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# Assessment of dietary calcium intake in young subjects and its association with obesity

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**ABSTRACT**

Many of the studies had shown an inverse association between dietary calcium intake and weight loss so the present study was aimed to investigate the association between dietary calcium intake and body mass indices. This cross-sectional study was conducted to investigate the association between dietary calcium intake and anthropometric correlates. 1000 people (492 males and 508 females) were randomly selected from different educational institutes of Lahore, Pakistan. Anthropometric measures were calculated, while demographic and dietary information (especially high-calcium sources) was assessed with the help of a questionnaire. Out of 1000 individuals, about 5% were obese, 33.3% overweight, 53.3% normal, and 8.4% were underweight for the studied population. The average calcium intake for the studied population was 706.66 ± 4.2 mg/d. The average BMI of 22.84 kg/m² was observed in the studied population. Percentage of calcium deficient (<400 mg/day) obese and overweight subjects was found to be 13%. A statistically significant inverse association ($r=-0.063$, $p<0.05$) was observed between dietary calcium intake and obesity suggesting that an increase in calcium intake can decrease the chances of obesity incidence.

**Keywords:** Calcium, Obesity, BMI, Young population

## INTRODUCTION

In the past 40 years, obesity has increased inevitably and now it has become a leading cause of many diseases worldwide (NCD-RisC, 2016). The incidence of overweight and obesity increased rapidly in developed countries after 1980. About 2 billion of the world population was affected by obesity in 2015. Obesity along with its determinants is considered a major risk factor for the development of non-communicable diseases globally. The obesity epidemic is a component of The Global Syndemic, which also includes under nutrition (Swinburn *et al.,* 2019). Overweight and obesity have reached epidemic proportions in many Asian countries. These countries also face a grave burden of obesity-related disorders such as diabetes, hypertension, cardiovascular diseases, ischemic heart diseases, chronic kidney and liver diseases, etc. (Fan *et al.,*2017). Pakistan is similar to other countries undergoing many transitions simultaneously, where obesity affects first urban middle-aged women, then in men and younger women with economic development, increasing urbanization and lifestyle changes including diet. As obesity is associated with health risks, monitoring the prevalence of obesity is relevant for public health programs that focus on reducing or preventing obesity (Ogden *et al.,* 2016). Dietary intervention is an important aspect in the treatment of excessive body weight and a decrease in energy intake is the most important component of any weight-loss strategy (Gibson & Sainsbury, 2017; Barquissau *et al.,* 2018). Dietary calcium and dairy food intake appear to play a significant role in healthy weight management as well as in attenuating metabolic risk associated with obesity (Subih *et al.,* 2018). Estimates of the prevalence of obesity and effects of dietary calcium in managing body mass indices will help

**Author's Contribution: S.S. &S.N.,** Conceived and designed the experiment; **N.P.,** Collected data and wrote manuscript; **A.A.L.** & **F.Z.,** Analyzed data and reviewed manuscript; **T.F.**, Data analyzed and wrote manuscript; **S.S. & F.M.**, Reviewed manuscript determine the magnitude of the problem in the selected population so that the need for preventive measures can be assessed and high-risk population groups can be identified.

## MATERIALS AND METHODS

### Study design

In the current study, the aim was to assess the role of dietary calcium in controlling obesity and energy balance. A questionnaire was designed to obtain information regarding studies. The questionnaire included mostly close-ended questions to collect the exact knowledge. Questions asked were mainly about the diet or food containing an average of 30 mg calcium per dose for example daily or weekly milk or other foods intake. Other questions asked were about, obesity prevalence in family, supplemental calcium intake, and monthly income of family to assess the social status of the family. Questions regarding family history and social status were asked because these are major causes of obesity in developing countries like Pakistan.

### Data collection

After designing a standard questionnaire, we approached different educational and medical institutes of Lahore.1000 individuals were randomly selected with ages ranging between 17-29 years. Out of which 508 were females and 492 males. Overall data was collected from more than 1000 individuals but the individuals who did not provide the complete or accurate information were excluded from final studies. Every individual was asked to fill the questionnaires, carefully and truly to provide accurate information.

