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Association between zinc deficiency and obesity among a sample of adult in Al-Najaf City, Iraq

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***Abstract*---**Background: Obesity has become a major health problem, defined as an abnormal or excessive accumulation of fat in adipose tissue and is diagnosed with a BMI ≥30 kg/m2. The study aimed to find the correlation between zinc deficiency and obesity, also, to study the association between obesity and different socio-demographic factors. Material and Methods: A case-control study was conducted to achieve the aims of the study that has been conducted from the beginning of December 2021 until June 2022. The size of the sample comprises 140 participants who were equally divided into two groups, obese group (body mass index (BMI) ≥ 30 kg/m2) and the control group, (BMI18.5 - 24.9 kg/m2). All participants were taken randomly from adult peoples ages ranged between (18-65) years in Al-Najaf Governorate. Results: The association between serum zinc and obesity was significant (p-value = 0.041, O. ratio (95%CI) = 2.01(1.02-3.97)). The correlation between serum zinc level with both BMI and waist hip ratio (WHR) was negatively correlation (r = -0.241, r = -0.033, respectively). The association between obesity and socio-demographics characteristics was only significant with gender and marital status (P-value =0.002, 0.016, respectively), while the other characteristics were not significant (p-value = >0.05). Conclusion: The study concluded that obese people had a lower serum zinc level than non-obese people,

and those who had a low serum zinc level were twice more likely to develop obesity than those who had a normal serum zinc level.

***Keywords*---**Obesity, serum zinc, BMI and case-control study.

Introduction

World Health Organization (WHO) well-defined Obesity as excessive or abnormal fat deposition that may affect human health and is detected at body mass index ≥30 kg/m2 (1). Overweight and obesity are the fifth leading cause of death worldwide. (2). Deaths among adults are estimated at 2.8 million per year According to the WHO,(1.9) billion adults are overweight or obese (3).

If current trends continue, (60%) of the world's people could be overweight and obese in the year 2030 (4). Studies conducted in Iraq showed a high prevalence of overweight and obesity, as in a study in Erbil on overweight and obesity were prevalent (33.4%, 40.9% respectively) (5). while, overweight and obesity were prevalent in Basra, Southern Iraq, from 2003 to 2010 as (55.1%) (6). Also, In Baghdad, (35.2%) of female relatives of primary care attendees were obese (7).

Zinc (Zn) is one of the most important necessary elements with enormous public health implications (8). It is second only to iron (4), also, shows a fundamental part in its extensive participation in proteins, lipids, DNA metabolism, gene transcription, and numerous other biological processes (9). It has three key biological functions in the body (structural, catalytic and regulatory) (10). Zinc is involved in many processes, It is involved in the structure of more than 2,000 transcription factors and cofactors for more than 300 enzymes (9). The effects of zinc depend on the functions of zinc ions (Zn2+) inside and outside cells, as well as their interaction with proteins. An extensive network of metal transporters is responsible for maintaining the cellular homeostasis of zinc. and cellular signaling systems that respond to changes in zinc availability caused by a change of factors such as diet, chronic disease, inflammation and a variety of other factors (11).

Zinc deficiency occurs in the body when zinc absorption cannot meet physiological needs (12). the global prevalence of zinc deficiency affects approximately 17% of the world's population (13). More than 25% of the population in underdeveloped nations suffers from zinc deficiency as a result of insufficient zinc consumption, while 15% of the population in developed countries suffers from zinc deficiency. (14). It is more commonly observed in developing regions attributable to malnutrition, however, it is associated with aging and many chronic diseases in developed regions (15). Zinc deficiency remains a major public health problem among the top ten factors that contribute to the burden of disease in developing countries (16) Zinc deficiency causes problems with a variety of metabolic processes, as well as decreased resistance to infection due to weakened immunological function and abnormalities of the skin (11).

Methodology

A case-control study was conducted to achieve the aims of the study that has been conducted from the beginning of December 2021 until June 2022. The size of the sample comprises 140 participants who were equally divided into two groups, obese group (BMI ≥ 30 kg/m2). and the control group(non-obese) (BMI18.5 - 24.9 kg/m2) according to (WHO) assessment of the presence of obesity by BMI (17). All participants from the same geographical area and taken randomly from adult peoples ages ranged between (18-65) years from Al-Sadr medical city in Al-Najaf Governorate, excluded the take any nutritional supplements (vitamins or minerals) or medications that affect zinc levels, suffering from diseases (hypertension, diabetes, kidney disorders and liver disease, chronic diarrhea and cancer), suffer from thyroid disorder, pregnant women and smokers.

Data Collection

Study data were obtained by using a questionnaire, Anthropometric Measurements and blood sample collection.

A. Questionnaire:

The questionnaire contains 10 questions (10 items) that includes age, gender, Residence, educational level, marital status, Occupational, monthly income, exercise, does he suffer from chronic diseases or other diseases and take zinc supplements or drugs that affect zinc levels or smoking.

