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# Relationships between Overweight and Obesity with Preferred Mode of Transportation and Use of Neighborhood Facilities in Riyadh, Saudi Arabia

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## Abstract

**Purpose:** To examine possible associations of obesity with mode of transportation to neighborhood facilities, social environment, type of work, and physical activity at neighborhood facilities and at home.

**Methods:** This cross-sectional descriptive survey included a total of 312 respondents aged 18 years or older who attended three family medicine centers in the National Guard Hospital, Riyadh, for routine heath care from January 2012 to April 2012. The following measures were analyzed: Body Mass Index (BMI), self-reported modes of transportation to neighborhood facilities, physical activity, social environment, and socio-demographic status.

**Results:** One-third of participants (33.7%) were overweight and just over one-third (39.2%) were obese. The majority of participants drove to work (98%), school/college (90.2%), shopping malls (95.7%), restaurants (91.5%), and social visits (84%) but walked to mosque (84.3%) and to grocery stores (50.2%). The rate of obesity was higher among participants who drove (45%) than in participants who walked (30%) to grocery store ($X^2$=7, p=0.03). No other significant differences in rate of obesity noted for other destinations.

**Conclusions:** Obesity rate was higher among participants who used car to reach grocery store (45%) than participants who used to walk to the grocery store (30%) ($X^2$=7, p=0.03). No other significant differences in rates of obesity noted for other destinations. Further investigation is warranted in order to establish whether this relationship is causal.

**Keywords:** Obesity; Built environment; Neighborhood facilities; Physical activity; Transportation

## Introduction

Obesity is considered a substantial public health crisis all over the world, with a rapidly increasing prevalence in numerous developed and developing countries [1].

The rapid increase in obesity rates over recent years has, however, occurred in too short a time to result from significant genetic changes alone, suggesting that environmental and socioeconomic factors are likely contributing to the rapid global increase in obesity [2]. Increasingly sedentary lifestyles together with greater consumption of high-energy foods appear to be the major contributing factors [3].

Regular physical activity reduces the risk of mortality and the incidence of cardiovascular diseases, diabetes, and some cancers [4]. However, the prevalence of physical activity among Saudi adults is relatively low. Over 40% of Saudis are inactive, 34.3% are minimally active, and 25.1% are physically active [5]. Increasing engagement in physical activity and reducing obesity at the population level have been identified as international health priorities [6]. Interventions that target individuals have only a minimal impact on the physical activity levels of populations as a whole. However, changes to the physical environment are believed to have a long-term and substantial impact [4].

Given the high prevalence of obesity and physical inactivity, recent research has focused on the roles that the social and physical environments, including neighborhood safety and maintenance, play in influencing individual physical activity and obesity. Walking is the most common form of physical activity and is usually performed on neighborhood streets and in open, public spaces. While some neighborhood characteristics have been consistently associated with higher levels of walking, other features have received mixed support in the literature to date. Objective or perceived safety from crime is one such characteristic [7-9].

Previous research has cited the perception of crime and safety as a barrier to achieving adequate levels of physical activity, which leads to overweight and obesity [10]. Neighborhood maintenance warrants attention as a feature that might promote or detract from perceived safety and thus influence physical activity. Composite measures, including indicators of safety and perceptions of maintenance, are linked with increased physical activity [11].

Internationally, many studies have measured the effects of mode of transportation on physical activity and obesity [3,4,7,9,10,12-15]. In 2006 in Australia, a study was conducted to examine the associations between driving to work, physical activity, and overweight and obesity. They found that people who drove to work were less likely to achieve recommended levels of physical activity compared to users of alternate modes of transportation. Driving to work was associated with being

overweight or obese, and inadequate level of physical activity was independently associated with overweight or obesity [3].

In 2004 in the United States, a study examined the relationship of obesity with community design, physical activity, and time spent in cars. Their results showed that each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity. Conversely, each additional kilometer walked per day was associated with a 4.8% reduction in the likelihood of obesity [12].

To our knowledge, no similar study was done in Saudi Arabia to examine the relationship between obesity and mode of transportation to neighborhood and obesity.

