Assessment of Efficacy of Nutritional Therapy in Weight Management Program Using Objective Parameters and Body Composition

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The high prevalence of obesity in affluent societies coupled with an increasingly lean aesthetic ideal has resulted in unprecedented rate of dieting. Aside from physical activity, treatment of obesity has evolved dietary, pharmacological and surgical approaches. Dietary methods have included low calorie, very low calorie, dietary fat restrictions etc. These show signs of deficiencies and loss of vitality. Thus, the urge to study the impact of the intervention for Weight loss with or without adjuvant therapies surfaced. In the present study, the effect of a scientifically planned weight management program, was studied on overweight and obese adult women of all the age groups. It concludes that reduction in body weight is possible when a negative calorie balance is created in the body, irrespective of variations in the support group of the treatment.

Key Words - *Pharmacological, Dietary methods, Obesity*

Introduction

Ethnic groups in many industrialized countries appear to be attended by obesity as a result of modernization and urbanization. Genetic predisposition for obesity suggested to be a factor that only becomes apparent after exposure to a modern lifestyle. (A.O.A. Fact Sheet, 2002). Clearly, efficacy of the scientifically planned strategies for body weight management needed to be studied thoroughly. An ideal kind of intervention should successfully result in weight reduction and help to obtain ideal body composition, maintain metabolic rate and correct waist- hip ratio towards a safer range.

The effect of a scientifically planned weight management program, which was considered ideal as per the above guidelines, was studied during the research study on overweight and obese adult women of all the age groups. The study was conducted in an established and registered center for health and fitness. The selection of the subjects was done through purposive sampling method. The inclusion criterion was females of 18 years and above ages with no medical complications joining for the weight reduction in this center.

Objective

In search of a scientifically planned method of weight reduction which would be non-detrimental to wholesome health status in the long term besides imparting support to achieve the desired physiological parameters, the present study was taken up.

Material & Method

The study was conducted in a globally established and registered centre for health and fitness. The selection of subjects was done through purposive sampling method. The inclusion criterion was females of 18 yrs and above age with no medical complication joining for weight reduction program in this centre. Total number of subjects studied over a time period of 1 year, were 2000. Out of which data of 1050 subjects who adhered to the program till the planned treatment period, were finally retained for the study purpose.

Duration of the treatment was for a minimum of 8 weeks and above, depending of the total weight loss required. The planned speed of weight loss was 1- 1.25 Kg /week.

3 Groups were run. The first group received appliance session (passive exercise) for 1- 1 ½ hr thrice/week, second group received appliance session with aroma oil treatment in 1: <1 ratio and third group received appliance session with aroma oil treatment in 1:1 or 1: >1 ratio.

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All the groups received dietary modifications along with lifestyle modifications with regular active exercises and were monitored subsequently thrice/ week.

The parameters assayed were as follows:

1. Total reduction in body weight
2. Total reduction In Body Mass Index (BMI)
3. Changes in Waist Hip Ratio (WHR)
4. The indices of body components i.e., Lean body mass, Fat Mass and water mass, expressed in Kg and in percentages.
5. Changes in Basal Metabolic Rate (BMR) in calorie
6. Nutritional Parameters
    - Assessment of normal dietary behavior in terms of deviation in the actual intake from the recommended dietary allowances (RDA) of macronutrient proportions.
    - Formulating absolutely individualized diet prescriptions. The line of intervention followed in the study was based on creating total dietary calorie deficit with regards to balanced proportion of macro nutrients i.e. energy, protein, carbohydrate and fat.

Statistical Analyses:

Cross tabulation was used to perform bivariate analysis between selected variables, with statistical significance based on chi square tests for independence. The t test method was used for testing difference in means. Standard error was calculated for each variable. Analyses were based on the result of 1050 participants who completed both baseline and minimum of 8 weeks data screening. Procedure statements used for analyzing the data were PROC UNIVARIATE, PROC FREQUENCY, PROC T TEST and PROC ANOVA.

Result and Discussion:

All of the weight reduction techniques resulted in significant loss of body weight which in turn influenced BMI, WHR, BMR and body composition of the subjects undergoing the intervention program. The resultant changes that occurred at the final stage of the study can be briefly summarized under following heads presented below:

1. Anthropometric analyses
2. Body composition analysis
3. Basal metabolic rate
4. Dietary modifications

The complete data of the present study has been subjected to appropriate statistical tests and interpreted in tables below. The result of the study is presented under following subheads:

1. Anthropometric analyses:
    - Weight Reduction
    - Body mass index (BMI)
    - Waist Hip Ratio (WHR)
2. Body composition analysis:
    - Fat percent
    - Fat mass
    - Lean percent

- Lean mass
- Water percent
- Water mass

3. Basal metabolic rate
4. Dietary modifications

In an effort to become precise and focused, incorporating the entire relevant data did not seem practically possible. Hence, detailed discussions on following parameters have been avoided.

