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Impact of Hypocaloric Diet Suggested With Dairy Food Products on Selected Biomarkers of Weight Gain in Overweight and Obese Working Women

Research Article

Upasana[1]*, Pandey V[2], Chakravarty A[3], Tripathi YB[2] and Gupta KK[4]

[1]Department of Home Science, Mahila College, Dalmianagar, Veer Kunwar Singh University, India

[2]Department of Medicinal Chemistry, Banaras Hindu University, India

[3]Department of Home Science, Banaras Hindu University, India

[4]Department of General Medicine, Banaras Hindu University, India

***Corresponding author:** Upasana, Department of Home Science, Mahila College Dalmianagar, Dehri-on-Sone, Rohtas, India, Pin Code: 821307, Phone num: 9889191742; E-mail: me.upasana87@gmail.com

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Abstract

Overweight and obesity is a major public health concern of today's era and become a global pandemic now. The present study aimed to compute changes in biomarkers of weight gain via hypocaloric diet suggested with dairy food products. In order to investigate effect of intervention study 32 cases and 12 controls were selected from different faculties and institutes of Banaras Hindu University, Varanasi. The respondents were selected by purposive sampling technique and the tools used for data collection was interview schedule. Assessment of anthropometric, clinical, biochemical, proinflammatory and anti-inflammatory biomarkers was done before and after intervention i.e. of 6 months. The result showed that there was significant difference observed between case and control group after 6 months in weight, waist circumference, visceral fat, percent body fat, systolic blood pressure and fasting plasma glucose among both overweight and obese grade I respondents. Significant difference was also observed among overweight case and control respondents in total cholesterol, high density lipoprotein, low density lipoprotein, total lipids, non-HDL cholesterol and cholesterol HDL ratio. Inspite of these, significant difference was also noticed among overweight respondents in TNF-alpha and among obese grade I in hs-CRP and adiponectin between case and control group. Significant difference was also observed between case and control group of overweight and obese grade I respondents in fat, carbohydrate, energy, calcium and dairy calcium intake after 6 months of intervention. Therefore, it seems reasonable to argue that dietary management via hypocaloric diet suggested with dairy food products and increased physical activity may retard the growing incidence of overweight and obesity in future.

Keywords: Hypocaloric diet; Dairy; Overweight; Obesity; Women

Introduction

Overweight and obesity is one of the biggest public health concerns of today's era which affects the individual not only physically but physiologically and psychologically as well. The elemental cause of obesity is a result of positive energy balance between energy consumption and its expenditure-or a combination of both. The altered phenomenon of hunger and satiety, lack of physical activity, decreased thermogenesis and resting metabolic rate over a long period of time may lead to the energy imbalance [1].

Now-a - days, obesity is regarded as a complex dysfunctional neuroendocrine problem in which genetic makeup and environmental factors act in concert [1-3]. The non-genetic risk factors encompass a wide range of social, physiological, environmental, and behavioral factors. Sedentary lifestyle and over-consumption high-fat and energy dense foods, is a major contributor of energy imbalance. In addition, other external factors like age, gender, food preference, medications, socio-economic status as well as psychological factor may give rise to weight gain problem [4]. It is considered as a major contributor to the global burden of chronic diseases like hypertension, type 2 diabetes, hypercholesterolemia, heart diseases, insulin resistance, asthma, orthopedic disorders, several types of cancer, hormonal imbalance, disability and many other diseases. Overweight and Obesity also plays a pivotal role in the development of low grade inflammation

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also. In view of the high prevalence of overweight and obesity in women, the present study designed to assess the effect of hypocaloric diet suggested with dairy food products on biomarkers of overweight and obesity.

Methodology

Selection of the respondents

The working women from different faculties and institutes of Banaras Hindu University were selected as respondents for the study. Purposive sampling technique was followed for the collection of data and the tool used for the present study is interview schedule. The average age of the respondents varies from 29 to 60 years. All respondents were undergone 6 month of intervention programme i.e. dietary guidelines of following hypocaloric diet suggested with dairy food products. In this study inclusion and exclusion criteria were also considered. These are as follows:

- **Inclusion criteria:** The enrolment of respondents was based on their range of BMI i.e. only those respondents were selected whose BMI was more than 24.9 which is the upper limit of normalcy as per the guidelines of NHLBI Obesity Education Initiative 2000 and Report of WHO Expert Consultation 2008.
- **Exclusion criteria:** The BMI range of less than 24.9, pregnant women as well as those who have some hormonal aberrations was excluded from this present study.

Ethical consideration

The studies were conducted under the rules and regulation of Institute Ethical Committee, IMS,

BHU (Ethical Committee Letter Number - Dean/2012-13/183).

