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***Research Article** (Open Access)*

FACTORS AFFECTING ANTHROPOMETRIC INDICES, BODY COMPOSITION AND WEIGHT REDUCTION

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ABSTRACT
*Introduction***:** Obesity is a multifactorial disease arising from a complex interaction between genetic and environmental factors. Why some people succeed at adopting and sustaining behaviors associated with weight control while others, undergoing similar treatment programs, do not, remains largely unknown
*Objective***:** To identify factors affecting response *vs.* non-response in subjects undergoing comprehensive weight reduction program.
*Methodology***:** Purposive sampling technique was used to enroll subjects in the age group of 20-60 years visiting a commercial weight reduction center with the purpose of weight loss. Baseline data included 624 subjects (310 males and 314 females) with the BMI ≥25kg/m^2. Total 200 subjects participated in the study with 102 visiting a commercial weight reduction center and 98 visited a Gymnasium. In the comprehensive study these subjects were assessed at both pre and post intervention stages for various parameters such as nutritional status - anthropometric indicators, body composition and diet recall.
*Results***:** Factors such as food habits, skipping of breakfast, marital status, stress, change in physical activity, cardiorespiratory fitness affect weight loss, change in body composition and fitness levels. Significant associations were found between different variables. The macronutrient, stress and physical activity level model had a strong association with weight loss (r =0.649) and was responsible for 42.13% variability.

INTRODUCTION
Obesity is a multicomponent disease arising from a complex interaction between genetic and environmental factors. However, the dramatic increase in obesity prevalence observed in the last decade seems attributable mainly to environmental changes promoting the intake of energy dense foods and/or reduced physical activity due to high number of sedentary jobs, different transportation systems and increasing urbanization. A 'running society' with a high level of stress develops compensatory and gratifying behaviours, where eating has a primary role (Grave *et al.,* 2013). The treatment of obesity continues to present major challenges, including poor adherence to diet, inadequate and unsatisfactory weight loss, weight regain and high rates of attrition (Colombo *et al.,* 2014).Why some people succeed at adopting and sustaining behaviours associated with weight control while others, undergoing similar treatment programs, do not, remains largely unknown (Wing 2003). Findings of a recent research also stated that health behaviour changes such as eating more fruits and vegetables, increasing physical activity and reducing stress were all predictive of clinically significant weight loss (Carpenter *et al.,* 2014).
*Objective***:** To identify factors affecting response *vs.* non-response in subjects undergoing comprehensive weight reduction program.

MATERIALS AND METHODS
The study was conducted in Jaipur city**.** Purposive sampling technique was used to enroll women in the age group of 20-60 years visiting a commercial weight reduction center (CWRC) with the purpose of weight loss. Baseline data included 624 subjects (310 males and 314 females) with the BMI ≥25kg/m^2. Success rate of any commercial weight reduction programme have been predicted to be 20%. Therefore, a sample size of 176 (44 in each group) women was computed, at 5% confidence

interval and 10%confidence limit; for the comprehensive study on the basis of willingness to participate in the study. Total 200 subjects participated in the study with 102 visiting a commercial weight reduction center and 98 visited a Gymnasium. In the comprehensive study these subjects were assessed at both pre and post intervention stages for various parameters such as nutritional status – anthropometric indicators, body composition and diet recall. Anthropometric indicators such as height, weight, waist circumference (WC) and hip circumference (HC) were measured using standard W.H.O. protocols (Jeliffe, 1966). Body composition was assessed by OMRON HBF-362 body composition analyzer based on biological impedance. Body fat % was compared against the standards given by American College of Sports Medicine (2009). Diet and nutrient intake were assessed by 24 hour food recall. 'Overload and stress assessment' questionnaire by Girdin *et al.,* (1996) was used for stress assessment. Written consent was acquired from all participants and the study was approved by Sanjeevani ethical committee in Jaipur.

