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Military Psychology

ISSN: 0899-5605 (Print) 1532-7876 (Online) Journal homepage: http://www.tandfonline.com/loi/hmlp20

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To cite this article: Hormoz Sanaeinasab, Mohsen Saffari, Seyed Hassan Sajedi, Mojtaba Sepandi, Saad Al Shohaib & Harold G. Koenig (2018): The effect of a psycho-educational intervention on weight management in obese military personnel, Military Psychology, DOI: 10.1080/08995605.2018.1522926

To link to this article: https://doi.org/10.1080/08995605.2018.1522926

Published online: 16 Oct 2018.

MILITARY PSYCHOLOGY
https://doi.org/10.1080/08995605.2018.1522926

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The effect of a psycho-educational intervention on weight management in obese military personnel

Hormoz Sanaeinasab[a], Mohsen Saffari [a,b], Seyed Hassan Sajedi[b], Mojtaba Sepandi[a,c], Saad Al Shohaib[d], and Harold G. Koenig [e]

[a]Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran; [b]Health Education Department, Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran; [c]Department of Epidemiology and Biostatistics, Baqiyatallah University of Medical Sciences, Tehran, Iran; [d]Department of Medicine, Nephrology Division, Director, Renal Dialysis Unit, King Abdulaziz University, Jeddah, Saudi Arabia; [e]Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, North Carolina; King Abdulaziz University, Jeddah, Saudi Arabia; and Ningxia Medical University, Yinchuan, China

ABSTRACT

Obesity is a serious health problem for many population groups, including military personnel. Model-based health education programs have been shown to be effective in reducing weight. This study assessed the efficacy of an educational intervention based on a trans-theoretical model (TTM) targeting weight loss among active duty military. A single group experimental study using a before-after design was conducted in 49 military personnel with obesity. Constructs such as self-efficacy, decisional balance, stages of change, and processes of change as well as anthropometric measures including weight, waist circumference, and body mass index (BMI) were assessed at three times (baseline, 2 months after the intervention, and 4 months later). The intervention consisted of 10 educational sessions developed based on TTM constructs. At baseline, 30 (61%) and 19 (39%) persons were in the pre-action and action stages, respectively. By 2 months after the intervention, only 24 persons (49%) were in pre-action stages and 25 (51%) were in the action stages. Four months later, one (2%) and 43 (88%) were in pre-action and action stages. The mean changes in self-efficacy (25.7 ± 4.1 to 29.3 ± 2.4), decisional balance (9.2 ± 3.6 to 13.8 ± 1.9), total cognitive (74.7 ± 8.5 to 84.7 ± 6.3), and total behavioral change (60.8 ± 9.8 to 71.7 ± 7.8) were significantly different across the three time points. Reductions in weight (99.8 ± 10.4 to 93.0 ± 9.6), waist circumference (105.9 ± 14.2 to 100.2 ± 13.0), and BMI (32.5 ± 5.2 to 30.3 ± 4.5) from baseline to 4 months after the intervention were also significant ($p < 0.05$). An educational program based on TTM may be effective in reducing weight among obese military staff.

ARTICLE HISTORY
Received 29 November 2017
Accepted 6 September 2018

KEYWORDS
Trans-theoretical model; weight loss; health education; military; obesity

What is the public significance of this article?—The findings of the current study suggest that using an education program based on trans-theoretical model may be effective for weight management among military personnel. So, the policy makers in military affairs and health professionals who work in military settings may consider application of the model to educate military personnel regarding weight reduction.

Introduction

Obesity is a world-wide chronic health problem and is defined11 as an accumulation of excessive fat in the body that may have adverse health consequences. Those with a body mass index (BMI) equal to or higher than 30 are considered obese (World Health Organization, 2018). It is estimated that more than 500 million adults worldwide suffer from obesity (Morgen & Sorensen, 2014). This condition is found in every age group, from children to adults to the elderly. However, those in certain professions may be at particular risk due to the nature of their work. Obesity is especially problematic when their work requires physical fitness and readiness for prompt action. For those in the military, a fit body and normal weight is very important. Studies show that between one-third and one-half of military forces in different countries are overweight or obese (Bin Horaib et al., 2013; Eilerman et al., 2014; Payab et al., 2017). Of particular concern is that many of these individuals had a normal weight at the time of recruitment, but they gained excessive weight during the course of their military service (Payab et al., 2017). Thus, better understanding ways to prevent obesity during military service and to reverse it need further investigation. Speculation has been that weight gain may be related to psychological processes and emotional distresses that military people experience during their

CONTACT Mohsen Saffari m.saffari@bmsu.ac.ir; m.saffari@bmsu.ac.ir Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences Tehran, Iran; and, Health Education Department, Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran.

training (Berkel et al., 2005). However, there is evidence that sufficient emphasis may not have been placed on the importance of maintaining fitness throughout their time in the military (Williamson et al., 2009). Thus, the current programs that focus on weight control and fitness may not be adequate, and given the rate of obesity among military personnel, it is urgent that new approaches be developed and tested to address this issue.