Sample size

Sample size can be described as a small proportion of a population selected for observation and analysis. The sample size was estimated by using the following formula-

$$n = \frac{\left\{ Z_{1-\frac{\alpha}{2}} \sqrt{2\mathbf{P}_2(1-\mathbf{P}_2)} + Z_{1-\alpha} \sqrt{P_1(1-\mathbf{P}_1) + \mathbf{P}_2(1-\mathbf{P}_2)} \right\}^2}{(\mathbf{P}_1 - \mathbf{P}_2)^2} \quad [1]$$

Where,

P_1 = Anticipated probability of exposure of cases (0.68)

P_2 = Anticipated probability of exposure of control

Z_1-α/2= Value of normal deviate at considered level of significance

Z_1-β = Value of normal deviate at considered power of study

The value of P_2 is generally obtained by considering odd ratio (OR) and is calculated by-

$$\mathbf{P}_2 = \frac{\mathbf{P}_1}{\{\mathbf{OR}(1-\mathbf{P}_1) + \mathbf{P}_1\}} \quad [2]$$

Here, the value of anticipated probability of exposure of cases was taken as 0.68 and the anticipated odd ratio was considered as 4.

$$\mathbf{P}_2 = \frac{0.68}{\{4(1-0.68)+0.68\}} = \mathbf{0.3469} \sim \mathbf{0.35}$$

he sample size estimated at 5 % level of significance and 80% power of test. Here, the values of P_1 = 0.68, OR = 4, Z_1-α/2 = 1.96, Z_1-β = 0.842, P_2 = 0.35 (calculated from equation 2), were substituted in equation to get the minimum sample size. Therefore, the required sample size is 32 i.e. 32 cases and study. But due to lack of fund, the number of cases and control were manipulated according to experiments.

Socio-demographic characteristics

This section deals with the general characteristics of the respondent i.e. about their age, marital status, type of family, religion, education, occupation, family income per month, socio-economic status and food habits.

Anthropometric measurements

The anthropometrical measurements of the respondents i.e. height and weight were measured by using standard technique [5]. BMI was calculated by dividing weight in kilograms by height in meters square [6]. BMI was then categorized based on standards i.e. NHLBI Obesity Education Initiative 2000 and Report of WHO Expert Consultation 2008 for the assessment of obesity [7,8]. After that, waist and hip circumference were measured to assess the abdominal obesity. Waist Hip Ratio (WHR) was calculated by dividing the waist circumference and hip circumference. As per classification of WHO Expert Consultation 2008, cut off values were used for WC and WHR for the assessment of central or abdominal obesity [8]. Visceral Fat (VF) and Percent Body Fat (PBF) were also measured by using Omron Body Composition Monitor - HBF 212 [9].

Clinical parameters

The clinical parameters include systolic blood pressure and diastolic blood pressure. Blood pressure was measured by using mercury sphygmomanometer (Novaphon 300) and Life - Line stethoscope from the left upper arm of the respondents in sitting position [10,11].

Biochemical, proinflammatory and anti-inflammatory markers

For the assessment of biochemical, proinflammatory and anti-inflammatory markers 5 ml of blood sample was withdrawn from the anticubital vein following overnight fasting. For serum, blood sample was collected in plain vial and incubated at 37 ˚C for 30 minutes. After that, samples were centrifuged at 3000 rpm for 10 to 20 minutes and the supernatant collected in clean and dry serum test tube for analysis. For plasma separation, commercially available anti-coagulant treated tubes (i.e. EDTA treated) was used.

Measurement of concentration of Fasting Plasma Glucose (FPG) was done by Accurex Biomedical), total cholesterol, triglycerides, high density lipoprotein (HDL) cholesterol was done by Tulip group of corals by using Robonik Prietest Touch Biochemistry Analyser, Mumbai, India [12]. Similarly measurement of fasting insulin was done by Siemens Health care Diagnostic kit and Advia Centaur

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Chemiluminescence Immunoassay (CLIA) analyzer. Additionally, measurement of Low Density Lipoprotein (LDL), Very Low Density Lipoprotein (VLDL) and total lipids were calculated by Friedewald's equation. The analysis of insulin resistance i.e. HOMA-IR was calculated by Mathews et al., equation i.e. Glucose (mg/dl) X Insulin (µU/ml) / 405 and QUICKI was calculated by using formula 1/ (log fasting insulin [µU/ml] + log fasting glucose [mg/dl]) [13-14]. The analysis of proinflammatory markers i.e. hs-CRP and TNF- alpha was done by using Diagnostics Biochem Canada Inc. and Diaclone - Human TNF-alpha ELISA kit respectively [15,16]. The measurement of anti-inflammatory marker i.e. adiponectin was done by Assay Pro: Assay Max Human Adiponectin ELISA kit [17]. The ELISA reader used in the assessment of proinflammatory and anti-inflammatory markers was Transasia ELISA reader [18].

