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☐ Original Article ☐

The Effect of an Energy Restriction Program on the Weight Loss and the Change of Biochemical Nutritional Status in Obese Women*

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ABSTRACT

This study was conducted to investigate the effect of an energy restriction program on the weight loss and changes of the biochemical nutritional status for 35 obese women. The energy restriction program took place over a 3-week period that was devided into two parts. The first part consisted of 750 - 800kcal diet and the second part of 800 - 1000kcal. Subjects were provided a low energy formula and a menu for the recommended diet. Anthropometric and biochemical measurement before and after the energy restriction program were estimated. Mean weight loss was 3.0kg, accordingly the obesity rate was lowered from 40.2 to 34.4, BMI from 29.2 to 28.9 and fat weight from 23.3kg to 21.0kg($p<0.01$, $p<0.05$). Waist circumference loss was most prominent(4.4%) compared to triceps(2.1% loss) and hip circumference(2.2% loss). Mean RBC count, hemoglobin and hematocrit were significantly lowered($p<0.01$) but they were in the normal range. Systolic blood pressure was significantly decreased from 124.1mmHg to 113.1mmHg. Mean SGOT and SGPT were lowered from 29.3u/L to 20.0u/L and from 28.7u/L to 16.6u/L, respectively.

It seems that the 3 weeks of energy restriction program used in this study was effective in improving anthropometric measurements without producing deficiency of iron or other susceptible nutrients. (*Korean J Community Nutrition* 2(5) : 695~700, 1997)

KEY WORDS : obese women · energy restriction program · anthropometric measurements · biochemical parameters.

Introduction

Obesity is an accumulation of an excessive amount of fat in the adipose tissue(Bray 1990) and the number of obese people is increasing in Korea due to changes of meal patterns to western style.

A National Nutritional Survey done in 1992 showed that the proportion of subjects whose BMI was higher than 25, usually regarded as overweight or obese, were 19.4% and 19.9% for male and female, respectively(Division of Health and Wellfare 1992).

The primary health conditions associated with obesity is hypertension(Blair et al. 1984), diabetes(Toeller & Grie 1982), cancer and atherosclerosis(Larsson et al. 1984).

Very Low Calorie Diets(VLCD) are generally regarded as being safe under proper medical supervi-

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Table 1. Diet program

	Breakfast	Midmorning snack	Lunch	Mid afternoon snack	Dinner	Total
First part (1 - 10days)	Formula* (125kcal)	Snack (50kcal)	Recommended diet (400 - 450kcal)	Snack (50kcal)	Formula* (125kcal)	750 - 800kcal
Second part (11 - 21days)	Recommended diet (200 - 300kcal)	Snack (50kcal)	Recommended diet (400 - 450kcal)	Snack (50kcal)	Formula* (125kcal)	800 - 1000kcal

sion with supplements of complete protein, vitamins and minerals and have been effective in inducing rapid weight loss in very obese patients(Jong Ho Lee 1993).

However there may be some contraindications to their use like hunger, weakness, deficiency of microminerals and rapid weight loss(Williams 1992).

Low Calorie Diets(LCD) providing about 1200 kcal, are ideal ways recommended by health professionals.

Dietary fiber like galactomannan and glucomannan swell in the stomach and give feeling of satiety. Therefore a commercial formula including dietary fiber can be effectively used to control appetite and food intake.

This study was conducted to investigate the effect of an energy restriction program using a low energy formula including dietary fiber for 35 obese women over a period of 3 weeks.

Subjects and Methods

1. Subjects

Fifty obese(OR> 20%) females aged 20 - 50y were recruited from Pucheon area for the present study. All subjects were apparently healthy according to the results of medical examination performed by a physician and had no reported medical illness like diabetes or hypothyroidism.

Thirty five women completed the 3-week energy restriction program. Seven of them were students, five of them were office worker and twenty three of them were housewives.

2. Experimental design

The study lasted 4 weeks. The first week was considered baseline, during which anthropometric measurements, mean activity level and biochemical measurements related to obesity were estimated.

After this period, the subjects followed the diet program for 3 weeks. All measurements were repeated at the end of this 3-week period.

3. Diet

The energy restriction program took place over 3-week period that was devided into two parts(Table 1).

The first part consisted of a low energy formula* (Kwang Dong co. 1996) for breakfast and dinner and recommended diet for lunch and snacks for 10 days. Subjects were free to choose food containing the same amount of exchange suggested in the recommended diet.

One low energy formula* provided 125kcal, 4.4g of fiber and micronutrients. The micronutrients contents met 50 - 70% of Korean recommended daily intake.

