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# Serum calcium and dietary intake in patients with ischemic heart disease

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**Abstract**
**Background:** Calcium plays a vital role in heart health. Some studies suggest that getting enough calcium from your diet may be protective against ischemic heart disease, while others suggest that it may increase the risk of ischemic heart disease.
**Objectives:** to evaluate serum calcium level and dietary calcium intake in patients with ischemic heart disease.
**Subjects and Methods:** a cross-sectional study was conducted in Baghdad from the 1st of June to the 31st of December 2023; including 88 patients with ischemic heart disease. Direct interview with all the Participants to complete the questionnaire, nutritional assessment and blood sampling were also performed.
**Results:** the average age of the study sample was 59.5 years; the average daily calcium intake from food source was 515 mg/day; the average serum calcium level was 9.24 mg/dl; and 55.7 % of the study sample have history of one or more acute myocardial infarction.
**Discussion:** the highest serum calcium was found in patients younger than 70 years old, male patients, nonsmokers, normal and overweight BMI category, those with history of hypertension.
**Conclusion:** dietary calcium intake was significantly correlated with serum calcium level in patient with ischemic heart disease; while the opposite is not because serum calcium level is controlled by serum level of vitamin D and parathyroid hormone.

**Keywords:** Calcium, diet, cardiology

## Introduction

Cardiovascular disease is the major cause of mortality in humans [1]. Acute coronary syndrome (ACS) represents a life-threatening manifestation of atherosclerotic cardiovascular disease [2]. Calcium plays a vital role in many biological processes associated with cardiovascular disease, including platelet adhesion and aggregation, blood clotting, enzymatic activity, cardiac contraction, and cardiomyocyte apoptosis [3]. Calcium plays a number of critically important roles in physiology and pathology, in addition to its most widely recognized function as a critical structural component of bone. Many cells have calcium-sensing receptors, with evidence that the concentrations of calcium ions in the extracellular fluid directly regulate cell function (e.g., parathyroid, renal tubule, and many more) [4].

There is some conflicts about serum calcium association with cardiovascular outcome. Some studies suggested that serum calcium correlated with blood pressure (BP), serum lipids, and serum glucose; moreover, it was positively associated with cardiovascular events in the general population and especially those with ischemic heart disease [5].

Low calcium intake raise plasma parathyroid hormone (PTH) levels, that increase intracellular calcium directly or through calcitriol activation, and stimulating the renin–angiotensin–aldosterone signaling. In those with low calcium intake, blood pressure is improved when dietary calcium intake is increased to reach the recommended levels. While in those with adequate calcium intake; No benefits for blood pressure by more increasing in calcium intake [6].

## Objectives

To evaluate serum calcium level and dietary calcium intake in patients with ischemic heart disease.

## Methodology

A cross sectional study was conducted in Baghdad, capital of Iraq, including a convenient sample of patients with ischemic heart disease from three governmental cardiology centers. The data was collected from the 1st of June to the 31st of December 2023. The study was conducted to assess serum calcium level in patients with ischemic heart disease, and correlate the result with calcium intake and the demographic and clinical characteristics of the patients. It include a total sample size of 88 patients (61 males and 27 females), with an age groups range from (31-79 years old) with a mean age and SD (59.5± 9.7). the data was collected by direct questionnaire with all the participant who were attending the consultation clinic or after an acute coronary syndrome after stabilization of clinical status, the interview takes about 10-15 minutes and include demographic data and clinical and diet history, vital signs, weight and height measurements and blood sampling.

## Inclusion criteria

Adult patients and a known case of ischemic heart disease.

**Exclusion criteria**
Patients with acute or chronic renal failure and those with thyroid disease or thyroid surgery.

**Blood sampling to assess serum calcium and diet history assessment**
A needle is inserted into a vein in the arm, and a small amount of blood was collected into a tube. The blood draw should take less than five minutes (and without tourniquet). Total serum calcium levels was measured using a standard colorimetric method; serum level of total protein in the blood also performed for correction for hypocalcaemia; fasting blood sugar was also measured. The patient should be fasting for at least eight hours.
A diet history; which include asking about the frequency of eating specific foods that are considered as a dietary source of calcium and include milk, yoghurt, cheese, soy milk, sea food, egg, collard, turnip greens, broccoli, nuts and figs.

