Development and Impact Assessment of a Computer Mediated, Body Weight Related Nutrition and Fitness Program

Richa Soni[1], Vibha Bhatnagar[2] and N.K. Jain[2]

[1,3]*Department of Life Sciences, University School of Science, Gujarat University*
Ahmedabad, Gujarat, India
[2]*Department of Foods and Nutrition, College of Home Science,*
Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India
[1]*Phone: +917043134162,* [1]*E-mail: richasoniricha@gmail.com*

ABSTRACT This study was conducted to develop a nutrition and fitness program and examining its efficacy in reducing weight and improving physical fitness in obese adults. The program was having four main sections, that is, personal profile, weight management, physical fitness and food exchange list. It was providing facilities of creating personal profiles, assessing daily nutrient intake and physical activities, suggesting nutritional and exercise requirements and planning individualized diet charts. Twenty-two obese subjects (BMI>25kg/m²) were assigned to the program group (n=12) and no information control group (n=10). The program group was asked to strictly follow the program for one month. Significant reduction in the intake of calories, fat and carbohydrates was observed while intake of fruits and vegetables was increased (p<0.05). The program was also found to be effective in reducing body weight and body fat, whereas physical fitness improved significantly (p<0.05). There was no significant alteration observed in any parameters of the control group.

INTRODUCTION

Even as India fights malnutrition, the country has developed another nutritional problem-overweight and obesity. According to the National Family Health Survey, in the past ten years, the number of obese people has doubled in India (NFHS-4 2016). Among women it has increased by eight percent (from 13% in NFHS-3 to 21% in NFHS-4) and among men it has doubled from nine percent to nineteen percent. Globally, the World Health Organization has computed that there are 1.9 billion overweight and nearly 600 million obese people in the world. Overweight and obesity are major risk factors for non-communicable diseases such as heart disease, diabetes, hypertension, hyperlipidemia and certain types of cancers (WHO 2016).

This increase in the prevalence of obesity has led to a significant burden in the economic cost of India and the country's national health care system can simply not afford the massive cost of therapeutic care of these diseases on a large scale (Subramanian et al. 2009). In view of national growth and development, it becomes essential to maintain physical power of the population at an optimal level. For this purpose the requirement is to work out a way to help the population to improve personal and family nutrition in face of economic handgrip.

Most of the approaches for treatment of obesity are based on changes in diet and physical activity meant to decrease energy intake while increasing energy output (Reed 2012). Recent research studies have suggested that including behavior modification or principles of social learning, such as target-setting and self-monitoring, can increase the effectiveness of these methods (Shaw et al. 2005).

Rapid upsurge in access to the Internet and the World Wide Web have made it a practical and logical mode for public health interventions. Diet counseling through computers is the new dimension in counseling at present welcomed by both patients and by health teams. Computer tailoring refers to the documentation of participant information using a computerized expert system, which then generates feedback and advice based on such information (Neville et al. 2009).

There are approximately 70 million computer literates in India (IAMAI 2012). Computer-based delivery of health-related programming is increasingly popular. The number of Indian adults

who subscribe to the Internet has surged from 4.55 million in 2004 to 13.54 million in past ten years (TRAI 2008).

Nowadays numerous computer and mobile applications and programs are available on the Internet for weight management and improving physical fitness that provides guidelines for dietary management of obesity and suggest sample diet but there is uncertainty about how many of these applications are developed by trained nutritionists. There is dearth of scientifically valid programs available on the Internet and also the effectiveness of these programs remains doubtful.

Objectives

The aim of this study was to design and develop a computer mediated body weight related nutrition and fitness program and to assess its effectiveness in reducing body weight and improving physical fitness in obese adults. The developed program had many unique features that allows users to plan and modify diets and activity plans according to the user's daily needs.

METHODOLOGY

This study was funded by the Department of Science and Technology, Ministry of Science and Technology, Government of India and was approved by the institutional advisory committee of Maharana Pratap University of Agriculture and Technology, Udaipur, India. The study was conducted in two phases.

Phase I: Development and Evaluation of the Program

An interactive, user friendly, easy to operate, computer based weight management and fitness program was developed using Microsoft Visual Studio 2005 and the database was developed using Microsoft Access. The program had four main sections, that is, personal profile, weight management, physical fitness and food exchange list. The details of the each section are given below.

