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Effect of the Intervention Based on New Communication Technologies and the Social-Cognitive Theory on the Weight Control of the Employees with Overweight and Obesity

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ABSTRACT

Background: Work settings provide a unique opportunity for health promotion interventions. Considering the issue of obesity in employees, this study was conducted to evaluate the effect of the intervention based on new communication technologies and the social cognitive theory (SCT) on weight control in the governmental employees of Hamadan City, western Iran in 2014.

Methods: This randomized control trial study was conducted in "telephone- assisted intervention", "web- assisted intervention", and "control" groups comprising 435 employees of Hamadan City with overweight or obesity in 2014 (Ethics Committee Code: 93/D/130/1139). The educational intervention was performed for 6 months under the title of "lifestyle program". Then, the participants were evaluated in terms of weight and changes in the constructs of the social-cognitive theory 6 and 9 months after the intervention. A researcher-made questionnaire based on the Dishman and Dewar questionnaires was used to evaluate the constructs of social-cognitive theory. The data were collected and analyzed using SPSS-20.

Results: The lifestyle intervention resulted in a weight loss of 1.92 and 1.08 kg in the telephone-assisted and web-assisted intervention groups, respectively. The intervention in the telephone-assisted group increased the mean scores of the constructs of self-efficacy ($P=0.001$), environment ($P=0.001$), outcome expectations ($P=0.040$), and outcome expectancies ($P=0.001$) among participants. In the web-assisted intervention group, the mean scores of the constructs of self-efficacy ($P=0.001$) and outcome expectancies ($P=0.020$) increased.

Conclusions: Our results showed the effectiveness of the intervention based on new communication technologies and the Social-Cognitive Theory. Future studies with more retention strategies regarding self-efficacy and environment constructs are needed to further explain the application of SCT and technology-based approaches to reduce obese and overweight.

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Introduction

Obesity and overweight are the most important public health challenges in the world today that have physical, mental, and social consequences. They increase the risk of diseases like the metabolic syndrome, cardio-vascular disease, respiratory disorders, diabetic retinopathy, and cancer. Moreover, they affect the quality of life, education, and income^{1,2}.

In 2014, more than 1.9 billion people aged 18 yr and above had overweight of whom 600 million were obese. Although overweight and obesity are health issues in high income countries, they are also increasing in low and middle income countries, as well³.

Obesity is a growing problem in Iran where the rate of overweight and obesity is 22 and 16% in the age group of 15-35 yr old^{4,5}. Obesity is increasing in clerks and employees due to their sedentary lifestyle. In a study in Iran, the rate of

overweight and obesity was estimated 45 and 14%, respectively⁶.

Evidence suggests that health-related behavioral interventions based on certain theories are much more effective than interventions that do not follow theoretical approaches^{7,8}. The social-cognitive theory (SCT) is one of these theories whose effectiveness in weight control has been confirmed⁹⁻¹². Accordingly, the behavior change results from the reciprocal determinism of environmental, personal, and behavioral factors¹³. Work settings provide a unique opportunity for disease prevention and health promotion interventions; however, time and location issues limit the level of the participation of the employees¹⁴. Interventions based on new communication technologies like the Short Message Service (SMS) and Internet, which are effective and convincing methods, can be used to overcome these limitations¹⁵.

This study was conducted to evaluate the effect of the intervention based on new communication technologies and the social cognitive theory on weight control in the governmental employees of Hamadan City, western Iran in 2014.

Methods

Type of the study

This randomized control trial was conducted over 1 year period from 1 January to 31 December 2014 in “telephone-assisted intervention”, “web-assisted intervention”, and “control” groups comprising 435 employees with overweight or obesity. Patients in the three groups received the brochures of weight control but the subjects in the control group did not receive education through new communication technologies.

Participants

The participants of the study were 435 governmental employees in Hamadan whose BMI (Body Mass Index) was above 25. The inclusion criteria were: 1) BMI $>25\text{kg/m}^2$, 2) working for at least 8 hours per week, 3) having computer and to be familiar with working with computer, 4) access to the telephone, cell phone, and the Internet and familiarity with working with these technologies, 5) age above 18 years. The exclusion criteria were pregnancy, depression, and other disorders leading to physical inactivity.

Recruitment

The participants were recruited between January and March 2014 through the inviting them to participate. After coordination with the directors of the offices, a brochure consisted of information about the study was distributed among the employees. In addition, a poster was placed on organizations board. For whom agreed to participate, the rationale for the study and details were explained through classmate. The participants were informed about: (a) inclusion and exclusion criteria; (b) the potential risks and benefits of participation; (c) ethical considerations of the study.