- Weight Reduction
- Fat Mass
- Lean Mass
- Water Mass

Relative variations of above indices are also reflected in other indices that are discussed in detail. Namely, Body mass index, Fat Percent, Lean percent and Water percent.

Anthropometric Analyses:

1-a. Body Mass Index (BMI

A decline in body mass index occurred that paralleled the direction and magnitude of the progressive decrease observed in body weight reduction. This indicates that line of treatment in all the groups had the ability to provide weight loss to the subjects.

Resultant decline in BMI between groups suggests that changes that occurred in BMI of the subjects at the final stage of the treatment in all the groups is statistically highly significant (p=0.000). Mean BMI reduction in group M to M2 is in ascending order. Similar findings were noticed in percentages of differences.

This trend of change can be explained by the resultant findings in weight loss. Since weight reduction reduced in ascending order from group M to M2, subsequent change in BMI can be accepted to be in similar manner.

A comparative study of the methods of treatment across the treatment groups and age-groups has been carried out by analyzing the mean value of BMI and statistically interpreting the results. Correlation and regression analyses were performed to examine anthropometric change through variation of treatments. The data is presented in table 1 below:

Table 1 : Tests of Between-Subjects Effects Dependent Variable: BMI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1267.424(a)	14	90.530	3.987	.000***
Intercept	437858.123	1	437858.123	19284.134	.000***
Group	450.903	2	225.451	9.929	.000***
Age Group	397.730	4	99.433	4.379	.002**
Group * Age Group	211.982	8	26.498	1.167	.316
Error	23500.311	1035	22.706		
Total	892150.811	1050			
Corrected Total	24767.736	1049			
a R Squared = .051 (Adjusted R Squared = .038)					

The statistical significance is represented as *p=<0.05 **p = <0.01 ***p = <0.001

Table No. 2 : Tests of Between-Subjects Effects Dependent Variable: WHR

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.253(a)	14	1.807E-02	3.943	.000***
Intercept	487.399	1	487.399	106378.532	.000***
Group	1.166E-03	2	5.831E-04	.127	.881
Age Group	.187	4	4.668E-02	10.188	.000***
Group * Age Group	2.120E-02	8	2.650E-03	.578	.796
Error	4.673	1020	4.582E-03		
Total	935.794	1035			
Corrected Total	4.926	1034			
a R Squared = .051 (Adjusted R Squared = .038)					

The statistical significance is represented as*p=<0.05 **p = <0.01 ***p = <0.001

Table 1 illustrates the statistical analysis of the correlation of the resultant decline in BMI between groups which suggests that change in BMI of the subjects is statistically significant (p=.000). Result of the tests also suggests that the changes observed in between age groups are also statistically significant (p=.002).

This means reduction in BMI varies according to the type of treatment as well as the age groups. However, no significant effect was seen in treatment groups across the age-groups.

The data indicate gradual increase in mean BMI values along with advancement of age irrespective of the line of treatment given. BMI values increase with both age (Bray, 1987) and body fatness (Key et al 1972) assessed in the current study.

Waist Hip Ratio (WHR)

Mean difference in WHR of the subjects between the baseline and the final reading was compared. It was found that the mean difference in WHR was highest in group M2 and lowest in group M. The changes were statistically significant in Group M1 and M2 (p = 0.022 and 0.001 respectively), but insignificant in treatment in Group M (p = 0.331). Probably, this suggests finding that WHR needs specific treatment to be corrected to the ideal range.

The effectiveness of the method of treatment and correlation of the changes in WHR between groups and age groups has been assessed by comparing the mean values and statistically interpreting the results. The result is presented in table no 2

The significance of the correlation of changes in WHR of the subjects between age-group, treatment group and age group * treatment group was tested through application of ANOVA technique. It is observed from the values presented in table 2 that the between group effect of changes in WHR is statistically insignificant (p = 0.881). This finding indicates that no particular treatment group can be adjudged most effective in giving positive changes in WHR.

Interaction between groups and age groups doesn't show any significant difference (p = 0.796). It means changes in WHR are similar in all three treatment groups across the age groups.