Section I: Personal Profile

This first section of the program was user specific and was designed to provide a facility to create personal profiles. A user ID and password generates for each user when they first register and then the user can log in to his/her personal profile as and when needed. Upon entering body measurements (like height, weight, waist circumference, hip circumference etc.), the program automatically calculates body mass index (BMI), basal metabolic rate (BMR), ideal body weight (IBW), waist hip ratio, and body fat percentage for the user. This section also provides facilities of assessing daily nutrient intake and energy expenditure in different activities. An exhaustive list of nutrient content of 900 Indian food items has given in this section, a user can select the food items and add the amounts he/she had eaten all day and the program calculates the nutrient content of his/her diet and compare it with the recommended dietary allowances and shows it in a graphical presentation. Similarly, a list of energy expenditure of different activities is provided in this section. A user can select the activities he/she has involved in during the day and the program calculates his/her energy expenditure for the day and shows the energy balance graph. The program also helps users in setting weight loss goals, according to a user's existing weight and the program plans diet and exercise charts for them, suggests nutrient requirement, plans individualized menus, keeps food intake records (food diary) and revises diet and exercise plans for the user if needed. Overall the program allows user to make personalized diet and physical activity plans to reach a goal weight within a specific time period and to maintain it afterwards.

Section II: Weight Management

Additional features of the program included a generalized section of the program in which information about body weight, overweight and obesity, nutrient requirement in weight related disorders, importance of physical fitness, dietary management of overweight and obesity was given in interesting pictorial presentation to increase the awareness and to create interest of the user in reducing body weight.

Section III: Physical Fitness

This section was again user specific. It included basic information on physical fitness, components of physical fitness and guidelines

for doing physical exercises to improve physical fitness. For better understanding of users, the researcher shot and developed videos on different exercises featuring a trained physical fitness expert showing the correct way of doing different exercises. These videos were added in the program and written guidelines and methods were also given for the same. This section was also providing a facility to assess level of physical fitness of the users.

Section IV: Food Exchange List

An exhaustive food exchange list consisting energy value of 900 Indian food recipes was given in this section to serve three functions to the user, that is, choice, substitution and serving. With the help of this list, the user can substitute one food item with any other food item in the same list and compare any two food items in terms of calories and servings.

The program was made interesting with colorful and attractive graphics in order to improve the understanding and the retaining capacity of the individual.

Evaluation of the Program

To test the reliability, validity, adequacy and suitability of the developed program, it was critically assessed by a panel of experts. A panel of 15 members was formed, consisting of nutritionists, doctors and dietitians or counselors. The program was evaluated in terms of content, language, clarity, organizational lay out, continuity or sequence, calculations, graphical presentation, pictorial presentation, audio recordings, video recordings and overall presentation

Evaluation sheets were distributed to the panel members and they were requested to critically evaluate each section of the program on the basis of criteria stated in the evaluation sheet. The filled sheets were collected back. A discussion was then held with the panel members and verbal and viable suggestions given by the evaluators were noted and suitable modifications were incorporated. Diet and exercise charts generated by the program were evaluated in terms of accuracy.

The entire program was reviewed and modified in light of suggestions obtained. The program was then re-evaluated by the same panel of experts and the mean weighted scores of first evaluation and second evaluation were compared.

Phase II: Impact Assessment of the Program

For assessing the impact of the developed program, 22 obese subjects (11 males and 11 females) aged 26±3.4 years having a body mass index (calculated as weight in kilogram divided by height in meter square) of 28.68 ± 0.82 kg/m^2 were recruited from morning walk places, religious centers and local clubs and screened for eligibility. Eligibility criteria included, age between 20 to 40 years, body mass index >25 kg/m^2, willingness to participate in the study, computer literacy and availability of a computer. Exclusion criteria included any other physical (other than obesity) or psychological health problem, pregnancy or any other condition that prohibit exercise. A small sample size was taken due to limited research budget, time constrains and more number of study parameters.

