# The relationship between body mass index and hospital admission: a cross-sectional study on the Saudi population 

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#### Abstract

Background: Obesity is a medical condition in which the excess body fat is accumulated to an extent that it may have a negative effect on health. It is recognized currently as a worldwide epidemic causing various chronic disease and high mortality rates. This study aimed at assessing the relationship between body mass index (BMI) and hospital admission in Saudi ethnicity. Methodology: A cross-sectional study was conducted involving 968 study subjects who visited King Abdulaziz University Hospital, Jeddah, Saudi Arabia during the month of July 2017. The body measurements were taken. Chi-square, $t$-test, and one-way analysis of variance test were used for statistical analysis of the data. Results: Among the 968 studied subjects, 516 were male subjects and 452 ( $46.9 \%$ ) were females. Based on BMI categorization, majority of the subjects $70(7.2 \%)$ were found to be underweight, 298 (30.8\%) had normal weight, 310 ( $32 \%$ ) were overweight, and 290 ( $30 \%$ ) were obese. There was no significant association between BMI and hospital admission among the studied subjects. However, a statistically significant association was found between BMI and admission based on the gender difference ( $p<0.05$ ). The study also revealed that females were more in number than males when admission was evaluated based on the gender difference.

Conclusion: The study signifies the need for further health campaigns to educate the general population on the possible harmful consequences of being obese. Considering the controversy between previous studies on this topic and the present study results, more studies are suggested to be conducted for better conclusive results.


Keywords: Hospital admission, inpatient, hospitalization, body mass index (BMI), obesity, overweight.

## Introduction

Obesity is a medical condition in which the excess body fat has accumulated to an extent that it may have a negative effect on health. Furthermore, in the last decades, it is recognized as a "worldwide epidemic" overwhelming the developed and the developing nations. The obesity and overweight are highly among Saudi Arabian ethnicity with an increasing trend reported in the recent studies [1]. Studies on the Saudi population also state that the majority of the adult population is more likely to be either obese or overweight by 2030 [2]. There are a quite number of parameters used globally in determining body weight status (whether normal or not), the most common formula is the Quetelet index, which
is known commonly as body mass index (BMI). Several studies conducted in the USA [3] and Canada [4] share the same idea that there is a strong positive association between obesity and the use of health care services,

[^0]which means excess BMI increases the risk of hospital admission. Other studies were conducted in Scotland [5] and USA [6] also established that high BMI rates increases the duration of stay in hospitals and increases the utilization of health care facilities. Age has a huge impact on patient hospitalization. A previous study found that underweight, overweight, and obese individuals, aged between 65 and 75 years, had a higher risk of hospital admission when compared with subjects with normal BMI, whereas most of the persons aged 75 years and above showed no significant relationship between BMI and hospitalization [7]. Underweight patients of both genders are also at high risk of hospitalization as it increases the length of hospital stay in most of the reported studies [6]. Furthermore, another study has shown that underweight females have an increased rate of hospital admissions and stay period comparing with the underweight male subjects [8].
Results have been inconsistent and confusing. Many studies have found a positive relationship between obesity and the utilization of healthcare services including hospital admission, while an almost equal number of studies had reported no association $[9,10]$ or negative relationship [11]. Because of this controversy being existing and due to a very limited number of studies regarding this in the Saudi population, this study was conducted to assess the relationship between BMI and hospital admission at King Abdul-Aziz University Hospital in Jeddah, Saudi Arabia

## Subjects and Methods

A cross-sectional study was conducted involving 968 study subjects who visited King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia during the month of July 2017. KAUH is one of the biggest tertiary referral and teaching centers in the western region of Saudi Arabia with a capacity of 800 beds. Among the total subjects studied, 504 ( $52.1 \%$ ) were inpatients, while the rest were apparently healthy participants who visited the hospital. The healthy volunteers included hospital visitors and relatives of the patients. Pediatric patients, subjects with severe edema, burns, peritoneal or hemodialysis, rehydration perfusion, the patients who had been admitted for non-morbid obesity, and pregnant ladies were excluded from the study. Thirty-four patients have refused to participate in this study. They were later removed from the analysis because of missing and non-interpretable information. Informed consent was received from all the participating subjects. The study was approved by the Institutional Review Board of KAUH.