Causes and health-threatening complications of obesity in general population may be similar to those in military personnel. Because of changes in lifestyle, urbanization, modernization, and social development, a nutritional transition has occurred throughout societies. The consumption of fatty, carbohydrate-rich foods, together with a lack of exercise, has led to a significant increase in obesity (Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006). Obesity, in turn, has been associated with an increased risk of Type 2 diabetes, ischemic heart disease, certain cancers, hypertension, atherosclerosis, and a host of other chronic disorders (Segula, 2014). A high BMI has been associated with increased mortality (Yang et al., 2016). In fact, among those whose BMI is higher than 30, mortality is two times greater than in those with normal weight (Martin & Martin, 2015). Many studies have reported a linear relationship between BMI and risk of death among persons with cardiovascular disease or diabetes (Kaur, Johnston, & Godsland, 2016; Leong, Porneala, Dupuis, Florez, & Meigs, 2016). In addition, sleep problems such as sleep apnea are common among obese people and may further increase their risk of early mortality (Li et al., 2010).

Unfortunately, a considerable proportion of Iranian military personnel experience problems with obesity, similar to armed forces in other countries (Payab et al., 2017). Although developed countries such as United States, Britain, France, and Germany have reported the obesity prevalence between 14% and 31% among military personnel (Bauduceau et al., 2005; Eilerman et al., 2014; Kalff, Maya-Pelzer, Andexer, & Deuber, 1999; Sundin, Fear, Wessely, & Rona, 2011), the problem may be even more common in the Middle East because the lifestyle of the population, also reflected among military people in this region, is quite different when compared to developed countries. Fatty food and high caloric drink consumption in this region of the world is greater than global norms (Hwalla, 2013). In a recent study from Saudi Arabia, nearly one third of military personnel nationwide were found to be obese (Bin Horaib et al., 2013). Studies in Iran likewise indicate that between 20% and 30% of Iranian military forces are overweight or obese (Payab et al., 2017). Given that the military forces of a country may constitute a significant proportion of the population, obesity may affect their readiness for military action, their effectiveness during combat, and ultimately threaten national security. Addressing the problem of overweight active duty military personnel, then, becomes imperative to both protect the country and reduce the financial costs of maintaining a fit and ready military force.

One of the most common ways to reduce the risks of being overweight is to prevent it by health education programs (Saffari, Pakpour, Mohammadi-Zeidi, Samadi, & Chen, 2014). Educational interventions can both motivate and provide instructions on exercise, nutrition issues, and health behaviors designed to control weight and ultimately improve the health of such individuals. Designing effective educational interventions based on psychological and behavioral principles is crucial to the success of such programs (Saffari, Shojaeizadeh, Ghofranipour, Heydarnia, & Pakpour, 2012).

The trans-theoretical model (TTM) includes components such as stages of change, self-efficacy, decisional balance, and processes of change (POC) that each address a particular dimension of change. The stages of change describe at what point a person decides to change his or her behavior. Individuals tend to change their behavior in five steps: precontemplation, contemplation, preparation, action, and maintenance. People who are in the precontemplation stage have no intention of changing their behaviors in the near future (i.e., within next 6 months). In the contemplation stage, individuals are thinking about taking action during the next 6 months, whereas in the preparation stage they see themselves as ready to change their behavior in the next month. In the action stage, individuals have started to change their behavior within the last 6 months and have decided to keep at it. When the action stage is sustained for more than 6 months, this is considered the maintenance stage. The factor of time plays an important role in the stages of change. Individuals at different stages of change can be differentiated and shifts between these stages can be observed. This enables educators to categorize individuals based on the particular stage they are in and provide tailored educational interventions that meet their specific needs at that stage (Glanz, Rimer, & Viswanath, 2008).