Selected subjects were randomized in two groups, program and control. Participants of the program group attended one face-to-face session in which they were explained about the program and were instructed on how to use the program. Then the program group was given a 30 days trial version of the developed program and asked to strictly follow the program for one month. The other group served as control receiving no information. Dietary survey, anthropometric measurements, body composition and physical fitness tests were done before (0 day) and after (after 30 days) the completion of the study period. Dietary survey was done using 24 hours recall method for three consecutive days. The mean intake of food and nutrients by the subjects were compared with the recommended dietary allowances (Gopalan et al. 1989; ICMR 2010). Anthropometric measurements included height, weight, body mass index, waist circumference, hip circumference and waist hip ratio (WHO 2000; Khanna et al. 2003).Body composition consisted of measurement of percent body fat, body fat mass, fat free mass and total body water. Body composition analyzer (Tanita Body Composition Monitor MC-980 MA Plus) was used to assess the body composition of selected subjects.

Physical fitness test included a three-minute step up test for assessing cardiorespiratory endurance, curl up test for assessing muscular endurance, the maximum bench press test for assessing muscular strength, and sit and reach test for assessing flexibility of the subjects(Plowman and Meredith 2013).

Statistical Analysis

Mean weighted scores of first and second evaluation were compared to assess the improvement in the program.

A "paired t-test" was used to assess the impact of the program on dietary intake, anthropometric measurements, physical fitness and body composition of the subjects before and after using the program. Statistical results were considered to be significant at $p <= 0.05$.

RESULTS

Even the lowest mean weighted score after the second evaluation was 4.53 as reported in rating of graphs in fitness section, fell under the category of very good (Table 1). After modifying the program in light of suggestions, it got good remarks and was appreciated by the expert panel.

Effect of Program on Anthropometric Measurements

After following the program for one month body weight (-2.02%), BMI (-3.32%), waist circumference (-5.07%), hip circumference (-1.78%) and waist hip ratio (-3.44%) were reduced significantly (P<0.01) in the program group, whereas no significant changes were observed in the control group (Table 2).

Effect of Program on Body Composition

The program group reported significant (P<0.01) reduction in percent body fat (-5.72%) and total fat mass (-8.5%). Total body water also

Table 1: Mean weighted scores of first and second evaluation of the program

Section	Content		Language		Continuity		Calculation		Graphs		Pictures		Audio		Video		Overall acceptability	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Personal profile	4.8	4.9	4.6	4.8	4.4	4.5	5.0	5.0	4.5	4.5	4.6	5.0	-	-	-	-	4.4	4.8
Weight management	4.6	4.8	4.7	4.8	4.4	4.8	-	-	-	-	4.9	5.0	-	-	-	-	4.8	4.8
Physical fitness	4.6	4.6	4.4	4.8	4.6	4.8	5.0	5.0	-	-	4.6	4.8	4.4	4.8	4.4	4..5	4.6	4.8
Food exchange list	4.7	4.7	4.5	4.6	4.6	4.8	5.0	5.0	4.4	4.5	4.5	5.0	-	-	-	-	4.8	4.9

a – Mean Weighted Score of first evaluation
b - Mean Weighted Score of second evaluation

Table 2: Impact of program on anthropometric measurement of the subjects

S. No.	Parameters	Mean , SE values				't' value a v/s b
		Before 0 day (a)		After 30 day (b)		
		Mean	SE	Mean	SE	
1. Program Group (n=12)						
	Weight (kg)	75.7	2.1	74.0	2.0	2.9**
	Height (cm)	164.0	1.9	164.0	1.9	-
	BMI (kg/m²)	28.6	0.7	27.6	0.7	4.9**
	Waist circumference (cm)	94.9	2.2	89.5	2.2	12.4**
	Hip circumference (cm)	107.1	1.0	105.2	1.2	4.2**
	Waist – Hip ratio	0.8	0.0	0.8	0.0	11.3**
2. Control Group (n=10)						
	Weight (kg)	76.2	2.6	76.3	2.4	0.3 NS
	Height (cm)	163.5	2.2	163.5	2.2	-
	BMI kg/m²	28.7	0.5	28.7	0.6	0.5 NS
	Waist circumference (cm)	96.8	1.8	96.9	1.3	0.2 NS
	Hip circumference (cm)	105.2	0.7	105.0	0.0	0.3 NS
	Waist – Hip ratio	0.9	0.0	0.9	0.0	0.1 NS

** Significant at both (P<0.01) and (P<0.05) level of significance
NS- Non significant

increased significantly (+4.68%) after the completion of the study in the program group. While no significant change in body composition was observed in the control group (Table 3).