Because of the high prevalence of obesity in Saudi Arabia, our study examined the relationships between overweight and obesity with preferred mode of transportation, use of neighborhood facilities for physical exercise, and perceived neighborhood safety and maintenance. Other objectives were to explore the participants' perceptions of the safety and maintenance of neighborhood facilities, level of physical activity at work, and preferred time and season to engage in physical exercise.

## Methods

Prior to conducting the study and for literature review, we searched PubMed for all published articles related to our topic using the keywords obesity, built environment, neighborhood facilities, physical activity, and transportation.

For this study, data were collected from National Guard personnel and their dependents who attended one of three large family medicine centers in the central region of Saudi Arabia: King Abdul Aziz Housing Clinics (Iskan) and the Health Center for Specialized Care (Khashm Alaan) in eastern Riyadh and the National Guard Center for Specialized Care (Um Alhamam) in northwest Riyadh.

Eligible subjects were recruited from patients who attended the three family medicine centers from January 2012 to April 2012 for routine health care. Subjects were recruited using random sampling method. Each week three random days are selected for subject recruitment for a total period of 12 weeks. Based on the order of patient appearance at the clinic reception every $n^{th}$ subject (n is a random generated number between 1 to 9 obtained on the day of recruitment) is screened for eligibility and included in the study if inclusion criteria are met. 10 subjects were selected on each recruitment day.

Eligibility criteria were defined as follows: age 18 years and older, subjects who did not have any physical disability preventing them from physical activity, and being able to complete the questionnaire in Arabic.

The sample recruited from each center was proportionate the size of the population served by the center. The total study population size is 200,000. Based on 35.5% prevalence of obesity in Saudi Arabia from Al-Nozha MM study [16], using a 95% confidence interval, 5% margin of error and effect size of 1 the calculated sample size was 352 adjusted to 360 to account for incomplete questionnaires. Sample size was calculated using open epi epidemiologic calculator.

We developed a new questionnaire based on a review of questionnaires in similar studies [6,10,13]. It contained both closed and open-ended questions to assess the following: preferred transportation mode to work and other routine activities, time spent to reach neighborhood facilities and places of work and leisure ("time spent"; later categorized as being ≤10, 11-20, 21-30, 31-40, and 40-60 minutes), whether participants exercised at their neighborhood facilities, level of physical activity at work (sedentary, moderate, or vigorous), participants' perception about safety and maintenance of their neighborhoods, and finally, the preferred time of year and time of day for physical exercise. The number of participants who use to go to work by walking was small and therefore it was considered unreliable for statistical inference.

Accuracy of questionnaire translation ensured using back translation method. Content validity ensured by consulting with experts in the fields of obesity, physical activity and built environment.

Socio-demographic characteristics of the participants, such as age, sex, marital status, work status (military vs. non-military–laborer, private sector employee, government employee, and business owner), and educational level were included in the questionnaire. Height (in centimeters) and weight (in kilograms) were recorded for each participant by designated nurses using calibrated scales in each center.

A pilot study on 10 participants was conducted and analyzed before the main study to assess the ease of using the questionnaire, data collection, and tabulation procedures. Necessary changes were made accordingly.

For statistical analysis, completed questionnaires were coded and entered into SSPS software v. 18 (Statistical Package for Social Sciences, IBM, New York, USA) by a data entry clerk. Statistical significance was set at $p<0.05$. A descriptive analysis was carried out, estimating means, Standard Deviations (SDs), frequencies, and percentages. The associations between variables such as time spent, mode of transportation, and BMI were explored using Chi-square and Student's T-tests.

Ethical approval was obtained from the Institutional Review Board of King Abdullah International Medical Research Center, Riyadh. Participants were assured of the purpose and confidentiality of the research data before giving verbal consent to participate in the study. The questionnaire included a consent statement clarifying this. The study was conducted according to the principles of the Declaration of Helsinki [17].