Dietary assessment

Nutrient intake of the respondents was recorded by 7 days food record method and calculated with the help of nutritive value of Indian foods [19]. The respondents reported the type and quantity of meal (i.e. food and beverages) consumed over the past 7 days. The quantities of food consumed were converted into raw equivalents by using household measurements to estimate the portion size of consumed food. The intake was then compared with recommended dietary allowances i.e. RDA 2010 [20].

Statistical analysis of the data

Statistical analysis was performed by using trial version of Statistical Package of Social Sciences (SPSS) Version 20.0. The data was analyzed by using descriptive statistics such as mean and standard deviation. For determining the significance between the variables chi square test was used. Furthermore, to find statistical difference between case and control respondents unpaired t test was used.

Results

In the present study, Table 1 shows the background characteristics of the respondents. The table reveals that maximum respondents in the case group belongs to the age group of 36-50 years and of the control belongs to either 36-50 years or >50 years. The table also showed that maximum respondents of both the group i.e. case as well as control group were married, lives in a nuclear type of family and of Hinduism religion. Irrespective of the group maximum of them had graduation and above type of educational status, had profession type of occupation and had family income Rs ≥36,997 per month. Moreover, maximum of case as well as control group respondents belonged to upper socio-economic status and vegetarian type of food habits.

Table 2 reveals about the anthropometric measurement of case and control respondents during intervention study. It was observed that in context of overweight respondents significant difference exists between case and control respondents in the measurement of weight ($P < 0.05$), waist circumference ($P < 0.01$), visceral fat ($P < 0.01$) and percent body fat ($P < 0.001$) after 6 month of intervention. Similar result were also noticed among case and control respondents of obese grade I respondents i.e. significant difference persists in the measurement of weight ($P < 0.001$), waist circumference ($P < 0.05$), visceral fat ($P < 0.001$) and percent body fat ($P < 0.001$) after intervention. From Table 3, significant difference was observed between case and control respondents in clinical parameter i.e. systolic blood pressure in both overweight ($P < 0.05$) and obese grade I ($P < 0.001$) after 6 month of intervention. Similarly, after 6 month of intervention, significant difference observed between case and control respondents in the level of fasting plasma glucose among both overweight ($P < 0.05$) and obese grade I respondents ($P < 0.05$).

Average biochemical parameter change between case and control respondents after 6 month of intervention was depicted in Table 4. From this table it was interpreted that among overweight respondents there was significant difference persists between case

Table 1: Background characteristic of respondents.

PARAMETERS	GROUP					
	CASE		CONTROL		TOTAL	
	No.	%	No.	%	No.	%
AGE GROUPS (IN YEARS)						
≤35	8	25.0	2	16.7	10	22.7
36 - 50	17	53.1	5	41.7	22	50.0
>50	7	21.9	5	41.7	12	27.3
TOTAL	**32**	**100.0**	**12**	**100.0**	**44**	**100.0**
χ^2= 1.75 ; df = 2; P > 0.05						
MARITAL STATUS						
Unmarried	2	6.2	0	0.0	2	4.5
Married	29	90.6	8	66.7	37	84.1
Widow	1	3.1	4	33.3	5	11.4
χ^2= 8.35 ; df = 2; P <0.05						
TYPE OF FAMILY						
Nuclear	23	71.9	12	100.0	35	79.5
Joint	9	28.1	0	0.0	9	20.5
Fischer's Exact Test = P < 0.05 χ^2= 4.24 ; df = 1; P < 0.05						
RELIGION						
Hindu	31	96.9	12	100.0	43	97.7
Christian	1	3.1	0	0.0	1	2.3
Fischer's Exact Test = P > 0.05						
EDUCATIONAL STATUS						
Profession or Honors	12	37.5	9	75.0	21	47.7
Graduate and Post - graduate	20	62.5	3	25.0	23	52.3
χ^2= 4.92 ; df = 1; P <0.05						
OCCUPATIONAL STATUS						
Profession	23	71.9	10	83.4	33	75.0
Semi - profession	2	6.2	1	8.3	3	6.8
Clerical	7	21.9	1	8.3	8	18.2
χ^2= 1.09 ; df = 2; P >0.05						
FAMILY INCOME PER MONTH (IN RS.)						
≥36,997	20	62.5	10	83.3	30	68.2
18,498 - 36,996	12	37.5	2	16.7	14	31.8
χ^2= 1.75 ; df = 1; P >0.05						
SOCIO - ECONOMIC STATUS (SES)						
Upper	24	75.0	10	83.3	34	77.3
Upper middle	8	25.0	2	16.7	10	22.7
χ^2= 0.35 ; df = 1; P >0.05						
FOOD HABITS						
Vegetarian	20	62.5	8	66.6	28	63.7
Eggitarian	1	3.1	2	16.7	3	6.8
Non - vegetarian	11	34.4	2	16.7	13	29.5
χ^2= 3.30 ; df = 2; P >0.05						

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Table 2: Average anthropometric of case and control respondents according to their body mass index during pre and post intervention.

