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## Impact of dairy products consumption and physical activity on obesity and osteoporosis: A survey at faculty community of Sohag University

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**Abstract**

This study aimed to determine the effect of dairy products consumption and certain physical activities on bone mineral density (BMD) and mass index (BMI) as rates for osteoporosis and obesity used. BMI was classified as underweight (<18.5 BMI), normal weight (18.5–24.9 BMI), overweight (25– 24.9 BMI), Overweight (25-29.9 BMI) and obese (> 30 BMI) are considered as the obesity degree. BMD was measured for the right foot using a pDEXA densitometer with dual-energy X-ray absorptiometry (DXA) and expressed as a T-score then subdivided as normal ( $T \geq 1$ ), osteopenia ( $T (-1) - (-2.5)$ ) and osteoporosis ( $T < -2.5$ ). The correlation was performed using Pearson's correlation coefficient formula. The results showed that mean BMI, BMD, and milk product consumption were  $27.3 \pm 0.98$ ,  $0.79 \pm 0.76$ , and  $62 \pm 0.43$ , respectively. Results showed that most respondents were consuming insufficient amounts of dairy products, leading to high rates of osteoporosis (21%) and osteopenia (37%). The correlation value of physical activity was negative with BMI (-0.073) and positive with BMD (0.053). The results showed that dairy consumption and daily physical activity can increase bone mineral density and prevent obesity.

**Keywords:**

dairy products; bone mineral density; body mass index; Osteoporosis

## INTRODUCTION

Dairy foods are good sources of calcium, vitamin D (in fortified dairy foods), protein, and magnesium, nutrients that have been related to bone health, [1] which has a key role in maintaining normal skeletal growth in children and adolescents [2]. Also, dairy products provide a package of essential nutrients that is not easy to obtain in low-dairy or dairy-free diets, and for many people cannot be possible to achieve recommended daily calcium intakes with a dairy-free diet [3]. Previous research has suggested a positive link between milk intake and bone mineral density (BMD). A recent systematic review reported that daily intake of low- or non-fat dairy products as part of a healthy habitual dietary pattern may be associated with improved BMD of the total body and at some bone sites [4]. Inconsistent findings of dairy intake and bone measures in recent studies has led to considerable controversy surrounding potential benefits of dairy foods for bone health. Previous studies on this topic have largely associated dairy food intake with dual energy x-ray absorptiometry (DXA) derived areal bone mineral density (BMD), which can be confounded by individual differences in bone size, and it does not provide information about bone microstructure, a key determinant of bone strength. More advanced, novel imaging (e.g., bone microarchitecture analysis), use of existing images to generate measures associated with fracture risk beyond BMD as well as common fracture risk tools like FRAX are now available. Yet, these methods have not been used by many nutrition studies. Protein intake specifically from dairy has been favorably associated with bone microarchitecture in older men [5], and post-menopausal women [6]. Due to the mineral components of bone, dietary calcium's importance for bone growth is evident even before birth. Bone mineral mass BMD is measured as the amount of bone accumulated at the end of skeletal growth (peak bone mass) and by the amount of bone lost subsequently. Building a strong skeleton from birth to adulthood and maintaining healthy bones through menopause and aging are vital to minimize frailty in the elderly. Post the age of 20 years, there is a slight change in bone mineral mass until menopause in women when a rapid drop in