### Assessment of Anthropometric Measures

### Calculation of BMI

BMI (Body Mass Index) is a measurement of body fat based on height and weight that applies to both men and women between the ages of 18 and 65 years. To calculate the body mass indices of the subjects, the weight and heights of the individuals were measured.

### Measurement of weight

Weight in kilograms of each individual was taken by using an analogous scale. Participants were asked to remove the shoes and heavy clothing, such as sweaters. It was made sure that participants were standing with both feet in the center of the scale. Weight was then recorded accurately from scale.

### Measurement of height

Height was measured in meters using a measuring tape while a person standing on straight, plain, and leveled ground surface and was barefooted. Distance between the top of the headpiece and floor while the participant’s heels were touching the back plate of the measuring tape was measured. Then the body mass index (BMI) was calculated by using the metric formula, which calculates BMI by dividing the weight in kilograms by square of height in meters. Participants were categorized as obese, overweight, underweight, or normal by using a standard chart for classification of BMI (Gutiérrez-Pliego *et al.,* 2016).

### Calculation of WHR

WHR measures the ratio of one’s waist circumference to hip circumference. To determine the hip circumference individuals were asked to stand up straight and breathe out. Then measured the distance around the largest part of hips i.e. the widest part of buttocks by using a measuring tape. To find the waist circumference, wrapped the measuring tape around the smallest part of the waist just above the belly button (while individuals were asked to breathe normally). We made it sure that the measuring tape was snugged to the body, but not so tight to compress the skin. All these measurements were taken very precisely and carefully and were repeated thrice to attain concordant readings. WHR was calculated by dividing the waist circumference to hip circumference. WHR was categorized as low, moderate, or high health risk using standard WHR range chart (Ahmad *et al.,* 2016).

### Assessment of dietary calcium intake

Dietary calcium intake was estimated using a food frequency questionnaire (FFQ) which requested information relating to food choices, frequency, portion size, quantity, and consumption rate of different foods containing considerable amounts of calcium. The calcium content of different foods was estimated by using the Calcium sources along with calcium contents chart by NIH. Daily calcium intake was calculated by summing up the calcium from the data provided by participants.

**Statistical analysis**

All of the data was orderly organized and then was entered on the data sheet using Microsoft Excel 2016. The data were analyzed by using SPSS (Statistical Package for Social Sciences version 25). Descriptive information including mean, standard error of means, and frequencies were determined. Mean ± standard error of the mean was calculated for quantitative variables like age, body mass index, waist circumference, WHR, and Monthly income. For categorical variables frequencies were calculated. Graphs and charts were produced by using Microsoft Excel 2016. To find any association or correlation between different variables Pearson's Correlation was applied. A p-value of less than 0.05 was considered to be statistically significant.

## RESULTS

### Anthropometric measures

### Anthropometric measures of studied population

We performed our study with 1000 participants, having an average age of 24.46 ± 0.10 years, ranging between 17 and 29 years. To classify the subjects based on obesity BMI (Body mass index) and WHR (Waist to hip ratio) were measured. The average BMI for the studied populations was observed to be 22.84 kg/m² showing the lowest value of 14.15 kg/m² (Underweight) and the highest value of 43.57 kg/m² (Obese). The population under study had a mean WHR of 0.84 ± 0.004 with a minimum and maximum value of 0.57 and 1.52, respectively. Average Calcium intake calculated by using a food frequency questionnaire (FFQ) was 706.66 ± 4.2 mg/d, the lowest intake being 396 mg/d while the highest 996 mg/d. The monthly family income of the subjects used to assess the socioeconomic status (SES) averaged 67397 ± 1478 (PKR). The lowest income found was 12500 PKR (Lower Class) while the highest being 7,80,000 PKR (Upper Class). The studied population was categorized into two groups based on gender which included 508 females and 492 males. Mean values of anthropometric variables for both genders are given in Table I.

