Original Article

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Association of Body Mass Index with Serum Calcium Levels among Adult Sudanese, Gezira State

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ABSTRACT

Background: Calcium is a necessary nutrient for normal growth and development.
Aim: To document the normal values of serum calcium levels in healthy Sudanese adults in Gezira State as well as how it relates to body mass index (BMI).
Materials and Methods: A cross-sectional study was conducted in 2018 in Gezira state on 534 adults, 42.3% (226) were males and 57.7% (308) were females, aged between 20 and 60 years, A questionnaire was used for data collection to assess the essential demographic data. A volume of 3ml of blood was collected in heparin vacuum tubes and serum calcium was measured by Calcium-O-Cresolphthalein Complexone colorimetric method. SPSS version (23) was used for the statistical analysis. Chi-square, Students T-test, Pearson correlation, and linear regression were used to estimate the correlation between variables, P-value < 0.05 was considered statistically significant. The BMI calculation was weight in kilograms divided by height in meters squared (kg/m2). On the basis of BMI, the subjects were further divided into four categories: underweight, normal, overweight, and obese.
Results: The mean serum calcium levels of participants who were overweight and obese were 9.58± 0.68 and 9.75 ± 0.64, respectively, for females and 9.42 ± 0.63 and 9.47 ± 0.62 for males, respectively, as compared to 9.43 ± 0.72 and 9.52 ± 0.79 for females and 9.26 ± 0.67 and 9.35 ± 0.72 for males who were underweight and had normal BMI, respectively. In an obese person, BMI is significantly and positively linked with serum calcium levels. ($r = 0.72$, $P = 0.00$)
Conclusions: Serum calcium is positively associated with BMI in both sexes. In the treatment of obesity and excess weight, calcium should be taken into account.

Keywords: Body Mass Index, Calcium, Obesity, Bodyweight.

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INTRODUCTION

The World Health Organization (WHO) defines obesity and overweight as having a body mass index (BMI) of greater than 30 kg/m2 and more than 25 kg/m2, respectively. These conditions stand out among the non-transmissible chronic diseases because they are risk factors for health conditions like dyslipidemia, cardiovascular disease, diabetes, hypertension, and cancer.[1] An energy imbalance between calorie intake and energy expenditure is the primary concern with obesity.[2] It has been noted that an obese person can retain more than 70% of body mass as fat, which typically results from both adipocyte hypertrophy and hyperplasia.[3] Reduced physical activity, behavioral, social, environmental, genetic, urbanization, and modernization variables all contribute to obesity.[4] Within the last three decades, there has been a geometric increase in the prevalence of obesity.[5] It was identified by the WHO as a global epidemic in 1997.[1] Around the world, one in six persons is obese, and almost 2.8 million deaths related to obesity or overweight have been recorded.[6] Recent research suggests that frequent errors in the metabolism of several divalent cations, such as calcium and magnesium, are responsible for some obesity-related illnesses, particularly metabolic disorders, such as hypertension and cardiovascular diseases.[1,7] The most prevalent mineral in the human body is calcium, which is essential for many physiological processes, including muscle contraction, hormone, and neurotransmitter release, glycogen metabolism, cell proliferation, and differentiation, blood clotting, the transmission of nerve or sympathetic impulses, structural support of the skeleton, and acts a second messenger in several signaling pathways.[8] Calcium's involvement in regulating weight When taken in large amounts, calcium tends to bind to dietary fats and create insoluble compounds, which lowers the rate of fat absorption, and thus, the number of calories produced.[9,10] Researchers found that low dietary calcium consumption increases the levels of calcitropic hormones such as parathyroid hormone (PTH) and 1, 25-dihydroxy vitamin D, which control intracellular calcium and increase intracellular calcium levels in adipocytes. Adipocytes with high calcium levels promote lipogenesis and prevent lipolysis. High dietary calcium intake lowers intracellular calcium, inhibits lipogenesis, and accelerates lipolysis because it lowers PTH and 1, 25-dihydroxycholecalciferol levels.[11,12] The goal of the current study was to describe the typical serum calcium levels in healthy Sudanese individuals in the state of Gezira and their relationship to body mass index (BMI).