The body measurements including the height were measured to the nearest centimeter using a meter tape, by instructing the participants to stand upright and barefoot. Bedridden patients have been measured while lying supine. Also, the weight was taken from the hospital records of the patients according to the hospital protocol. These records were measured routinely on hospital
admissions and in the clinics. All the measurements were done by an experienced nurse staff following very strict hospital protocol that favors very accurate weight measuring to the nearest kilograms using a balance beam scale. BMI was calculated by dividing the individual's weight in kilograms $(\mathrm{kg})$ by the square of the body height in $\mathrm{m}^{2}$. Subjects were grouped into four BMI categories: underweight ( $<18.5 \mathrm{~kg} / \mathrm{m}^{2}$ ), normal weight ( $18.5-24.9$ $\mathrm{kg} / \mathrm{m}^{2}$ ) and obese ( $>30.0 \mathrm{~kg} / \mathrm{m}^{2}$ ).
A data sheet was formulated based on previous studies available. Variables have been obtained by interviewing the participants. The demographic data such as age, gender, and current level of education have been taken. There were three possible levels of education that were found. The first one was "low education" in which subjects did not proceed further after secondary school education. The second one was "middle education" in which secondary school was completed with or without post-secondary school. The third one was "higher education" in which post-secondary school certificate or diploma was completed. Also, there were some questions that have been asked to the participants about smoking, having a previous or current known diagnosis and any chronic diseases. The estimation of the activity level was performed by asking individuals two questions about the recreational and the usual activities. Participants were classified as inactive, active, and moderately ones. The inactive participants were the ones who showed a negative attitude toward both questions, whereas, the active ones were totally positive toward them. Finally, the moderately active participants who had been found active for all other possibilities.
The data collected was entered in the form an excel sheet, and then was transformed to Statistical Package for the Social Sciences version 21 for further analysis. Categorical variables including primary variables were described as frequency, whereas the continuous variables for normally distributed were described using mean, standards deviation, and range. Later on, the data were processed to find the statistical significance using the $t$-test, chi-square test, and one-way analysis of variance (ANOVA) test. For all statistical tests, $p$-value lesser than 0.05 was considered as significant.

## Results

This study aimed at assessing the relationship between BMI and hospital admission among the Saudi population. The total number of the subjects enrolled for the study was 1,002 which included both inpatients and outpatients at the hospital. Among total enrolled subjects, 34 participants were later excluded due to the missing information on their weight and height details. Further, a total of 968 subjects were considered for future analysis. Among the final available 968 subjects, 504 subjects ( $53.3 \%$ ) were from the inpatient wards, while 464 (47.9 \%) were apparently healthy participants. The total subjects included 516 (53.3 \%) male and 452 (46.9 \%) female. It was found that $190(19.0 \%)$ were smokers
and 778 (80.4\%) were non-smokers among the studied subjects. In general, 122 (12.6\%) were active participants, 298 (30.8\%) were moderate ones, and the rest 548 (56.6\%) were inactive. Concerning the education, there were 374 ( $38.6 \%$ ) with high education, 242 ( $25 \%$ ) with middle education, and 352 (36.4\%) with low education. Based on the BMI categorization, majority of the subjects 70 (7.2\%) were found to be underweight, 298 (30.8\%) had normal weight, 310 ( $32 \%$ ) were overweight, and 290 (30\%) were obese. BMI scores ranged from 13.8 to $53.9 \mathrm{~kg} / \mathrm{m}^{2}$, with a mean BMI of $27.2( \pm$ SD 6.3$)$, which showed that the average studied subjects belonged to the overweight category. Male subjects were found to have slightly higher mean BMI than female subjects: $27.6 \mathrm{~kg} / \mathrm{m}^{2}$ (SD 5.6 , range $14-47.1$ ), $27 \mathrm{~kg} / \mathrm{m}^{2}$ (SD 7.5 , range 14.3-65), retrospectively. The frequency of each BMI category for healthy participants was: 124 (43.2\%) obese, 162 ( $52.3 \%$ ) overweight, 154 (51.4\%) normal weight, and $24(34.3 \%)$ underweight. On the other hand, the frequency of each BMI category for inpatient participants was: 166 (56.8\%) obese, 148 (47.7\%) overweight, 144 ( $48.6 \%$ ) normal weight, and 46 ( $65.7 \%$ ) underweight. The mean age of the studied subjects was 43.1 ( $\pm$ SD 18) ranges from 18 to 94 , the mean height was 163.65 cm (SD 10.04), and the mean weight was 76.4 kg (SD 19.6). The distributions of selected characteristics of each BMI category and their relationship with BMI groups are represented in Table 1. Considering the gender of the studied subjects, we divided the samples into two groups. We included the obese and overweight categories in one group, while the normal weight and underweight
in another group. Furthermore, we conducted a chisquare test in each of the above groups. It was found that females had a significant relationship between admission and obese, overweight group ( $p<0.05$ ) as shown in Table 2, while in males, there was a significant relation between admission and normal weight, underweight group ( $p<0.05$ ) as shown in Table 3.
A chi-square test was conducted to assess the relationship between BMI groups and number of subjects being admitted which revealed no significant association ( $p$-value $=0.104$ ), while another chi-square test was conducted to assess the relationship between BMI categories and subjects being admitted for each gender separately, which was significant ( $p<0.05$ ) in both gender as shown in Table 4. Figure 1 shows the distribution of each BMI category among inpatients and healthy participants.

