumed in 24 hours. If the sum of the duration reported by patients was more or less than 24 hours, the MET time was corrected by subtracting or adding the difference of time multiplied by 2 (which is the MET daily activity at home).[19]

Food habits: Participants were asked to self-report how often they ate fast food and candy in a typical week and sweet beverages on a typical day.

Another outcome measured was the presence of bedtime snoring reported by the patients or their family members.

5. Cost Calculation

To calculate the direct cost, we considered the average cost of sending SMS messages, personal wages, and transport fees. The cost of sending an SMS was obtained from the website of the Iran Telecommunication Company. The salary of teaching staff with bachelor's degrees was requested from the Shiraz University of Medical Sciences. The cost of transportation from home to the clinic was calculated by considering the average taxi fee for an average distance of 4 km (the family doctor must be within the same distance from home).

6. Statistical Analysis

The information was entered into IBM SPSS ver. 20.0 software (IBM Corp., Armonk, NY, USA), and descriptive data were expressed as frequencies and graphs. A paired t-test was used to compare the means of the data in each group. ANOVA and chi-square tests were used to compare quantitative and qualitative data between the three groups. A nonparametric test was used for variables with a non-normal distribution, such as the number of times the patients consumed fast food, sweet beverages, and candy. The effect size was calculated using Cohen's d. The effect size <0.2, 0.2–0.49, 0.5–0.79, and >0.8 were considered negligible, small, moderate, and large, respectively.[20] Significance level was set at $P<0.05$.

RESULTS

Two hundred fifty people were surveyed to participate in the study. Finally, 90 participants were assigned to each of three groups. Twenty-eight of these people attended the group education sessions; 29 people from the SMS group responded to the SMS according to the protocol (response rate to 50% of SMS: 96.6%), and 30 people from the control group responded to the final review after repeated follow-up (Figure 1). The average age of participants in the class, SMS, and control groups were 40.6, 40.3, and 36.6 years, respectively, which was not statistically significant. There was no significant difference between the three groups in terms of sex, literacy level, or the percentage of married people (Table 2).

At baseline, of the three selected food behaviors (consumption of fast food, sweet beverages, and cookies), only fast food consumption showed a statistically significant relationship with initial weight gain. (r=0.27, P-value Spearman=0.01). There was no significant relationship between the MET changes and weight reduction in the three studied groups (r=0.2, r=0.12, and r=0.2 in the SMS, group-based, and control groups, respectively).

1. Before-After Comparison

Changes in mean weight, BMI, and waist circumference after 3 months of the study were statistically significant compared to those before the study in each of the three groups (Table 3, Figure 2). Regarding MET-hours in the group-based education and SMS groups, physical activity increased by 2 MET-hours (from 43.7 to 45.7) and 1.1 MET-hours (from 41.4 to 42.5), respectively, but this increase was not statis-

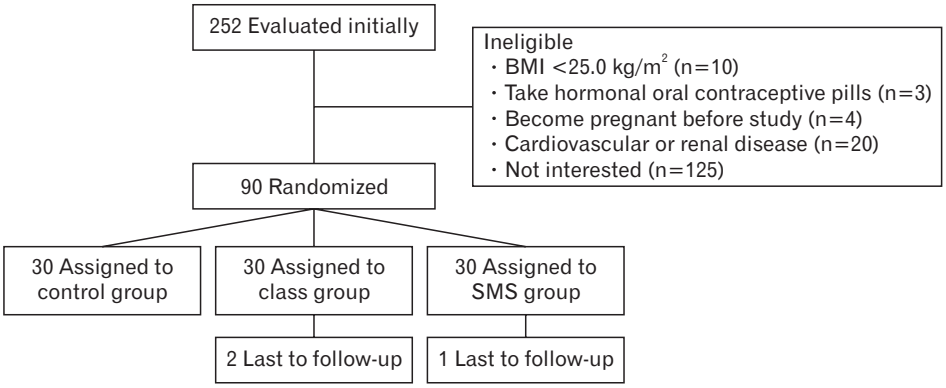

Figure 1. Participants' flowchart. BMI, body mass index; SMS, Short Message Service.

