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Research Article

The Association between Body Mass Index and Metabolic Conditions

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Abstract

Introduction: Obesity is one of the significant public health epidemic and its global prevalence is increasing. Along with this, certain risk factors including malnutrition, lack of physical activity and high stress levels contribute to the emergence of various other metabolic conditions that may cluster together in enhancing the effects of obesity and might hinder in its control.

Methods: This is a cross sectional study in which chart review of patients' files for all patients coming to the outpatients department (OPD) clinic in Prince Sattam bin Abdul-Aziz University, Alkharj, Saudi Arabia until the sample size i.e. 354 was achieved. Data was analysed with SPSS version 21. Descriptive statistics were obtained as frequencies. Pearson Chi-square analysis was used to assess any differences between Body Mass Index (BMI) categories and study variables. The logistic regression model was used to examine the relationship between BMI categories and potential causal factors at p-value<0.05 which was considered significant.

Results: Findings showed that 45.8% of study population was obese, 28.5% was overweight Gender distribution showed that highest number of females i.e. 47.2% were obese followed by overweight (28.8%). Similar trend was found among males i.e. 35.6% and 26.7% respectively. Across various BMI categories, individuals between 16-30 years were healthy; 16-45 years were obese and overweight. Among all, 11% were found to be hypertensive, 45.5% anemic while 58% had vitamin D deficiency. Hypertension was prevalent in 17.4% of obese whereas anemia remained constant in all BMI categories. Likewise, vitamin D deficiency was evident in obese (63.4%), healthy (65.5%) and underweight (54.5%). Chi square showed age groups, Vitamin D deficiency and hypertension to be the significant predictors of BMI however, logistic regression showed no significant association.

Conclusion: The present study showed no significant association between BMI categories and anemia, vitamin D deficiency, hypertension along various age groups; indicating that there might be other causes in Saudi population causing. Longitudinal and interventional studies are required to prove this association incorporating factors like socio-demographics, diet and exercise. Strategies should be build up to minimize the prevalence of such preventable conditions under discussion in order to promote better health among Saudi population.

Keywords: Obesity; Anemia; Vitamin D deficiency; Hypertension

Introduction

Obesity is one of the significant public health issues nowadays and its global prevalence has turned into an epidemic. It can be defined as excessive body fat [1], whichaffected approximately one third of the population worldwide. It was reported to cause greater than 2.8 million deaths i.e. 4% Years of Life Lost (YLL) and around 35.8 million Disability-Adjusted Life Years (DALYs) [2]. Estimations show that if such trend continues, by 2030, 85% of the people living in US will be affected by it [3] while 20% of the total population of the world will be obese and 38% will be overweight [4]. Significant declined life expectancy was also reported in obese individuals as compared to non-obese [5].

Contribution of obesity towards increased risks of non-communicable diseases (NCDs) is well documented; despite being a preventable and modifiable risk factor, it is reported to cause metabolic syndrome [6], dyslipidemia [7] hypertension, heart diseases [8], insulin resistance, glucose intolerance [9]. ischemic stroke [5], asthmatic emergencies [10], Obstructive sleep Apnea [11], vitamin D deficiency [12], cholelithiasis and gastroesophageal reflux disease [13] polycystic ovarian syndrome in females, osteoarthritis, various psychiatric illnesses and cancers [14], and also impotence as well as infertility in men [15]. The third National Health and Nutrition Examination Survey (NHANES III) showed overweight American children [16] and adults [17] to have iron deficiency anemia while Chinese did not had this association [18].

Recent statistics show that 5-14% of the people living in gulf

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Table 1:

male 14.0 to 17.5 g/dL female 12.3-15.3 g/dL	Hemoglobin
20 to 100 ng/mL	Vitamin D

Table 2: Baseline characteristics of the study participants.