Anthropometric measurements	Intervention study	Respondents					
		Overweight		Statistical significance	Obese grade I		Statistical Significance
		Case	Control		Case	Control	
Weight (kg)	Pre	68.57 ± 6.11	70.98 ± 2.20	t =0.76, P > 0.05	73.48 ± 8.97	80.43 ± 5.84	t = 1.97, P > 0.05
	Post	64.45 ± 5.84	72.18 ± 4.15	t =2.48, P < 0.05	68.86 ± 8.13	82.16 ± 5.29	t = 4.16, P < 0.001
Waist circumference (cm)	Pre	92.98± 4.30	95.12 ± 6.82	t = 0.81, P > 0.05	96.19 ± 8.26	101.63 ± 7.51	t = 1.55, P > 0.05
	Post	89.19 ± 2.85	95.12 ± 6.82	t = 0.27, P < 0.01	91.45 ± 9.09	100.19 ± 7.97	t = 2.29, P < 0.05
Waist hip ratio	Pre	0.89 ± 0.03	0.87 ± 0.05	t = 1.18, P > 0.05	0.91 ± 0.04	0.89 ± 0.04	t = 0.78, P > 0.05
	Post	0.87 ± 0.04	0.84 ± 0.05	t = 2.01, P > 0.05	0.92 ± 0.05	0.88 ± 0.04	t = 1.58, P > 0.05
Visceral fat	Pre	12.53 ± 2.15	11.25 ± 1.89	t = 1.09, P > 0.05	16.27 ± 4.45	18.13 ± 3.44	t = 2.21, P < 0.05
	Post	8.59 ± 1.37	11.50 ± 2.52	t = 3.26, P < 0.01	11.67 ± 3.06	17.75 ± 3.20	t = 4.47, P < 0.001
Percent body fat	Pre	38.38 ± 1.97	40.73 ± 1.53	t = 2.21, P < 0.05	41.70 ± 2.09	43.41 ± 1.60	t = 2.01, P > 0.05
	Post	35.13 ± 2.13	41.02 ± 3.48	t = 4.44, P < 0.001	36.73 ± 2.33	43.41 ± 1.60	t = 4.86, P < 0.001

(Overweight case = 17, Overweight control = 4; Obese grade I case = 15, Obese Grade I control = 8)

Table 3: Average systolic, diastolic blood pressure, fasting plasma glucose, fasting insulin and insulin resistance of case and control respondents according to their body mass index during pre and post intervention.

Biochemical parameters	Intervention study	Respondents					
		Overweight		Statistical significance	Obese grade I		Statistical significance
		Case	Control		Case	Control	
Systolic Blood Pressure (mmHg)	Pre	122.24 ± 4.17	121.06 ± 2.25	t = 1.21, P > 0.05	126.93 ± 6.45	131.50 ± 5.73	t = 1.68, P > 0.05
	Post	121.06 ± 2.25	124.50 ± 3.42	t = 2.51, P < 0.05	121.47 ± 2.33	127.50 ± 4.37	t = 4.36, P < 0.001
Diastolic Blood Pressure (mmHg)	Pre	78.82 ± 14.32	86.00 ± 4.00	t = 0.98, P > 0.05	82.27 ± 3.97	86.50 ± 3.50	t = 2.53, P < 0.05
	Post	81.88 ± 2.29	83.50 ± 4.72	t = 1.03, P > 0.05	81.20 ± 1.26	82.00 ± 2.39	t = 1.06, P > 0.05
Fasting plasma glucose (mg/dl)	Pre	93.63 ± 18.17	130.18 ± 57.78	t = 2.32, P < 0.05	104.31 ± 34.69	115.93 ± 42.09	t = 0.71, P > 0.05
	Post	86.40 ± 9.29	119.65 ± 52.26	t = 2.66, P < 0.05	83.39 ± 10.23	103.69 ± 30.27	t = 2.39, P < 0.05
Fasting insulin (µU/ml)	Pre	9.64 ± 8.48	5.38 ± 4.09	t = 0.86, P > 0.05	7.71 ± 6.83	10.49 ± 6.52	t = 0.94, P > 0.05
	Post	4.50 ± 2.47	5.66 ± 3.14	t = 0.81, P > 0.05	6.92 ± 4.67	9.29 ± 4.73	t = 1.15, P > 0.05
HOMA - IR	Pre	2.35 ± 2.32	1.81 ± 1.41	t = 0.45, P > 0.05	1.99 ± 2.13	3.20 ± 2.51	t = 1.22, P > 0.05
	Post	0.97 ± 0.55	1.64 ± 0.93	t = 1.92, P > 0.05	1.44 ± 1.05	2.33 ± 1.18	t = 1.86, P > 0.05
QUICKI	Pre	0.36 ± 0.04	0.37 ± 0.06	t = 0.86, P > 0.05	0.37 ± 0.04	0.34 ± 0.05	t = 0.94, P > 0.05
	Post	0.40 ± 0.04	0.37 ± 0.05	t = 0.81, P > 0.05	0.38 ± 0.04	0.35 ± 0.04	t = 1.15, P > 0.05