Self-efficacy is a measure of a person's beliefs about their ability to get things done. It depends on the situation and environment. As defined by Bandura, self-efficacy may help to explain and predict changes in human behavior. This construct indicates the degree of confidence that an individual has to begin and sustain the change when faced with situations that tempt the individual toward relapse (Bandura, 1995). Decisional balance is an individual's perception of the

benefits and barriers to behavioral change based on the Janis and Mann's conflict model of decision making. This model focuses on the importance of weighing pros and cons when deciding about behavior change. An individual will not change his/her behavior unless the perceived pros are more than he perceived cons (Glanz et al., 2008). When there is progression in the stages of change, the balance between pros and cons begins to change. Studies have shown that with progress through the stages of change, perceived pros increase and perceived cons decrease, whereas in the contemplation stage there is a relative balance between pros and cons (Dijkstra, de Vries, & Bakker, 1996; Horiuchi, Tsuda, Kobayashi, Fallon, & Sakano, 2017). In the precontemplation stage, perceived cons are more important than pros, and in the action and maintenance stages vice versa (Saffari et al., 2012). The change processes are part of a TTM that enables one to understand how behavior changes. Change processes including overt and covert activities and experiences that are used in behavior modification. Studies have shown that at each stage of change, specific processes are operative (Sharma & Romas, 2012). The model consists of 10 change processes divided into cognitive and behavioral categories. Consciousness raising, dramatic relief, environmental reevaluation, self-reevaluation, and social liberation are cognitive processes, whereas behavioral processes include self-liberation, counter conditioning, helping relationships, reinforcement management, and stimulus control. Cognitive processes are engaged in the early stages of change, whereas behavioral processes are implemented in the final stages (Shumaker, Ockene, & Riekert, 2009).

Regarding the consequences of obesity, the importance of weight control programs, and plans to prevent obesity among military people, it is necessary test the efficacy of new educational programs based on solid underlying theory. Therefore, the current study aimed to evaluate the efficacy of a TTM-based educational intervention to control obesity among military personnel.

Methods

Design and sample

This was a single group quasi-experimental study where participants were assessed at baseline (T1), 2 months following the intervention (T2), and 4 months later (T3). Participants were recruited from a military base located in Tehran, Iran. Inclusion criteria were (a) active duty military, (b) body mass index (BMI) of 30 or higher (obese); (c) no limitations in ability to perform physical activities; (d) not taking medication for the treatment of obesity; and (e) available for at least 6 months during the implementation of the study. The study was conducted during summer and autumn of 2015. Sample size was determined using the formula suggested by Rosner for a single group experimental study (Rosner, 2011). The parameters for calculating sample size were α (two-tailed) = 0.05, β = 0.2, effect size = 0.4, and S (Δ) = 1.0. Based on these power calculations, 49 participants were sufficient. A total of 55 military personnel were approached for inclusion in the study; of those, 89% agreed to participate (n = 49). The intervention was announced by fliers on the notice boards, along with conducting a review of medical records to identify obese individuals who were then contacted and encouraged to participate. No financial or other incentive was provided other than informing participants about the potential benefits of the program to manage weight and improve fitness. In addition, the military commanders released participants from their military duties to engage in the educational sessions. Participation was voluntarily and all who agreed were fully informed of the details of the study prior to data collection. All participants provided written informed consent and the study was approved by the ethics committee of the Baqiyatallah University of Medical Sciences.

Measures

Demographic and anthropometric information

Demographic, military, and physical health characteristics assessed included age, sex, education, marital status, employment duration, work type, military rank, time spent in moderate to vigorous weekly physical activity (jogging, running, football, volleyball, etc.), and physical comorbidity (hypertension, diabetes, arthritis, etc.). Anthropometric measurements included height, weight, waist circumference, calculated BMI, and blood pressure assessed by a trained research aide.

TTM questionnaire

This questionnaire consisted of four main subscales:

(1) Stages of change were assessed using a five-item scale adapted from Sanaeinasab et al (Sanaeinasab, Saffari, Nazeri, Karimi Zarchi, & Cardinal, 2013) to assess stages of readiness for change: (a) Have you thought about a weight reduction program? If no, the subject is placed in the pre-contemplation stage. If the answer yes, the participant is asked four additional questions: (b) Do you intend to engage in a weight reduction program in the next

6 months? (contemplation), (c) Do you intend to engage in a weight reduction program in the next month? (preparation), (d) Do you currently engage in a weight reduction program? (action), and (e) Have you been engaged in a weight reduction program during the past six months? (maintenance). A "yes" answer to any of these four questions (2 to 5) indicates the stage that the participant belongs to. This scale is recognized as valid and reliable for measuring stages of change. We further investigated scale psychometrics by conducting 10-day test-retest reliability among 15 military personnel who did not participate in the study and found that the measure had good stability over time (intraclass coefficient = 0.93, confidence interval [CI]: 0.82-0.97).