However, changes in WHR in various age groups are significant (p = 0.000).

This finding is supported by few other studies presented below. Antonia had found that in women neither energy intake nor energy expenditure were associated with the WHR in any way other than that mediated through BMI. **(**Antonia, 2002)

Since the changes in WHR were indicated to be age dependent, the effectiveness of the treatment in WHR in various age categories has been statistically interpreted. The results illustrated that mean values of WHR of the subjects at the final level were increasing with age in all the treatment groups except for the age-group 40-49 yrs.

This suggests that WHR increases in higher age-groups along with increase in body fat mass as the women reach pre-menopausal, menopausal and post menopausal stage. This finding is also supported by the cross-sectional studies of **Shimokata et al (1999)** and **Tuemelehto et al(1990)** which indicates that whereas the most significant increase in abdominal girth occurs in the post menopausal period, women begin to gain body fat before menopause,

and that excess adipose tissue is increasingly stored in the abdominal area as women approach menopause.

This finding is supported by various studies stating that body fat percent increases with advancement of age. One of them is presented here. Carol stated that abdominal obesity, as measured by the waist-to-hip ratio, atherogenic lipid profiles and the development of CVD in women, especially in the late premenopausal and early postmenopausal periods. **(Carol, 2004)**

Body Composition Analysis:

The effect of three methods of weight reduction on body composition was studied. The mean initial and final values of body composition parameters have been statistically interpreted. After assessment of changes in the body components resulting in all treatment Groups, the findings are described below:

Effect of The Treatment in Three Groups

Group M

- Mean fat percent and fat mass between baseline and final had declined significantly in **group M** ($p = 0.000$).
- In Mean Lean Percent and Mean Lean Body Mass showed an increase at the end, although difference was statistically insignificant ($p = 0.325$ or < 0.05).
- Mean Water Percent and Mean Water Mass at the final level depicted an increase of highest level of significance ($P = 0.000$). The change was found to be highly significant ($p = 0.000$).
- BMR has reduced at the final level. This reduction was indicated to be of highly significant level ($p = 0.000$).

Group M1

- Mean fat percent and the fat weight reduction was highly significant ($p=0.000$).
- Mean lean percent had increased from the baseline to the end. This rise was tested to be statistically significant ($p=0.000$). In case of lean body mass, although the increase is indicated to be insignificant ($p=0.143$), in view of loss of total body weight it can be considered that marginal increase in lean mass resulted in sharp rise in lean mass percent.
- Mean Water Percent and Water Mass was found to have increased during the course of treatment, which is statistically significant ($p = 0.007$).
- BMR had decreased significantly ($p = 0.000$).

Group M2

- Mean fat percent and mean fat mass at the final level reduced and was indicated to be statistically highly significant ($p = 0.000$).
- Mean lean percent increased significantly ($p = 0.000$). Mean lean weight also showed increase, but this change was indicated to be statistically insignificant ($p = 0.848$).
- The mean water percent increased significantly ($p = 0.000$) with this treatment. There was insignificant ($p = 0.245$) gain in water mass.
- BMR has decreased significantly ($p = 0.000$).

Comparison of Observations Between Treatment Groups

The Comparison of the observations between treatment groups indicates the following:

- BMI reduces in all the treatment groups as significant weight loss was observed in all treatment groups in ascending order from group M to M2.
- It also suggests a significant variation in the dependent variable **fat mass and percent**. Fat percent and fat mass declines significantly with weight loss irrespective of the treatment group.
- Mean reduction in fat percent rises in ascending order from group M to group M2. The percentage of reduction also shows similar results. These reductions are statistically significant.

- Gradual increase with age advancement in the total values of mean fat percent was observed although there is variability of the values among the treatment groups.
- There is a significant difference in the resultant **fat mass** of the subjects in various treatment groups across the age groups. Similar to the changes found in the value of fat percent, the fat mass depicts increase in ascending order with increase in age.
- This shows effectiveness of the treatment in this weight reduction program. It proves that anti-cellulite treatment helps reducing fat. The more is the frequency of this treatment the more is the fat loss.
- Various age groups showed significant difference in changes in fat mass scores. The difference is observed among all the groups across the age groups.

This finding establishes the hypothesis that significant fat loss occurs during weight loss when the method is scientifically sound and the support of anti-cellulite treatment helps in enhancing the positive effect.

This also proves the hypothesis that total body fat mass increases with age. The hypothesis that changes occur in body composition along with reduction in body weight is supported by various other studies. Few of them are presented here.