and control respondents in the level of total cholesterol ($P < 0.05$), high density lipoprotein ($P < 0.01$), low density lipoprotein ($P < 0.05$), total lipids ($P < 0.05$), non-HDL cholesterol ($P < 0.01$) and cholesterol HDL ratio ($P < 0.05$). Table 5 shows about proinflammatory and anti-inflammatory markers significant difference between case and control respondents after 6 month of intervention. The table shows that there was significant difference exists between case and control respondents in the level of tumor necrosis factor- alpha ($P < 0.05$) among overweight respondents. Similarly among obese grade I respondents, significant difference exists in the level of hs-CRP ($P < 0.01$) and adiponectin ($P < 0.01$) among case and control respondents of obese grade I after intervention.

From Table 6, it was interpreted that among overweight respondents, there was significant difference exists between case

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Table 4: Average biochemical parameters of case and control respondents according to their body mass index during pre and post intervention.

Biochemical parameters	Intervention study	Respondents					
		Overweight		Statistical significance	Obese grade I		Statistical significance
		Case	Control		Case	Control	
Total cholesterol (mg/dl)	Pre	208.05 ± 30.08	221.98 ± 65.72	t = 0.66, P > 0.05	208.67 ± 37.32	184.35 ± 19.35	t = 1.71, P > 0.05
	Post	168.79 ± 27.31	209.45 ± 41.37	t = 2.44, P < 0.05	185.83 ± 27.90	185.61 ± 44.51	t = 0.02, P > 0.05
Triglycerides (mg/dl)	Pre	150.62 ± 48.55	173.85 ± 99.11	t = 0.79, P > 0.05	165.29 ± 40.94	114.68 ± 21.01	t = 3.25, P < 0.05
	Post	117.76 ± 24.11	141.93 ± 25.30	t = 1.79, P > 0.05	133.89 ± 26.43	123.06 ± 39.87	t = 0.78, P > 0.05
High Density Lipoprotein (mg/dl)	Pre	27.96 ± 3.76	34.65 ± 12.23	t = 2.02, P > 0.05	26.84 ± 5.49	38.65 ± 9.90	t = 3.71, P < 0.01
	Post	38.87 ± 6.34	29.10 ± 3.79	t = 2.89, P < 0.01	38.50 ± 6.96	40.20 ± 11.17	t = 0.45, P > 0.05
Low Density Lipoprotein (mg/dl)	Pre	146.05 ± 27.57	153.33 ± 56.97	t = 0.39, P > 0.05	149.41 ± 34.20	123.31 ± 14.40	t = 2.05, P > 0.05
	Post	113.26 ± 29.13	155.35 ± 42.80	t = 2.39, P < 0.05	120.89 ± 31.11	129.50 ± 37.43	t = 0.59, P > 0.05
Very Low Density Lipoprotein (mg/dl)	Pre	29.86 ± 9.85	34.65 ± 19.89	t = 0.72 P > 0.05	32.96 ± 8.19	22.85 ± 4.26	t = 3.24, P < 0.01
	Post	24.26 ± 4.78	28.25 ± 5.07	t = 1.49, P > 0.05	26.65 ± 5.37	25.72 ± 9.12	t = 0.31, P > 0.05
Total lipids (mg/dl)	Pre	561.86 ± 99.99	620.75 ± 219.84	t = 0.84, P > 0.05	574.07 ± 98.39	481.75 ± 46.71	t = 2.49, P < 0.05
	Post	458.21 ± 75.01	552.25 ± 87.69	t = 2.20, P < 0.05	506.87 ± 73.75	517.38 ± 92.79	t = 0.30, P > 0.05
non- HDL Cholesterol (mg/dl)	Pre	180.09 ± 31.32	187.33 ± 74.38	t = 0.32, P > 0.05	181.33 ± 38.17	145.70 ± 19.41	t = 2.49, P < 0.05
	Post	130.05 ± 28.26	180.35 ± 42.94	t = 2.92, P < 0.01	147.33 ± 30.40	145.41 ± 51.14	t = 0.11, P > 0.05
Cholesterol HDL ratio	Pre	7.38 ± 2.05	7.84 ± 5.85	t = 0.28, P > 0.05	8.12 ± 2.12	5.16 ± 2.17	t = 3.16, P < 0.01
	Post	4.96 ± 1.20	7.45 ± 2.27	t = 3.15, P < 0.05	5.31 ± 1.76	5.38 ± 2.16	t = 0.08, P > 0.05