estrogen leads to an increase in bone remodeling. Menopause is associated with an average annual bone loss of 3–5 % during the first few years and around 1 % thereafter [7]. Many observational and interventional studies have shown that adequate Ca intake is required to attain maximal peak bone mass [8,9]. In addition, several researchers have demonstrated a favorable effect of increased milk and other dairy intake on bone parameters [2]. However, Lanou et al. [10] conducted a systematic review that revealed insufficient evidence to support the idea that increased intake of milk or other dairy products has a favorable effect on promoting bone mineralization in children and adolescents. They also pointed out that such evidence is scarce in non-Caucasian children and adolescents. Osteoporosis is a systemic metabolic disease of bone characterized by reduced bone density as well as structural abnormalities [11,12]. Asymptomatic fractures and pathologic fractures are often the first clinical symptoms. A decrease in bone mineral density (BMD) with age is generally inevitable. In the age group 20–79, the proportion of people with steady bone mass and BMD values decreased almost linearly, while the incidence of osteoporosis increased linearly [13]. Until recently, the diagnosis and treatment of osteoporosis relied on bone density (BMD) measurements. Dietary risk factors for bone fractures play a special role in preventing osteoporosis. Many studies have shown that adequate calcium intake improves bone mineral density [14]. However, the role of calcium and dairy products in preventing osteoporosis has not been fully explained. It is generally believed that adequate calcium intake during childhood and adolescence is most important [15,16]. It is thought that in adulthood, the role of nutritional factors may be less and mainly influencing the rate of bone loss. It has been estimated that in postmenopausal women, the rate of bone loss can vary over a range of values from 1% to 5% or more per year [13]. Although many studies showed the relationship between dairy product intake all over the world [2,3,10,14,17]. There is not enough data about the consumption level of dairy products and its effect on bone health or body weight in Egypt. Also, there are no more reviews that studied the relationship between physical activities and bone health in the Sohag region. With this background, the main objective of this study was

to determine the impact of consuming dairy products (milk, yogurt, and cheese) and some physical activities (walking, running, and using elevators), for bone mineral density (BMD) and body mass index (BMI) are used as markers of osteoporosis and obesity, respectively. among the faculty members of Sohag University in Egypt.

## MATERIALS AND METHODS

### 1. Subjects

In this study, we targeted the faculty members of Sohag University. 85 persons have been invited to participate in this study as volunteers. This study was conducted according to the guidelines established by the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethics Committee of Sohag University.

### 2. Demographic Characteristics Data

Pre-designed structured interview Schedule (in a questionnaire form) was used to collect data about socio-demographic characteristics. The questionnaire included a group of questions regarding the subject's gender, age, height, weight, current consumption of dairy products, and current physical activity level. Body mass index (BMI) was calculated by dividing weight (kg) by the square of height (m<sup>2</sup>) and classified as the following:

- Underweight < 18.5 BMI
- Normal weight 18.5-24.9 BMI
- Overweight 25-29.9 BMI
- Obesity > 30 BMI

Questions 4-6 were designed to measure dairy product consumption; 16-18 were designed for physical activity.

### 3. Assessment of Bone Mineral Density BMD

Bone mineral density (BMD) was measured in the right foot using a pDEXA densitometer with dual-energy X-ray absorptiometry (DXA) and expressed as a T-score, i.e., the number of standard deviations associated with highest bone mass for all sample studies [12]. The results were divided into groups with different BMD:

- BMD  $\geq 1$  is interpreted as regular bone mineral density.
- BMD (-1) - (-2.5) is interpreted as

low bone mineral density (osteopenia)  
BMD < -2.5 interpreted as very low  
bone mineral density (osteoporosis)

### 4. Statistical Analysis

After completion of data collection, data have been revised, coded, and fed to the computer using the Statistical Package for Social Science Software (SPSS) version 17 (SPSS Inc., Chicago, Illinois, USA) for tabulation and analysis. Data was presented tabular, graphically, and mathematically as the number and percent and using mean and standard deviation (SD) as well as the correlation has been done according to Pearson Correlation Coefficient Formula.

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]}}$$

Where:

- N= number of pairs of scores
- $\sum xy$ = sum of the products of paired scores
- $\sum x$ = sum of x scores
- $\sum y$ = sum of y scores
- $\sum x^2$ = sum of squared x scores
- $\sum y^2$ = sum of squared y scores