RESULTS AND DISCUSSION

Classification of responders and non-responders

After the post-treatment assessment participants were classified as responders and non-responders on the basis of "Key Recommendations *Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults: Evidence Report*, 1998" which states that adequate weight reduction is about 1 to 2 pounds per week (about 0.450 kg – 0.900 kg/ week). This quantity sums up to 1.8 – 3.6 kg /month (3.6 -7.2 kg/ 2 months) (NHLBI 1998). Subjects were assessed for their total weight reduction during the 60 days period. Subjects who were able to reduce ≥ 3.6 kg were considered as respondents (R) and those who reduced< 3.6 kg were considered as non-respondents (NR). Mean weight loss for females was higher than that for males but the difference was not statistically significant. When analyzed for subjects attending different Centers mean weight loss for CWRC (3.58 ± 2.82 kg) subjects was higher as compared to weight loss of subjects attending Gym (1.95 ± 2.84 kg) and the difference was statistically significant at 5% significance level (t =3.62). This rejected our null hypothesis that there will be no difference in the weight loss of subjects attending different combination program **(Table 1)**.

Table 1: Mean Weight Loss (kg) of Subjects

Variable	Weight (kg)	t-Test	
CWRC			3.62**
Males (n=50)	3.26 ± 2.50	0.722^{NS}	
Females (n=52)	3.75 ± 2.96		
Total (n=102)	3.58 ± 2.82		
Gym			
Males (n=50)	1.84 ± 2.32	0.361^{NS}	
Females (n=48)	2.03 ± 3.15		
Total (n=98)	1.95 ± 2.84		

**Significant at 5% **Significant at 1% level NS – Not significant*

Overall, 30% subjects were successful in achieving the target. Response rate was low among subjects attending Gym (17%) as compared to those attending CWRC (45%).

Association of various parameters with weight loss, anthropometric indices and changes in body composition

A. Family and Personal Profile: Gender was not found to have any effect on weight reduction. Among females strong association was observed for professionally engaged women and homemakers. Type of family was found to have no effect on obesity grades and weight loss. For females menstrual cycle regularity had significant relationship with obesity grades and weight loss. Presence of co-morbidities affected weight loss and obesity grade significantly **(Table 2)**.

Table 2: Association between Personal and Family Profile with Weight Loss

Variables	df	Chi-square
Marital status and weight loss response	1	8.54**
Gender and weight loss	1	0.995^{NS}
Home maker vs. Professionals and weight loss (Females)	1	10.09**
Type of family and obesity	1	0.00 ^{NS}
Type of family and weight loss	1	1.02 ^{NS}
Menstrual history and obesity grade (Females)	2	8.73**
Menstrual history and weight loss (Females)	1	8.83**
Comorbidities and weight loss	1	5.82**
Comorbidities and obesity grade	1	3.35*

**Significant at 5% level **Significant at 1% level NS –Not significant*

Strong association was observed for marital status and weight loss but not for obesity grades. Married subjects had an odds ratio of 2.77 for non-response as compared to unmarried or divorced subjects. An analysis of the marital status and body weight of 9043 adults in the US National Health and Nutrition Epidemiological Follow-up Survey (NHEFS), a longitudinal national study that interviewed and measured adults in a baseline assessment and reassessed them again in a follow-up approximately 10 years later. Men's and women's weights were differently associated with marital changes. Women who were unmarried at baseline and married at follow-up had greater weight change than those who were married at both times. Analysis of weight loss and weight gain separately revealed that socio-demographic variables, including marital change, were more predictive of variation in weight loss than weight gain. Unmarried women who married gained more weight than women married at both times. Men who remained divorced/ separated and men who became widowed lost more weight than men married at both baseline and follow-up(Sobal, Rauschenbach, and Fronqillo 2003).

B. Food Habits

Vegetarianism has been found to have strong association with weight loss response. Skipping of meals also had a strong association with response to non-response. Subjects who were not skipping meals had 2.1 times more odds of losing weight. Smoking and alcoholism among males also significantly affected weight loss **(Table 3)**.