Calculation of the sample size

A primary study¹⁶ showed that about 35% of the study population had overweight and we expected to decrease it to 20% through the intervention. Therefore, the sample size was calculated 135 participants in each group with a confidence interval of 95% and a power of 80%. Since three groups each including 135 participants (a total of 405 subjects) were required to execute the intervention, the number of the participants in the intervention and control groups increased to 145 to prevent possible loss to follow-up.

Randomization

In order to prevent type 1 error, improve the power of trial and achieve balance among groups in terms of subjects' baseline characteristics (covariates), we used Stratified randomization. The type of organization and age of subjects were covariates. Based on the rate of physical activity in each organization¹⁷, we divided them to type: 1) Active organization (e.g., the road and city building organization) and 2) Passive organization (e.g., university). The participants were divided in two groups: 1) >50 yr old and 2)

<50 yr old. Stratified randomization achieved by generating a separate block for each combination of covariates, and subjects were assigned to the appropriate block of covariates. After all subjects were identified and assigned into blocks, simple randomization was performed within each block to assign subjects to one of the groups. A random numbers table was used for randomization; the numbers 1-3 were allocated to the first, 4-6 to the second, and 7-9 to the third group. The number zero was not considered.

The measurement of the outcomes

Weight: The participants' weight was measured using a digital scale (Trillion) to the nearest 0.1kg with minimal clothing without shoes. To determine the validity of the scale, a standard 5 kg weight (as control) was used after each 10 times of weight measurement.

Waist circumference: A measuring tape was used to measure the waist circumference to the nearest 0.1cm. The measurement was performed twice midway between the lowest rib and the iliac crest. The mean of two measurements was used for analysis.

Blood pressure

The blood pressure was measured with an aneroid sphygmomanometer (AGI-40, Microlife). The cuff was applied to the right arm that was rested on a flat surface. The measurement was performed twice with a 5-minute interval and the mean of two measurements was used for analysis.

The constructs of the social-cognitive theory

The characteristic of each scale is shown in Table 1. The constructs of the social-cognitive theory were evaluated through a researcher-made questionnaire based on the most recent valid and reliable studies. The questionnaires of Dishman (2010)¹⁸ and Dewar et al (2012)¹³ (with modifications) were used to evaluate the constructs of SCT in the two sections of physical activity and nutrition. First, the questionnaire was forward and backward translated by a panel of researchers. The panel of experts included: a specialist in English, six experts in health education and health promotion and one in Biostatistics. The experts were requested to evaluate the questionnaire in terms of face validity, clarity, readability, and relevance. Cronbach's alpha and test-retest were used to assess internal and external reliability, respectively. The questionnaire was completed twice by 20 employees with a one-week interval and reliability coefficients were calculated 94%.

Scales in these questionnaires were: 1) self-efficacy, 2) intention 3) situation 4) social support 5) behavioral strategy, 6) outcome expectations, 7) outcome expectancies.

Lifestyle program

The program was an adapted version of previous work of health partners in Minnesota, USA¹⁹ and ALIFE @ work in The Netherlands^{14,34}. Based on principles of SCT, it comprised 10 modules (lessons) that provided the participants with information on the nutrition and physical activity. In SCT, human behavior is explained in two-way and dynamic interactions of personal, environmental, and behavioral factors. Regarding the formative research²¹, many of the employees were obese or had overweight and had eaten unhealthy foods (personal factor); in their organizations and home, there were no supportive environment

(environment) and their behaviors must be changed (behaviors) by the use of examples and activities from evidence based diet and physical activity interventions^{14,19,22,34} and SCT principles, modals designed. These modals provided information on nutrition and physical activity and taught healthy cooking and exercise skills (behavioral capability). Participants learnt how to eat a healthy diet so that exercising would benefit them

(expectations). Health advisors created contracts with participants, setting incremental goals (self-efficacy). According to the group, telephone or email consultations were provided at the end of every two weeks (between the assignments). Respected members served as role models (observational learning). Participants received two books as incentives, and were taught to reward themselves by making time to relax (reinforcement).