## RESULTS

### 1. Description of Characteristics and Consumption of Dairy Products

A group of faculty members from Sohag University in Egypt (85 persons) participated in this study. The average respondents' age was 42.32±11.79 years. According to characteristics data which showed in Table 1 the study respondents were 48% male and 52% female. Most of them were not use any medical drugs for chronic disease and all of them didn't drink alcohol products but only 8% of them were smokers. Results also cleared that more than 70% consumed dairy products like milk, cheese, and yogurt within their daily diet programs. The study found that most respondents preferred to consume a moderate amount of cheese every day as a source of calcium more than liquid milk or yogurt as shown in Figure 1 which may be due to the availability of liquid milk in the surrounding environment and preference of most producers to manufacture cheese with the largest economic return. The intake of milk showed 68.24%, 7.33%, and 25.88% for once-daily, twice-daily, and once-weekly

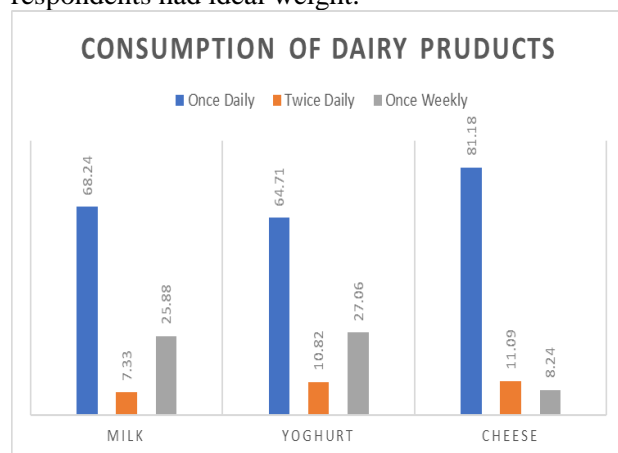
consumption respectively. Consumption of yogurt 64.71% once daily, 10.82% twice daily, and 27.06% once weekly within a dietary system of study respondents. About 81.18% of Sohag University faculty members consumed cheese once daily while 11.09% of them consumed cheese twice daily.

**Table 1.** The respondent's characteristics proportion and standard deviations.

Subject characteristics	Proportion (%) <i>n</i> = 85	SD
AGE	42.32	11.79
BMI	27.3	0.98
BMD	0.79	0.77
SEX	M= 48 % F= 52%	0.50
Smoking	Y= 8.23% N= 91.76%	0.28
Diary Intake	62 (72.94%)	0.43
Soft drinks intake	65 (76.47%)	0.40
Meat intake	72 (84.70%)	0.30
Sports and physical activities	36 (42.35%)	

## 2. Distribution of Obesity within Respondents

Figure 2 showed the distribution of Body Mass Index (BMI) which is used as an indicator of obesity. BMI values recorded 10%, 33%, 39%, and 18% for underweight, ideal, overweight, and obese respectively, with a  $27.3 \pm 0.98$  average. Data shows that most of the samples have a high BMI which may be due to the wrong dietary habits and the low level of sports activities as shown in Table 1. Moreover, data cleared that only about 30% of respondents had ideal weight.