(Overweight case = 17, Overweight control = 4; Obese grade I case = 15, Obese Grade I control = 8)

Table 5: Average proinflammatory and anti - inflammatory markers of case and control respondents according to their body mass index during pre and post intervention.

Biochemical Parameters	Intervention study	Respondents					
		Overweight		Statistical significance	Obese grade I		Statistical significance
		Case	Control		Case	Control	
hs-CRP (ng / ml)	Pre	2860.76 ± 815.03	2378.50 ± 337.49	t = 1.14, P > 0.05	3078.27 ± 643.38	3000.13 ± 499.06	t = 0.30, P > 0.05
	Post	2136.26 ± 611.10	2362.50 ± 449.68	t = 0.69, P > 0.05	2333.43 ± 439.12	3086.75 ± 607.97	t = 3.43, P < 0.01
TNF - alpha (pg / ml)	Pre	27.48 ± 5.85	26.97 ± 3.80	t = 0.16, P > 0.05	29.80 ± 6.54	25.03 ± 3.86	t = 1.88, P > 0.05
	Post	21.66 ± 4.28	27.22 ± 3.18	t = 2.43, P < 0.05	22.61 ± 4.77	26.14 ± 3.67	t = 1.82, P > 0.05
Adiponectin (µg / ml)	Pre	8.46 ± 1.41	9.55 ± 1.01	t = 1.43, P > 0.05	8.33 ± 1.36	8.55 ± 1.60	t = 0.33, P > 0.05
	Post	9.60 ± 1.41	9.45 ± 1.02	t = 0.21, P > 0.05	10.02 ± 0.79	7.89 ± 2.08	t = 3.25, P < 0.01

Here, for hs-CRP and TNF - alpha -Overweight case = 17, Overweight control = 4; Obese grade I case = 15, Obese Grade I control = 8 and for adiponectin - Overweight case = 16, Overweight control = 4; Obese grade I case = 12, Obese Grade I control = 8

and control respondents in the intake of protein ($P < 0.001$), fat ($P < 0.001$), carbohydrate ($P < 0.001$), energy ($P < 0.001$), calcium ($P < 0.05$), dairy calcium ($P < 0.001$) and total fibre ($P < 0.01$) after 6 months of intervention. Similarly, in the context of obese grade I, it was observed that significant difference exists in the intake of fat ($P < 0.001$), carbohydrate ($P < 0.001$), energy ($P < 0.0012$), calcium ($P < 0.001$), dairy calcium ($P < 0.01$), phosphorus ($P < 0.01$) and iron ($P < 0.02$) among case and control respondents after intervention.

Discussion

Obesity is a condition in which the natural energy reserve, stored in the fatty tissues of human and other mammals is increased to a

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Table 6: Average nutrient intake of case and control respondents according to their body mass index during pre and post intervention.