Characteristics	N (%)
Age in years (N=420)	
2-15'	22(5.2)
16-30	241(57.4)
31-45	101(24)
45-60	40(9.5)
60-≥70	15(3.6)
Total	
Gender (N=420)	
Female	355(84.5)
Male	65(15.5)
BMI (N=354)	
underweight	18(5.1)
healthy	73(20.6)
overweight	101(28.5)
obese	162(45.8)
Hypertension (n=343)	
Yes	37(11)
No	306(89)
Anemia (n=330)	
Yes	150(45.5)
No	180(54.5)
Vitamin d deficiency (292)	
Yes	169(58)
No	123(42)

region including Saudi Arabia, Qatar, Oman, Kuwait, Bahrain, Lebanon and United Arab Emirates were obese [19]. Data from Saudi Arabia reveals that 66% men and 71% women were overweight whereas 28% males and 44% females were obese. Similar situation was with Kuwaiti population where 36% men and 48% females were obese while 74% men and 77% women were overweight [20]. Etaiwi et al, concluded that Obesity was significantly associated with an augmented incidence of hypertension and its complications [21]. The prevalence of obesity and vitamin D deficiency is high in Saudi Arabia [22,23] but their association was not established in a sample of females from Jeddah [24]. However, obese children were foundat risk of developing vitamin D deficiency [25].

The World Health Organization (WHO) has implemented a parameter called body mass index (BMI) scale, to measure obesity. This can be attained by dividing the total body weight n kilograms by the square of the height taken in meters [7]. Considering this, obesity can be confirmed with BMI value of ≥30Kg/m^2. An increased risk for co-morbidities was declared by WHO between the BMI of 25.0 and 29.9 whereas moderate to severe risk exists when it is >30 [2] BMI can be altered by various determinants that can be genetic or environmental. For instance, female gender, education, occupation, marital status, physical activity, dietary habits, presence of NCDs etc. [20,26].

A study from the eastern province of Saudi Arabia found 43.8% overall prevalence of obesity with peak in the age group 50-59 years being higher among females; significantly in housewives and less educated [27] in Western regions, it was 10% while in Eastern it was 14%including Jizan (12%), Hail (34%) and Riyadh (22%) pertaining to more fast food utilization and sedentary lifestyle [28] and high Income [29]. Taking into account the current situation of Saudi Arabia and the high prevalence of obesity, vitamin D deficiency, anemia and hypertension among different age groups and across both genders [21-23,30], we aim to study the association between various BMI categories and certain metabolic conditions including anemia, Vitamin D deficiency and hypertension.

Materials and Methods

The cross sectional study was the selected for the design for the study.All the patients who came to the outpatient clinic from 1st August to 30 November 2016 were selected until the sample size was achieved. The study was conducted in the University hospital of Prince Sattam bin Abdul-Aziz University, Al Kharj, Saudi Arabia. Given that prevalence of obesity (35.5) and overweight (36.9) in Saudi Arabia according to study done in Jeddah [31] and the total population of Al Kharj governorate is 376325 [32], by using raosoft. com website the sample size was calculated using Open Epi sample size calculator keeping confidence level at 95% and margin of error at 5%, the total sample would be 354. Based on thorough review of relevant literature, the researchers constructed a chart review of patient files including age, presence of metabolic conditions as shown by blood tests and anthropometric measurements i.e. body weight (in kilograms), height (in meters) and then body mass index (BMI) was calculated.

Data collection

We conducted the following tests to find any association between BMI categories and anaemia, vitamin D deficiency and age groups (Table 1).

BMI categories were made according to WHO recommendations [33]. Inclusion criteria include Patients from two to 70 years old who came to the outpatient clinic within the specified time. Exclusion criteria include pregnant females, individuals having Cushing syndrome or using any steroid medicine or those patients who were admitted.

Ethical consideration

All procedures performed in the study were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Patient confidentiality was maintained at all levels. The Study was approved by the Institutional Review Board University hospital of Prince Sattam bin Abdul-Aziz University, Alkharj, Saudi Arabia

Statistical analysis

Statistical Package for Social Science (SPSS) software Version 21 will use for data entry and analysis. Descriptive statistics were

Table 3: Body mass index among patients with various metabolic conditions.