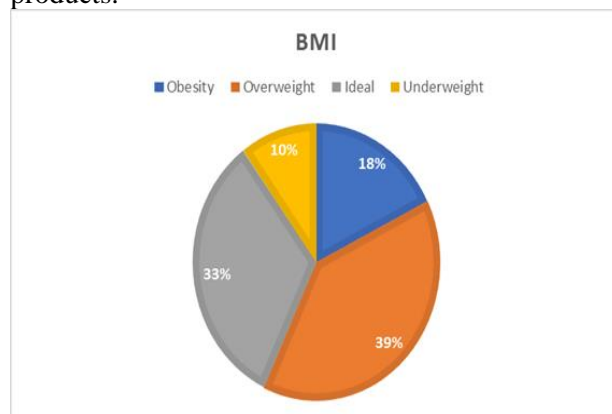


**Figure 1.** Consumption of dairy products

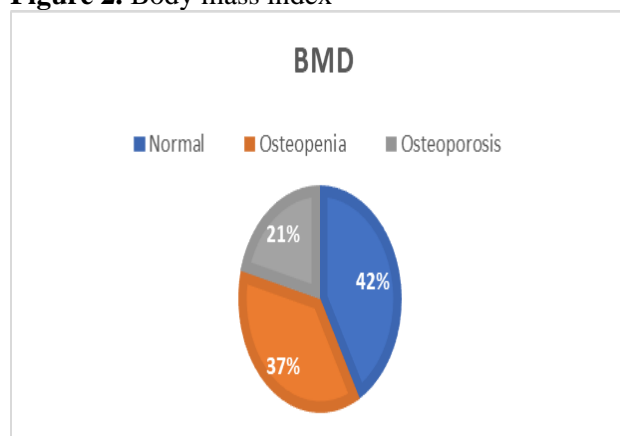
## 3. Distribution of Bone Mineral Density (BMD)

Results in Figure 3 revealed the bone mineral density which is used as an indicator of steoporosis. BMD values were 21%, 42%, and 37% for normal, osteopenia, and osteoporosis

respectively, with  $0.79 \pm 0.76$  average. According to findings, most of respondents were at risk of Osteoporosis or Osteopenia (79%) which may be due to the lack of calcium sources such as dairy products.



**Figure 2.** Body mass index



**Figure 3.** Bone mineral density

## 4. Correlations between BMI, BMD, and the various experimental variables

### 4.1. Correlations between BMI, BMD, and Description Characteristics

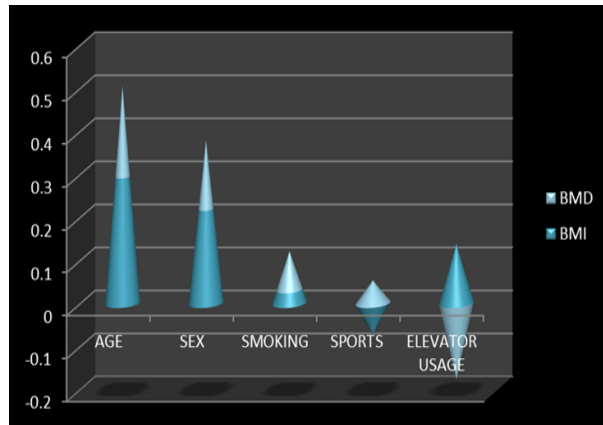
Table 2 and Figure 4 showed the correlation results between the various variables and both BMI and BMD showing certain correlations in a varying value such as below: There is a clear positive correlation between the BMI with age (0.294) and with sex (0.219). Correlation values for BMD with age (0.211) and sex (0.16). Although sports



activities like walking and running give a clear negative correlation with BMI (-0.073) it has a positive value with BMD (0.053) which reports that sport can enhance BMI and bone health.

**Table 2.** Correlations between BMI, BMD, and Description Characteristics and physical activities N= 85 respondents

Variables	BMI	BMD
Age	0.294	0.211
Sex	0.219	0.16
Smoking	0.031	0.09
Sports	-0.073	0.053
Elevator Usage	0.138	-0.177



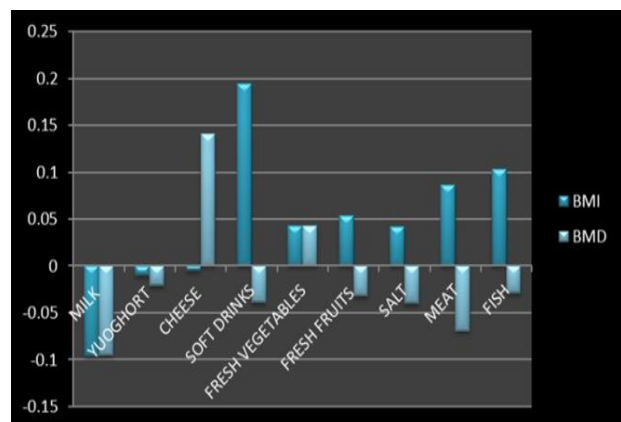
**Figure 4.** Correlations between BMI, BMD, and description characteristics, N= 85 respondents.