B. Anthropometric Measurements:

The following anthropometric measurements were taken from the participating.

1- **BMI:** Height and weight were measured to extract the BMI measurement by the equation $BMI = \frac{\text{weight kg}}{\text{height m2}}$.

2- **WHR:** A flexible holtain tape was used to measure waist circumference(WC) and hip circumference(HC) by researcher, to determine the WHR by calculation. $WHR = \frac{\text{WC cm}}{\text{HC cm}}$

3- **Blood pressure:**

The blood pressure (BP) of each individual was measured by an experienced trained person using a mercury sphygmomanometer, in a seated position. Measurement was performed after at least five minutes of rest (18).

C. Biochemical measurement:

Blood Samples Collection in this study involved drawing 5 ml of venous blood from obese and non-obese participants after fasting for 12 hours using disposable syringes. Then, the blood was placed in a normal tube and waited to coagulate at room temperature, then the serum was separated by centrifugation at 3000 rpm for 10 minutes, After separation, the serums are placed in Eppendorf tubes, after which the sample is kept at -20°C for later analysis.

Estimation of Serum Zinc for all participants. Globally, there is no acceptable cut-off value for zinc concentration in serum. The International Zinc Nutrition Consultative Group (IZiNCG) determined 70 µg/dL (10.7 µmol/L) was the cut-off value for serum zinc concentration (19). In our study, we used this

recommendation issued by the IZiNCG, where a concentration of less than 70 µg / dl was approved for a low level of zinc in the serum and a greater value equal to 70 µg / dl is considered a normal level of zinc in the serum. Principle of zinc kids a colored compound is formed when zinc reacts with the chromogen in the reagent, and the intensity of the color is proportional to the zinc concentration in the sample (20).

Statistical Analysis

Statistical analysis was done by using statistical package for social sciences (SPSS) version 20. Frequencies, percentages, and mean with standard deviation were obtained as descriptive statistics. Chi square, t-test, Pearson correlation coefficient and odds ratio used for analysis.

Results and discussion:

Socio-demographic characteristics of both groups obese and control groups (non-obese)

Table (1) shows the distribution of search participants pertaining to socio-demographic features. according to the age group of the participants in the study whose ages were between (18-65) years, in the obese group, the age group (18-45) years represented the highest percentage (81.4%) among other age groups, while in the control group (non-obese) The highest percentage (82.9%) was in the age group (18-45) years,. This result is in line with a study on Overweight and Obesity among Adults. in Iraq (21), where the highest age group was in Obese group (18-44) years old, and also normal weight was (18-29) the highest percentage of participants in these study.

The majority of the total participants in the study were females (61.4%), in the obese group the percentage of females was (74.3%), and this result is consistent with a study conducted in Erbil / Iraq (5), which found that (75.5%) of the participants are females. On the other hand, in the control group, males (51.4) were slightly more than females, and this is in line with the results of the study that was conducted in Iraq (21) where the proportion of males was higher than females in Normal Weight. while, in the obese group of females was higher than males. the explanation of this result is due to the prevalence of obesity among females (28.8%) in Iraq is higher than that of males(18.0) (22).

The results also showed that the majority of participants in the study in both groups were urban residents, in obese group represented (65.7%), and the control group (non-obese) represented (61.4%). This result is consistent with the result of a study conducted in Tokat , a northern province of Turkey (23), finding (56.6%) city residents (urban).

At the educational level, the results showed that the highest percentage (42.9%) of the participants in both groups was a college (university) graduate, in the Obese group it represented (37.1%), while in the control group it represented (48.6%), on the other hand the lowest percentage (5.7%) of the participants Illiterate, in the obese group it represents (2.9%) while in the control group (non- obese)

represents (8.6%), and this result is similar to a study conducted in Qalat Saleh City/ Iraq (24) show the percentage of college (university) graduate, was(30.0%), also study conducted in Al-Diwaniya City found lower the participant were Illiterate (4.2%).

The results of this study indicated that the majority of participant in both groups were married, in the obese group (80.0%) and in the control group (non-obese) represented (61.4.%), and this result is similar the result of a study conducted in Indonesia (25). if the married couples in obese group represent (76.31%). The results of our study indicated that the highest percentage of participants in both groups are housewives, in the obese group their percentage was (51.4%), while in the control group (non-obese) it represented (27.1%). In the opposite direction, the lowest percentage of participants was from the student category, representing (2.9%) in the obese group, while in the control group (non-obese) it represented (5.7%), this result is in line with the study results which conducted in Erbil \ Iraq (5), which found the highest percentage of The participants represented housewives (62.6%), and the lowest percentage (2.4%) represented students.