Table 1: The characteristics of social-cognitive theory constructs in modified questionnaires, change strategies and Cronbach's alpha coefficient (α)

| Scale | Number of item | | Type of Likert scale | Scoring | Change Strategies | α |
|----------------------|------------------|------------------|----------------------|---------|--|----------|
| | Original version | Modified version | | | | |
| Self-efficacy | 9 | 7 | Six-point | 1=6 | Approach behavior change in small steps to ensure success; be specific about the desired change monitoring and reinforcement | 79.0% |
| Intention | 5 | 5 | Four-point | 1=4 | Promote self-initiated rewards and incentives | 72.4% |
| Situation | 6 | 4 | Six-point | 1=6 | making adjustments to the environment | 76.0% |
| Social support | 7 | 5 | Five-point | 1=5 | Making healthy policy in organizations promotes available of healthy diet and exercising at home | 73.0% |
| Behavioral strategy | 6 | 6 | Five-point | 1=5 | Promote mastery learning through skills training | 71.0% |
| Outcome expectations | 5 | 5 | Six-point | 1=6 | Model positive outcomes of healthful behavior learn how eating a healthy diet and exercising will benefit them | 85.0% |
| Outcome expectancies | 5 | 5 | Four-point | 1=4 | Learn about importance of healthy diet and exercising | 85.0% |

The assignments included educational content mixed with behavior change strategies (for example, Encouragement and Split off desired behavior were used to increase self-efficacy). The assignments taught the participants how to use the strategies in their daily lives. Subjects in the telephone-assisted and web- assisted groups received the lessons via the SMS and web, respectively. According to the group, telephone or email consultations were provided at the end of every two weeks (between the assignments). The intervention was continued for 6 months. All groups including the control group received general brochures about lifestyle and overweight although they did not receive the lifestyle program.

Internet intervention

We designed a web site for the intervention. This web site was called "healthy employee". Unique username and password was assigned for each participants and intervention started when the employees received a welcome e-mail. The employee was asked to fill out some personal details for the counselor. The employee then started with the first module. The web site provided information about healthy nutrition and PA skills.

Phone intervention

A cell phone line was developed for the intervention. The intervention started when the counselor first called the participant about two week after randomization. In this first contact the counselor explained the goals of the "life style program". The content of modules was based on WHO recommendations and evidence-based diet and physical activity interventions. During two contacts, the employees studied the module and filled out the assignments. SMS messages were sent every two week.

Data Analysis

Data were analyzed with SPSS-20 (Chicago, IL, USA) using descriptive and analytical statistics. Frequencies,

percentage, mean standard deviation were used to describe demographic characteristics. The main statistical tests used in the study were linear regression, Repeated Measure and two-way ANOVA. P value <0.05 considered as significant.

Ethical Considerations

Ethics committee approval was obtained from the Ethics Committee of Tehran University of Medical Science (Ethics Committee Code: 93/D/130/1139). Informed consent was obtained prior to study enrollment

Results

The screening questionnaire was returned by 1200 employees who were eligible to take part in the study. At base line 765 employees were excluded for not meeting inclusion criteria, and 435 employees were randomized. The participant flow is depicted in Figure 1.

Between base line and nine month after intervention up 34 subjects withdrew from the study. Most employees withdrew because of personal reasons and lack of time. Two participants withdrew due to musculoskeletal disorders and one withdrew because of pregnancy. The logistic regression analysis showed no differences between droppers and stayers ($P>0.05$).

The majority of the participants in all three groups were women (71.3%) with a bachelor's degree, an age range of 42 yr, and 16-18 yr of work experience. The baseline demographic characteristics of the participants are presented in Table 2.

Linear regression analysis (Table 3) showed that among the constructs of the social-cognitive theory, environment and self-efficacy were the strongest predictors of weight control. They explained 24.2% variance in the research unit ($R_{\text{Square}}=0.242, P=0.001$).

Table 2: Baseline demographic characteristics of the participants

| Group variable | Control group | Web-assisted group | Telephone- assisted group |
|-------------------------------|----------------|--------------------|---------------------------|
| Female gender (%) | 64.4% | 72.2% | 78.6% |
| Age (SD) | 42.20 (7.80) | 42.49 (7.28) | 41.08 (7.15) |
| Bachelor's degree and higher | 46.1% | 58.7% | 55.7% |
| Experience (SD) | 18.87 (7.72) | 17.82 (8.35) | 16.89 (8.17) |
| Waist circumference (SD) | 95.97 (10.83) | 92.37 (9.02) | 94.07 (12.86) |
| Systolic blood pressure (SD) | 112.58 (14.28) | 112.74 (17.31) | 115.49 (15.18) |
| Diastolic blood pressure (SD) | 74.07 (9.53) | 78.24 (10.67) | 77.04 (11.62) |

Table 3: Summary of regression analysis for social-cognitive theory constructs as the predictors of behavior (weight control)

| Variables | β | SE | Beta | t | P value |
|---------------|---------|-------|-------|-------|---------|
| Self-efficacy | 0.231 | 0.175 | 0.137 | 1.320 | 0.010 |
| Environment | 1.096 | 0.436 | 0.261 | 2.514 | 0.014 |

The lifestyle intervention resulted in a weight loss of 1.92 and 1.08 kg in the telephone-assisted and web-assisted intervention groups, respectively (Table 4).