Effect of Program on Dietary Intake

Intake of pulses, fruits and green leafy vegetables increased and intake of oil/ghee and sugars reduced significantly in the program group after following the program for one month. In terms of nutrients, intake of energy, fat and carbohydrates was decreased significantly in program group after their participation in the study. No significant improvement and reduction was observed in food and nutrient intake of control group except for pulses, which was increased

significantly after the completion of the study (Tables 4 and 5).

Effect of Program on Physical Fitness

The developed program generates personalized exercise charts and suggests physical activity patterns for each user. Significant improvements were observed in various components of physical fitness including cardio respiratory endurance, muscular endurance and flexibility. 15-second pulse count during three-minute step up test was reduced from 46.33 to 42.5 (-8.23%) after following the program for one month (P< 0.01). The maximum volume of oxygen ($VO_{2\,max}$) was increased from 33.07 to 37.13 in the program group (P< 0.01) after the completion of the study.

Table 3: Effect of program on body composition of the subjects

S. No.	Parameters	Mean, SE values				't' value a v/s b
		Initial 0 day (a)		After 30 day (b)		
		Mean	SE	Mean	SE	
1.	*Program Group (n=12)*					
	Body fat percent	31.5	2.0	29.7	2.0	17.2**
	Body fat mass (kg)	23.8	1.6	21.8	1.6	13.6**
	Fat free mass (kg)	51.9	2.4	52.3	2.4	3.0*
	Total body water (kg)	37.7	1.8	39.5	1.9	5.9**
2.	*Control Group (n = 10)*					
	Body fat percent	32.4	1.7	32.6	1.7	0.4 NS
	Body fat mass (kg)	24.5	1.2	24.6	1.1	0.1 NS
	Fat free mass (kg)	51.6	2.6	51.6	2.7	0.1 NS
	Total body water (kg)	37.3	1.8	37.4	2.0	0.1 NS

** Significant at both (P<0.01) and (P<0.05) level of significance
* Significance at (P<0.05) level of significance
NS: Non significant

Table 4: Effect of program on food intake of the subjects

S. No.	Food groups	Program group						Control group					
		Before mean	SE	After mean	SE	t' value	% change	Before mean	SE	After mean	SE	t' value	% change
1.	Cereals (g)	225.4	4.8	173.3	11.3	1.0NS	23.1	260.5	15.1	239.0	13.3	1.9NS	8.0
2.	Pulses (g)	30.0	5.9	47.0	6.6	2.2*	56.5	17.0	3.2	26.5	4.7	3.0*	55.8
3.	Leafy vegetables (g)	40.4	12.7	78.7	10.4	2.4*	94.8	37.5	11.7	66.5	16.1	1.5NS	77.3
4.	Roots and tubers (g)	171.6	26.4	110.8	17.3	2.4*	35.4	148.0	25.0	148.0	22.6	0.6NS	0.0
5.	Other vegetables (g)	98.3	30.3	125.8	11.5	0.7NS	27.9	178.0	21.2	171.0	32.2	0.1NS	3.9
6.	Fruits (g)	52.	17.1	100.8	11.7	2.4*	93.2	35.0	15.0	38.0	14.5	0.1NS	8.5
7.	Milk and milk products (ml)	256.8	8.1	168.2	28.2	0.3NS	34.4	224.0	13.6	214.0	10.8	1.0NS	4.4
8.	Sugars (g)	31.4	3.3	13.1	2.1	5.4**	58.0	26.0	0.1	24.0	1.7	1.1NS	7.6
9.	Fats and oils (g)	49.0	4.2	21.7	1.6	5.8**	55.6	48.2	3.4	48.9	2.7	0.3NS	0.0

** Significant at both (P<0.01) and (P<0.05) level of significance
* Significance at (P<0.05) level of significance
NS- Non significant