Table 2. Comparison of demographic and anthropometrics before the study in three groups: group-based education, SMS-based education, and control group

Characteristic	Group-based education	SMS-based education	Control group	Test	P-value
Gender				1.4*	0.49
Female	22 (78.6)	21 (72.4)	20 (67.0)		
Male	6 (21.4)	8 (27.6)	10 (33.0)		
Education				8.5*	0.06
Less than diploma	15 (53.6)	9 (31.0)	5 (16.7)		
Diploma	10 (35.7)	14 (48.3)	17 (56.7)		
More than diploma	3 (10.7)	6 (20.7)	8 (26.7)		
Marriage				2.45†	0.37
Single	2 (7.0)	3 (10.0)	6 (20.0)		
Married	26 (93.0)	26 (90.0)	24 (80.0)		
Age (y)	40.6±12.1	40.3±7.1	36.6±11.0	1.4‡	0.25

Values are presented as number (%) or mean±standard deviation.
SMS, Short Message Service.
*By chi-square test. †By Fisher's exact test. ‡F-value by analysis of variance test.

tically significant. Physical activity levels did not change in the control group. All unhealthy eating habits in all three groups decreased before and after the study period, except for fast food consumption in the SMS group. However, only sweet beverage and candy consumption reductions were statistically significant in the control group.

Bedtime snoring reporting was also asked of participants. In the SMS group, six of the 11 participants who complained of snoring reported that this symptom improved after the intervention. This symptom improved in one of six and two of eight participants in the control and group-based groups, respectively. These proportions were not significantly different (P-value=0.36).

2. Comparing Mean Changes between Three Groups

The mean weight changes in the three groups differed significantly (P=0.04) (Table 3), and the mean BMI changes were near significant (P=0.06). However, waist circumference measurement, physical activity, and food consumption behavior changes after 3 months of intervention were not significantly different among the three groups. A post hoc comparison of changes in weight and BMI showed a significant difference between the control and SMS groups, with a better outcome in the SMS group (Table 4).

There was no significant relationship between the MET changes and weight reduction in the three studied groups. (r=0.12, P-value Pearson=0.56; r=0.19, P-value Pearson=0.32; r=0.2, P-value Pearson=0.3, respectively in group-based, SMS-based, and control groups).

3. Comparing the Direct Financial Cost of Two Educational Methods

Finally, we compared the direct costs between the two intervention groups. As shown in Table 5, SMS-based education incurred much lower costs for patients and healthcare services than group-based education did.

DISCUSSION

Mobile technology has recently been considered a suitable option for health education owing to its low cost and public access. This study conducted a controlled educational trial using mobile technology for weight loss training in overweight and obese individuals. The three intervention groups included group-based education, SMS-based education, and a control group under the usual care of their family physicians. Weight, BMI, and waist circumference decreased significantly in all three groups compared to baseline, although participants in the SMS-based education group showed more weight loss. The mean

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Table 3. Comparison between means of anthropometric indices, METs score, and studied food intake before and after study and between three studied groups