**Table I: Anthropometric Measures of Male and Female Participants**

| **Parameters** | **Gender** | **Mean ± SEM** | **P Value (t-test)** |
|---|---|---|---|
| Age (Years) | Male<br>Female | 24.58 ± 0.14<br>24.35 ± 0.14 | 0.258 |
| BMI (kg/m²) | Male<br>Female | 24.16 ± 0.17<br>21.56 ± 0.18 | 0.000* |
| WHR | Male<br>Female | 0.92 ± 0.005<br>0.76 ± 0.004 | 0.000* |
| Daily Calcium intake (mg/d) | Male<br>Female | 685 ± 7.15<br>727 ± 4.70 | 0.000* |
| Monthly Family Income(PKR) | Male<br>Female | 68517 ± 2328<br>66312 ± 1840 | 0.458 |
| ***Significant p≤0.01** | | | |

### Distribution of different parameters among males and females

**Dietary intake**

Among the participants consuming high calcium (900-1200 mg/day) 19% were males and 12% were females. 29% of males and 46% of females were taking medium amounts (400-900 mg/day) of calcium. Low calcium intake (<400 mg/day) was observed in 52% males and 42% females (Table II). It was observed that 64% of the sample population were taking no calcium supplements while the remaining 36% were found to use calcium-related supplements.

**Table II: Frequency Distribution of Studied Parameters**

| Parameters | Male n (%) | Female n (%) | Total n (%) |
|---|---|---|---|
| **BMI** | | | |
| Underweight | 15 (3) | 69 (13) | 84 (8.4) |
| Normal | 232 (47) | 301 (59) | 533 (53.3) |
| Overweight | 212 (43) | 121 (24) | 333 (33.3) |
| Obese | 33 (7) | 17 (3) | 50 (5) |
| **WHR** | | | |
| Low | 181 (37) | 319 (63) | 500 (50) |
| Normal | 123 (25) | 92 (18) | 215 (21.5) |
| High | 188 (38) | 97 (19) | 285 (28.5) |
| **Waist Circumference** | | | |
| Normal | 316 (64) | 331 (65) | 647 (64.7) |
| Abnormal | 176 (36) | 177 (35) | 353 (35.5) |
| **Calcium Intake** | | | |
| High | 93 (19) | 58 (12) | 151 (15.1) |
| Medium | 145 (29) | 235 (46) | 380 (38.0) |
| Low | 254 (52) | 215 (42) | 469 (46.9) |
| **SES** | | | |
| High | 19. (4) | 21 (4) | 40 (4.0) |
| Medium | 439 (89) | 449 (88) | 888 (89) |
| Low | 34. (7) | 38 (8) | 72 (7.0) |

### Prevalence of obesity

According to the standard table for obesity classification in our study more males (7%) were obese and overweight (43%) than females. While more females were normal (59) and underweight (13%) than males. Similarly, a greater number of females (29%) had a normal waist-hip ratio as compared to males (25%). The percentage of males and females having a normal waist circumference was 64 and 65, respectively (Table II). About 52% of individuals had family backgrounds with the prevalence of obesity while 42% had no such family history.

### Socioeconomic status

Most of the participants (89%) had a medium socioeconomic status i.e. belonged to the middle class (Income =40,000-100,000 PKR) (Table II).

### Correlations

By applying a two-tailed Pearson Correlation test we obtained the correlations between studied variables i.e. between daily calcium intake and BMI, daily calcium intake and WHR, BMI, and Monthly income as well as between WHR and monthly income. The current study showed that there was a negative correlation between calcium intake and BMI of the participants ($r=-0.063$, $p<0.05$), which indicated that calcium intake was inversely associated with BMI of the subjects (Table III) (Fig. 1). An increase in calcium intake may cause a corresponding decrease in BMI of subjects. The waist-hip ratio of the participants was also negatively correlated with the calcium intake of the subjects ($r=-0.159$, $p<0.01$) (Table III) (Fig. 2). Because of this inverse association between calcium intake and WHR an increased level of calcium intake can decrease the WHR whereas a decrease in calcium intake may cause an increase in WHR.