#### 4.2. Correlations between BMI, BMD, and Dietary Habits

The results in Table 3 and Figure 5 showed the correlation results between the dietary habits of respondents and both BMI and BMD. Data showed a certain correlation in various values such as below: There is a clear negative correlation between the consumption of dairy products and BMI, values were (-0.096, -0.01, -0.005) for milk, yogurt, and cheese respectively. Also, correlation values between BMD and dairy products were (-0.095, -0.021, 0.141) for milk, yogurt, and cheese respectively. Soft drinks have a positive correlation with BMI (0.194) while it has a negative one with BMD (-0.039) which is clear that the consumption of soft drinks may increase BMI and decrease BMD.

**Table 3.** Correlations between BMI, BMD, and dietary habits N= 85 respondents

Variables	BMI	BMD
Milk intake	-0.096	-0.095
Yogurt intake	-0.010	-0.021
Cheese intake	-0.005	0.141
Soft drinks	0.194	-0.039
Fresh vegetables	0.043	0.043
Fresh fruits	0.053	-0.032
Salt	0.042	-0.040
Meat	0.086	-0.069
Fish	0.103	-0.029



**Figure 5.** Correlations between BMI, BMD, and dietary habits, N= 85 respondents

## DISCUSSION

### 1. Description of Characteristics and Consumption of Dairy Products

Bostick et al. [18] mentioned that the potential benefits of consuming dairy products are generally attributed to the main nutrients found in dairy products such as Calcium. Our findings were in the same trend as Martini et al. [19] who reported that dairy products provided 67% of calcium daily amount which related to bone health in similar studies. On the other hand, Pravina et al. [20] reported that dietary calcium deficiency is a condition in which calcium intake is inadequate, which can lead to the depletion of calcium stores in the bones, thinning and weakening of the bones, and osteoporosis.

## 2. Distribution of Obesity within Respondents

Results were in agreed with [21] they discussed the relationship between exercises and weight loss. Also, Saris et al. [22] recommended that a level of physical activity of 225 to 300 minutes per week was essential to avoid going from normal weight to obesity. Moreover, Bendtsen et al. [23] indicates the high-calorie content of dairy products and the high calcium intake prevent weight gain. Dairy consumption has been found to play an important role in maintaining a healthy body weight [24]. On the other hand, Wadolowska et al. [25] found that diets that include a variety of dairy products with suboptimal levels of dietary calcium, as well as dietary calcium, can prevent obesity in adolescent and adult women. In this regard, Weaver [26] reported that diet and exercise are two lifestyle choices that can affect fracture risk.

## 3. Distribution of Bone Mineral Density (BMD)

Similar results were reported by [27] who cleared that dairy products could provide the main source of calcium and sodium for building bone tissues. Also, Pravina et al. [20] mentioned that calcium is important for maintaining the overall health of the body. The body needs it every day not only to keep bones and teeth strong throughout life but also to keep muscles and nerves functioning properly Calcium deficiency is usually caused by insufficient calcium intake, when blood calcium levels are too low, an essential mineral is borrowed from the bones. Dietary calcium deficiency is a condition in which calcium intake is inadequate, which can lead to depletion of calcium stores in bones, thinning and weakening of bones, and osteoporosis. Wadolowska et al. [14] showed that good bone health is highly dependent on the combined effect of dietary factors and some non-modifiable risk factors for osteoporosis, such as age and menstrual periods. Eating dairy products during childhood and adolescence can improve bone mineral density and reduce the risk of osteoporosis in adult women. On the other hand, both [28,29] reported that the key nutrients positively associated with bone health include calcium, magnesium, phosphorus, potassium, vitamin D, Vitamin K, protein, and omega 3 fatty acids.