**Ethical approval**
An official letter of permission from the Arab board of medical specializations was obtained. verbal consent was taken from all the participants.

**Statistical analysis**
Analysis of data was carried out using the available statistical package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences- version 29, Chicago, IL, USA). Data were presented in simple measures of frequency, percentage, mean, standard deviation, and range (minimum-maximum values) [7, 8].

**Results**
In this cross sectional study; the mean age and SD of the study sample was 59.5±9.7, and males making most of the study sample; about 69.3%, and only 30.7% of the study sample were females; 64.8% were non-smoker and 30.7% of them were current smokers. In describing the clinical data; 53.4 % of the study sample were having diabetes mellitus type II, 55.7% of the study sample were having history of hypertension. Regarding the number of comorbidities; about 58% of the study sample were having 2 and more comorbid diseases. Comorbid diseases that were considered (hypertension, diabetes mellitus, smoking and obesity (BMI>=30) as in figure 1.

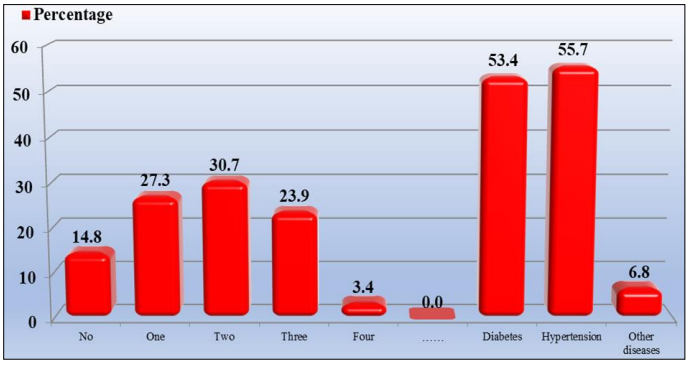


**Fig 1:** Percentage of number of comorbidities and prevalence of diabetes and hypertension across the study sample

44.3% of the study sample did not having any history of previous acute myocardial ischemia, 46.6% were having only a single attack of acute MI. Most of the study sample were having at least one coronary intervention; either coronary angiography, percutaneous coronary intervention and CABG.
The mean body weight and SD of the participant in the study was 78.82±13.75 kg; that ranging from (55-118) kg .

(figure 2). About 72.7% of the study sample were almost having normal systolic blood pressure of equal or less than 140 mmhg; and 68.2% of the participant were having normal diastolic blood pressure equal or less than 80mmhg. About 86.4% of the participant did not report any history of supplement intake of any king. Calcium supplement also were not reported by the other group who receive supplements (13.6% of the study sample).

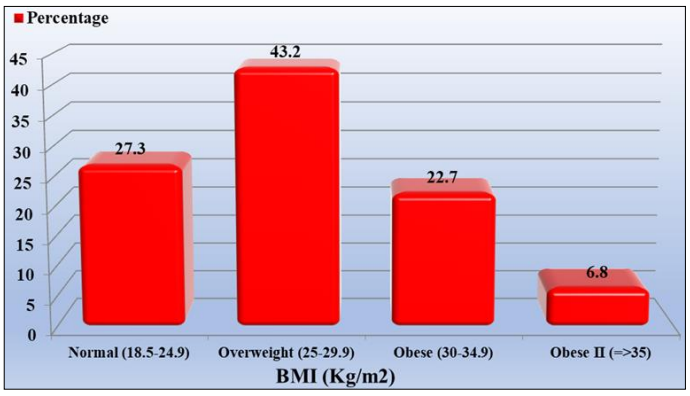


**Fig 2:** BMI categories across the study sample participants

The mean and SD of FBS was 149.64±60.79 mg/dl with the majority of the participant were in the pre-diabetic and diabetic level (above 100 mg/dl). Only 18.2% of them were having normal fasting blood glucose. The mean and SD of