Recommended total energy intake of the first part was 750 - 800kcal. During the entire periods subjects were instructed to record their food intake.

The second part consisted of a low energy formula for dinner and recommended diets for breakfast, lunch and snacks for eleven days.

Recommended total energy intake for the second part was 800 - 1000kcal.

4. Activity

Subjects were recommended to do their usual work. Their activity for one day were classified into 20 kinds and subjects were asked to write down the length of activity. Their activity level were calculated with the means of Lee & Moon(1993).

*One bag of low energy formula contained 15.4g of protein, 15.3g of carbohydrates, 0.23g of lipid, 4.4g of fiber, 35.0mg of ascorbic acid, 0.5mg of thiamin, 6.2mg of riboflavin and 1.1mg of vitamin B_6.

5. Anthropometric measurements and blood pressure

Anthropometric measurements were composed of skinfold thickness for triceps, subscapular and suprailiac and circumferences of waist and hips.

Fat percent was measured with bio-electrical impedance fattness analyzer(Gilwoo trading, GIF-891, 1994).

Systolic and diastolic blood pressure were measured with sphygmomanometer after 10 hours of fasting.

6. Biochemical analysis

Fasting blood samples were obtained from the subjects by venipuncture. RBC count, Hb and Hct were measured with coulter counter(Coulter T890, 1994) to assess the iron status.

Serum ferritin was measured with use of the two-side immunoradiometric assay(Addison et al. 1972) and TIBC was analyzed by the Nitroso-PSA method (Tietz 1982).

25-OH vitamin D_3(Omdanl et al. 1977) and serum folic acid(Mincey et al. 1973) were measured with use of radioimmuno assay.

The activity of alkaline phosphatase(ALP) was analyzed by using a biochemical autoanalyzer using the BM ALP kit(Hitachi 747 Japan Hitachi co.).

Serum zinc was analyzed with AAS(Atomic Absorption Spectrophotometer) and insulin level was measured by radioimmuno assay using INC kit(Wilson & Miles 1977)(Immuno Nucleo Cooperation USA).

7. Statistical analysis

Statistical analysis was done by using the Statistical Analysis System(SAS). Data was expressed as the mean ± standard deviation. The difference of the means before and after the diet program was analyzed statistically by paired-t-test at $\alpha=0.05$.

Results and Discussion

1. Changes in anthropometric parameters and activity level

Mean age of the subject was 40.9y(20 - 58y).

Before the diet program, the mean weight and PIBW were 72.7kg and 140.2% respectively, which are classified as moderate obesity by Lee(1992).

The subjects showed a mean BMI of 29.2 regarded as degree 1 obesity(Lee & Nieman 1996) and showed a mean body fat percentage of 31.7%.

The mean weight loss was 3.0kg after 3 weeks of the energy restriction program, accordingly the obesity rate of subjects was lowered from 40.2 to 34.4, BMI from 29.2 to 28.0 and fat weight from 23.2kg to 21.0kg(Table 2).

Body weight loss is composed of water, protein and fat loss. This study showed significant fat weight loss of 2kg. It seems that weight loss of 3.0kg was largely due to fat weight loss.

Energy used for the activity of the subjects was 17.7kcal/kg per day before diet program and it was nonsignificantly changed after diet program.

When the weight loss and other anthropometric data were analyzed by age group, the largest loss of weight and lowering of the obesity rate and BMI were observed in the 20 - 30y group. It seemed that the reducing diet program was more effective in the younger group(Table 3).

The group in the forties showed 2.9kg of weight loss and largest loss in fat weight(Table 3). Waist cir-

Table 2. Changes of weight, fat percentage and other anthropometric indices (N=35)

	Before diet program	After diet program
Weight(kg)	72.7± 7.6	69.7± 7.9**
Obesity rate(%)	40.2±15.0	34.4±15.7**
BMI(Body mass index)	29.2± 2.9	28.0± 3.1**
PIBW(%)	140.2±15.0	134.4±15.7**
Body fat%	31.7± 4.7	29.8± 8.6
Fat weight(kg)	23.2± 4.9	21.0± 7.5*
SBP(mmHg)	124.1± 3.9	113.1± 3.4**
DBP(mmHg)	79.4± 7.2	78.0± 9.0**
Activity(kcal/kg)	17.7± 5.5	17.6± 1.0

*$p<0.05$ **$p<0.01$

Table 3. Mean changes of anthropometric data according to age (N=35)