Variable	Control group	SMS group	Group-based education	F	P-value
Waist circumference (cm)					
Before	100.5±10.2	101.0±9.2	102.7±9.0	0.4*	0.67*
After	96.8±9.1	94.8±9.3	96.5±8.4	0.37*	0.7*
P-value*	0.003	<0.001	<0.001		
Difference	3.0±4.3	4.5±4.4	5±5	1.4*	0.25*
95% CI	4.8	2.7–6.4	3.1–7.1		
Effect size (Cohen's d)†	0.7	1	1		
Weight (kg)					
Before	76.8±12.4	79.9±10.9	78.3±11.6	0.65*	0.53*
After	75.0±12.0	76.3±9.6	75.4±10.4	0.1*	0.9*
P-value‡	0.008	<0.001	<0.001		
Difference	1.7±3.4	3.6±3.0	2.9±2.1	3.2*	0.04*
95% CI	0.5–3.0	2.5–4.7	2.0–3.7		
Effect size (Cohen's d)†	0.5	1.2	1.4		
Body mass index (kg/m^2)					
Before	28.6±2.8	29.1±2.8	29.0±3.0	0.22*	0.8*
After	28±2.8	28.4±2.7	28.7±3.2	0.4*	0.67*
P-value‡	0.009	<0.001	<0.001		
Difference	0.66±1.3	1.3± 1.02	1.1± 0.7	2	0.06*
95% CI	0.18–1.1	0.9–1.7	0.8–1.3		
Effect size (Cohen's d)†	0.5	1.3	1.6		
MET time (kcal/h/d)					
Before	42.7±6.5	41.5±6.4	43.7±6.0	1*	0.36*
After	42.5±7.0	42.9±6.4	45.5±7.8	1.5*	0.2*
P-value‡	0.9	0. 24	0.12		
Difference	0.2±6.4	-1.6±6.9	-1.7±5.7	0.8*	0.4*
95% CI	-2.2 to 2.5	-4.2 to 1.1	-4 to 0.5		
No. of times consume sweet drinks per days					
Before	2.2±1.3	2.4±1.9	2.1±1.5	0.5§	0.8§
After	1.5±0.8	2±1.1	1.6±1.0	3§	0.2§
P-value‖	0.01	0.2	0.07		
Difference	0±4.4	0.4±1.87	0.53±1.8	0.7§	0.7§
No. of times consume fast food in a week					
Before	1.6±1.0	1.3±0.5	1.3±0.6	2§	0.4§
After	1.3±0.7	1.3±0.5	1.2±0.4	0.28§	0.87§
P-value‖	0.1	0.8	0.16		
Difference	0.3±0.86	0.03±0.7	0.14±0.5	1.1§	0.6§
No. of times consume candy in a week					
Before	2.2±1.6	1.8±1.0	1.8±1.2	0.45§	0.8§
After	1.6±1.4	1.4±0.6	1.5±1.1	1§	0.6§
P-value‖	0.009	0.07	0.09		
Difference	0.6±1.2	0.5±1.3	0.4±1.2	0.45§	0.8§

Values are presented as mean±standard deviation unless otherwise stated.
MET, metabolic equivalents of task; SMS, Short Message Service; CI, confidence interval.
*Calculated P-value from analysis of variance test. †Effect size for paired t-test (Cohen's d) = $\frac{|m_1-m_2|}{sd}$. ‡Calculated P-value from paired t-test. §Calculated from Kruskal-Wallis test. ‖Calculated by Wilcoxon test.

changes in weight among the three groups were statistically different, and the BMI changes were near significant owing to the difference between the control and SMS groups. This study also showed that although the amount of fast food consumed per week, which was approved as a determinant factor of overweight at baseline, was reduced after the intervention, it was not affected significantly by the studied interventions. SMS-based education incurred much lower costs for patients and healthcare services than group-based education.

In a similar study of overweight and obese people, text messages were sent to participants every 2 weeks for a year. In this study, the only intervention in the control group was to record initial weight and recommend weight loss during the same visit. The results showed significant weight loss in the intervention group and insignificant weight gain in the control group.[21] The results of that study regarding weight loss in the SMS group are consistent with those of the present study. However, in our study, the control group also showed significant

weight loss, probably because the control group also received routine family physician care for weight loss, including a visit by a healthcare provider and referral to a nutrition consultant for face-to-face counseling. In the present study, the three groups showed significant differences in weight loss and BMI, and a pairwise comparison showed a significant difference between the control and SMS groups in changes in weight and BMI.