serum calcium level was 9.24±0.71 mg/dl; with almost the majority of the study sample (84.1%) were having normal serum calcium between (8.5-10.5) mg/dl. And only 15.9% were having low serum calcium below 8.5 mg/dl and even without any clinical signs of hypocalcaemia. The greatest majority of the study sample (96.6%) were taking inadequate calcium intake from food below 1000 mg per day. The average daily calcium intake was 515.2 mg per day (from calcium rich foods); calcium rich food that was included in the food frequency questionnaire are addressed here with the calcium content for every single serving of the specific food [9].

| Food source of calcium | Calcium (mg) per serving |
|---|---|
| Milk (1 cup) | 299 |
| Cheese (1.5 ounce) | 314 |
| Yoghurt (3/4 cup) | 452 |
| Egg (1 egg) | 25 |
| Collard green (1 cup) | 170 |
| Turnip (1 cup) | 190 |
| Green vegetables (2 cups) | 99 |

There was no much differences in average calcium intake in all age groups and between males and females, the results does not reaches level of significance, with p value above 0.05. Patients with higher number of comorbidities tend to eat more calcium rich food and those with the all four comorbidities (DM, HTN, obesity and smoking) had average of 608 mg of calcium per day (table 1).

**Table 1:** Mean calcium intake in different age groups and between male and females and comorbidities

| | | Average daily calcium intake (mg/ml) | | P value |
|---|---|---|---|---|
| | | No | Mean±SD | |
| Age (years) | <50years | 12 | 511.0±372.1 | 0.947 |
| | 50---59 | 26 | 526.8±276.8 | |
| | 60---69 | 30 | 527.8±247.2 | |
| | =>70years | 20 | 483.8±261.9 | |
| Gender | Male | 61 | 503.1±280.6 | 0.538 |
| | Female | 27 | 542.4±262.4 | |
| Number of comorbidities | 0 | 13 | 432.0±176.0 | 0.626 |
| | 1 | 24 | 481.1±337.7 | |
| | 2 | 27 | 553.3±251.6 | |
| | 3 | 21 | 543.3±279.3 | |
| | 4 | 3 | 608.7±265.5 | |
| #Significant difference between two independent means using Students-t-test at 0.05 level. | | | | |
| ^Significant difference among more than two independent means using ANOVA-test at 0.05 level. | | | | |

Higher calcium intake was found in those with serum calcium level between (8.5-9.1) mg/dl and was 684 mg per day of calcium from food source. The results was significant with a p-value of 0.024 (table 2)

**Table 2:** Average daily calcium intake with serum calcium level

| | | Average daily calcium intake (mg/ml) | | P value |
|---|---|---|---|---|
| | | No | Mean±SD | |
| Serum calcium level | Low (<8.5) | 14 | 389.7±248.6 | 0.024^ |
| | Lower normal (8.5-9.1) | 16 | 684.3±245.2 | |
| | Mid normal (9.2-9.8) | 45 | 500.0±283.0 | |
| | Upper normal (9.9-10.5) | 13 | 494.9±227.2 | |
| ^Significant difference among more than two independent means using ANOVA-test at 0.05 level. | | | | |

The higher intake of dietary calcium comes from milk, cheese and yoghurt and were significantly affecting the daily calcium intake with a p-value of (0.0001). Other food source were not significantly affecting the average daily calcium intake in spite of higher intake of them. Table (3)