## Results

Table 1 shows the demographic characteristics of the participants. Of the total 360 subjects targeted, 312 (86%) returned completed questionnaire. The age of the participants ranged from 18 to 75 years (mean, 38.8 ± 14.3 years). BMI ranged from 15.5 kg/m$^2$ to 47.75 kg/m$^2$ (mean, 28.9 ± 14.3 kg/m$^2$). There were 103 (33.7%) overweight and 120 (38.5%) obese participants.

Participants varied in the number of times per week that they visited neighborhood facilities and places to exercise. As shown in Table 2, the mosque was visited most frequently (mean number of weekly visits, 27.19 ± 12.51). Participants visited restaurants 2.31 ± 1.9 times per week (range, 1-10 (more than one visit per day)).

As shown in Table 3, the majority of participants used cars to reach their work place (98%); school and college (90.2%); restaurants (91.5%); shopping malls (95.7%); and to meet relatives and friends (84%), with a mean time ranging from 20 to 30 minutes. Nearly half (50.9%) of the participants went to the grocery store by car (n=143). However, most (84.3%) participants walked to the mosque (n=194).

| Variable | N | % |
|---|---|---|
| **Gender** | | |
| Male | 201 | 64.4 |
| Female | 111 | 35.6 |
| **BMI (kg/m$^2$)** | | |
| Normal <25 | 83 | 27.1 |
| Overweight 25-29.9 | 103 | 33.7 |
| Obese ≥ 30 | 120 | 39.2 |
| **Center** | | |
| NGCSC | 101 | 32.4 |
| HCSC | 113 | 36.2 |
| Iskan | 98 | 31.4 |
| **Educational status** | | |
| None | 52 | 16.7 |
| Primary school | 39 | 12.5 |
| Secondary school | 52 | 16.7 |
| High school | 96 | 30.8 |
| College and above | 73 | 22.4 |
| **Marital status** | | |
| Married | 231 | 75.5 |
| Single | 75 | 24.5 |
| **Work** | | |
| Yes | 146 | 46.8 |
| No | 166 | 53.2 |
| **Job type** | | |
| Non-military | 47 | 32.9 |
| Military | 96 | 67.1 |
| **Level of activity at work** | | |
| Sedentary | 18 | 12.2 |
| Moderate | 96 | 65.3 |
| Vigorous | 33 | 22.4 |

**Table 1:** Socio-demographic data for study participants (n=312). BMI: Body Mass Index; NGCSC: National Guard Center for Specialized Care; HCSC: Health Center for Socialized Care.

Table 3 shows that participants who used cars to reach specific facilities (such as shopping malls, school, and places to meet people) also walked to other facilities such as the mosque, and participants were split in half regarding preferred mode of transportation to grocery stores. Further analysis on time spent in a car or walking showed that higher BMIs were associated with more time spent in a car and lower BMIs were associated with more time spent walking. However, these trends did not reach statistical significance.

| Variable | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| **Routine activity** | | | | | |
| Grocery store | 215 | 3.4 | 2.25 | 1 | 7 |
| Mosque | 196 | 27.19 | 12.51 | 1 | 35 |
| School | 90 | 4.12 | 1.29 | 1 | 5 |
| Restaurant | 145 | 2.31 | 1.94 | 1 | 10 |
| Gym | 58 | 3.36 | 2.15 | 1 | 7 |
| Shopping mall | 205 | 1.67 | 1.35 | 1 | 7 |
| Meeting people | 263 | 2.14 | 1.63 | 1 | 7 |
| **Exercise venues** | | | | | |
| Gym | 33 | 3.27 | 2.11 | 1 | 7 |
| Sidewalk | 116 | 2.56 | 2.06 | 1 | 7 |
| Shopping mall | 56 | 1.73 | 1.47 | 1 | 7 |
| Walking track | 72 | 2.85 | 2.11 | 1 | 7 |

**Table 2:** Number of visits per week to facilities and places to exercise in neighborhoods. SD: Standard Deviation.

There was a significant statistical difference in BMI between participants who drove vs. participants who walked to the grocery store. Almost half of participants (45.1%) who went by car were obese, compared to 30% among those who walked (Table 4).