A chi-square was conducted to study the association between gender and BMI categories, and the $p$-value was found significant ( $p<0.05$ ). There were $37.2 \%$ of males who were overweight, $30.2 \%$ were obese, and $4.7 \%$ underweight. A smaller percentage of females than males were found to be overweight (26.1\%), but less were found obese ( $29.6 \%$ ), and more were found underweight ( $10.2 \%$ ). The proportions of men were the highest in the overweight category, while women were the highest in the normal weight category. There was a slightly higher percentage of males in the higher BMI groups (BMI $\geq 30$ ) compared with females. The mean BMI of each group (underweight, normal weight,

Table 1. Distribution of selected characteristic of each BMI category.

|  | Total | $\begin{gathered} \text { Obese } \\ (>30) \\ n(\%)=290(30) \end{gathered}$ | $\begin{gathered} \text { Overweight } \\ (25-29.9) \\ n(\%)=310(32) \end{gathered}$ | $\begin{gathered} \text { Normal } \\ (18.5-24.9) \\ n(\%)=298(30.8) \end{gathered}$ | $\begin{aligned} & \text { Underweight } \\ & (<18.5) \\ & n(\%)=70(7.2) \end{aligned}$ |  | $\underset{\text { value }}{p}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age groups | 462 (47.7\%) | 102 (35.6\%) | 128 (41.3\%) | 174 (58.1\%) | 58 (82\%) | 18-39 | 0.000 |
|  | 290 (30\%) | 108 (37\%) | 96 (31\%) | 82 (27.7\%) | 4 (5.7\%) | 40-59 |  |
|  | 216 (22.3\%) | 80 (27.4\%) | 86 (27.7\%) | 42 (14.2\%) | 8 (11.4\%) | >60 |  |
| Age, mean $\pm$ SD $\dagger$ | $43.1 \pm 18$ | $47.4 \pm 20$ | $46.2 \pm 17$ | $38.7 \pm 17.6$ | $30.6 \pm 19$ |  |  |
| Gender | 452 (46.7\%) | 134 (46.6\%) | 118 (38.1\%) | 154 (51.4\%) | 46 (65.7\%) | Female | 0.011 |
|  | 516 (53.3\%) | 156 (53.4\%) | 192 (61.9\%) | 144 (48.6\%) | 24 (34.3\%) | Male |  |
| Smoking | 190 (19.6\%) | 48 (16.4\%) | 76 (24.5\%) | 50 (16.9\%) | 16 (22.9\%) | Yes | 0.239 |
|  | 778 (80.4\%) | 242 (83.6\%) | 234 (75.5\%) | 248 (83.2\%) | 54 (77.1\%) | No |  |
| Admission | 504 (52.1\%) | 166 (56.8\%) | 148 (47.7\%) | 144 (48.6\%) | 46 (65.7\%) | admt $\ddagger$ | 0.104 |
|  | 464 (47.9\%) | 124 (43.2\%) | 162 (52.3) | 154 (51.4\%) | 24 (34.3\%) | Not-admt |  |
| Education | 374 (38.6\%) | 98 (34.2\%) | 126 (40.6\%) | 130 (43.2\%) | 20 (28.6\%) | High | 0.061 |
|  | 242 (25\%) | 66 (22.6\%) | 96 (31\%) | 62 (20.9\%) | 32 (25.7\%) | Middle |  |
|  | 352 (36.4\%) | 126 (43.2\%) | 88 (28.4\%) | 106 (35.8\%) | 38 (45.7\%) | Low |  |
| Exercise | 122 (12.6\%) | 28 (9.6\%) | 48 (15.5\%) | 40 (13.5\%) | 6 (8.6\%) | Active | 0.153 |
|  | 298 (30.8\%) | 74 (25.3\%) | 156 (34.2\%) | 88 (29.7\%) | 30 (42.9\%) | Mod. active§ |  |
|  | 548 (56.6\%) | 188 (65.1\%) | 106 (50.3\%) | 170 (56.8\%) | 34 (48.6\%) | Inactive |  |
|  | 968 (100\%) | 290 (30.0\%) | 310 (32.0\%) | 298 (30.8\%) | 70 (7.2\%) | Total |  |