A negative body fat composition happens when we lose the same or a larger percentage of lean weight to fat weight (www.weightlossforall.com,2005).

Van Loan, in 2002 studied the effect of exercise and concluded that the combination of moderate energy restriction and either resistance or aerobic exercise induces significant reductions in visceral and subcutaneous adipose tissue and are thus effective means of reducing total and upper-body obesity in obese women (Van Loan,2002).

Fat Percent

Statistical analysis and interpretation of mean changes in body fat, based on various age groups was performed. The correlation of the changes in Fat Percent between the treatment groups and age groups has been assessed by comparing the mean values and statistically interpreting the results. The result is presented in table no 3.

Table 3 Tests of Between-Subjects Effects Dependent Variable: FAT PERCENT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3254.446(a)	14	232.460	5.621	.000***
Intercept	639502.858	1	639502.858	15464.714	.000***
Group	595.510	2	297.755	7.200	.001**
Agegroup	1087.785	4	271.946	6.576	.000***
Group * Agegroup	510.902	8	63.863	1.544	.138
Error	42799.721	1035	41.352		
Total	1295851.858	1050			
Corrected Total	46054.167	1049			
a R Squared = .071 (Adjusted R Squared = .058)					

The statistical significance is represented as*p=<0.05 **p = <0.01 ***p = <0.001

Table 3 suggests a significant variation between the treatment groups across the age groups in the dependent variable fat percent. It also demonstrated that, body fat percent of the subjects increase gradually with age advancement in the total values although there is variability of the mean fat percent in the treatment groups.

Therefore, it can be stated here that combination of moderate energy restriction and either resistance or aerobic exercise induces significant reductions in visceral and subcutaneous adipose tissue and are thus effective means of reducing total and upper-body obesity in obese women.

Lean Percent

The effect of various treatment lines on the dependent variable lean percent and the corresponding changes and the correlation among treatment groups, age groups and age groups*treatment groups were analyzed and statistically interpreted. The results are presented in table 4.

Table 4 : Tests of Between-Subjects Effects Dependent Variable: LEAN PERCENT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3249.187(a)	14	232.085	4.002	.000***
Intercept	2286283.861	1	2286283.861	39421.469	.000***
GROUP	837.466	2	418.733	7.220	.001**
AGE GROUP	1010.472	4	252.618	4.356	.002**
GROUP* AGE GROUP	685.284	8	85.661	1.477	.161
Error	60025. 764	1035	57.996		
Total	4493166.331	1050			
Corrected Total	63274.951	1049			
a R Squared = .051 (Adjusted R Squared = .039)					

The statistical significance is represented as*p=<0.05 **p = <0.01 ***p = <0.00

The result achieved through the application of ANOVA technique presented in table 4 showed that lean percent differ significantly (p = 0.001) between three groups. The mean values of this variable show significant changes between base level and final readings. The differences are statistically significant (p = 0.000) in all the groups. The mean lean percent observed to be gradually increasing towards lower age groups. This variability was also found to be significant (p = 0.002).

In the Nutrition Reviews, June 92;medline, it is reported that data from both human and animal experiments show that exercise cannot conserve lean weight in the face of significant energy deficit. **(www. Medline-adiposity).** Therefore, it can be assumed here that the dietary modifications advised to the subjects were nutritionally balanced and complete with regards to all the macro and micronutrients.

The **interaction between age groups and treatment groups** however was not found to be significant. This finding suggests that average lean mass percent in the body reduces with age and this is independent of the any other supportive treatment as far as regular exercise and well balanced diet schedule is followed.

Statistical analysis and interpretation of the mean changes in body component lean percent based on age groups were performed. It is observed from the analyses that lean percent in the final stage is higher in younger age groups and it decreases with advancement of age. The assessment of treatment-wise effect suggests that

- Lean Body Mass has increased in all the treatment groups.
- Lean percent was observed to increase in ascending order from group M to M2 and the changes in all the groups are highly significant (p=0.000).
- The increase in Lean Body Mass (LBM) of the subjects was observed to be indirectly proportionate to the reduction in fat mass. The mean lean percent observed to be gradually increasing towards lower age groups.

- The variability in Fat Mass in age groups also found to be significant (p = 0.002). It is observed that lean percent in the final stage is higher in younger age groups and it decreases with age.

Probably, the positive changes in **LBM** can be explained by the significant reduction in fat percent and these positive changes in body composition can be attributed to the effectiveness of the treatment.