There was a significant difference in BMI by sex. In our study, females had a lower mean BMI than did males. There was a significant difference in BMI based on type of work, in that military personnel had a lower BMI than did non-military personnel. Mean BMI was not affected by whether or not someone worked or by level of physical activity at work. Singles had significantly lower BMI than married participants (Table 5).

As shown in Table 6, more than two-thirds of participants indicated that they did not exercise in the facilities available in their neighborhoods (gym, sidewalk, and walking track).

Participants were divided nearly evenly regarding preferred time of day to exercise, with 157 (51.6%) noting evening as their preferred time for exercise and 147 (48.4%) preferring to exercise during the day. Although 81.3% of participants perceived their neighborhood to be safe, nearly 40% of them perceived the venue of choice in their neighborhood to be poorly maintained (Table 7).

Analyzing each neighborhood exercise center separately, Iskan, located at the military housing, had the most unsatisfied participants; 50% of them rated the maintenance of this venue as poor. Iskan, however, was perceived to be safe by 90% of the participants, although this perception was not significantly associated with mean BMI. NGCSC (the Um Alhamam center) had the most satisfied participants, with nearly 75% rating the maintenance of the venue to be between good (51.5%) and excellent (24.2%). Nearly 85% of female participants perceived their neighborhoods to be safe and free from crime.

| Variable | Car | | | Walk | | | P value for mean | |
|---|---|---|---|---|---|---|---|---|
| | N (%) | Mean time (min) | Mean BMI | N (%) | Mean time (min) | Mean BMI | BMI | time |
| **Job** | 144 (98) | 28.79 | 28.83 | 3 (2) | 12.5 | 36.01* | 0.38 | 0.12 |
| **Grocery** | 143 (50.9) | 7.16 | 29.37 | 138 (49.1) | 6.19 | 28.34 | 0.15 | 0.07 |
| **Mosque** | 36 (15.7) | 7.16 | 28.16 | 194 (84.3) | 4.22 | 28.65 | 0.65 | 0.24 |
| **School or college** | 119 (90.2) | 22.82 | 27.09 | 13 (9.8) | 20.89 | 27.66 | 0.75 | 0.72 |
| **Restaurant** | 162 (91.5) | 18.03 | 28.37 | 15 (8.5) | 11.71 | 27.95 | 0.81 | 0.009 |
| **Gym** | 57 (79.2) | 17.73 | 28.53 | 15 (20.8) | 10.73 | 27.24 | 0.48 | 0.01 |
| **Shopping** | 244 (95.7) | 24.27 | 28.72 | 11 (4.3) | 35.17 | 29.52 | 0.66 | 0.03 |
| **Meeting relatives/ friends** | 247 (84) | 28.57 | 28.74 | 47 (16) | 10.73 | 30.14 | 0.147 | 0.001 |

**Table 3:** Mode of transportation used to reach facilities in the neighborhood and mean time needed to reach to them correlated with mean BMI. *The N of walking is small and unreliable for statistical inference; BMI: Body Mass Index.

| | BMI | | | |
|---|---|---|---|---|
| | Normal N (%) | Overweight N (%) | Obese N (%) | Total |
| **Car** | 37 (26.1) | 41 (28.9) | 64 (45.1) | 142 |
| **Walk** | 36 (27.1) | 56 (42.1) | 41 (30.8) | 133 |
| **Total** | 73 | 97 | 105 | 275 |

**Table 4:** Comparing modes of transportation between weight status categories. $X^2$=7.08; p=0.029; BMI: Body Mass Index.

## Discussion

The aim of this study was to explore the relationship of level of physical activity at home and work, use of neighborhood facilities for physical exercise, and perceived neighborhood safety and maintenance with overweight and obesity.