Table 5: Effect of Program on nutrient intake of the subjects

S. No.	Nutrients	Program group						Control group					
		Before mean	SE	After mean	SE	t' value	% change	Before mean	SE	After mean	SE	t' value	% change
1.	Energy (kcal)	1947.9	45.7	1256.8	52.1	11.3**	35.4	1863.1	80.3	1876.4	57.3	0.2NS	0.6
2.	Protein (g)	50.2	1.7	43.1	1.9	1.4NS	14.1	50.4	2.1	51.7	1.4	0.9NS	2.5
3.	Fat (g)	74.4	4.6	36.6	1.7	7.5**	50.7	67.7	3.3	69.4	2.8	0.7NS	2.3
4.	Carbohydrates (g)	269.2	6.6	189.4	9.6	5.2**	29.6	264.6	13.7	261.2	13.1	0.4NS	0.7
5.	Fiber (g)	6.8	0.5	7.4	0.4	0.5NS	8.9	8.5	0.7	9.0	0.6	0.0NS	5.6
6.	Calcium (mg)	806.0	56.6	675.2	65.9	1.1NS	16.2	739.6	51.	800.7	68.7	0.8NS	8.2
7.	Iron (mg)	15.9	1.5	15.9	0.9	0.8NS	0.0	17.3	0.9	20.5	1.5	1.4NS	18.3
8.	Vitamin A (µg)	710.1	154.2	1183.3	160.6	2.2*	66.6	760.2	172.2	717.6	156.5	0.5NS	1.5
9.	Thiamin (mg)	1.5	0.1	1.2	0.	0.8NS	18.8	1.8	0.1	2.1	0.2	1.1NS	16.9
10.	Riboflavin (mg)	0.8	0.0	1.1	0.	3.7**	41.6	0.8	0.0	0.8	0.0	0.3NS	1.4
11.	Niacin (mg)	12.7	0.7	10.1	0.6	1.6 NS	20.5	13.0	1.2	13.4	0.7	0.4NS	2.5
12.	Vitamin C (mg)	122.9	27.3	140.7	22.1	2.5*	14.4	152.9	28.2	216.1	53.8	1.3NS	41.3

** Significant at both (P<0.01) and (P<0.05) level of significance
* Significance at (P<0.05) level of significance
NS- Non significant

No significant reduction was observed in cardio respiratory endurance in control group.

The program was proved efficient in improving muscular endurance of the subjects of the program group after one month of use. The maximum number of curl ups performed by the subjects were increased from 22 to 28 (+25%) at the end of the study in the program group. Mean values of curl up test of control group remained static.

Besides these above mentioned tests, flexibility test also underwent significant change after the use of the program in the program group. The program group included stretching exercises in their exercise chart, which resulted in significant improvement in terms of maximum distance that the subjects could cover during the sit and reach test after the completion of the study. The mean value increased from 27.25 cm to 29.78 cm (+9.25%), while control group did not endure any such change (Table 6).

The muscular strength of the subjects of both the groups did not undergo any significant change. The repetition maximum value remained almost static for both program and control groups, may be because of short duration of the study.

DISCUSSION

As the prevalence of obesity continues to rise, the need for practical, easily disseminated and effective weight loss and weight mainte-nance programs has become increasingly important. Computer-based interventions may serve as an efficient and cost-effective method to meet this growing public health need (WHO 2011).

This study shows that a computer mediated weight loss and fitness program produced significant reduction in body weight, BMI, waist hip ratio, body fat percent, and intake of calories, fat and carbohydrates, while intake of fruits, green leafy vegetables, pulses and scores of physical fitness increased significantly.

There are few studies available that have examined the use of fully automated computer or Internet based programs for weight loss involving no human contact. To best of the researchers' knowledge and after reviewing literature, this is the first report that demonstrates the effect of individualized nutrition program on the food intake, body weight, body composition, physical fitness and behavior of Indian obese subjects.

The results of the present study are in alignment with the results published by Tate and colleagues in a randomized trial, which studied the effect of an Internet education or in Internet behavior therapy program. The features of the Internet behavior therapy include additional behavioral procedures like sequence of 24 weekly behavioral lessons via e-mail, weekly online submission of self-monitoring diaries with individualized therapist feedback via e-mail, and an online bulletin board. Body weight and waist circumference were measured at 0, 3 and 6 months.