A positive change in body composition resulted in a gradual reduction of body fat stores, while maintaining as much lean body weight to keep the metabolism high. The retention of Lean Body Mass can be the effect of regular systematic active exercise schedules as well as passive exercise schedules through appliances.

Water Percent

To test the significance of the changes in water percent of the body between treatment groups, age groups and age * treatment groups statistical analysis was performed and the Interpretation is presented in table 5.

Table 5 : Tests of Between-Subjects Effects Dependent Variable: WATER PERCENT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1628.465(a)	14	116.319	2.341	.003**
Intercept	1259736.145	1	1259736.145	25349.184	.000***
GROUP	438.938	2	219.469	4.416	.012*
AGE GROUP	552.623	4	138.156	2.780	.026*
GROUP* AGE GROUP	269.678	8	33.710	.678	.711
Error	51434.669	1035	49.695		
Total	2482443.101	1050			
Corrected Total	53063.134	1049			
a R Squared = .031 (Ad justed R Squared = .018)					

The statistical significance is represented as*p=<0.05 **p = <0.01 ***p = <0.001

Table 5 illustrates the interactions of water percent between various parameters. Statistical analyses illustrate the scores of changes in **water percent** between treatment groups is significant (p= 0.012). This probably suggests that with weight loss, percentage of fat mass and lean mass change, subsequent change in the water percent can also occur. This can happen only if the method of treatment is based on absolute scientific principles so that general health status is maintained. The changes in water percent across the age groups demonstrated to be statistically significant (p=.026). It was discussed earlier that water percent declines as the age advances. This trend was observed in all the three groups.

However, no significant correlation was found among the treatment groups across the age groups. Improvement in the proportion of body components is indicative of better health status, which further indicates effectiveness of the intervention. As the total body weight reduced along with significant reduction in fat percent and fat mass during the treatment, subsequent reduction in lean body mass and water mass may be justified. But with the right kind of intervention the scores of these variables should be improved towards better health status.

In the present study changes in these parameters was towards positive. Probably this explains the rise in body water percent and percent lean mass in spite of insignificant gain in the total weight of these variables.

Basal Metabolic Rate:

The correlation of the changes in Basal Metabolic Rate between the treatment groups and age groups has been assessed by comparing the mean values and statistically interpreting the results. Results represented that the total reduction of mean BMR value at final stage was minimum in group M and maximum in group M2. The result of statistical application suggests that this reduction is significant in all the treatment groups (p= 0.000).

A comparative study of the intervention across the treatment groups and age-groups has been carried out by analyzing the mean value of BMR and statistically interpreting the results. The correlation of changes in basal metabolic rate occurring in different age groups, treatment group and age * treatment group are presented in table 6.

Table : 6 Tests of Between-Subjects Effects Dependent Variable: BMR

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3971394.690(a)	14	283671.049	4.105	.000***
Intercept	1223429446.984	1	1223429446.984	17704.323	.000***
Group	291107.247	2	145553.623	2.106	.122
Age Group	1712290.979	4	428072.745	6.195	.000***
Group* Age Group	2105126.592	8	263140.824	3.808	.000***
Error	71522049.673	1035	69103.430		
Total	2436004863.000	1050			
Corrected Total	75493444.363	1049			
a R Squared = .053 (Adjusted R Squared = .040)					

The statistical significance is represented as*p=<0.05 **p = <0.01 ***p = <0.001

The figures presented in table 6 establish, that there exists a correlation between age group and BMR. It represents that mean BMR reduced with age in all the treatment groups. The effect is of a higher significance level (P=.000). The relationship between treatment groups and age-groups is also significant. However, any significant effect of the type of intervention of weight loss on changes in level of BMR was not observed. Probably, this trend of reduction is suggestion of a correlation between decline in BMR and weight reduction. As it was described earlier that the total reduction of body weight at the final stage was lowest in group M and highest in group M2, it can be correlated with the subsequent reduction in BMR.