**Table 3:** Food source and number of servings per week of calcium rich food sources

| Average daily calcium intake (mg/ml) | | Milk | | Cheese | | Yoghurt | |
|---|---|---|---|---|---|---|---|
| | | No | Mean±SD | No | Mean±SD | No | Mean±SD |
| Number of serving (per week) | 0 | 40 | 348.3±221.8 | 33 | 336.2±217.4 | 18 | 217.0±170.8 |
| | 1 | 7 | 473.4±144.9 | 7 | 411.2±229.9 | 11 | 290.3±131.3 |
| | 2 | 2 | 557.3±155.0 | 2 | 459.9±17.2 | - | - |
| | 3 | 9 | 618.4±245.4 | 17 | 506.8±198.5 | 5 | 524.1±278.4 |
| | 4 | 8 | 609.4±227.2 | 7 | 550.1±203.9 | 11 | 480.2±135.3 |
| | 5 | 8 | 775.2±133.3 | 11 | 803.6±189.9 | 22 | 617.5±170.8 |
| | 6 | 2 | 631.9±273.2 | 5 | 759.9±148.7 | 12 | 757.2±169.4 |
| | 7 | 12 | 755.9±281.4 | 6 | 890.2±188.1 | 9 | 851.8±202.8 |
| P value | | 0.0001^ | | 0.0001^ | | 0.0001^ | |
| #Significant difference between two independent means using Students-t-test at 0.05 level. | | | | | | | |
| ^Significant difference among more than two independent means using ANOVA-test at 0.05 level. | | | | | | | |

Serum calcium level were divided into 4 quartiles; the first one is serum calcium level below 8.5 mg/dl (hypocalcaemia), second, third and fourth were serum calcium level (8.5-9.1 mg/dl or lower normal), (9.2-9.8 mg/dl or mid normal) and (9.9-10.5 mg/dl or upper normal). No patient was having hyperkalemia or serum calcium level above 10.5 mg/dl (table 4).

These categories will be correlated with age, gender, smoking status, history of hypertension, and fasting blood sugar and will be discussed in details in the discussion.

**Table 4:** Serum calcium quartiles categories and its correlation with different study sample characteristics

| | | Serum calcium | | | | | | | | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low (<8.5) (n=14) | | Lower normal (8.5-9.1) (n=23) | | Mid normal (9.2-9.8) (n=34) | | Upper normal (9.9-10.5) (n=17) | | |
| | | No | % | No | % | No | % | No | % | |
| Age (years) | <50years | 1 | 8.3 | 4 | 33.3 | 5 | 41.7 | 2 | 16.7 | 0.227 |
| | 50---59 | 3 | 11.5 | 8 | 30.8 | 7 | 26.9 | 8 | 30.8 | |
| | 60---69 | 5 | 16.7 | 6 | 20.0 | 17 | 56.7 | 2 | 6.7 | |
| | =>70years | 5 | 25.0 | 5 | 25.0 | 5 | 25.0 | 5 | 25.0 | |
| Gender | Male | 7 | 11.5 | 15 | 24.6 | 27 | 44.3 | 12 | 19.7 | 0.233 |
| | Female | 7 | 25.9 | 8 | 29.6 | 7 | 25.9 | 5 | 18.5 | |
| Smoking | Current smoker | 6 | 22.2 | 9 | 33.3 | 8 | 29.6 | 4 | 14.8 | 0.468 |
| | Ex-smoker | - | - | 1 | 25.0 | 3 | 75.0 | - | - | |
| | Not | 8 | 14.0 | 13 | 22.8 | 23 | 40.4 | 13 | 22.8 | |
| Hypertension | Yes | 8 | 16.3 | 9 | 18.4 | 22 | 44.9 | 10 | 20.4 | 0.289 |
| | No | 6 | 15.4 | 14 | 35.9 | 12 | 30.8 | 7 | 17.9 | |
| BMI (Kg/m2) | Normal (18.5-24.9) | 4 | 16.7 | 6 | 25.0 | 8 | 33.3 | 6 | 25.0 | 0.645 |
| | Overweight (25-29.9) | 6 | 15.8 | 7 | 18.4 | 18 | 47.4 | 7 | 18.4 | |
| | Obese (30-34.9) | 4 | 20.0 | 8 | 40.0 | 6 | 30.0 | 2 | 10.0 | |
| | Obese II (=>35) | - | - | 2 | 33.3 | 2 | 33.3 | 2 | 33.3 | |
| FBS | Normal (<100) | 4 | 25.0 | 4 | 25.0 | 8 | 50.0 | - | - | 0.120 |
| | Prediabetic (100-125) | 4 | 13.3 | 6 | 20.0 | 15 | 50.0 | 5 | 16.7 | |
| | Diabetic (>125) | 6 | 14.3 | 13 | 31.0 | 11 | 26.2 | 12 | 28.6 | |
| Average daily calcium intake | Inadequate (<1000) | 14 | 16.5 | 22 | 25.9 | 33 | 38.8 | 16 | 18.8 | 0.827 |
| | Adequate (1000-1200) | - | - | 1 | 33.3 | 1 | 33.3 | 1 | 33.3 | |