MATERIALS AND METHODS

The cross-sectional descriptive study was carried out in the Sudanese state of Gezira between 2018 and 2021. A total of 534 adults in Gezira State, Sudan, with ages ranging from 20 to 60, were selected randomly. They were healthy adults, with 42.3% (226) males and 50.7% (308) females making up the group.

Exclusion and inclusion criteria

Participants with conditions that can affect serum calcium levels, as well as BMI, were

excluded. Patients with syndromic, endocrine, or hereditary obesity were not included. Patients taking oral calcium and vitamin D supplements as well as those with preexisting hypertension, diabetes mellitus, cardiovascular illness, renal, or liver disease were excluded.

Ethical Considerations

Ethical approval is issued by the medical ethics committee of the University of Gezira.

Blood sample and data collection

The blood samples, about 3 ml of venous blood [without a tourniquet] because venous stasis can result in loss of fluid across the wall of the vein and a relative increase in protein-bound calcium. Samples were collected in heparin vacuum tubes from each participant between 8:30 am -11 am and transferred to a plain centrifuge tube, Serum was separated by centrifuging blood for 10 minutes at 3000 rpm. Serum was used for estimation of total calcium by Calcium-O-Cresolphthalein Complex one colorimetric method. Using a weighing scale, weight was measured to the nearest 0.1 kg (Soen Le, Germany). Each participant's height was gauged to the closest 0.5 cm by making them stand straight on a stadiometer without shoes. Weight was divided by the square of height (kg/m2) to determine the BMI. According to WHO guidelines, adults with a BMI of less than 18.5 were considered underweight, those with a BMI of 18.5 to 24.9 were considered normal weight, those with a BMI of 25.0 up to 30.0 were considered overweight, and those with a BMI of greater than 30.0 were considered obese.[13]

Statistical analysis

The Statistical Package for the Social Sciences (IBM-SPSS) software for Windows, version 23.0, New York, USA, was used to analyze the data of this study. The mean and standard deviation were used to express numerical data (SD). Frequency and percentage were used to express qualitative data. At a significance threshold of ($P<0.05$), an analysis of variance was performed. To calculate the correlation between two variables, the Chi-square, Student T-test, Pearson correlation, and linear regression were used.

RESULTS

The average respondents' age, height, weight, and BMI are shown in Table 1 as 24.67± 4.82, 1.65±0.70, 62.82±5.56, and 24.42±3.44, respectively. Males are more likely than females to be overweight or obese, with 20.4 percent and 15 percent, respectively. The prevalence of overweight and obesity among females was 31.2 percent and 19.2 percent, respectively. Participants had mean serum calcium values of 9.43±0.63. The results were displayed as mean SD. Tables were used to display the data.

Fig. 1 displays the percentage of destitution of the subject according to the BMI, whereas Table 2 lists the body mass index for males and girls. Table 3 demonstrates the connection between the study participants' BMI and their serum calcium levels. When compared to persons who were underweight and had a normal BMI, people who were overweight and obese had

significantly higher mean serum calcium levels (P< 0.05).

Table 1: General features of the participants and prevalence of overweight/obesity.

Variable	Mean ±SD
Age (years)	24.67±4.82
Height (Cm)	1.65±0.70
Weight (Kg)	62.82±5.56
BMI (Kg/m^2)	24.42±3.44
Prevalence of overweight (%) male female	 20.4% 31.2%
Prevalence of obesity (%) male female	 15% 19.2%
Calcium (mg/dL)	9.43±0.63

SD: Standard deviation, BMI: Body mass index

Table 2: BMI in males and females.