Statistical analysis and interpretation of mean changes in Basal Metabolic Rate based on various age groups was performed. The results of age group and treatment group wise effects on the mean BMR was found to reduce with increase in age in all the treatment groups. Precisely, it can be stated here that Basal metabolic rate reduces with the reduction in weight and advancement of age. According to Ravussin, approximately one half of the 24 EE reduction (1590 kJ/d) was accounted for by a decrease in RMR, the latter being mainly accounted for by a reduction in FFM **(Ravussin, 1985).**

Individuals with a larger body mass naturally require more energy to maintain that mass. However the calorie-burning effect of a larger body mass is not simply linear, because overweight individuals also have an elevated metabolic rate. For each kilogram of weight lost, metabolic rate has been seen to drop by 20 calories per day. **(Boselo, 1998)**

Dietary Modifications:

Assessment of actual dietary practices of the subjects showed it to be significantly high in calories but still not balanced in terms of macro and micronutrients. It also indicated that there was higher intake of simple carbohydrates and fat against significantly lower intake of protein. Dietary modifications prescribed to the subjects were based on Recommended Dietary Allowances (RDA) of macro nutrients and micro nutrients proportions suitable for various age groups, level of fitness, level of activity and lifestyle. The total calorie requirement was calculated based on measured actual BMR of the subjects considering lifestyle and regular exercise schedules of the subjects making necessary calorie deduction to create a negative calorie balance for desired weight loss.

As far as the micronutrient proportions were concerned, the proportions were fixed as presented below:

- Proteins were kept 30-40% of prescribed total calorie to be consumed.
- Carbohydrates were fixed for 45-65% total calorie, complex carbohydrates forming the most part of it.
- Calories to be derived from fats were fixed 15-**20%** total calorie consumption**.**

The diet plans were absolutely individualized based on the calorie deficit required for weight loss and prescribed nutrient ratio. The functional foods and anti oxidants were also taken into consideration to boost the immunity and strength.

Figures 4.1 to 4.6 show the bar diagrams to depict the comparative analyses of the actual dietary intake of the macronutrients and modified intake of the macronutrients during the study period.

Adherences to the prescribed diet and exercise schedule by the subjects were monitored thrice a week. The corrective measures were taken to compensate for the inter session deviations to maintain the calorie deficit required to achieve the target weight loss.

Conclusion

In the light of existing literature and the observation of the present study following conclusions emerge:

1. Reduction in body weight is possible when a negative calorie balance is created in the body, irrespective of variations in the support group of the treatment.
2. Combination of aroma oil therapy and passive exercises is effective in cellulite control and therefore accelerates the process of weight loss and subsequently improves the BMI, WHR, BMR and body composition.
3. WHR indicated to be age dependent. This variable increases with age. As trend of an increase in body fat mass with advancement of age was observed, it could be concluded here that WHR is directly proportionate to gain in fat mass. Apparently, WHR is influenced towards positive reduction of the score, whenever supported by anti cellulite therapy through aroma oils although not always statistically significant.
4. In spite of significant weight reduction, lean body mass can increase if proper care is taken regarding physical exercises, dietary and lifestyle modification.
5. Decline in fat percent can be directly proportionate to the reduction in BMI and increase in lean percent is indirectly proportionate to decrease in fat percent.
6. Total body water mass increases with improvement in the ratio of body fat and lean body mass.
7. In view of total weight reduction through an intervention program, increase in lean body mass and water mass may not be significantly evident. But as a whole percentage of these body indices rise significantly.
8. Basal metabolic rate falls with reduction in body weight in spite of significant gain in lean body mass. The reduction in resting metabolic rate can be attributed to a reduction of body mass. Interestingly, a decrease in resting metabolic rate is not seen when body weight is expressed as “calorie per kilogram.
9. In case of obese people who are physically unfit for performing strenuous exercises, passive exercises can be advisable as a support therapy.

Recommendations

1. Calorie restriction has been the cornerstone of obesity treatment. To effectively intervene, dietetic professionals and other healthcare professionals need to address both sides of the energy balance equation while counseling patients. The focus on energy intake should not supersede the promotion of a physically active lifestyle. Incorporating appropriate and sufficient physical activity into one's life is an essential component of achieving a healthful body weight and body composition.
2. While reducing weight, care should be taken that the negative calorie balance is created in a way that stress is neither on exercise nor on dietary modification but a holistic approach is applied which includes psychological counseling and necessary lifestyle modification manifold.
3. Decline in fat mass results in subsequent reduction in WHR. Therefore, reducing body fat percent through self monitoring with regards to dietary modification, physical activity and lifestyle modification will lead to correction of WHR.
4. Periodical analysis of body composition is advised during weight loss program for assessment of health and efficacy of the treatment, so that corrective measures can be taken accordingly.
5. Among nutritional parameters protein intake should be monitored as this macronutrient will aid to maintain lean body mass hence avoidable reduction of lean body mass could be assured. Restoration of lean body mass influences the basal metabolic rate positively. Subsequently, the elevated BMR will check weight gain.

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