Nutrient Intake	Intervention study	Respondents					
		Overweight		Statistical significance	Obese grade I		Statistical significance
		Case	Control		Case	Control	
Protein (g)	Pre	61.02 ± 6.75	63.37 ± 11.17	t = 0.55, P > 0.05	61.62 ± 7.83	62.11 ± 7.00	t = 0.15, P > 0.05
	Post	49.71 ± 3.72	63.40 ± 7.19	t = 5.54, P < 0.001	49.71 ± 2.73	51.94 ± 8.03	t = 0.99, P > 0.05
Fat (g)	Pre	41.51 ± 8.71	37.39 ± 11.61	t = 0.80, P > 0.05	41.90 ± 5.91	41.12 ± 9.14	t = 0.25, P > 0.05
	Post	27.02 ± 1.63	39.46 ± 11.28	t = 4.74, P < 0.001	27.46 ± 2.32	38.06 ± 8.99	t = 4.38, P < 0.001
Carbohydrate (g)	Pre	284.26 ± 34.88	298.57 ± 25.39	t = 0.77, P > 0.05	279.74 ± 31.80	281.55 ± 20.25	t = 0.14, P > 0.05
	Post	212.88 ± 15.31	274.75 ± 16.68	t = 7.19, P < 0.001	207.86 ± 15.89	247.80 ± 19.48	t = 5.31, P < 0.001
Energy (kcal)	Pre	1764.79 ± 165.83	1789.37 ± 206.26	t = 0.25, P > 0.05	1766.72 ± 140.67	1782.09 ± 144.55	t = 0.25, P > 0.05
	Post	1328.81 ± 71.76	1710.41 ± 121.03	t = 8.42, P < 0.001	1304.43 ± 86.46	1544.17 ± 170.03	t = 4.35, P < 0.001
Calcium (mg)	Pre	819.80 ± 152.76	696.42 ± 312.42	t = 1.19, P > 0.05	743.65 ± 217.70	613.52 ± 207.03	t = 1.39, P > 0.05
	Post	1172.24 ± 67.29	929.24 ± 376.65	t = 2.70, P < 0.05	1162.03 ± 87.71	687.57 ± 115.21	t = 11.09, P < 0.001
Dairy calcium (mg)	Pre	486.77 ± 168.38	345.71 ± 240.19	t = 1.40, P > 0.05	414.72 ± 209.80	305.00 ± 206.67	t = 1.20, P > 0.05
	Post	893.33 ± 58.81	522.92 ± 338.84	t = 4.60, P < 0.001	890.80 ± 98.37	390.35 ± 125.46	t = 10.57, P < 0.001
Phosphorus (mg)	Pre	1662.31 ± 244.35	1598.49 ± 270.50	t = 0.46, P > 0.05	1584.83 ± 252.99	1522.03 ± 223.93	t = 0.66, P > 0.05
	Post	1617.47 ± 124.89	1562.78 ± 331.64	t = 0.56, P > 0.05	1547.43 ± 142.79	1380.68 ± 190.17	t = 2.38, P < 0.05
Iron (mg)	Pre	19.70 ± 3.21	20.96 ± 1.07	t = 0.76, P > 0.05	20.07 ± 4.12	18.46 ± 1.97	t = 1.03, P > 0.05
	Post	21.47 ± 3.05	21.02 ± 2.91	t = 0.27, P > 0.05	21.14 ± 3.00	17.86 ± 3.07	t = 2.48, P < 0.05
Total fibre (g)	Pre	45.49 ± 6.92	47.93 ± 4.21	t = 0.67, P > 0.05	45.45 ± 6.64	41.83 ± 5.86	t = 1.29, P > 0.05
	Post	38.75 ± 5.20	49.11 ± 9.21	t = 3.10, P < 0.01	39.07 ± 4.14	43.17 ± 5.51	t = 2.02, P > 0.05

point where it is associated with certain health condition or increased mortality [21]. It is described as an abnormal growth of adipose tissue due to an enlargement of fat cell size (hypertrophic obesity) or an increase in fat cell number (hyperplastic obesity) or a condition of both.

In this present study, it was found that irrespective of group maximum respondents were either overweight or obese grade in the age group of 36 years or above. Therefore, it may be concluded that maximum respondents started suffering from the problem of weight gain in the younger age. This may be due to faulty eating habits, sedentary lifestyle, lack of physical activity, genetic makeup, stress, hormonal imbalance or may be due to any other reasons. Inspite of this, it was also noticed that maximum respondents belongs to the upper socio-economic status, this may be reason of their overweight and obesity. Since, as we know that high socio-economic status respondents have more purchasing power, as a result they may take more energy dense food outside the home. Hence, this may contribute to the development of weight gain of the respondents.

As we know that overweight and obesity is a global public health nutritional problem of today's era and are rising at a faster pace in developing countries also. Many researchers reported that dairy food as a nutrient dense food as well as health promoting food that offers many health benefits [22,23]. It was observed from the Table 2 that with the consumption of hypocaloric diet with dairy food products, there was decrement in the measurement of weight, waist circumference, waist hip ratio, visceral fat and percent body fat observed in both case group of overweight and obese grade I respondents. Inspite of this, there was significant difference also exists in the measurement of weight, waist circumference, visceral fat and percent body fat among case and control respondents after intervention. A prospective investigation in the Nurse's Health Study I and II and Health Professional Follow up study on 120,887 men and women showed that there was inverse association exists with the consumption of yoghurt with4-year weight change [24,25]. Another 9-year prospective study on 3417 respondents also reported that irrespective of gender, respondents who consumed more dietary calcium (in form of low or high fat dairy products) had a lower increase in waist circumference [26]. This may be due to the fact that dietary calcium may contribute to the precipitation of long chain fatty acids that prevents their absorption in intestine and increase their excretion [27,28]. The precipitation of long chain

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fatty acids by calcium may be possible mechanism of dairy's impact on central obesity [23]. Murphy et al also reported that dairy food consumption was inversely associated with body mass index, percent body fat and waist circumference. The mechanism was not entirely clear regarding impact of dairy food consumption on improvement of body composition however, it was been postulated that the benefit may be due to calcium which is thought to reduce lipogenesis and increase lipolysis [25].