Type of category	BMI range	Male	Female
Under weight	<18.5	22	24
Normal	18.5-24.9	124	129
Overweight	ß25-29.5	46	96
obese	≥30.0	34	59
Total		226	308

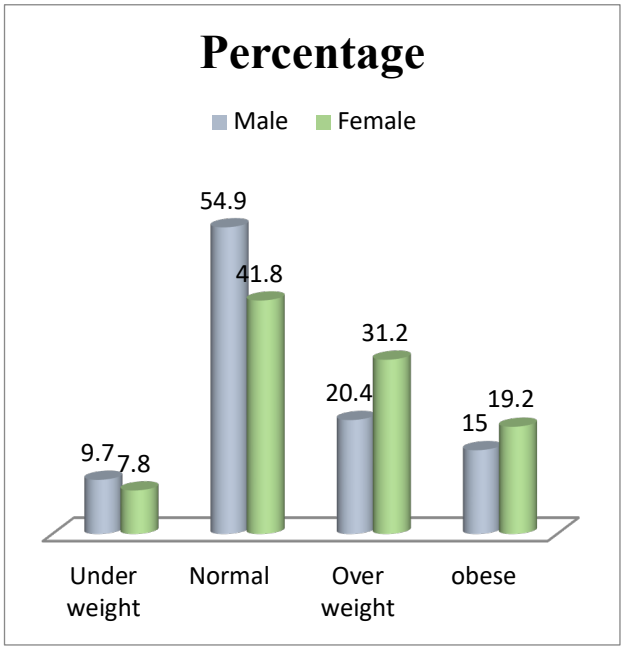

Figure 1: Percentage destitution of the subjects according to the BMI.

Table 3: Relationship between serum calcium levels and body mass index.

Type of category	BMI range	Mean ±SD	
		Male	Female
Underweight	<18.5	9.26±.67	9.43±.72
Normal	18.5-24.9	9.35±.72	9.52±.79
Overweight	25-29.5	9.42±.64	9.58±.68
Obese	≥30.0	9.47±.79	9.75±.64

Correlation studies show that BMI correlated positively and significantly with serum calcium levels in obese individuals ($r = 0.72$, $P = 0.00$).

DISCUSSIONS

The distribution of body fat and excess mass of adipose tissue has been described as the hallmarks of the complicated medical condition known as obesity, which negatively affects health and well-being.[14] Data analysis revealed that obese people had higher total serum calcium levels than overweight and normal-weight people ($P < 0.05$). It also showed that the serum calcium levels of the participants exhibit a positive correlation with their BMI ($P < 0.05$). These results are consistent with past research, [15-17] which found that obese people had higher serum calcium levels and that there was a positive relationship between BMI and serum calcium. Other research revealed that there were no appreciable variations in total serum calcium levels between obese and non-obese people.[18] Their dietary habits may have contributed to the discoveries of lack of effects in their reports. The precise mechanism(s) underlying the association between serum calcium and obesity are currently unknown. Several potential explanations have been given: Numerous studies have shown that compared to non-obese people, obese people typically have high PTH levels and low basal vitamin D levels.[2,19] Calcium influx into cells like fat tissues is increased by low vitamin D levels and excessive PTH. Increased intracellular calcium promotes fatty acid synthase activity and suppresses hormone-sensitive lipase expression, promoting lipogenesis and suppressing lipolysis.[14,18] Patients who are severely obese are reported to be less exposed to sunlight Additionally, 25-hydroxycholecalciferol may be confined to fat tissues, which would reduce its bioavailability.[16] By influencing adipocyte death, intracellular calcium may have an impact on energy metabolism. It's also possible that 25-hydroxycholecalciferol is stored in adipose tissues, which would reduce its bioavailability.[20] Obesity is a condition of persistent, low-grade systemic inflammation that is accompanied by elevated oxidative stress and inflammatory cytokine production. These effects raise serum calcium levels via increasing osteoclastic activity and bone resorption.[21,22] Obesity and an increased risk of type 2 diabetes have been linked to higher levels of circulating pro-inflammatory cytokines.[22] New evidence and review of earlier studies support the view that calcium also plays a role in adipocyte lipid kinetics at the cellular level and in moderating fatness at the population level. Within adipocytes, intracellular calcium levels alter the balance between lipid synthesis and breakdown, preferring lipogenesis when cytosolic calcium levels are high.[23]

CONCLUSIONS

Serum calcium is positively associated with BMI in both sexes. In the treatment of obesity and excess weight, calcium levels should be taken into account.

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