(2) Self-efficacy was assessed by an eight-item scale. The items examine the perceived ability of the respondent to engage in the activities necessary to reduce weight. For example, "I can set a regular physical activity program and nutritional regimen to reduce my weight" and "I can choose suitable food products that will help me reduce my weight." Each item is rated on a 5-point Likert scale from 0 (*disagree*) to 4 (*agree*). Total scores range from 0 to 32, with higher scores indicate greater self-efficacy. The content validity ratio (CVR) and content validity index (CVI) for this scale developed for the study were 0.81 and 0.79 (10 panelists), respectively. The scale also has solid internal consistency (Cronbach's $\alpha = 0.87$).

(3) Decisional balance assesses the pros and cons of behavior change. The pros include the benefits of changing behavior that may motivate the person toward change and the cons contain barriers that may reduce motivation towards change. The 4-item scale measuring this construct includes four items that primarily are stated in a way that indicates "con" responses when the participant agrees: (a) participation in a weight reduction program is time consuming, (b) engagement in a weight reduction program needs financial resources, (c) my family may not support me when engaging in a weight reduction program, and (d) if I participate in a weight reduction program, it may hurt my job status and bring about worksite problems for me. Again, each item is rated on a 5-point Likert scale from 0 (*agree*) to 4 (*disagree*), with a total score ranging from 0 to 16. This scale had a CVR = 0.79 and a CVI = 0.83, and demonstrated good reliability (Cronbach's $\alpha = 0.81$).

(4) Processes of change were measured using a scale that assessed both cognitive and behavioral processes. In the cognitive section, assessed were processes such as consciousness raising (four items), self-reevaluation (five items), environmental reevaluation (three items), emotional arousal (five items), and social liberation (seven items). In the behavioral section, processes such as self-liberation (five items), counter-conditioning (three items), stimulus control (five items), reinforcement management (four items), and helping relationships (four items) were assessed. Each of the 45 items on this scale are rated on a 5-point Likert scale from 0 (*completely disagree*) to 4 (*completely agree*). The total score ranges between 0 and 180, with higher scores indicate greater involvement in the change processes. The Cronbach's alpha for the scale was 0.84, and for its subscales, the alpha ranges from 0.73 to 0.95 indicating acceptable internal consistency. The content validity of the scale was also high with CVR = 0.81 and CVI = 0.85 based on a poll of 10 experts.

Intervention

After the baseline assessment, subjects were categorized into two categories: (a) inactive (passive) participants who were in the pre-contemplation, contemplation and preparation stages, and (b) active participants in the stages of action and maintenance. The educational intervention consisted of ten 1-hr sessions conducted over 3 weeks. This involved group discussion, role playing, role modeling, self-contract, and interactive lecture methods. To increase self-consciousness, two training sessions focused on obesity and ways to control it using lecture and group discussions, and at the end of the second session participants were given a pamphlet that summarized the information that was presented. In the third and fourth training sessions, both the active and passive participants interacted together as they learned about impact stimulus control, helping relationships, and self-reevaluation. In these sessions, those who were active expressed their experiences and reasons for adopting healthy behaviors. The experiences of inactive participants in the past 2 months regarding their diet and physical activity were also discussed. In the next session, role playing was done to demonstrate emotional arousal and environmental reevaluation. In this session, a scenario was presented regarding benefits of having a normal weight, including its impact on the person's life and living conditions.

The sixth session was dedicated to teaching participants how to replace their unhealthy behaviors with healthy ones. This was conducted using a desensitization technique to

reduce sensitivity of participants toward performing new behaviors by counter-conditioning. To improve reinforcement and self-liberation, a self-contract template was presented to participants at seventh session, which explained how to use this template to improve healthy behaviors such as physical activity and healthy eating. The next session involved a focus group discussion to address social liberation and social achievements that might be possible when the participant achieved a healthy weight. This session included a description of the types of social support that participants might receive that could empower themselves. Self-efficacy was addressed in the ninth session when a short documentary film was shown about life of well-known role models in society and how they planned on being healthy. Participants were then asked to discuss the film among themselves. Several practical solutions were also provided to participants on how to break bad habits and form healthier ones. In the tenth and last session, participants were asked to discuss the pros and cons of the behavior change as they sought to achieve a normal weight. By the use of brain storming, possible strategies to overcome the cons and improve the pros were discussed. A 5-min summary and conclusion was provided at the end of each session. Finally, information on how to contact the researchers was provided for any questions or if there was a need for guidance concerning the practice of healthy behaviors encouraged during the education program. A description of each session of the intervention is provided in Table 1.