BMI for our participants resembled the international figures, with 39.2% obese and 33.7% overweight [18]. Most of the participants preferred cars to walking as their preferred mode of transportation to reach facilities in their neighborhoods, which showed a trend toward a relationship with higher BMI; however, that was not significant. In contrast, previous studies similar to ours found significant correlations between mode of transportation and overweight. One study found that walking or bicycling to work was significantly negatively associated with overweight and, to some extent, obesity [13]. Another study found that driving to work was associated with being overweight or obese, and people who used cars to go to work were less likely to achieve recommended levels of physical activity [3]. Another study demonstrated that owning private cars was associated with physical inactivity and obesity [19]. At the country level, walking and bicycling are far more common in European countries than in the United States, Australia, and Canada. Active transportation is inversely related to obesity in these countries. These results suggest that active transportation could be one of the factors explaining international differences in obesity rates [14].

| Variable | Mean BMI (kg/m$^2$) | SD | T/F | p |
|---|---|---|---|---|
| **Gender** | | | | |
| Female | 29.18 | 6.65 | 621 | 0.53 |
| Male | 28.74 | 5.58 | | |
| **Marital status** | | | | |
| Single | 25.56 | 6.07 | 5.726 | <.001 |
| Married | 29.96 | 5.56 | | |
| **Work** | | | | |
| No | 28.8 | 6.03 | 0.201 | 0.84 |
| Yes | 28.96 | 5.95 | | |
| **Type of work** | | | | |
| Military | 28.17 | 5.49 | 2.107 | 0.037 |
| Non Military | 30.34 | 6.14 | | |
| **Level of physical exercise at work** | | | | |
| Sedentary | 30.9 | 5.4 | 2.6 | 0.075 |
| Moderate | 29.2 | 5.7 | | |
| Vigorous | 27.1 | 6.4 | | |

**Table 5:** Comparing mean BMI with participants characteristic. BMI: Body Mass Index; SD: Standard Deviation.

Our insignificant result may be explained by our finding that the participants who walked to the mosque or grocery store also used cars to go to other facilities, such as restaurants, shopping malls, and to meet friends. Thus, participants' decision to go by car or to walk was influenced by the purpose of the trip. If the trip was to visit a worship place or to run errands (eg, to visit grocery stores), participants preferred to go walking, but if it was for leisure (eg, going to the

shopping mall and meeting friends) or to go to work, the participants preferred cars. Other studies have also found significant associations between walking purpose and BMI [20].

| | NO | | YES | |
|---|---|---|---|---|
| | N (%) | Mean BMI (kg/m$^2$) | N (%) | Mean BMI (kg/m$^2$) |
| **Gym** | 268 (89.1) | 28.95 | 34 (10.9) | 28.41 |
| **Sidewalk** | 194 (62.2) | 29.11 | 118 (37.8) | 28.53 |
| **Shopping mall** | 253 (81.1) | 29.07 | 59 (18.9) | 28.15 |
| **Walking track** | 238 (76.3) | 29.15 | 74 (23.7) | 28.04 |

**Table 6:** Comparing mean BMI between groups with different exercise facilities availability. *p-value was not significant; BMI: Body Mass Index.

| | N (%) | Mean BMI (kg/m$^2$) |
|---|---|---|
| **Safety** | | |
| No | 57 (18.7) | 28.27 |
| Yes | 248 (81.3) | 29.09 |
| **Preferred time of the day for regular exercise** | | |
| Day | 147 (48.4) | 29.02 |
| Night | 157 (51.6) | 28.71 |
| **Maintenance of the venue of choice for your physical activity** | | |
| Excellent | 59 (20.1) | 28.44 |
| Good | 123 (41.8) | 28.94 |
| Poor | 112 (38.1) | 29.16 |

**Table 7:** Comparing mean BMI difference in relation to participant's perception of neighborhood safety, maintenance and preferred time to exercise. *P value was not significant; BMI: Body Mass Index.

Another important finding of this study was that most participants walked to the grocery store, and that was associated with a lower BMI compared to those who used cars. We attribute this higher percentage of walking to the proximity of the grocery store, with a mean walking time of 6.19 minutes. One study showed that those who own cars and travel farther to grocery stores have higher BMI [21]. Another study showed that people in households with no car and living more than 1 mile away from a grocery store had lower obesity rates [22].

Because all participants in this study were Muslims, and Islam encourages adults to perform all five prayers in the mosque, more than 80% of the participants went to the mosque by walking, which were in close proximity reached with a mean walking time of 4.22 minutes.