A study comparing weight loss in daily personalized, tailored text messaging with a control group reported no difference between the two groups after 1 year. This inconsistency with the results of our study likely arose from the differences between the studied populations. Our study population consisted predominantly of individuals of low socioeconomic status; therefore, this training could be more attractive. In the present study, SMS education was followed by weekly counseling with experts, which was also conducted via interactive SMS. This method can increase the efficacy of SMS. Another reason may be the shorter duration of the intervention in our study. A longer duration may decrease its effectiveness by decreasing its attraction.[22]

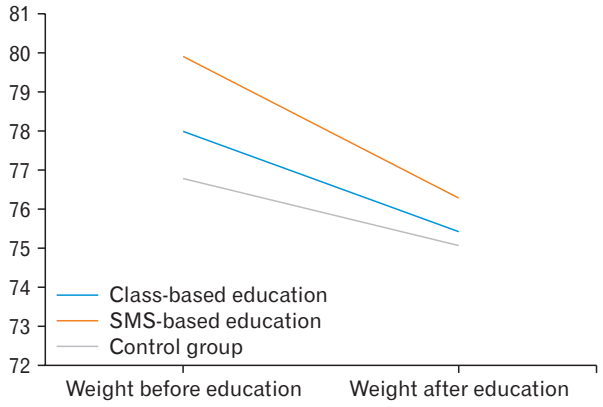

Figure 2. Comparison of mean weight changes before and after 3 months of training in the three studied groups. SMS, Short Message Service.

A meta-analysis of 15 studies investigated the effects of SMS interventions on weight loss, showing that SMS intervention resulted in about 2.28 kg of weight loss. It was concluded that the SMS, which delivered lifestyle change interventions for weight loss, had a small to moderate effect on weight reduction.[23] In our study, SMS-based education resulted in about 3.6 kg of weight reduction with a large effect size (1.2). This stronger effect may be due to the more intense schedule of daily SMS delivered in our study. Another reason may be the difference in the socioeconomic status of the studied population. Information provided to lower socioeconomic populations with little or no knowledge about weight loss will probably be more effective than that on higher socioeconomic populations.

In a 2015 study, text messages were sent every 2 weeks for 6 months, and there was an increase in physical activity among overweight participants. However, the energy intake did not differ significantly from that of the control group.[24] In our study, although there was an increase in physical activity in both intervention groups, the difference was not statistically significant. A shorter intervention duration (3 months) may have caused a difference in the results.

It is possible that these changes in the three groups could be made

Table 4. Pairwise comparison of significant changes between studied groups (post hoc test: least significant difference)

	Class group weight	SMS group weight
Comparing weight changes (Δ mean)		
SMS group	0.7±0.76	
Control group	-1±0.8	-1.8±0.75*
Comparing BMI changes (Δ mean)		
SMS group	0.2±0.3	
Control group	-0.4±0.3	-0.6±0.3*

Values are presented as mean difference±standard error. Mean difference: Δ mean values of the group in the column–Δ mean values of the group in the row (Δ mean values: mean of values after intervention–mean of values before intervention).
SMS, Short Message Service; BMI, body mass index.
*P<0.05.

Table 5. Comparing the total direct financial cost spent for education in two educational groups, SMS-based education, and group-based education

	SMS group		Group-based education	
	Calculation	Cost (IRR)	Calculation	Cost (IRR)
The cost paid by the project-implementing organization				
Cost of education tools	270 IRR (average fee for sending each SMS)×90 (total number of SMS in 3 months)×30 (number of participants)	729,000	0	
Personnel wages	150,000 IRR (staff salaries per hour)×2 hours (spent for content selection and preparation in the form of short text messages)+4 hours (1 h/wk spent replying to patient questions)	900,000	150,000 IRR (staff salaries per hour)×20 hours (spent for preparing PowerPoint, preparing, and holding a class)	3,000,000
Total		1,629,000		3,000,000
The cost paid by the patients				
Out-of-pocket cost by patient	0	0	20,000 IRR (average cost of transportation by taxi)×4 (class sessions)	80,000
Total for all patients	0	0	80,000 IRR×30 participants	2,400,000

1 IRR=0.000004$.
SMS, Short Message Service; IRR, Iranian rial (the currency of Iran).

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significant by increasing the duration of training or the number of participants.

In a systematic review conducted in 2015, cumulative data from 14 controlled trials on the effect of SMS on weight loss showed an average weight loss of 2.56 kg in the intervention group and approximately 0.37 kg in the control group.[12] More weight reduction in the control group (1.8 kg) in the present study may have been because this group received routine family physician care. In contrast to most other studies in which the control group received no care, this group in the present study received face-to-face counseling. However, our study showed that the weight reduction in the SMS group was significantly higher than that in the control group. This result highlighted the superiority of SMS-based education over face-to-face counseling, which is more expensive and time consuming. However, training content may be another reason for this difference. Although the training content in the control group was very similar to that in the intervention group, it was not the same because of implementation problems.