[^1]Table 2. The distribution of admitted patients among (obese and overweight) categories in females.

| Females | Overweight | Obese | Total |  |
| :--- | :---: | :---: | :---: | :---: |
| Not-admitted | 162 | 34 | 196 | 0.001 |
| Admitted | 148 | 102 | 250 |  |
| Total | 310 | 136 | 446 |  |

Data are expressed as counts.

Table 3. The distribution of admitted patients among (normal and underweight) categories in males.

| Males Underweight |
| :--- |
|  Normal <br> weight Total $p$-value   <br> Not-admitted 24 80 104 0.03 <br> Admitted 46 64 110  <br> Total 70 144 214  |

Table 4. The relationship between BMI categories and being an in-patient in each gender.

| Number |  | Being admitted |
| :--- | :---: | :---: |
| Male | $p$-value (0.001) |  |
| Underweight | 24 | 24 |
| Normal weight | 144 | 64 |
| Overweight | 192 | 76 |
| Obese | 156 | 92 |
| Total (Males) | 516 | 228 |
| Female |  | $p$-value (0.023) |
| Underweight | 46 | 22 |
| Normal weigh | 152 | 80 |
| Overweight | 118 | 72 |
| Obese | 136 | 102 |
| Total (Females) | 452 | 276 |
| Total (both) | 968 | 504 |



Figure 1. The distribution of each BMI category among admitted and not-admitted participants.
overweight, and obese) was $16.9,22.3,27.3$, and 35.1 , respectively. Furthermore, a one-way ANOVA test was conducted to evaluate the relationship between BMI and age groups, and it was found statistically significant
( $p<0.05$ ) which revealed a significant mean difference between age group (18-39 years) and age group (40-59 years) [mean difference(MD) $=-2.83$ ]. Also, there was a significant difference found between age group ( $18-39$ years) and age group ( $>60$ years) ( $\mathrm{MD}=-3.02$ ). However, there was no significant difference between age group (40-59 years) and age group ( $>60$ years) (MD $=0.19$ ) as presented in Table 5 .
Patients with higher mean age ( 47 years, SD 17) tend to have $\mathrm{BMI} \geq 30$, and the BMI further tended to increase as mean age increased. Subjects in the (40-59 years) age group were the most likely to be obese ( $37.2 \%$ ) and those in the (18-39 years) were the least likely ( $22 \%$ ). In addition, a significant difference ( $p<0.05$ ) was found between BMI categories and age groups after conducting a chi-square test. Figure 2 shows the distribution of each BMI category among different age groups.