Table 6: Effect of program on physical fitness of the subjects

S. No.	Physical fitness test	Mean , SE values				't' value a v/s b
		Initial 0 day (a)		After 30 day (b)		
		Mean	SE	Mean	SE	
	Program Group (n=12)					
1.	3 Minute Step Up Test					
	15 Sec. pulse count	46.3	2.2	42.5	1.7	6.1**
	VO$_2$ max (ml/kg/min)	33.0	2.9	37.1	2.4	3.1**
2.	Curl Up Test					
	Maximum number of curl ups performed	22 .0	3.7	28.0	3.4	6.4**
3.	Maximum Bench Press Test					
	1RM (kg)	23.1	1.4	23.5	1.5	0.8NS
4.	Sit and Reach Test					
	Maximum distance covered (cm)	27.2	1.0	29.7	0.9	12.4**
	Control Group (N=10)					
1.	3 Minute Step Up Test					
	15 Sec. pulse count	41.7	1.6	42.4	1.4	0.9 NS
	VO$_2$max (ml/kg/min)	37.5	2.2	36.4	1.4	0.9 NS
2.	Curl Up Test					
	Maximum number of curl ups performed	18	1.3	17.0	1.5	1.4 NS
3.	Maximum Bench Press Test					
	1 RM (kg)	23.0	1.8	23.0	1.8	0.0 NS
4.	Sit and Reach Test					
	Maximum distance covered (cm)	26.1	0.9	26.0	0.9	0.3 NS

** Significant at both (P<0.01) and (P<0.05) level of significance
* Significance at (P<0.05) level of significance
NS- Non significant,
RM – Repetition maximum

The behavior therapy group lost more weight than the education group and changes in waist circumference were also greater in the behavior therapy group than in the education group at both 3 months and 6 months (Tate et al. 2001). This was the first study published. Later few other studies have been published having a variety of computer intervention features.

In another study by the same group of researchers (Tate et al. 2003), they compared the effectiveness of Internet behavior counseling via email in addition to Internet weight loss program on weight loss in adults with risk of type 2 diabetes. It was observed that adding email counseling to basic Internet weight loss intervention significantly improved weight loss in adults and reduced the risk of type 2 diabetes.

Present findings are in line with literature on role of computer-based interventions for weight maintenance in obese people. Research trails and systematic reviews concluded that interactive computer-based programs are effective weight loss interventions and that e-mailed or automated counseling increases the effectiveness of computer-based interventions (Tate et al.2006; Wieland et al. 2012; LeRouge et al. 2016).

Increasing physical activity in the general population has an important role in the prevention of obesity and associated health problems (Hurling et al. 2007). Similarly, while there is less available evidence on effects of computer based program on body composition and physical fitness and this is the first study to assess the impact of interactive computer based nutrition and fitness program on dietary intake, body composition and physical fitness of Indian obese people. Results of the present study are similar to those previously reported. Previous results published by Hurling et al. (2007) also reported increased physical activity (average 2 hours 18 minutes) by participants engaged in an automated physical activity program. Similar to this

study Hurling and colleagues also observed significant reductions in BMI and body fat percent of participants of test group following the automated fitness program.

Goodrich et al. (2012) also reported significantly increased step count (an average of 1493 steps/day) in patients enrolled in an Internet mediated walking program. Physicians and medical assistants used the developed program and used the interface to refer patients to the program. Patients who completed the program significantly increased walking from pre- to post-intervention.

Participation in the developed program led to significant improvements in the cardio respiratory endurance, muscular endurance and flexibility of the members of the program group. Improvement in the physical fitness scores was also observed in a previous study. Significantly high fitness scores by 9th grade students using computer based individualized fitness program, which focused on individual goal setting and self-monitoring of fitness levels, was reported by Butler and Fernandez (2005).

CONCLUSION

This study demonstrates that a computer mediated weight loss and fitness program yielded significant decrease in body weight, BMI, waist hip ratio, body fat percent and intake of energy, fat and carbohydrates, while intake of fruits, green leafy vegetables, pulses and scores of physical fitness increased significantly. Thus computer mediated weight loss and fitness programs have the potential for producing weight loss and improving physical fitness and may help reducing the risk of chronic diseases.

RECOMMENDATION

The study recommends that more programs and computer based tools can be developed for managing other health problems and studies can also be planned to assess the impact of long term intervention on larger scale.

ACKNOWLEDGEMENT

REFERENCES

Butler K, Fernandez MT 2005. *An Analysis of the Effects of a Computer-Based Fitness Program on Ninth-Grade Students' Attitudes and Fitness Scores in Physical Education*. PhD Thesis, Unpublished. San Diego, USA: Alliant International University.