Data analysis

SPSS software version 20 for windows (IBM Statistics) was used to analyze the data. Categorical variables were described using number and percentages, and central tendency indices such as mean and standard deviation were provided for continuous variables. The Student's *t* test was used to assess changes in values of continuous measures between assessment points. Repeated measures analysis of variance was used to test for changes in continuous variables across the three time points from baseline to 2 months after intervention to 4 months after intervention. The normality of the data was assessed using Kolmogorov-Smirnov test and homoscedasticity was examined by the Leven test. Mauchly's test of sphericity was performed to assess the equality of variances of the differences between pairs for within-subject effects. Any change in measures during the stages of change was evaluated by the Friedman test. The sample was further categorized into the pre-action stages (precontemplation, contemplation, and preparation) and the action stages (action and maintenance) and changes between these two categories were assessed by Cochran Q test. An alpha of 0.05 was set for statistical significance, and the Bonferroni correction was used to adjust the confidence interval for multiple comparisons.

Results

All participants were male and married. The mean age of participants was 34.6 (*SD* = 4.4) years and about half (53%) had high school or lower education. The length of military service on average was 9.3 (*SD* = 3.6) years and more than two thirds were "enlisted" in terms of military rank. Only a quarter of the sample were combat specialists and majority (78%) were healthy without any medical comorbidities. The BMI at baseline was

Table 1. Content of educational intervention by session.

Session	Content
1	Provide definition of overweight and obesity, and present statistics about prevalence and incidence of obesity in the world and in Iran especially in military personnel; stress importance of normal weight in military personnel
2	Describe weight management techniques including healthy diet and physical activity; provide dietary recommendations on how to use the food pyramid to decide on suitable food servings: use of fiber and vegetables, how choose low fat foods, plate size, consumption of soups to maximize sense of fullness, etc. Also provide guidelines on frequency and types of physical activities needed to reduce weight, importance of aerobic sports for fitness, and time management to develop a daily physical activity plan
3	Provide principles of controlling unhealthy behaviors and engagement in supportive relationships to create an overall healthy lifestyle
4	Encourage use of imagination to assess self-concept, pattern healthy role models, express experiences regarding weight control, and dealing with failure
5	Describe the emotions and feelings regarding obesity problems, stress the importance of fitness to relieve negative emotions and feelings related to obesity and improve self-image, discuss how to set family environment goals to develop emphatic relationships, and summarize benefits of maintaining a healthy weight
6	Describe how to replace unhealthy behaviors with healthy ones, using the technique of desensitization to approach new health behaviors
7	Discuss self-contract, describe applications of self-contracts, and describe how to use self-contracts to achieve behavior change; encourage self-rewards when conducting healthy behaviors
8	Discuss how to change behavior and commit to this change over the long haul; describe how to make a list of socially approved alternatives for unhealthy behaviors related to obesity, and use social support to overcome potential barriers of behavior change
9	Define the concept of self-efficacy, describe how to learn self-efficacy from successful role models, discuss how to break bad habits and replace with healthy ones
10	Describe pros and cons of behavior change to reach a normal weight and strategies to overcome barriers to change and identify factors that may improve behavior change

32.5 (SD = 5.2) and blood pressure was 129/81 mmHg on average. A full description of participants' baseline characteristics is provided in the Table 2.

The distribution of the sample across the five stages of change is presented in Table 3 across the three assessment times. There was a significant movement ($p < 0.001$) from pre-action stages toward action stages from first to last assessments (i.e., Time 1 [T1] to Time 3 [T3]).

There were also changes in weight, waist circumference, and BMI across the three assessment times as indicated in Table 4. All of these showed promising changes from baseline to the last assessment. However, the change for individual components of the process of change construct such as emotional arousal, environmental reevaluation, social liberation, self-liberation, helping relationships, reinforcement management, and counter conditioning was not significant from baseline to the 2-month follow-up ($p > 0.05$). By the 4-month follow-up, these components showed significant change from the 2-month to 4-month follow-up ($p < 0.01$). For some components of the process of change construct, such as self-reevaluation and stimulus control, there were only substantial changes noted from baseline to the 4-month follow-up ($p < 0.001$). Despite these non-uniform changes across these different aspects of the POC, both total scores on the cognitive and behavioral sections of the construct showed a steady increasing improvement across all three time points.