The highest proportion of low education and being inactive were found among obese individuals, while overweight individuals had the highest proportion of being a smoker. There were no significant differences between BMI groups and being a smoker. Approximately $19.6 \%$ of the total sample were smokers, most of them (72.6\%) were male subjects, females were less likely to smoke ( $p<0.05$ ). There was a strong association between education level and smoking, which reveals that an increase in the level of education decreases the probability of smoking ( $p<0.05$ ). There also existed a significant association between age groups and smoking ( $p>0.05$ ). About $61.1 \%$ of smokers were in the age group 18-39 years and $22.1 \%$ of the subjects were in the age group 40-59 years. Among the subjects aged more than 60 years, $16.8 \%$ of them were found to be a smoker.

## Discussion

According to our knowledge, this is the first study conducted in Saudi Arabia that assesses the relationship between BMI and hospital admission in a tertiary center (KAUH). Our findings based on the 968 participants aged 18-94 years old found that when both the genders are compared, having a different BMI class would not make the chances for an individual to be hospitalized higher or lower. Thus, showing no association between BMI and being admitted when both genders were compared. This finding is inconsistent with another large national survey analysis done in Canada [4], which showed that the incidence of being admitted was higher among the obese people from both genders among a study population consisting of Canadian adults aged 20 years and above. Similar results have been reported from other studies done in the UK [12] and the USA [13] involving their respective populations. The UK study targeted the women aged between 50 and 64 years and the USA study was targeting adults aged between 45 and 64 years from both genders. Also, few other studies concluded the same results, one done at primary care center [3], another in Spain, which included women's only female subjects not representing to the whole population [10].

Table 5. Results of one-way ANOVA test to find the relation between BMI and age groups.

| $p$-value Mean difference (I-J) | Age groups |  |
| :---: | :---: | :---: |
| $p<0.05$ | -2.83 | $(18-39)$ and $(40-59)$ |
| $p<0.05$ | -3.02 | $(18-39)$ and $(>60)$ |
| $p<0.97$ | -0.19 | $(40-59)$ and $(>60)$ |



Figure 2. Distribution of each BMI category among different age groups.

On the other hand, other studies have suggested that there was no association between hospitalization and obesity $[9,10]$. This inconsistency could be attributed to the tremendous difference in the relatively small sample size with a higher mean age compared with the other studies. In addition, different racial and environmental factors could also be contributed to such inconsistent results. Another possible explanation is that the hospital involved in the present study was a tertiary hospital, as a reason most of the inpatient participants were already in advanced stages of life including subjects even with late-stage cancer (mainly in the underweight group). However, the picture was different when the study subjects were compared with respect to their gender, in other words, the higher the BMI, the greater was the chances of being admitted when being compared with subjects based on the gender. This inference was more prominent in females, which means that overweight and obese women have a higher chance to be admitted than women with normal weight. This result matches those who observed in an earlier study conducted in Spain which showed that overweight and obesity are associated with worse subjective health and greater utilization of health-care services among Spanish women [10], while a cohort study conducted in the USA found that normalweight men were more likely to be hospitalized than normal weight women; however, hospital admission due to being overweight or obese was higher among women [13]. The most reasonable explanation for this result may be due to a mechanism whose direction runs from overweight and obesity to poor health and the use
of health-care services. Such a result signifies a possible gender-specific factor that might make one gender responding differently compared with the other. Further large scale studies are warranted to assess the relationship between BMI and gender.