Age	Weight (kg)	Obesity rate(%)	BMI	Fat weight (kg)
20 - 29(N=7)	- 4.2	- 7.6	- 1.6	- 1.8
30 - 39(N=3)	- 3.5	- 7.4	- 1.5	- 1.9
40 - 49(N=18)	- 2.9	- 5.5	- 1.1	- 3.2
≥50(N=7)	- 3.0	- 3.9	- 0.8	0.6

Table 4. Changes of anthropometric measurements (N=35)

Variables	Before diet program	After diet program
Circumference(cm)		
Arm	32.2 ±2.6	61.5 ±2.7**
Waist	89.4 ±8.3	85.4 ±5.9**
Hip	104.8 ±5.2	102.4 ±4.6**
WHR[a]	0.85±0.06	0.83±0.06**
Skinfold thickness(mm)		
Triceps	29.4 ±4.4	29.1 ±4.2
Subscapular	39.6 ±7.3	35.6 ±6.7**
Suprailiac	35.7 ±8.4	31.0 ±7.3**

a) WHR : Waist Hip Ratio *$p<0.05$ **$p<0.01$

cumference loss was most prominent(4.4% loss) compared to arm(2.1% loss) and hip circumference(2.2% loss)(Table 4). Hip circumference was reduced from 104.8cm to 102.4cm.

As a result, WHR(Waist Hip Ratio) declined from 0.85 to 0.83. WHR is used as an indice showing body fat distribution. It was reported that females whose WHR was higher than 0.85 showed increased risk of having a cardiovascular disease(Lee & Nieman 1996).

A significant decrease in skinfold thickness of subscapular and suprailiac were observed($p<0.01$).

Suprailiac skinfold thickness was decreased from 35.7mm to 31.0mm(13.1% decrease) and subscapular skinfold thickness was lowered from 39.6mm to 35.6mm(10.1% decrease) after the diet program. It seems that the decrease of waist circumference is related to suprailiac skinfold thickness loss. Both of the measurements are associated with the amount of abdominal fat(Table 4).

Each age group showed a different loss in measurements of circumference and skinfold thickness.

The greatest mean decrease of arm circumference (1.4cm decrease) and hip circumference(2.7cm decrease) were observed in the groups in the thirties and the forties, respectively.

The groups in the thirties and the fifties showed the largest decrease in the mean subscapular skinfold thickness(5.9mm loss) and suprailiac skinfold thickness(4.6mm loss), respectively(Table 5).

2. Changes in biochemical parameters

The mean Hb and Hct of subjects before the energy restriction program were 14.5g/dl and 41.9%. That showed similar data to the of Nam & Lee (1992). No one was observed to be below 12g/dl of Hb or 35% of hematocrit(reference of WHO for iron deficiency 1972).

The mean RBC count, hemoglobin and hematocrit were significantly lowered after 3 weeks of the diet program. That means the iron nutritional status of the subjects progressively declined. However the indicators of iron status were within the normal range. No one was observed to be below 12g/dl of Hb and 35% Hct after the energy restriction program (Table 6).

The mean ferritin concentration was 32.0ng/ml before the diet program, which was higher than the data of 20.7ng/ml observed by Joeng et al.(1991). It was not significantly changed after the diet program.

Eventhough it is known that folic acid deficiency is a second factor resulting in anemia for females, folic acid deficiency is frequently observed in low calorie dieting(Colman 1977), serum folic acid did not show any significant difference after the energy restriction program(Table 7).

Serum alkaline phosphatase and 25-(OH) vitamin D_3 were measured to see if vitamin D deficiency had developed after the 3 weeks of the low energy diet.

Both mean serum alkaline phosphatase and 25-(OH)

Table 5. Changes of anthropometric measurements after diet program according to age (N=35)

Age	Arm circumference (cm)	Hip circumference (cm)	Waist circumference (cm)	Subscapular skinfold thickness (mm)	Suprailiac skinfold thickness (mm)
20-29(N=7)	1.0	-2.2	-6.1	-4.3	-4.6
30-39(N=3)	-1.4	-2.1	-3.9	-5.9	-4.3
40-49(N=18)	-0.5	-2.7	-3.8	-3.9	-4.6
≥50(N=7)	-0.5	-2.6	-3.0	-2.4	-5.4

Table 6. Changes of nutritional status of iron (N=35)

Variables	Before diet program	After diet program
RBC($\times 10^6$/mm^3)	4.7± 0.3	4.3± 0.4**
Hemoglibin(g/ㅇ|)	14.5± 3.6	12.9± 1.0**
Hematocrit(%)	41.9± 3.1	37.5± 2.9**
Ferritin(ng/ml)	32.0±27.7	32.1±27.0
TIBC(μg/dl)	353.1±47.5	372.0±39.7*