Although, as shown in Table 4, weight between baseline and 4-month follow-up, and between 2-month follow-up and 4-month follow-up, decreased significantly ($p < 0.05$), other anthropometric measures (i.e., waist circumference and BMI) only decreased significantly between baseline and 4-month follow-up. There was no considerable change between baseline and 2-month follow-up for these measures.

Table 2. Sample characteristics.

Variables	*n* (%)/*M*(*SD*)
Age	
< 35	31 (63.2%)
≥ 35	18 (36.8%)
Education	
High school or lower	26 (53.0%)
University	23 (47.0%)
Employment duration (years)	
< 10	35 (71.4%)
≥ 10	14 (28.6%)
Military rank	
Officer	10 (20.4%)
Enlisted	39 (79.6%)
Work type	
Combat specialist	12 (24.5%)
Others	37 (75.5%)
Physical activity (hours per week)	
< 2	31 (63.2%)
≥ 2	18 (36.8%)
Comorbidity	
Yes	11 (22.4%)
No	38 (77.6%)
Height (cm)	175.2 (12.3)
Weight (kg)	99.8 (24.7)
Waist circumference (cm)	105.8 (15.4)
Body mass index (kg/m2)	32.5 (5.2)
Blood pressure (mmHg)	
Systole	129.3 (15.6)
Diastole	81.7 (10.5)

Table 3. Distribution of the sample across stages of change at the three assessment times.

	T1		T2		T3		
Stages of change	*n*	%	*n*	%	*n*	%	*p* value
Precontemplation	11	22.4	0	0.0	0	0.0	< 0.001
Contemplation	11	22.4	6	12.2	0	0.0	
Preparation	8	16.3	18	36.7	1	2.0	
Action	13	26.5	19	38.8	42	85.7	
Maintenance	6	12.2	6	12.2	6	12.2	
Pre-action stages	30	61.2	24	49.0	1	2.0	< 0.001
Action stages	19	38.8	25	51.0	48	98.0	

Note. T1 = Time 1 (baseline); T2 = Time 2 (2 months after intervention); T3 = Time 3 (4 months after intervention).

Discussion

This study examined the efficacy of a TTM-based health education program designed to reduce weight among obese military personnel. We found that the program may be capable of successfully motivating participants to progress through the stages of change from pre-action toward action. In addition, although constructs such as self-efficacy and decisional balance showed change after only 2 months, many behavioral and cognitive domains of POC needed further time to shown significant change. Similarly, variables such as weight, waist circumference, and BMI required at least for 4 months to demonstrate significant change.

Several TTM-based programs have attempted to reduce weight and maintain it among overweight or obese people (Enwald & Huotari, 2010). However, there are certain aspects about the current study that differentiate it from similar studies. First, all components of the TTM were examined here, whereas other studies have examined only certain components of this model. For example, in a recent study conducted in South Korea to address childhood obesity, researchers only examined three constructs of the TTM, i.e., self-efficacy, stages of change, and decisional balance. They examined rope-skipping exercises along with counseling sessions for 12 weeks, finding that although self-efficacy improved significantly, no reductions in BMI were found after 6 months (although they were able to maintain BMI in the intervention group compared to the control group that demonstrated an increase in BMI; Ham, Sung, Lee, Choi, & Im, 2016). These findings in children indicated that a TTM-based program is able to improve self-efficacy and control weight. Participants in the current study likewise reported significantly higher scores on all

Table 4. Mean changes in TTM dimension scores (self-efficacy, decisional balance, and processes of change with subscales) and anthropometric measures at the three assessment times.