The other important finding of the present study was that the average sample size fell in the overweight category. This result was consistent with a study conducted in the USA [3] and also with Framingham heart study [14] which showed that the mean BMI of the study subject corresponds to overweight level. This result may be explained by the fact that overweight and obesity are between two-thirds and three-quarters among the adults of Arabian Gulf states [15]. Another significant finding was that males were found to have slightly higher mean BMI than females. This finding was contrary to a previous study which had shown that a higher proportion of women had higher BMI categories (BMI > 36) compared with males [16]. Also, our results were found to be contradicting to multiple studies with similar conclusions, which included: the WHO report published in 2000 [17], a systemic review aimed at studying the obesity prevalence in Saudi Arabia [18]. The inconsistency in results could be attributed to the recent cultural changes regarding the awareness of obesity negative effects and the negative body image that obesity has been exaggerated to have. Not mentioning the psychological stress in the meantime of being judged negatively as not being as the "advertised successful women" who have been told they should be. Further another study talked regarding the topic of "gender differences concerning obesity" based on the data from National Health and Nutrition Examination Survey in the USA in 2009-2010 [19], which studied the prevalence of obesity in the United States and showed its equal prevalence among both the genders. This study finding [19] were different when compared with a previously published study which stated that the obesity prevalence was higher among the women than men. This inconsistency in the findings could signify the need for larger studies to be conducted for better clarification of the results. In the present study, male subjects were found to have a higher percentage in overweight and obese categories, which was supported by a previous study found similar findings [13]. A possible explanation for the results could be that our sample size is higher in males than females by $6.4 \%$ and the reason for different results of the BMI between men and women could be related to the difference of the population characteristics and environmental variations.

The current study also found that obese patient tended to have higher mean age and the mean age increases with increasing BMI. Thus, aging 40 -year old or higher would increase your chances of having a higher BMI reading when it is being compared with the younger age groups. The data from the National Health and Nutrition Examination Survey in the USA [19] have demonstrated that the adults aged 60 years or above have higher chances of being obese than the younger age groups. Mean BMI
increases with the aging in all age groups, especially between the age group of 40 and 70 years [20]. It seems to be logic as the person gets older, his physical activity level and functional fitness decrease due to the reduction of muscle strength, changes in body-fat percentage and flexibility of joints. In contrast to the earlier findings, our result disagrees with a study conducted in the USA which pointed out that the mean age tended to decrease as BMI gets increased [16]. We believe our results could be attributed to our sample size, which was with a higher mean age and range compared with other studies mentioned above.

The present study has got the following limitations: (1) the present study followed a cross-sectional design, which cannot ascertain the direction of the relationship between variables. (2) The study did not look into the health conditions of the subjects in analyses, where these conditions such as type II diabetes, hyperlipidemia, and hypertension could have also acted as a causal pathway between obesity and hospitalization. However, the purpose of this study was to determine the association between BMI and hospital admission, not disease-related factors on morbidity. Moreover, the hospital involved in the present study was a tertiary hospital which receives advanced cases as a referral from multiple centers. For the sake of expanding our sample size and potentially our population, we intended at the beginning to use the data from the medical recording system as our source of data collection. However, lots of data that we were interested were missing and few of them were not precisely recorded. This made us interview the participants directly during data collection procedures.

## Conclusion

The mean BMI in the studied subjects was found to be in the overweight category. Taken each gender on its own, there was a direct relationship between increased BMI and increased chances of being hospitalized. However, there was no relationship in between, when both genders were compared one to the other. Furthermore, there was a significant relationship between gender and being admitted which revealed that females were more common to be admitted than males. Such a conclusion, signify the need for better health campaigns to educate the general population on the possible harmful consequences of being obese or overweight. Considering the controversy between previous studies on this topic, the present study suggests the need for larger studies to be conducted on this topic for better conclusive results. In addition, multicenter studies could be conducted to assess the relationship and identify agents affecting hospital admission. This is the first study of its kind to be conducted in Saudi Arabia, and we recommend further studies to be carried out in different hospitals in Saudi Arabia.

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## List of Abbreviations <br> BMI Body Mass Index <br> KAUH King Abdulaziz University Hospital

## Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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## Consent for publication

Informed consent was obtained from all the participants.

## Ethical approval

Ethical Approval was sought from the Institutional Review Board at King Abdulaziz University Hospital.

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[^1]:    *BMI = body mass index, $\dagger$ SD = standard deviation, $\ddagger a d m t=$ admitted, $\S$ Mod. Active = moderately active.