Age Group	Underweight (< 18.5 kg/m²) N (%)	Healthy (18.5-25 kg/m²) N (%)	Overweight (25-29.9 kg/m²) N (%)	Obese (³ 30 kg/m²) N (%)
Age Group (354)				
2-5 years*	9 (50)	6 (8)	1 (1)	5 (3)
16-30 years*	9 (50)	62 (85)	65 (64)	73 (45)
31-45 years*	0 (0)	3 (4)	28 (28)	58 (36)
46-60 years*	0 (0)	2 (3)	5 (5)	21 (13)
61-≥70 years	0 (0)	0 (0)	2 (2)	5 (3)
Total*	18 (5)	73 (21)	101 (28)	162 (46)
Hypertension (343)				
Yes	0 (0)	1 (1.4)	8 (8)	28 (17.4)
No	11 (1)	70 (98.6)	92 (92)	133 (82.6%)
Total*	11 (3)	71 (21)	100 (29)	161 (47)
Anaemia (330)				
Yes	8 (47.1)	30 (42.9)	47 (49)	65 (44.2)
No	9 (52.9)	40 (57.1)	49 (51)	82 (55.8)
Total*	17 (5)	70 (21)	96 (29)	147 (45)
Vitamin D deficiency (292)				
Yes	6 (54.5)	42 (65.6)	36 (43.4)	85 (63.4)
No	5 (45.5)	22 (34.4)	47 (56.6)	49 (36.6)
Total*	11 (4)	64 (22)	83 (28)	134 (46)

obtained for all participants and were divided into age groups, gender, presence of hypertension, anaemia, vitamin D deficiency. The presence of these variables across various BMI categories was also calculated and reported as percentages. Pearson Chi-square analysis was used to assess any differences between BMI categories and study variables. All variables that showed to be significant in an initial chi-square analysis were considered potential predictors of high BMI. The logistic regression model was used to examine the relationship (adjusted odds ratios) between BMI categories and potential causal factors. Significance level for all statistical analysis was specified as a p-value<0.05.

Results

Table 2 illustrates the baseline characteristics of the study population. Majority of the respondents belonged to 16-30 age group (57.4%) followed by 24% in 31-45 years age group demonstrating the mainstream of middle aged population. Out of total, 84.5% sample was of females while the rest (15%) were males. The prevalence of underweight was found to be 5.1 while healthy individuals were 20.6%.

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A linear positive trend was observed in increasing age group and BMI among the participants. The maximum number of study

Table 4: Pearson Chi-square test.

Variables	*p*-value*
Age groups	0
Gender	0.027
Hypertension	0.001
Anemia	0.856
Vitamin D deficiency	0.015

*significant if >0.05

population i.e. 45.8% was obese whereas 28.5% were overweight. Table 2 also shows that 11% people were hypertensive and 89% were not. Anemia was also present in about half of the study population (45.5%). Similarly, 85% high serum TSH levels as compared to 15% who had either normal or low TSH levels. Vitamin D deficiency was also identified in 58% of the study sample (Table 3).

When different BMI categories including underweight (BMI <18.5kg/m²), healthy (25-29.9kg/m²), overweight (25-29.9) and obese (≥30kg/m²) were checked against various age groups, it was found that majority i.e. 85% of the individuals in 16-30 age group fell in healthy BMI category when compared to other age groups. This trend was also seen in overweight (64%) and obese category (45%). 31-45 years age group followed it, which was the next group having high number of overweight (28%) and obese individuals (36%).

Table 1 also demonstrates the highest prevalence of hypertension in obese people i.e.17.4% followed by overweight category (8%). Anemia was reported to be uniform across all BMI categories.. However, vitamin D deficiency was observed in obese patients i.e.63.4% had this deficiency. Likewise, in 65.6% he healthy and 54.5%

Table 5: Multivariate analysis of the association between BMI categories and metabolic conditions.