	T1	T2	T3		
Variables	*M* (SD)	*M* (SD)	*M* (SD)	F statistic	Significant comparison
Self-efficacy	25.69 (4.11)	27.75 (3.38)	29.26 (2.42)	88.73**	T1< T2< T3
Decisional balance	9.16 (3.57)	11.22 (2.43)	13.79 (1.94)	87.01**	T1< T2< T3
POC (cognitive)					
Consciousness raising	11.62 (3.03)	13.02 (2.06)	14.72 (1.96)	55.93**	T1< T2< T3
Emotional arousal	15.02 (2.93)	15.65 (2.13)	16.95 (2.03)	49.36**	T1< T3, T2< T3
Environmental re-evaluation	7.62 (2.43)	8.46 (1.97)	9.67 (1.92)	54.33**	T1< T3, T2< T3
Self-reevaluation	17.36 (2.08)	17.64 (1.68)	18.20 (1.53)	47.36*	T1< T3
Social liberation	23.12 (3.95)	23.82 (3.43)	25.13 (2.57)	76.39**	T1< T3, T2< T3
Total cognitive score	74.75 (8.48)	78.59 (6.98)	84.68 (6.26)	98.99**	T1< T2< T3
POC (behavioral)					
Self-liberation	14.32 (3.65)	15.28 (3.43)	16.88 (3.12)	51.36**	T1< T3, T2< T3
Helping relationships	12.58 (3.61)	13.39 (2.58)	14.67 (1.93)	54.22**	T1< T3, T2< T3
Reinforcement management	10.75 (3.64)	11.53 (3.05)	13.12 (2.33)	56.38**	T1< T3, T2< T3
Counterconditioning	9.30 (2.36)	10.10 (1.81)	10.89 (1.22)	52.96**	T1< T3, T2< T3
Stimulus control	13.82 (3.94)	14.87 (3.66)	16.14 (3.71)	49.39*	T1< T3
Total behavioral score	60.78 (9.77)	65.18 (8.23)	71.71 (7.77)	87.58**	T1< T2< T3
POC (total)	135.53 (16.56)	143.78 (14.43)	156.39 (13.12)	104.36**	T1< T2< T3
Weight	99.85 (10.43)	97.11 (9.82)	92.96 (9.57)	92.86**	T1< T3, T2< T3
Waist Cir.	105.88 (14.23)	103.58 (13.56)	100.21 (12.96)	94.86*	T1< T3
BMI	32.53 (5.22)	31.69 (4.98)	30.31 (4.53)	79.66*	T1< T3

Note. T1 = Time 1 (baseline); T2 = Time 2 (2 months after intervention); T3 = Time 3 (4 months after intervention); POC = processes of change; Cir. = circumference; BMI = body mass index.
**$p < 0.001$. $p < 0.01$.

dimensions of the TTM and improved anthropometric measures over time.

Second, to our knowledge, this was the first interventional model-based study that examined weight management among active duty military. Although the TTM-based program has been examined in other groups such as children, primary care patients, and minority women (Ham et al., 2016; Logue, Sutton, Jarjoura, & Smucker, 2000; Suris, Trapp, DiClemente, & Cousins, 1998), we could not find any studies examining a TTM-based health education program in military personnel. However, the stages of change construct has been previously proposed for use in smoking cessation in military personnel (Clements-Thompson, Klesges, Haddock, Lando, & Talcott, 1998), but its efficacy has not been examined in a study.

Another unique characteristic of the present study that distinguishes it from others is that previous intervention studies involved only participants in the pre-action stages, not in the action stages as well. Although, this may seem reasonable, we would argue that those in the action stage also need to be included. First, those in action stages may often slip back into pre-action stages (e.g., stop or reduce exercising and fall back into unhealthy eating habits; Glanz et al., 2008). Therefore, any comprehensive program should involve encouragement of further weight reduction and maintenance of that weight loss through education about risk factors related to relapse. Second, is that individuals in the action phase may serve as positive role models to encourage undecided persons in the pre-action stage to move onto the action stage. When heterogeneity exists within a group, this increases the likelihood of rational decision-making within the group that leads to the successful accomplishment of goals (Sharma & Romas, 2012). Furthermore, those in the action stage may share valuable experiences that can help those in the pre-action phase overcome barriers that might prevent them from making necessary changes in exercise and diet and maintaining them. However, intervention studies of this type need to include a majority of participants in the pre-action stage so that there is sufficient power to demonstrate change. The ratio of participants in first four stages of change to maintenance stage (last one) in the current study was approximately 8 to 1 that may be sufficient to indicate movements across stages.

In the present study, the changes in other dimensions of the TTM (self-efficacy, decisional balance, and POC) were not the same over time. For example, although the self-efficacy and decisional balance progress steadily across measurements, change on certain subscales of the POC dimension needed addition time to occur. Thus, one cannot expect all psychological components of the TTM to change at the same rate. We observed 4 months after the intervention that all aspects of the POC dimension of the TTM changed significantly similar to other dimensions of the model. Therefore, to identify acceptable change among all TTM dimensions requires at least 4 months of observation (except among those who intend to enter into the maintenance phase). However, this may vary depending on the quality of interventions, the particular population studied, and other factors.