Table 4: Comparison of the weight changes in the evaluated employees in the baseline and 6 and 9 months after the intervention

| Group time | Telephone-assisted | | Web-assisted | | Control | | P value |
|-------------|--------------------|-------|--------------|-------|---------|-------|---------|
| | Mean | SD | Mean | SD | Mean | SD | |
| Baseline | 83.01 | 13.14 | 79.44 | 11.26 | 78.63 | 11.60 | 0.060 |
| Follow-up | 81.09 | 12.97 | 78.36 | 10.23 | 78.67 | 10.48 | 0.001 |
| Maintenance | 82.02 | 13.01 | 78.04 | 11.06 | 78.83 | 10.53 | 0.001 |
| P value | 0.001 | | 0.001 | | 0.170 | | |

In addition, the interactive effect of time and group was also significant ($P=0.030$); in other words, a significant difference was observed in weight loss among the groups in the course of time.

Table 5: Mean and standard deviation (SD) for social-cognitive theory constructs in telephone assisted group (PA section)

| Variables | Baseline | | Follow-up | | Maintenance | | F | P value |
|----------------------|----------|------|-----------|------|-------------|------|-------|---------|
| | Mean | SD | Mean | SD | Mean | SD | | |
| Self-efficacy | 22.73 | 4.47 | 26.30 | 3.97 | 24.73 | 3.88 | 15.60 | 0.001 |
| Environment | 14.30 | 4.56 | 15.96 | 3.66 | 17.62 | 3.82 | 18.64 | 0.001 |
| Outcome expectations | 20.29 | 3.99 | 23.32 | 2.45 | 19.44 | 2.67 | 12.72 | 0.040 |
| Outcome expectancies | 21.85 | 3.73 | 25.83 | 2.50 | 21.88 | 2.60 | 4.72 | 0.001 |

In the section of physical activity in the web- assisted group, the mean scores of outcome expectancies increased from 22.70 (± 2.61) to 26.36 (± 2.14) at follow-up period and 21.69 (2.29) at maintenance phases, respectively ($P=0.02$). The Repeated Measure ANOVAs showed that difference was meaningful.

In the section of nutrition in both the telephone- assisted and web- assisted group, the mean score of outcome expectancies increased ($P=0.001$).

The mean scores of nutrition self-efficacy in the telephone- assisted group, increased from 28.18 (± 4.74) to 35.29 (± 4.46) at follow-up period and 30.17 (4.70) at maintenance phase, respectively ($P=0.001$).

Discussion

In the present study, education through the SMS resulted in weight loss in the participants. The difference was significant in the three time points. The weight loss was also stable in the maintenance phase. This finding is in line with van Wier et al.¹⁴. In a study, the weight of the participants showed a decrease in middle time and the subjects in the intervention group experienced a weight loss of about 1.6 kg²³. In another study, 86% of the participants that received text

The lifestyle program did not change the participants' blood pressure and waist circumference significantly ($P>0.05$). However, telephone- assisted and web- assisted interventions resulted in changes in the scores of a number of SCT constructs as follows:

In the section of physical activity in the telephone assisted group: 1) self-efficacy, 2) environment, 3) outcome expectations, and 4) outcome expectancies.

The mean scores of self-efficacy increased from 22.73 (± 4.47) to 26.3 (± 3.97) at first follow-up period. This increasing sustained in maintenance phase. The Repeated Measure ANOVA (RM ANOVA) showed that differences is meaningful ($P=0.001$).

The mean scores of environment increased from 14.3 (± 4.56) to 15.96 (± 3.66) at follow-up period and 17.62 (3.82) at maintenance e phases, respectively. The Repeated Measure ANOVAs showed that difference was meaningful. The changes of other constructs are shown in Table 5.

messages on the cell phone responded to the text message and 80% stated that they recommended the program to their friends. The SMS group gained 6 pounds less during pregnancy on average²⁴. Moreover, participants in the telephone-assisted intervention lost more weight than subjects in the web-assisted group¹⁴. In Iranian female employees, a difference of about 1.5 kg in weight reduction was reported in participants in the intervention group compared with the subjects in the control group three months after the intervention²⁵. In South Korea, participants in the telephone-assisted intervention group lost about 1.6 kg of weight during 8 weeks²⁶. In another study, a weight loss of 3 kg twelve weeks after the intervention was reported²⁷.