Regarding to the monthly income, the highest percentage of respondents (44.3%) have between (500,000-1,000,000 IQD) per month in obese groups while in control group show the highest percent (54.3%). This result is in line with the results of the study in the Kurdistan region of Iraq (26) , where the highest percentage (53.3%) was recorded for people with a monthly income (500,000-1,000,000IQD).

On the level of physical activity, the results of our study show that (87.1%) individuals from the obese group do not exercise regularly, while the control group (non-obese) individuals who do not engage in regular exercise are slightly higher than those who do regular daily activity, representing (58.6%).Guidelines and recommendations issued by the World Health Organization for adults (18-64 years) on the amount of physical activity to maintain good health, It generally recommends at least 30 minutes of moderate physical activity every day

There are other study conducted in Erbil, Iraq (5) It was found that the percentage of those who practice non- regular exercises reached (94.1%, 94.3%, respectively) , and these results support our results. In addition, recent studies have shown that continues moderate physical activity per day prevents the development of obesity and fat mass without restricting calories (27,28).

Table (1). Distribution of the search participants pertaining to the socio-demographic features.

Socio- demographic features		obese	non-obese	Total
		N. (%)	N.(%)	N.(%)
Age/years	18-25	21(30.0)	27(38.6)	48(34.3)
	26-35	11(15.7)	20(28.6)	31(22.1)
	36-45	25(35.7)	11(15.7)	36(25.7)
	46-55	7(10.0)	6(8.6)	13(9.3)
	>55	6(8.6)	6(8.6)	12(8.6)
Gender	Male	18(25.7)	36(51.4)	54(38.6)

	Female	52 (74.3)	34(48.6)	86(61.4)
Residences	Rural	24(34.3)	27 (38.6)	51(36.4)
	Urban	46(65.7)	43(61.4)	89(63.6)
Educational level	Illiterate	2(2.9)	6(8.6)	8(5.7)
	Primary school	23(32.9)	10(14.3)	33(23.6)
	Secondary	19(27.1)	20(28.6)	39(27.9)
	College	26(37.1)	34(48.6)	60(42.9)
Marital status	Single	14(20.0)	27(38.6)	41(29.3)
	Married	56(80.0)	43(61.4)	99(70.7)
Occupational	Employee	21(30.0)	18(25.7)	39(27.9)
	Student	2(2.9)	4(5.7)	6(4.3)
	Earner	6(8.6)	18(25.7)	24(17.1)
	Housewife	36(51.4)	19(27.1)	55(39.3)
	Retired	5(7.1)	11(15.7)	16(11.4)
Monthly income	< 500000IQD	23(32.9)	21(30.0)	44(31.4)
	500000-1000000IQD	31(44.3)	38(54.3)	69(49.3)
	>1000000IQD	16(22.9)	11(15.7)	27(19.3)
Exercise/ 30minutes and more daily	No	61(87.1)	41(58.6)	102(72.9)
	Yes	9(12..9)	29(41.4)	38(27.1)
Total				140

Obesity and serum zinc (µg/dl):

Table (2) shows that was significant association between serum zinc and obesity. In which the percentage of obesity higher (57.7%) in group who have low serum zinc . studies inducted Those who having low serum zinc two times more likely to develop obesity than those with normal level of serum zinc. The results of our study show that the level of zinc in the obese group (mean ±SD 64.5±14.4) is lower than in the non-obese people (mean ±SD 74.3±13.4).

One of the studies conducted in Mexico by(29) to determine the extent of the association between obesity and the level of zinc in the blood, found a significant association between zinc and obesity at (p-value < 0.05), the results of this study indicate that the average zinc level reached (mean± SD 65.9±12.9) in obese group and reached (mean± SD 131.2±26.4) in healthy groups and this result supports the result of our study. Another study conducted in Taiwan also agrees with our results (30) .

However, the difference in (Zn) concentration between the obese group and the control group (non-obese) is not fully understood. There are many explanations for this result from studies explaining these relationships. First, serum leptin (satiation-related adipokine) concentration is related to (Zn) concentration, via effect of (Zn)alpha 2 glycoprotein (ZAG) on leptin concentration levels (31,32). As a result, a high dose of leptin in the circulatory system affects the doubling of several levels in the leptin signaling route, resulting in leptin resistance in obesity. Changes in receptor expression cause the hormone's access to its receptor to be restricted. (33)(34). To counteract leptin resistance, adipose tissue secretes additional leptin, which leads to obesity (35), (36). Second, Leptin plays a key

function in the expression of pro-inflammatory cytokines such IL-6 and TNF-. Increased inflammatory cytokines prolong inflammation in obese people, perhaps leading to obesity-related inflammatory disorders. (37).