The present study revealed that there was a slightly negative correlation between BMI and Monthly incomes of the subjects ($r=-0.015$, $p>0.05$) (Table III). So, the possibility that an increase in income may cause a decrease in BMI or a decrease in income may cause an increase in BMI is of negligible extent.

A trend similar to that of correlation between BMI and Monthly income was observed for correlation between monthly income and waist-hip ratio, which was also very weakly and inversely related to monthly income ($r=-0.008$, $p>0.05$), which showed that relationship was not statistically significant, and monthly income had a negligible effect in increasing BMI (Table III).

**Table: III Correlations between Calcium Intake and Anthropometric Variables**

| Pearson Correlation Between | BMI | | WHR | |
|---|---|---|---|---|
| | r value | p value | r value | p value |
| **Daily Calcium Intake** | -0.063 | 0.047* | **-0.**159 | 0.000** |
| **Monthly Income** | -0.015 | 0.62 | -0.008 | 0.79 |
| ***Significant p≤0.05 , **Significant p≤0.01** | | | | |

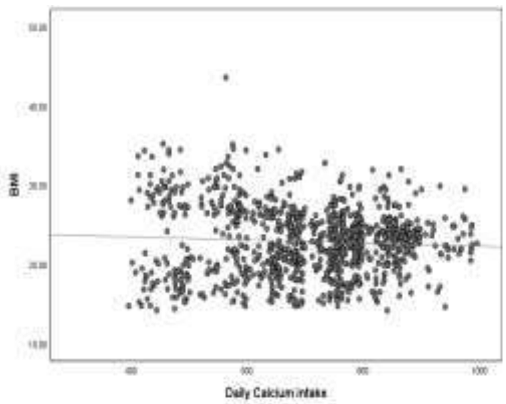


**Fig. 1:** A scatterplot for Correlation between Calcium Intake and BMI

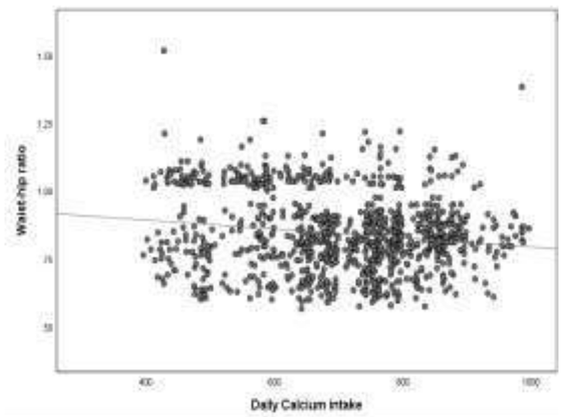


**Fig. 2:** A scatterplot showing Correlation between Calcium Intake and WHR

## DISCUSSION

The present study was conducted on 1000 participants having 22.84 kg/m² average BMI and an average calcium intake of 706.66 ± 4.2 mg/d. Association between Calcium intake and Body Mass Indices of the subjects were evaluated. Using the anthropometric measures i.e. BMI and WHR and daily calcium intake, the role of calcium in preventing obesity or in promoting weight loss was assessed. This association was investigated using Pearson's correlation. Calcium intake was found to be inversely associated (r= -0.063) with BMI which meant greater the person's calcium intake lesser would be the risk of getting overweight or obese. Results were significant at ($p \leq 0.05$) which showed that the results did not occurred by chance only in the sample population but there was statistical evidence for the existence of this phenomenon in the population.

The results from the present study are in agreement with many other studies showing a decrease in BMI or an increase in weight loss when calcium intake is increased. A similar cross-sectional research enrolling 244 adolescent females assessed the relationship between dietary calcium and obesity. 8.3% of the subjects were overweight while 0.7% were obese. This revealed that calcium intake was negatively associated with obesity. Calcium intake for this group of females was found negatively associated with BMI, WHR, and waist circumference. Overweight and obese participants were having a low average calcium intake as compared to those having normal body weight (Burbano *et al.,* 2016). Similarly, a meta-analysis including 33 studies with 4733 subjects concluded that increasing calcium intake tends to reduce the body weight. The meta-analysis showed that calcium intake was inversely related to the body mass index (Li *et al.,* 2016).

