انتشار السمنة في دولة الكويت: دراسة جغرافية على طلبة جامعة الكويت باستخدام نظم المعلومات الجغرافية

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ملخص: اهتمت هذه الدراسة بتعرف انتشار مرض السمنة بين طلبة جامعة الكويت وعلاقتها بالموقع الجغرافي؛ حيث تضمنت عينة الدراسة 735 مشاركاً: 231 من الذكور و504 من الإناث، وتبين أن العديد منهم يعاني من زيادة الوزن والسمنة. وبلغت نسبة أصحاب الوزن الزائد 21% (BMI > 25-30) بينما بلغت نسبة السمنة 13,7%. وبلغ إجمالي نسبة الأشخاص ذوي الوزن الزائد والسمنة 34,7%. تحوي منطقة الدراسة 327 مطعماً للوجبات السريعة في أماكن مختلفة من المناطق الحضرية. اعتمدت الدراسة على استخدام نظم المعلومات الجغرافية لتحليل التوزيع الجغرافي لمرض السمنة وعلاقاته بمطاعم الوجبات السريعة. توصلت الدراسة إلى أنه على بعد نصف كيلومتر من مطاعم الوجبات السريعة يوجد 33% من الوزن الطبيعي (BMI < 25) و 30% من الوزن الزائد، بينما الذين يعدون من الذين يعانون من السمنة فإن نسبتهم 43%؛ مما يدل على أن السمنة مرتبطة بالقرب من موقع الوجبات السريعة. استخدمت واحدة من الأدوات المهمة في هذه الدراسة، وهي الأماكن أو البقع الساخنة والباردة. ووجدت الدراسة أن مطاعم الوجبات السريعة تميل إلى أن تكون موجودة في مناطق البقع الساخنة للأشخاص الذين يعانون من الوزن الزائد. في الختام، إن دراسة مدى انتشار السمنة من منظور جغرافي يساعد على فهم هذه المشكلة الصحية وعلاقتها بتأثير الجغرافيا عليها.

المصطلحات الأساسية: دولة الكويت، السمنة، نظم المعلومات الجغرافية، مطاعم الوجبات السريعة.

The Prevalence of Obesity in Kuwait: A Case Study among Kuwait University Students Using GIS

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Abstract: This study seels to understnad the spatial relationship between the geography and its effect on obesity prevalence among Kuwait University students. The sample involved 735 participants, 231 male and 504 females, most of whom were overwight and obese. The percentage of overweight was 21% (BMI > 25-30), while the percentage of obesity was 13.7% (BMI > 30). The percentage of both overweight and obese people reached 34.7%. In the sutdy area, there were 327 fast food restaurants located in differenct places of the urban area. This study used the Geographic Information System to analyse the distribution of obesity and fast food restaurants. The study found that within half a kilometre of fast food outlets, there were 33% of people with normal weight (BMI < 25), 30% of overweight people, while the percentage of people who were considered obese reached 43%, which is a clear indication that obesity is linked with the procimity of the location of fast food restaurants. One of the significant tools used in this study was hot and cold spots. The study found that areas of hot spots of fast food restaurants tended to be located in areas of hot spots of obese people, In conclusion, studying the prevbalence of obesity from a gepographical perspective hepls understand this public health issue and the impact of gepography on it.

Key words: Kuwait, Obesity Prevalence, GIS, Fast Food Restaurants.

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Introduction

Living in urban areas nowadays could be related with several problems that is related to human health. These problems include various social, economic, and administrative problems, among others. For example, poor neighborhoods have become a critical feature of many cities. Additionally, many health problems and diseases have arisen because of lack of human activity as a result of changes in lifestyle and, in particular, increasingly sedentary lifestyles, such as overweight and obesity, which are proven to be associated with diabetes, high blood pressure, and bronchitis (Karageorgi, Alsamdi & Behbehani, 2013; Remington, Brownson, & Wegner, 2010). Therefore, human lifestyle factors, including the lack of physical activity and the consumption of unhealthy meals, such as fast food, have largely contributed to the increase in the numbers of overweight and obese patients (Jeffery, Baxter, McGuire, & Linde, 2006).