A prospective study on metabolic syndrome markers in 3417 French adults demonstrated that dairy and dietary calcium intake were associated with lower diastolic blood pressure in all participants but were associated with a lower increase in systolic blood pressure [23,26]. Another publication of same prospective study found that calcium density was also associated with a systolic blood pressure in all the participants [23,26]. van Meijl and Mensink, also reported that 8 weeks of dairy consumption was associated with lower systolic blood pressure among 35 overweight and obese adults [27-30]. Similar results were interpreted in this study that there was decrement in systolic blood pressure observed among both case group of overweight and obese grade I respondents and that difference was statistically significant after intervention. Recent studies also explained that the micronutrients present in the dairy's have an effect of lowering blood pressure. Dairy contains calcium, vitamin D, potassium and magnesium, all of which helps in regulating blood pressure [23,31].

From Table 3, it was also interpreted that there was significant decrement in the level of fasting glucose observed after intervention and that difference was statistically significant among both case and control group of overweight and obese grade I respondents. Previous reviews reported that dairy food products have insulinotrophic properties as a result of protein content of milk which may decrease serum glucose levels [23,31]. Previous researches also enumerated that meeting adequate dairy intake levels is associated with an improved serum lipid profile and reduced risk of cardiovascular diseases [30,32,33]. From Table 4, almost similar result was reported that highly significant difference exists among case and control group in the average level of total cholesterol, high density lipoprotein, low density lipoprotein, total lipids, non-HDL cholesterol and cholesterol HDL ratio of overweight respondents.

From Table 5, it was interpreted that among overweight respondents, decrement in the level of TNF-alpha as well as significant difference between case and control respondents observed was observed after 6 months. In context of obese grade I respondents also decrement in the level of hs-CRP and increment in the level of adiponectin observed and the difference between case and control respondents after 6 months was statistically significant. Similar findings was observed by Zemel et al that there was reduction in the level of plasma TNF - alpha and CRP by 15 percent and 13 percent happened at $P < 0.001$ as well as increase in the level of plasma adiponectin occurred by 20 percent at $P < 0.002$ were apparent at day 7 of the dairy supplemented diet and became more pronounced throughout the dairy treatment when compared with non-dairy supplemented diet [34-36]. A converse finding was also reported in previous study that there was no significant alteration in biomarkers of inflammation observed with energy restricted dairy intervention [37].

Various studies reported that inclusion of dairy products with energy restricted diet has an anti-obesity effect. Dairy products are the main source of calcium and different mechanism has been already reported regarding the impact of dietary calcium in regulation of energy metabolism and obesity risk. It was explained in previous studies that dietary calcium reduces intracellular calcium in adipocytes thereby reduces expression of fatty acid synthase enzyme required for lipid synthesis. The potential hypolipidaemic mechanism of calcium may occur at gastrointestinal tract via inhibition of fat absorption, increased fecal fat excretion, inhibition of bile acid absorption and calcium-induced increase in the conversion of cholesterol to bile acids [38-39]. Table 6, showed that the intake of calcium and dairy calcium increases after 6 months of intervention and there was significant difference also persists between case and control respondents of both overweight and obese grade I. This may be one of the reasons of improved status of anthropometric, clinical, biochemical, proinflammation of respondents of case group (i.e. overweight and obese grade I) *via* intervention.

It may be concluded that sedentary lifestyle, high intake of nutrients (i.e. protein, carbohydrate and phosphorus) and genetic predisposition may be the cause of overweight and obesity. Significant difference between case and control group was observed among both overweight and obese grade I respondents in anthropometric measurement except in waist-hip ratio. In context of clinical and biochemical parameters, significant difference between case and control group was observed in systolic blood pressure and fasting plasma glucose observed among both overweight and obese grade I respondents. Inspite of this, significant difference was also noticed between case and control overweight respondents in the biochemical parameters like total cholesterol, high density lipoprotein, low density lipoprotein, total lipids, non - HDL cholesterol and cholesterol HDL ratio. Furthermore significant difference was also noticed between case and control respondents in context of TNF-alpha in overweight respondents and hs-CRP and adiponectin in context of obese grade I respondents. Additionally highly significant difference was observed in the intake of calcium and dairy calcium between case and control respondents of both overweight and obese grade I after 6 month of intervention. In the nutshell, it can be concluded that incorporating hypocaloric diet with dairy food products and increased physical activity is the cornerstone for achieving and maintaining a healthy body weight and composition.

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