*p<0.05 **p<0.01

Table 7. Changes of other biochemical parameters (N=35)

Variables	Before diet program	After diet program
Folic acid(ng/ml)	25.8±10.1	21.6±15.5
Alkaline phosphatase(U/L)	62.8±14.4	69.4±18.3**
25-(OH)-D^3(ng./ml)	13.0± 3.2	15.9± 6.1*
Serum zinc(μg/day)	90.2±15.3	97.6±16.3

*p<0.05 **p<0.01

Table 8. Changes of nutritional status of iron (N=35)

Variables	Before diet program	After diet program
SBP(mmHg)	124.1 ±13.9	113.1 ±13.4**
DBP(mmHg)	79.4 ± 7.2	78.0 ± 9.0
SGOP(U/L)	29.3 ±15.5	20.0 ± 6.9**
SGPT(U/L)	28.7 ±17.8	16.6 ± 7.7**
Insulin(ulU/ml)	14.9 ± 9.1	12.1 ± 6.9
BUN(mg/dl)	14.0 ± 3.7	12.9 ± 4.0
UUN(g/day)	6.4 ± 2.7	6.8 ± 2.8
U Creatinine(g/day)	0.78± 0.31	0.72± 0.29

*p<0.05 **p<0.01
BUN : blood urea nitrogen
UUN : urinary urea nitrogen
U Creatinine : urinary creatinine

vitamin D_3 were significantly increased. It is known that serum alkaline phosphatase is elevated and 25-(OH) vitamin D_3 is lowered when vitamin D intake is inadequate(Gibson 1990).

In this study, 25-(OH) vitamin D_3 and alkaline phosphatase were significantly increased after the diet program and the means of the measurements were 69.4u/L and 15.9ng/ml respectively, which were in the normal range. It looks like the diet program did not produce vitamin D deficiency in the energy restriction program.

The mean serum zinc level did not show any significant change.

The systolic blood pressure of the subjects was significantly decreased from 124.1mmHg to 113.1mm Hg but diastolic blood pressure was not significantly changed(Table 8).

Liver function and the serum insulin level are related to overweight or obesity(Huh et al. 1993). The mean SGOT and SGPT before the diet program were 29.3u/L and 28.7u/L, respectively. Forty two percent of the subjects showed a higher level of SGOT or SGPT than 31u/L, the upper limit of SGOT or SGPT meaning decreased liver function.

The mean SGOT and SGPT were lowered to 20.0u/L and 16.6u/L respectively. No one was observed with a higher SGOT or SGPT than 31.0u/L after the diet program. It looks like the diet program improved liver function.

The mean BUN(Blood Urea Nitrogen) level, the UUN(Urinary Urea Nitrogen) level, and the urinary creatinine level did not show any significant change, and were within the normal range.

Summary and Conclusion

1) Mean weight loss was 3.0kg after 3 weeks of energy restriction diet program, accordingly the obesity rate was significantly lowered from 40.2 to 34.4, BMI from 29.2 to 28.9 and fat weight from 23.2kg to 21.0kg($p<0.01$, $p<0.05$).

2) The largest loss of weight, obesity rate and BMI were observed in the group in the twenties, whereas the group in the forties showed the largest loss in fat weight.

3) Waist circumference loss was most prominent(4.4% loss) compared to arm(2.1% loss) and hip circumference(2.2% loss).

4) The mean suprailiac skinfold thickness was decreased from 35.7mm to 31.0mm(13.1% decrease) and the mean subscapular skinfold thickness was lowered from 39.6mm to 35.6mm(10.1% decrease) after the diet program.

5) Mean RBC count, hemoglobin and hematocrit were significantly lowered after 3 weeks of the diet program($p<0.01$). It means that the nutritional status of iron progressively declined, however mean indicators of iron status were still within the normal

range.

No one was observed to be below 12g/dl of Hb or 35% of Hct after the energy restriction program.

6) Serum alkaline phosphatase and 25-(OH) vitamin D_3 were significantly increased and the means of the measurements were 6.94u/L and 15.9ng/ml respectively after the diet program, which were in the normal range. It looks like the diet program did not result in vitamin D deficiency.

Systolic blood pressure was significantly decreased from 124.1mmHg to 113.1mmHg.

7) Mean SGOT and SGPT were lowered from 29.3 u/L to 20.0u/L and from 28.7u/L to 16.6u/L, respectively. It looks like the diet program improved liver function.

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