## Discussion

Several studies have evaluated the association of dietary intake with serum calcium, although the value of having a diet high in calcium on increasing the serum level is still controversial [10, 11]. Most of the patients younger than 70 years old were having serum calcium level above 9.2 mg/dl, while those older than 70 years; serum calcium was lower and about 50% of them having serum calcium above 9.2 mg/dl. These results agree with previous studies done before; which found that serum calcium decrease with advancing age. And is attributed to the defective calcium balance with age due to inadequate vitamin D levels; which is the main factor that control calcium homeostasis [12, 13].

The higher serum calcium was found in male participants other than females; and these results of lower serum calcium in females can be attributed due to poor calcium intake over a prolonged time, especially in females of child bearing age, medications, dietary intolerance to foods rich in calcium and because of hormonal changes [14].

serum calcium was found to be higher in the ex-smokers and non-smokers; and lower in those who were currently smoking. Smoking has been found to have a negative effect on serum calcium levels [15]. It can be attributed to the fact that smoking inhibits the action of parathyroid hormone on the renal tubules, leading to a lowering of serum calcium [16, 17].

Serum calcium has been shown to be higher in patients with history of hypertension than those without hypertension; and most of those with hypertension have serum calcium level above 9.2 mg/dl and the majority of those free from hypertension have serum calcium level below 9.2 mg/dl. And these positive association between elevated serum total calcium levels and presence of hypertension is consistent with several previous studies [18, 19].

Regarding the body mass index; we found that most patients with normal and overweight BMI categories (<30) were having serum calcium level above 9.2 mg/dl while most of the obese patients were having serum calcium level below 9.2 mg/dl. These results can be attributed to the fact that serum calcium hemostasis and absorption is greatly dependent on the status of vitamin D in the body; and because obese patients tent to have lower serum level of vitamin D mostly because of vitamin D sequestration within the fat cells; so calcium absorption and level will be lower in obese patient than those with BMI lower than 30. And these facts are demonstrated by Lapik *et al* at Moscow 2020 [20].

Calcium level was found to be higher in patients with normal and pre-diabetic fasting blood sugar level; and lower in those patients with FBS > 126 mg/dl; and was in the level (9.2-9.8 mg/ dl) and (8.5-9.1 mg/dl) respectively. These results disagree with a recent study done in 2022 by hashim ***et al*** in Iraq which found that the mean calcium level in the diabetes was greater than that in the pre-diabetes and normal people [21].

However; serum calcium was not significantly affected by average daily calcium intake; probably because almost the majority of the study sample haning inadequate calcium intake and because calcium hemostasis is directly controlled by vitamin D level and parathyroid hormone [18].

## Conclusion and Recommendation

Dietary calcium intake was significantly correlated with serum calcium level in patient with ischemic heart disease; while the opposite is not because serum calcium level is directly controlled by serum level of vitamin D and parathyroid hormone. More and large prospective studies are required to find out the exact relationship of serum calcium level with the risk of cardiovascular events.

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