Several implications regarding the changes in cognitive and behavioral POC should be noted. We found that a cognitive process (i.e., consciousness rising) improved by the first assessment, whereas other cognitive processes did not significantly change until the second assessment. However, all cognitive process showed a trend in the right direction at all assessment times. This suggests that all cognitive processes may improve but at different speeds. In other words, improved knowledge about facts (consciousness rising) can occur in a short time, but improvement in attention to feelings (dramatic relief), impact on others (environmental reevaluation), self-image (self-reevaluation) and support from society (social liberation) may require more time. Therefore, studies that seek to replicate such interventions in military personnel using TTM need to consider the time necessary to impact different cognitive processes. This is also true for behavioral processes, where in the current study significant changes were not seen until the last assessment. Improvements in weight control and fitness may help to support compliance to the intervention over time with regard to behaviors. However, as Wilkinson suggested, the clinical significance of such changes vs. their statistical significance should be considered (Wilkinson, 2014). Even a positive change at a trend level, even if not statistically significant, may be valuable in high risk populations.

The primary outcome measure of current study was weight reduction based on BMI and waist circumference changes. Prior studies have shown that expectation of considerable change on these measures and maintenance of that change over a short period of time is unrealistic. For example, in a study using nutritional counseling based on the TTM that was conducted in overweight/obese females in Thailand, whereas BMI and waist circumference did not show any significant change at Weeks 4 and 8 after the intervention, by 3 months after intervention both changed significantly compared to a control group (Karintrakul & Angkatavanich, 2017). Similarly, Johnson et al. in a population-based study using the TTM found although 3 months after intervention there was limited weight loss among participants, weight loss was significant 6 to 12 months later (Johnson et al., 2008). Therefore, when designing health educational program using the TTM for weight loss, it is necessary to allow sufficient time for change to occur. Based on our findings and those of others, this observation period should be at least 3 months.

The present study had several limitations that need to be considered. First, this was not a randomized clinical trial, but rather a quasi-experimental study in a single group with assessments at baseline and two follow-up times after the intervention. Thus, without a control group, there is no way to ensure that the changes from the intervention were not simply due to the passage of time and social contact with the researchers. However, we did not have enough personnel and financial resources to conduct a randomized clinical trial. Second, these findings are limited to male military personnel, and should be generalized to women in the military only with great caution. We attempted to recruit both genders, but only males agreed to participate. Third, we measured the impact of the intervention over a relatively short period, and longer periods of follow-up, such as 12 to 24 months, will be necessary to determine whether the reductions in BMI and waist circumference persist over the long-term. Fourth, we used BMI to determine obesity among participants due to the ease of measurement. However, this measure may not be the most accurate way to assess military personnel because it cannot differentiate fat mass from lean mass; consequently, athletically fit military personnel may have an identical BMI as those with abdominal fat. Thus, use of more sophisticated measures such as bio-impedance technology to distinguish fat from muscle tissue is recommended for future studies. Fifth, we retained active participants in our intervention as the role models. Although this may be considered a study strength because many other studies (even those with an RCT design) exclude these participants from the intervention, this may also threaten the external validity of the present study. Finally, we chose relatively few objective measures to assess weight loss. Future studies should assess other physiologic parameters such as blood lipid profile and measure physical activity more precisely (such as by use of a pedometer).

Conclusion

We found that applying a TTM-based educational intervention may be useful for weight management among obese military personnel in Iran. However, changes in weight and psychological aspects of motivation to lose weight should not be expected to occur over a matter of only a few months but may require a longer observation period to detect (such as 6 months or longer). Among the behavioral and cognitive components involved in the process of change, variables such as self-reevaluation and stimulus control may not improve significantly until considerably after other constructs of the TTM change, such as self-efficacy and decisional balance that may change early on. Future interventions of this type should use multiple objective measures of weight loss and its physiological consequences, assess these outcomes over a prolonged period of time (6 to 24 months) to ensure changes are maintained, and examine their effectiveness in different populations, such as individuals in specific occupations

and minority populations from various cultures and backgrounds. In addition, before implementing this intervention in military personnel who are not yet obese (i.e., in those who are only slightly or moderately overweight), further investigation is required. The present study only applies to military personnel who are already obese and so it is in this group that the intervention should first be applied.

Acknowledgments

We would like to thank the military authorities who provided the facilities to conduct this study. Also, we thank Baqiyatallah University of Medical Sciences for the supports that made this study possible.

Declarations

Competing interests: The authors have no competing interests.

ORCID

Mohsen Saffari http://orcid.org/0000-0001-7590-9516
Harold G. Koenig http://orcid.org/0000-0003-2573-6121

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