A narrative review in 2017 showed that weight loss in the SMS group was approximately 2.17 kg compared with the control group, almost equal to the weight loss induced by traditional methods such as face-to-face training, group training, or medication.[25]

In a study conducted in Iran on 73 Iranian women, text messages were sent for 2 months, and they lost approximately 1.5 kg compared to the control group.[26] In our study, which was performed for 3 months, weight loss in the SMS group was 1.8 kg more than control.

This study also showed that the number of fast food consumptions per week was a weight-related factor before the intervention, and sweet beverages showed no correlation with initial weight. These results are consistent with the studies of Bowman and Vinyard[27] and Pereira et al.,[28] which showed that fast food consumption correlates with weight gain. However, in contrast to the present study, Greenwood et al.[29] showed that consuming sugar-containing soft drinks was most strongly associated with obesity and overweight. This difference may be due to Iranian food culture. In our country, sweetened tea is the sweet drink most consumed by people, and its use is considered part of the food culture of the country. Nearly everyone consumes this kind of drink; other sweet drinks are consumed much less frequently in Iran. Therefore, there was no difference between the obese and non-obese populations. In our study, even after the 3-month intervention, the reduction in consumption of sweet drinks did not significantly change from baseline, which may be due to the country's food culture; changing this habit requires more intense education.

Despite consuming fewer sugary drinks, sweet foods, and fast foods during the study, this reduction was not significantly associated with weight change. Perhaps because of the small sample size, these changes were not significant in our study, and a larger sample size is needed to further investigate these nutritional factors. However, it is possible that in Iran, other food habits such as rice and bread consumption are more important determinants of weight reduction than fast foods and sweet beverages.

With regard to direct costs, the results of the present study are consistent with those of other studies. A systematic review of other systematic reviews showed that SMS reminders caused 45% and 35% reductions in telecommunication costs and the cost of research assistants' working hours, respectively. In addition, the cost of SMS reminders was lower than that of telephone reminders in the control group.[30]

A study by Haghighinejad et al.,[10] which compared direct costs of SMS-based education and group-based education in patients with diabetes, showed much lower costs in the SMS group.

1. Limitations

Although the number of participants in the present study was adequate to show the effect of educational methods on weight loss, it was insufficient to measure the effect of individual behavioral factors such as physical activity and energy intake.

Another limitation of this study is that the exact effect of face-to-face education could not be evaluated because the educational content in our control group was not exactly the same as that of the other two intervention groups owing to implementation problems. In addition, to reduce the number of questions and increase the cooperation of the participants, the researchers in this study omitted the evaluation of other food habits such as the consumption of bread and rice, and the recording of daily diet.

On the other hand, although the duration of the intervention in this study was suitable for weight loss, increasing the duration of sending educational SMS and other methods can have different effects on the results.

Therefore, it is recommended that the number of participants and duration of the intervention be increased in future studies. In addition, it is recommended that the sustainability of the training program be checked at reasonable intervals.

2. Summary

(1) SMS-based education resulted in more weight and BMI reduction compared to routine care by family physicians but was almost equal compared to group-based education. (2) Although waist circumference decreased in the three studied groups compared with baseline, the changes did not differ among the three groups. (3) Physical activity increased more in SMS-based and group-based education groups than in the control group, although the difference was not statistically significant. (4) SMS-based education incurred much lower costs for patients and healthcare services than group-based education.

3. Conclusion

These results indicate that although routine care in the family physician system can be effective for weight loss, group-based and SMS-based education have a better trend in treating obesity. In addition, SMS-based education provided better results than group-based education. Considering the amount of time and money spent on attendance in class sessions, we can demonstrate the efficiency of the SMS method compared with the traditional group training method. As the Internet does not cover some areas in Iran, the SMS method can be

even more efficient than Internet methods in our country.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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