Websites are effective tools to present behavior change programs. The low costs and availability are the advantages of the use of the Internet in health promotion²⁸. Convenience, attractiveness, flexibility, and individual tailoring are the advantages of interactive health communication¹⁵.

In this study, web-assisted intervention resulted in weight loss, which is similar to previous study¹⁴. However, the amount of weight loss in web-assisted intervention was less than telephone-assisted intervention. The reasons could be the availability of the telephone text messages and the time-

consuming nature of and sometimes lack of access to the Internet. In a study by Dennis et al.⁹, the participants stated that online sessions were time consuming. In this study, no weight change was observed²⁹. In another study, the weight reduced by 2 kg²⁶.

In a study, a six-month intervention resulted in weight loss. The predictors of weight loss in this study were increased self-efficacy, self-regulation, social protection in nutrition, and outcome expectations in nutrition³⁰ while self-efficacy and environment were the strongest predictors of weight loss in our study.

Web-assisted intervention resulted in a weight loss of 5.5 kg in the third month and 5.6 kg in the sixth month when compared with other groups³¹. In this study, the participants in the Internet Behavioral Intervention (IBI) group had more tendency toward 5% weight loss in the third and sixth months than the subjects in the Internet Delivered Eating and Activity (IDEA) group and used weight loss strategies more often. The amount of weight loss was less in the web-assisted intervention group versus the behavior therapy group³².

Participation in consultation sessions can be considered, as determinant of adherence. Therefore, weight loss and physical activity should be more in the adherent individuals. From the viewpoint of the participants, a weight loss of about 2 kg in the telephone-assisted and 1.08 kg in the web-assisted group was not what they expected. However, small change in a large population can have huge impacts on public health^{14, 34}.

The more weight loss in the study by Tate³² and others could be due to their advice to maximum adherence to the daily diet while we put emphasis on the healthy diet. In the study by van Wier et al.¹⁴, the number of telephone consultation was more than our study. This finding is in line with the results of a study by Shaw et al.³³ indicating that more telephone consultations may result in more weight loss. However, increasing the number of consultation sessions may increase the costs of the program. In our study, we could not increase the number of consultation sessions due to time and budget limitations. Future studies may focus on the cost-effectiveness of increasing the number of consultation sessions.

In our study, the lifestyle program did not result in significant changes in the blood pressure and waist circumference of the participants while the intervention conducted by van Wier et al.¹⁴ resulted in 1.9 cmHg reduction in the telephone-assisted and 1.2 cmHg in the web-assisted groups¹⁴. The reduction in waist circumference was even more in the study by Tate³², which could be due to more weight loss. Both the blood pressure and waist circumference decreased in other studies^{26,27}. The scores of some SCT constructs increased in our study. The changes of scores of the SCT constructs are very different in various studies⁸⁻¹² that could be due to the educational method, intervention duration, composition of the methods, individual-social characteristics of the participants, the exposure of the participants, measurement tools, and the type of study. A systematic review of the above-mentioned studies and their qualitative evaluation should be considered in future investigations.

The potential limitations of the study are as follows: (a) Follow-up was not possible in about 8% of the participants.

This limitation has been reported in other studies with greater magnitudes^{14,34}. (b) There were too many questions to evaluate the SCT constructs which tired the participants and made the questionnaire even more unacceptable. (c) The study population may not represent all the employees (since more than 70% of them were female, and more than 45% of them had a bachelor's degree or higher), which could be due to the higher prevalence of overweight and obesity in women than men or the implemented inclusion criteria like access to the Internet and ability to use it. On the other hand, educated people are more interested in their health than other people. It is usually difficult to engage disadvantaged individuals in health promotion interventions. Future interventions could focus on the engagement of the people with lower education who are less at risk. (d) Evaluation of the SCT constructs was based on self-reporting. Self-reporting may increase the odds of social desirable bias. The strong points of this study included the objective measurement of weight, blood pressure, and waist circumference, extensive inclusion criteria, a large sample size, and theory-based intervention for work settings.

Conclusions

Our results showed that the effectiveness of the intervention based on new communication technologies and the Social-Cognitive Theory. Future studies with more retention strategies regarding self-efficacy and environment constructs are needed to further explain the application of SCT and technology-based approaches to reduce obese and overweight. Since, the changes of scores of the SCT constructs have been reported very different in various studies, a systematic review of these studies and their qualitative evaluation should be considered in future investigations.

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Conflict of interest statement

The authors declare that they have no conflict of interest.

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