Regarding the frequency of visits to neighborhood facilities, the maximum number of weekly visits to restaurants was 10, (ie, more than once per day), with a mean of 2.31 visits per week. This behavior might contribute to the higher mean BMI of the participants, because most restaurants are presumed to have unhealthy food. Many studies have examined the relation between food environment and obesity, but the findings are inconsistent [23]. One study showed no significant evidence that access to fast-food establishments or restaurants was associated with BMI [24]. However, another study showed that access to fast-food restaurants was positively associated with greater obesity rates in metropolitan cities [22]. A systematic review noted that there are different measurements tools used to assess food environment, which may explain these discrepancies [25].

Singles had a lower BMI compared to married participants, which has also been observed in previous study [3]. Military personnel had a lower BMI than did non-military personnel, which was statistically significant. This difference may be due to the military's requirements for laborious work and maintenance of physical fitness.

In our study, participants who perceived the level of physical activity at their work to be sedentary had a higher BMI compared to participants in moderate and vigorous activity jobs, but this difference was not statistically significant. However, previous studies have shown that low physical activity at work is a significant risk factor for obesity [26,27]. We attribute this insignificant result to the smaller sample size of workers in this study.

Participants who used their neighborhood facilities to exercise were found to have a lower BMI, but this was not statistically significant. Other international studies have found that there is a significant correlation between the perceived physical exercise in the neighborhood facilities and BMI [28].

Regarding the social environment variables measured in our study, perceived safety was not associated with BMI; whether participants perceived their neighborhoods as safe and free of crime or not did not affect BMI. Other studies have identified no significant associations between crime and physical exercise [4] or overweight/obesity [29], which might be due to the discrepancy between perceived and objective safety measures. The maintenance level of neighborhood facilities across centers was not associated with BMI. This observation is consistent with other studies [13,28].

Our findings highlight the importance of improving neighborhood design. Those that are walking-friendly would provide additional opportunities for physical activity and physical exercise that would help reduce obesity rates. We hope that our findings encourage others to develop community-based prevention programs against obesity.

## Study limitations

This cross-sectional study should be regarded as an exploratory study aiming to find relation between BMI and preferred mode of transportation, use of neighborhood facilities for physical exercise, and perceived neighborhood safety and maintenance. It should not be taken as an analytical study implying conclusions concerning a specific direction of causality.

A limitation was that both environmental and walking measures were based on self-reports. We acknowledge the possibility of a discrepancy or bias between perception and reality. Another limitation is that certain confounding variables, such as nutritional status and comorbidities as diabetes and hypertension that may influence obesity or activity were not measured.

In addition, the assumption that people both walk or use cars as alternate modes of transportation to carry out routine activities was not found to be accurate for our society, where walking or the use of a

car appeared to be used exclusively for specific purposes by each person. This finding cautions against comparisons between car use and walking. However, with grocery shopping, the results are comparable to other similar studies and can be generalized.

The study is describing a sub group of Saudi population and represents only National Guard employee and their dependents. Therefore, generalisability may not be possible.

## Conclusion

The preferred mode of transportation to the grocery store had a significant association with obesity; participants who walked to the grocery store had a lower BMI compared to those who used cars. This association warrants further investigation to establish whether this relationship is causal. Most neighborhoods were perceived to be safe for physical exercise; however, the facilities were not perceived to be well maintained. People rarely alternated between modes of transportation for specific, routine purposes (with the exception of visiting the local grocery store). Trends were noted for lower BMI with longer time spent walking for a routine activity and higher BMI was noted for longer duration spent in cars, although these associations were not statistically significant and require further long-term studies.

## Recommendations

Future research should focus on the assessment of physical activity via physical exercise diary or pedometer. In addition, future research should take into account the different walking purposes (ie, walking for leisure, walking to work, and walking for other purposes) when comparing all physical exercise and obesity. In addition, exploring other neighborhood characteristics, such as pleasantness and friendliness and the presence of streets lights and greenery, should be considered. Lastly, future studies should cover larger populations, to include not only National Guard employees and their families but also the entire Riyadh region and the country as a whole.

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