Likewise, a study enrolled 6,696 children (11.7± 1.8 years old), anthropometric and dietary information of the participants was collected. After 6 years 2,774 of these subjects were re-examined for the same data. The research assessed the relationship between dietary or dairy calcium and adiposity indices (BMI, WC, WHR, etc.). The incidence of being obese or overweight was significantly reduced with increasing calcium intake. A significantly lower increase was observed in body mass indices and waist circumference of boys having a higher calcium intake and vice versa (Nappo *et al.,* 2019). The results of the current study were consistent with these investigations and revealed a negative association between calcium intake and BMI (r= -0.063, $p<0.05$) of the studied population. Significantly different mean calcium intake was observed for males and females which was 685 ± 7.15 mg/d for males whereas 727 ± 4.7 mg/d for females. This difference might be due to the difference in dietary habits between males and females.

Many of the researchers also observed the results contradictory to that of current studies. In contrast to our work, a cross-sectional study enrolling 6582 adults assessed the association between average calcium intake, general obesity, and abdominal obesity. The researchers collected the data regarding dietary calcium intake and anthropometric measures using a standard questionnaire. Participants having a BMI ≥ 25kg/m2 were considered obese or overweight (general obesity); while participants having WC ≥ 88 cm (for females) or WC ≥ 102 cm (for males) were categorized for abdominal obesity. The study revealed a positive relationship between mean calcium intake and general obesity for men (Sadeghi *et al.,* 2018). This analysis is contradictory to the results of the current study which showed a statistically significant negative correlation between calcium intake and obesity.

The present study also showed that calcium intake was also inversely related to WHR. Higher is the intake of calcium of a person lower will be the risk of abdominal or central obesity. Values are significant at ($p<0.01$), hence the inverse association may also occur in the population not only in the sample. Results similar to those of current studies are also illustrated by many workers. Waist hip ratio value or waist circumference value greater than normal is categorized as abdominal obesity. A diet high in calcium content greatly increased the loss of central adiposity, as revealed by the decrease in waist circumference and waist-to-hip ratio (Burbano *et al.,* 2016; Nappo *et al.,* 2019). A study enrolling 350 children (8-9 years old) was conducted to assess the link between dietary calcium intake and abdominal adiposity. Increased waist circumference values (prevalence ratio= 2.86) were observed for children having low calcium intake. The study showed that reduced calcium intake increased the risk of abdominal obesity (Suhett *et al.,* 2018).

A larger proportion (47%) in our study was found to have a low calcium intake (<400 mg/day), while only a small percentage (15%) of participants had a high calcium intake (900-1200 mg/day). 13% of the obese and overweight subjects were found to be calcium deficient (<400 mg/day). The reason for such a low calcium intake might be a dietary transition from dairy foods to junk foods and excessive consumption of carbonated drinks. These drinks contain phosphoric acid as a flavor enhancer which can impede the calcium absorption from the gastrointestinal tract (Chaudhary *et al.,* 2018). Calcium is abundantly present in dairy products but in our youth junk food consumption has become common. Most of the junk foods are rich in fats but poor in other nutrients like calcium. Excessive consumption of junk foods can also cause a decrease in calcium absorption (Lim *et al.,* 2012). In our study, we found that socioeconomic status had a slight negative association with obesity but the results were not statistically significant. These results were consistent with the findings of many other researchers (Barich *et al.,* 2018; Jin & Lu, 2017). In short, the current study focused on associations between calcium intake and obesity. Results revealed that increased intake of calcium decreases the chances of being obese. As obesity is associated with many cardiovascular diseases, diabetes, Non-communicable diseases (NCDs), and cancer so, increased calcium intake tends to decrease the probability of occurrence of the above-mentioned diseases as well.

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