Table3: Association of Food Habits with Response and Non-Response in Subjects

Variables	Chi-square value	df	P value
Veg. /Non-veg with Response / Non-response	3.89*	1	0.005
Skipping meals with Response/Non-response	10.67**	1	0.001
Smoking and response /Non-response (Males)	5.71**	1	0.001
Alcohol and response/ non-response (Males)	29.67**	1	0.001

**Significant at 5% level **Significant at 1% level*

A study was conducted to compare nutrient intake, diet quality and weight/adiposity measures of consumers assigned to different breakfast patterns with breakfast skippers. These associations were assessed in adults 19+ years (N=18,988) participating in the 2001-2008 National Health and Nutrition Examination Survey. Intake was determined from 1-day 24-hour dietary recall. Diet quality was quantified using the Healthy Eating Index-2005. Body mass index (kg/m^2) and waist circumferences were determined. Covariate adjusted general linear models were used to compare nutrient intakes, Healthy Eating Index-2005 scores and body mass index/waist circumference of consumers of different patterns with breakfast skippers. Consumers of the Grain/100% Fruit Juice; pre-sweetened RTEC/Lower-Fat Milk; RTEC/Lower-Fat Milk/Whole Fruit/100% Fruit Juice; and Cooked Cereal

patterns had lower body mass indexes and waist circumferences than breakfast skippers (O'Neil, Nicklas, and Fulgoni 2014).

C. Physical Activity Level

Physical activity level and rate of change of PAL (Δ PAL) has been associated with various parameters among both males and females attending CWRC and Gym **(Table 4)**.

Table 4: Correlation Values of PAL and Δ PAL With Various Parameters

	CWRC (n=102)		**Gym (n=98)**	
	Male (n=50)	**Female (n=52)**	**Male (n=50)**	**Female (n=48)**
PAL				
Age	- 0.290*	- 0.288*	-0.367*	-0.413*
Initial Weight	-0.412*	-0.294*	-0.308*	-0.279*
BMI	-0.461*	-0.294*	-0.264*	-0.274*
WC	-0.442*	-0.134^{NS}	-0.267*	-0.139^{NS}
WHR	-0.349*	-0.275*	-0.280*	-0.264*
Body Fat %	-0.302*	-0.304*	-0.314*	-0.359*
Lean %	0.146*	0.260**	0.157*	0.155*
Visceral fat	-0.148*	-0.176*	-0.186**	-0.187**-
Δ PAL				
Weight Loss	0.587**	0.492**	0.708**	0.749**

**Significant at 5% **Significant at 1% level NS – Not significant*

Initial physical activity level was found to be negatively correlated with age for all the groups, with strongest inverse association among females attending Gym (r= -0.413). Initial body weight and Body Mass Index (BMI) were also inversely related with initial physical activity level. WC had an inverse relation with PAL in males but the same relation was not observed in females. Higher PAL resulted in lower WHR among all the groups. Physical activity was also found to reduce total body fat percent, visceral fat and conserve lean body mass. Change in PAL (ΔPAL) had a strong positive relation with Δ (change in) weight i.e. the greater the change (increase) in PAL greater will be the change in weight.

A meta-analysis of 45 studies of adults (***n*** = 218,166) and nine studies of children and adolescents (***n*** = 19,268) showed that physically active adults had a 33% lower odds of obesity (***p*** = 2×10^{-13}), 19% lower odds of overweight (***p*** = 7×10^{-9}), 0.79 kg/m^2 lower BMI (***p*** = 3×10^{-15}), 2.44 cm smaller waist circumference (***p*** = 1×10^{-20}) and 1.30% lower body fat percentage (***p*** = 2×10^{-15}) than inactive adults (Kilpeläinen, *et al.,* 2011).

D. Cardio- Respiratory Fitness Parameters

Table 5: shows significant associations of cardiovascular fitness with other parameters. Resting heart rate was found to have a significant association with age, whereas a strong association with body fat per cent and visceral fat. Recovery heart rate was found to be associated with body fat per cent.