Diseases		Healthy (18.5-24.9)		Overweight (25-29.9)		Obese (30 or more)	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Hypertension	No	1		1		1	
	Yes	30 (000-56.0)	0.995	$97x10^5$ (0.00-116.3 $x10^5$)	0.994	$22x10^5$ (0.00-41 $x10^5$)	0.994
Anemia	No	1		1		1	
	Yes	1.2 (0.19-7.4)	0.853	1.9 (0.306-11.6)	0.493	1.757 (0.289-10.6)	0.541
Vitamin D	No	1		1		1	
	Yes	1.12 (0.175-7.227)	0.902	0.45 (0.71-2.88)	0.4	1.376 (0.2168.751)	0.735
Age groups	2-5 y	1		1		1	
	16-30 y	0.236 (000-10.52)	0.999	3.2 $x10^5$ (0.00-5.4 $x10^5$)	0.993	6.51 $x10^8$ (0.00-9.1 $x10^8$)	1
	31-45 y	1.19 (0.000-10.56)	1	3.5 $x10^5$ (0.00-7.1 $x10^5$)	0.992	1.13 $x10^7$ (0.00-2.6 $x10^7$)	0.991
	46-60 y	71 $x10^5$ (0.00-10.56 $x10^5$)	0.993	1.675	0.571	0.862 (0.862-2.86)	0.991
	61-≥70 y	86 $x10^5$ (0.00-10.56 $x10^5$)	0.997	0.77	1	1.680 (000.3.68)	1

of the underweight were also identified to have vitamin D deficiency in their respective BMI categories (Table 4).

Pearson Chi-square analysis was carried out to evaluate the association between BMI categories and other health conditions of the study participants. The relationship between BMI categories was found statistically significant with age groups, presence of hypertension and vitamin D deficiency while the association was not significant with the presence of anemia.

Multivariate logistic regression analysis showed (represented in Table 5) hypertension was not significantly associated with any of the BMI categorieshowever the odds of hypertension increased with increasing BMI but this relationship was not found significant. (Healthy: OR = 30, 95% CI = 0.000-56.0, p-value 0.995, overweightOR = $97x10^5$, 95% CI = 0.00-116.3 $x10^5$, p-value 0.994, and Obese OR =$22x10^5$, 95% CI = 0.00-41 $x10^5$, p-value 0.994). Similar pattern was observed between anemia and categories of BMI, Vitamin D deficiency and BMI. Likewise, no significant difference was found between age groups across all BMI categories. Therefore, when BMI categories were regressed against various metabolic conditions and age groups, no statistically significant association was achieved.

Discussion

Findings from our study show that 45.8% of our study population was obese while 28.5% was overweight. Gender distribution showed that highest number of females i.e. 47.2% were obese followed by overweight (28.8%). Similar trend was found among males i.e. 35.6% and 26.7% respectively. Across various BMI categories, individuals between 16-30 years were found healthy while those from 16-45 years were obese and overweight. Among all, 11% were found to be hypertensive, 45.5% anemic while 58% had vitamin D deficiency. Hypertension was prevalent in 17.4% of obese participants whereas anemia remained constant in all BMI categories. Likewise, vitamin D deficiency was evident in obese (63.4%), healthy (65.5%) as well as underweight individuals (54.5%). Chi square showed age groups, Vitamin D deficiency and hypertension to be the significant predictors of BMI however, logistic regression showed no significant association.

Our study aimed at observing the relationship between a few metabolic conditions and age groups across BMI categories but did not find any significant associations however, previous studies declared few of them to be related. One of the major strengths of the study is the use of WHO approved definitions and laboratory sample cut-offs. The study is a cross-sectional study and so causal inferences were not achieved. Secondly, the proportion of females was higher in the sample so the actual gender distribution was also not appreciated. Sample size was calculated according to the prevalence of obesity and so variables; if related in this scenario should have shown their association.