Goodrich DE, Buis LR, Janney AW, Ditty MD, Krause CW, Zheng K, Sen A, Strecher VJ, Hess ML, Piette JD, Richardson CR 2012. Integrating an internet-mediated walking program into family medicine clinical practice: A pilot feasibility study. *BMC Med Inform Decis Mak, 11: 47-52.*

Gopalan C, Rama BV, Balsubramanian SC 1989. *Nutritive Value of Indian Foods.* Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.

Hurling R, Catt M, De Boni M, Fairley B, Hurst T, Murray P, Richardson A, Sodhi JS 2007. Using internet and mobile phone technology to deliver an automated physical activity program: Randomized controlled trial. *JMIR,* 9(2): e7

Internet and Mobile Association of India and Indian Market Research Bureau [IAMAI] 2012. *All India Estimates Census.* Annual Report. New Delhi, P. 21.

Indian Council of Medical Research [ICMR] 2010. *Nutrient Requirement and Recommended Dietary Allowances for Indians.* Hyderabad: An Expert Group of ICMR, NIN.

Khanna K, Gupta S, Passi S, Seth R, Mahna R, Puri S 2003. *Text Book of Nutrition and Dietetics.* Delhi: Phoenix Publishing House Pvt Ltd.

LeRouge C, Dickut K, Lisetti C, Sangameswaran S, Malasanos T 2016. Engaging adolescents in a computer based weight management program: Avatars and virtual coaches could help. *J Am Med Inform Asso,* 23: 19-28.

Magheshwari U, Sunitha V 1995. Development of software and its impact on weight reduction. *Ind J Nutr Diete,* 32: 238-241.

Mokdad AH, Marks JS, Stramp DF 2000. Actual causes of deaths in United States. *JAMA,* 291: 238-245.

National Family Health Survey-4 2015-16. *India Fact Sheet.* Mumbai, India: Ministry of Health and Family Welfare, International Institute for Population Sciences.

Neville LM, O'Hara B, Milat A 2009. Computer tailored physical activity behavior change interventions targeting adults: A systematic review. *Int J Behav Nutr Phys Act,* 6: 30.

Plowman SA, Meredith MD 2013. *Fitnessgram/Activitygram Reference Guide.* 4th Edition. Dallas, TX: The Cooper Institute.

Reed VA 2012. The effect of computers for weight loss: A systematic review and meta analysis of randomized trails. *J Gen Intern Med,* 27: 99-108.

Shaw K, O'Rourke P, Mar C, Kenardy J 2005. Psychological interventions for overweight or obesity. *Cochrane Database Syst Rev,* (2): Art No: CD003818.

Subramanian SV, Perkins JM, Khan KT 2009. Do burdens of underweight and overweight coexist among lower socio-economic group in India? *Am J Clin Nutr,* 90: 369-376.

Tate DF, Wing RR, Winett RA 2001. Using internet technology to deliver a behavioral weight loss program. *AMA,* 285: 1172-1177.

Tate DF, Jackvony EH, Wing RR 2003. Effects of internet behavior counseling on weight loss in adults at risk of type 2 diabetes. *JAMA,* 289: 1833-1836.

Tate DF, Jackvony EH, Wing RR 2006. A randomized trial comparing human e-mail counseling computer-automated tailored counseling, and no counseling in an internet weight loss program. *Arch Intern Med*, 166: 1620-1625.

Telecom Regulatory Authority of India [TRAI] 2008. *Indian Telecom Industry, Operational Performance*. New Delhi: TRAI.

Wieland LS, Falzon L, Sciamanna CN, Trudeau KJ, Brodney Folse S, Schwartz JE, Davidson KW 2012. Interactive computer based intervention for weight loss or weight maintenance in overweight or obese people. *Cochrane Database Syst Rev,* 8: 1-143.

World Health Organization 2000. *The Asia Pacific Prospective: Redefining Obesity and its Treatment*. Joint WHO/ASO/IOTF Expert Consultation and Health Communications Australia Pvt Ltd., Australia.

World Health Organization 2016. *Obesity and Overweight Fact Sheet No. 311*. Geneva: WHO.