Table 5: Association of Cardio Respiratory Fitness Parameters with Other Variables

S. No.	**Variables**	**CWRC (n=102)**		**Gym (n=98)**	
		Males (n=50)	**Females (n=52)**	**Males (n=50)**	**Females (n=48)**
1	RHR and Body Fat%	0.253**	0.348**	0.290**	0.252**
2	RHR and Visceral fat	0.146*	0.383**	0.139*	0.323**
3	ReHR and Body Fat%	0.181*	0.308**	0.288**	0.142*

**Significant at 5% **Significant at 1% level NS – Not significant*

A recent study on young medical students (n=132), in India reported that resting heart rate had higher values and significantly positive correlation with obesity indices among obese group compared to non-obese individuals ($p<0.05$). A significantly higher RHR points towards an altered autonomic balance in obese young adults (Itagi *et al.*, 2014). Another study on 60 young adult subjects in the age group of 18-20 years, established a significant correlation between obesity indices like BMI and RHR, with the obese group exhibiting significantly faster RHR (Shekokar *et al.*, 2013).

E. Stress Score

High stress scores were found to be related to high total cholesterol levels and low levels of high-density lipoprotein levels in subjects. Also, there was a negative association of stress with physical activity level and weight loss in both the genders of both the centres.

Table 6: Association of Stress Score with Weight Loss

Variable	CWRC (n=102)		Gym (n=98)	
	Male (n=50)	Female (n=52)	Male (n=50)	Female (n=48)
Weight Loss	-0.254**	-0.293**	-0.201**	-0.382**

Similar results have been found in a recent study which evaluated job related stress and lifestyle variables in 91,593 workers undergoing periodic check-ups. In the bivariate analysis, job stress was significantly associated with previous dyslipidaemia diagnosis ($p< 0.001$), lipid-lowering therapy ($p< 0.001$) and altered total-cholesterol ($p = 0.001$), HDL-cholesterol ($p< 0.001$) and LDL-cholesterol levels ($p = 0.025$). After adjusting for potential confounding variables, job stress was still associated with current dyslipidaemia diagnosis (OR = 1.10; 95% CI, 1.04–1.17), high LDL-cholesterol (OR = 1.14; 95% CI, 1.05–1.23), low HDL-cholesterol (OR 1.08; 95% CI, 1.01–1.15), high total cholesterol/HDL-cholesterol ratio (OR 1.13; 95% CI, 1.05–1.23) and high LDL-cholesterol/HDL-cholesterol ratio (OR 1.11; 95% CI, 1.04–1.19) (Catalina-Romero *et al.*, 2013).

Also, physical activity level and stress scores were found to be inversely related to each other and the relation was stronger in males than females. A recent study used baseline and follow-up self-report survey data comprising a cohort of 1382 women aged 18 to 46 years, in Victoria, Australia. The study revealed cross-sectional and longitudinal associations between stress and both less leisure-time physical activity and more frequent fast-food consumption. Longitudinal associations were also found between stress and increased television viewing time (Mouchacca, Abbott, and Ball 2013).

Initial stress scores were found to have an adverse effect on weight reduction for males and females attending either CWRC or Gym. Similar results were observed in a two-phase randomized control trial, the LIFE study, which provided an intensive behavioural weight loss intervention to 472 obese (BMI -30-50kg/m^2) adults. Using logistic regression, lower stress at entry level predicted success in weight loss program ($p=0.024$) and also weight loss was significantly correlated to decline in stress ($p =0.048$) (Elder *et al.*, 2012).

F. NUTRIENT, STRESS, PHYSICAL ACTIVITY

Multiple regression analysis revealed that post intervention nutrient intake had a strong impact on weight reduction ($p=0.001$). Macronutrient composition of diet (model comprising of protein, energy, carbohydrate and fat), significantly affected weight reduction. On adding stress and physical activity level to this model the effectiveness of the intervention increased. The macronutrient model was positively correlated to weight loss ($r = 0.497$) and resulted in 24.66% variability in weight loss. The macronutrient, stress and physical activity level model had a strong association with weight loss ($r =0.649$) and was responsible for 42.13% variability.

CONCLUSION

Multiple variables affect weight reduction and a pre-assessment of an individual can help in prediction of response or non-response in weight reduction. Focal point during a comprehensive weight reduction program should not be weight loss on scale alone but also on favorable changes in body composition, fitness levels and improved nutritional status. To achieve this; well-planned

nutritionally adequate diet combined with physical activity and stress reliving techniques are a pre-requisite.

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