A study conducted in Jeddah revealed 30.9% was overweight, 21.9% were obese and 12% of the study sample was diagnosed as 12% while in our study participants 17.4% were hypertensive, 28.5% were overweight and 45.8% were obese [21]. Yu Qin and team [34] described 34.2% of their study population to be overweight whereas 5.8% were obese.Another study found 69% of the Saudi women to be obese while our sample showed 47.2% females affected by obesity. The similar study also demonstrated that there was no significant association between vitamin D deficiency and obesity in Saudi population suggesting that vitamin D deficiency cannotbe a potential causative factor for obesity in Saudi population, which was in conjunction to our study [24]. Researches have shown obesity and vitamin D to be associated yet sufficient scientific evidence is not available until date that supports the use of vitamin D for preventingor treating obesity [35]. In India, low levels of Vitamin D level were present among overweight and obese women and revealed an inverse association with BMI [36].

Apossible connection between deficiency of iron and obesity was presented in several previous studies which was found more evident in individuals more than 40 years of age [37]; while Pinhas et al proved this association in adolescents in a cross sectional study [38]; likewise, overweight and obese women with central obesity were less likely to have anemia in comparison to females with normal weight in India [39] and China [34] however this association was not present in our sample. Winther and team investigated in revealing the association between obesity and anemia along with an augmented risk of long-term cardiovascular adverse events and morbidities among overweight or obese patients. Obesity may cause anemia by

relative iron deficit as well as low-grade inflammation [40].

Regarding hypertension and obesity, previous studies conducted in Saudi Arabia showed the coexistence of both of these conditions by finding that one third of the hypertensive individuals in their study were obese, hence indicating a possible role of obesity in the etiology of hypertension [41] while another also identified the connection between these two conditions [21]. Hazmi et al also concluded that in males and females who were non-obese, the occurrence of hypertension was 4.8% and 2.8% respectively. Whereas obese individuals had approximately 1.6 times higher odds of having hypertension in the men (8%) and 3.52 times higherodds in the obese women (8%) [42]. Likewise increased BMI was considered as one of the strongest risk factor for the development of hypertension with obese females having 4.7 time's greater incidence of hypertension as compared to those having a BMI less than 23.0kg/m^2. It was also reported that 40% of newly diagnosed hypertensive cases were overweight or obese pertaining to decreased physical activity [43].

Recommendations

In conjunction with a few other studies conducted previously in Saudi Arabia, our study did not show any significant association between BMI and some metabolic conditions; however further studies should be conducted with greater sample size in order to evaluate the actual relationship between such conditions. Longitudinal studies and randomized trials may give a better picture; hence should be conducted taking into consideration the bias created due to gender distribution and sample size.Various socio-demographic variables, nutrition and physical activity should also be checked. In public health context, obesity, anemia, hypertension and vitamin D deficiency are big concerns in themselves. Each condition is preventable and modifiable therefore, primary prevention and health promotion should be prevailed within the community and health practitioners should be encouraged to counsel people regarding preventive to measures, early diagnosis and prompt treatment.

Conclusion

The present study showed no significant association between BMI categories and anemia, vitamin D deficiency, hypertension along various age groups; indicating that there might be other causes in Saudi population causing. Various interventional studies are required to prove this association incorporating various other factors. In conclusion, the metabolic conditions under discussion whether found associated or not; should be minimized; evidence needs to be created by following up patients and designing various strategies to create awareness among the population regarding their potential associations and ultimate adverse effects and complications. Non communicable diseases including obesity and hypertension are increasing at an alarming rate in Saudi Arabia, likewise vitamin D deficiency and anemia are affecting females specifically which will further create a vicious cycle and the families and children of such individuals will also be affected. Hence, in line with global efforts, cascade interventions will prove effective in controlling such epidemics.

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