## 4. Correlations between BMI, BMD, and the various experimental variables

### 4.1. Correlations between BMI, BMD, and Description Characteristics

In contrast to these findings Reid [30] reported that obesity is associated with insulin resistance, which is characterized by high plasma insulin levels. Elevated plasma levels of insulin can contribute to various abnormalities, including the overproduction of androgens and estrogen in the ovaries and decreased production of SHBG by the liver. These changes can result in increased sex hormone levels, leading to increased bone mass due to decreased osteoclast activity and possibly increased osteoblast activity. Also, Guney et al. [31] reported that Much epidemiological data suggests that high body weight or BMI is associated with high bone mass and that weight loss can lead to bone loss. Moreover, Zhao et al. [32] increasing fat mass may not have a beneficial effect on bone mass. Morin et al. [33] concluded that low body weight and low body mass index predict osteoporosis and are associated with an increased risk of fracture. On the other hand, it must be recognized that there are studies that have not found a significant positive relationship between body weight and BMI and BMD or, conversely, have shown a negative relationship between obesity and BMD, seriously challenging the general assumption that obesity is protective. Paniagua et al. [34] found a high prevalence of osteopenia and osteoporosis in male nursing home residents who were more likely to be overweight and obese based on BMI. Similarly, [35] demonstrated that Obesity has been linked to osteoporosis and provided clinical evidence that obesity should not be viewed as a protective factor. [36,37] mentioned that mechanical stimulation is an important factor in bone growth and bone formation. Exercise provides physical and physiological stimulation that improves muscle strength, cartilage protection, and bone remodeling. [38] suggested that strenuous activity such as running increases bone mineral density in the lower extremities. Moreover, [28] concluded that While BMI is a good indicator of bone characteristics, high body fat percentage should also be a major risk factor for osteoporosis with age. Interestingly, high body mass index combined with moderate to vigorous activity supplemented

with optimal nutrition (qualitative and quantitative) have been identified as positive modulators of bone health. Sun et al. [39] concluded that certain demographic characteristics, dietary factors (particularly lipid levels, heavy metals), and unhealthy behaviors affect bone mineral density to varying degrees. In our study, there is still no consensus on the effect of smoking and alcohol consumption on bone mineral density.

#### **4.2. Correlations between BMI, BMD, and Dietary Habits**

In this regard Pravina et al. [20] reported that Long-term calcium deficiency can lead to osteoporosis, which causes bones to break down and increases the risk of fractures. A balanced diet can provide all the nutrients you need and help prevent calcium deficiency. De França et al. [40] conceded that excessive consumption of sugary foods and caffeinated beverages at the same time appears to harm bone mineral density, even when the skeleton already shows some demineralization. The consumption of food and drink is an influenceable factor in the treatment of people with osteoporosis that should not be underestimated. On the other hand, Weaver [26] concluded that Proper nutrition is one of many lifestyle choices important to maintaining good bone health. It's hard to underestimate the importance of good nutrition, as the effects are subtle over the long term. Small daily gains over decades may or may not affect fracture risk. Nutrition provides the raw materials necessary for bone formation but is not sufficient. Strength exercises stimulate the bones. Other lifestyle options that should be used in moderation as they are bad for bones are smoking and drinking alcohol. Also, Lee et al. [41] showed that Milk intake and physical activity have a combined effect on bone mineral density, suggesting that promoting both moderate-to-vigorous physical activity and milk intake during adolescence is important for healthy bone growth [42] concluded that high habitual consumption of milk, but no habitual consumption of yogurt or cheese, is associated with a reduced risk of osteoporotic fractures in postmenopausal women, regardless of bone mineral density. Our results disagreed with Rodopaios et al. [43] who reported that intermittent abstinence from dairy and animal

products, in general, does not appear to impair bone health in the elderly.

## **CONCLUSION**

Dairy products are a very good source of calcium, sodium, and other nutrients which enhance bone mineral density. In this present study, we tried to survey the consumption of dairy products in the dietary system within the respondent's society, the amounts of dairy product intake were insufficient to improve the BMD for most of the respondents. Moreover, physical activities were less than required to minimize osteoporosis risk. The study concludes that increasing intakes of dairy products such as milk, yogurt, and cheese may have a positive effect on both BMD and BMI. Also, a study suggests that daily physical activities including sport exercise may support bone health and prevent weight increase.

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