Finally, obesity causes oxidative stress disorder. Oxidative stress reverses (imbalance of antioxidants and concentrations of free radicals) (38). Zinc is an essential component of numerous antioxidant enzymes, including Superoxide Dismutase (SOD), and it may possibly play a role in lipid oxidation. Zinc's position in the Zinc 2-Glycoprotein (ZAG) protein, which is implicated in TNF transcription, may help to lower TNF levels. Zinc deficiency can cause a rise in TNF-alpha in the bloodstream, which causes the release of reactive oxygen species (ROS) in tissues, resulting in oxidative stress. (39,40) The fundamental mechanism underlying the occurrence and progression of obesity-related problems is oxidative stress. (41).

In addition, some studies have shown that individuals who are obese have zinc deficiency, with changes in adipose tissue metabolism (42,43) . Obesity is linked to (Zn)deficiency in general .On other hand Our results did not match that of researchers in Turkey, who observed no differences in Obese and non-obese child's (Zn)concentrations (P-value= 0.186) (44).

Table (2). Association between serum Zn (µg/dl) and obesity

Serum zinc (µg/dl)	Groups		Total	P value	Odds ratio(95%CI)
	Obese ≥30	Non obese < 30			
	No.(%)	No.(%)			
Low	45(57.7)	33(42.3)	78(100.0)	0.041	2.01(1.02-3.97)
Normal	25(40.3)	37(59.7)	62(100)		
Total	70	70	140		

Obesity and socio-demographics characters of participants:

Table (3) shows that there is no significant association between age groups and obesity, which corresponds to a study conducted in Kuwait (45) on a sample of the age group from 18 - 69 years, which found no significant association between age groups and obesity(p-value 0.061).

Table (3). Association between age groups and obesity

Age groups	Non obese < 30	Obese ≥30	Total	P-value
	No.(%)	No.(%)		
18-25	27(38.6)	21(30.0)	48	0.064
26-35	20(28.6)	11(15.7)	31	
36-45	11(15.7)	25(35.7)	36	
46-55	6(8.6)	7(10.0)	13	
>55	6(8.6)	6(8.6)	12	
Total	70(50.0)	70(50.0)	140	

Table (3-4) shows a significant association between gender and obesity P-value (0.002) our result is agrees with result of study conducted in Brazil by (46) at (P-value 0.03). The researcher believes that the explanation for this result is the existence of a significant association between obesity and gender, as the percentage of obesity in women is higher than in men, may be due to the fact that women are less active than men as a result of external social conditions and the small number of sports clubs for women, as well as most women are housewives or in a job Less physical activity, or it may be due to multiple births in women.

Table (4). Association between gender and obesity

Gender	Non obese < 30	Obese ≥30	Total	P-value
	No.(%)	No.(%)		
Male	36(51.4)	18(25.7)	54	0.002
Female	34(48.6)	52(74.3)	86	
Total	70(50.0)	70(50.0)	140	

No significant association between residences place and obesity as appear in table (5). Our result is agree with report result of (23) that conducted in turkey, if results of their study presented that there was no significant association among place of residence and obesity at (p-value 0.025). We conclude from this result that obesity does not depend on the place of residence.

Table (5) Association between residences and obesity

Residences	Non obese < 30	Obese ≥30	P-value
	N.(%)	N.(%)	
Rural	27(38.6)	24(34.3)	0.598
Urban	43(61.4)	46(65.7)	
Total	70(50.0)	70(50.0)	

From Table (6) also we note there is significant association between marital status and obesity, we note a higher percentage of obese married people compared to the Single, at p value (0.016), the results of our study are similar to the result of other study conducted in the Kurdistan region \ Iraq by (26) The results of their study showed that the percentage of married people who suffer from obesity is higher than the percentage of single people who suffer from obesity at a significant level (P-value 0.001) . It may be due to the reason that after marriage there are many changes in living patterns in addition to physiological changes, this is the researcher's interpretation.

Table (6) Association between marital status and obesity

Marital status	Non obese < 30	Obese ≥30	Total	P-value
	No.(%)	No.(%)		
Single	27(38.6)	14(20.0)	41	0.016
Married	43(61.4)	56(80.0)	99	
Total	70(50.0)	70(50.0)	140	

Conclusion

The study concluded that obese people had a lower serum zinc level than non-obese people, and those who had a low serum zinc level were twice more likely to develop obesity than those who had a normal serum zinc level. The gender and martial states not affect the result of zinc level lower in obese compared to non obese population

Recommendation

Encourage health care worker to measure serum zinc level in all obese patients. Also, health education and raising awareness about the importance and benefits of zinc and food containing zinc, especially for obese people. finally, more extensive research studies should be conducted on large sample size.

Limitation

This is a case and control study, some of its limitation is the temporary relationship so it is not clear wither the cause (zinc deficiency) preceded the outcome (obesity) or not.

Ethical approval:

Before starting the study and collecting data, Ethical approval was obtained from Al-Sadr medical city in Al-Najaf Governorate, also, oral consent was taken from all participants**.**

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