Obesity is defined in terms of the body mass index (BMI) wherein a BMI above a certain level indicates excess body fat relative to height as a result of an imbalance between energy intake (in the form of calories) and energy spent (Alnohair, 2014). Increase in BMI has been shown to be related to blood pressure, diabetes, and other illnesses. According to the World Health Organization (WHO), obesity nearly tripled from 1975 to 2016, causing obesity and overweight to be the fifth greatest reason for mortality. Overweight and obesity are differentiated by the BMI. A BMI equal to or greater than 25 indicates overweight, and a BMI equal or greater than 30 indicates obesity. Both developed and developing countries are facing high rates of obesity and overweight, and these rates have been increasing among wealthy countries (Thornton, Pearce & Kavanagh, 2011).

Wealthy countries, such as the Arabian Gulf countries, suffer from high rates of overweight and obesity similar to other third world countries that may, to a certain extent, exceed the levels of other countries because of the harsh climate that hinders the movement of people and physical activities (Alnohair, 2014). The high per capita income and lack of health awareness have also contributed to high rates of overweight and obesity in Saudi Arabia, the United Arab Emirates, Bahrain, Kuwait, Qatar, and Oman. In these countries, research has revealed a strong association between the increase of obesity and the

incidence of different illnesses (Alnohair, 2014). Due to the high numbers of obesity in these countries and the link between obesity and diseases such as diabetes and high blood pressure, many researchers are interested in studying obesity in the Gulf counties. Diverse studies have examined the elderly and young alike.

For example, Aljoudi et al. (2015) investigated the relationship between lifestyle factors and obesity among adults in Jeddah, Saudi Arabia, using a random sampling technique to obtain data according to geographic location. The study found a strong relationship between level of education and obesity, wherein a higher level of education decreased the chance of being obese. Moreover, obesity was studied in school children in Kuwait through random surveys on 6,574 students from 244 schools (Elkum, Al-Arouj, Sharifi, Shaltout, & Bennakhi 2006). The study found that boys have a higher percentage of obesity than girls. Another study in Riyadh, Saudi Arabia, examined the relationship between fast food intake and obesity in school children (Almuhanna, Alsaif, Alsaadi, & Almajwal, 2014) based on a survey administered to 196 students and found that the obesity in Riyadh school children was significantly associated with fast food intake.

Despite the increase in the number of studies on obesity in this region, no studies have used geographic information systems (GIS) to spatially analyze the spatial distribution of obesity in Kuwait at the districts level. Most studies of this nature have been carried out in developed countries. For instance, recently, one group of researchers used GIS to study the distribution of obesity in the United States (Le et al., 2014) based on questionnaire data collected at the state level by corresponding health departments. The study found higher obesity rates in the Southeast and greater increases in obesity in the West compared to the East. Additionally, Lebel, Pampalon, Hamel, & Thériault. (2009) investigated obesity in the Quebec area using GIS based on a sample of 20,449 adults. The study found significant geographic variation in overweight in the study area that was related to socio-economic factors and land use patterns.

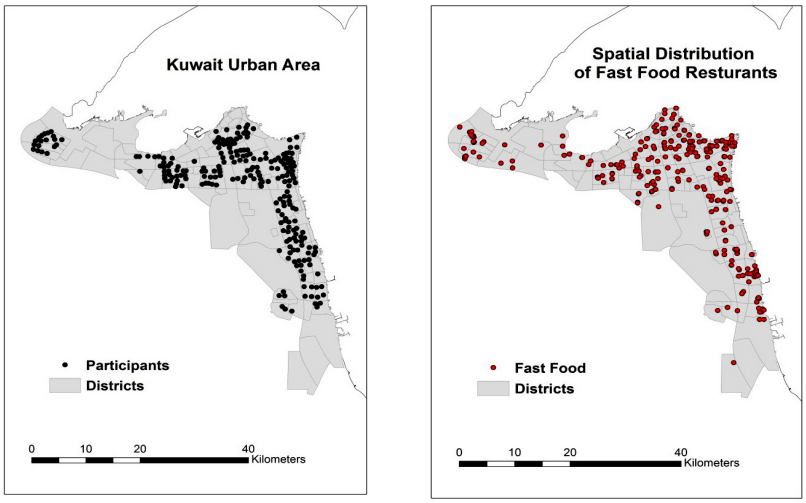
The present paper aimed to study overweight and obesity in Kuwait using GIS and survey data that were randomly collected among Kuwaiti university students and to compare these data to the distribution of fast food. Kuwait is one of the countries facing the highest rates of overweight

and obesity in the Gulf region. According to WHO, a study by the Department of Food and Nutrition of the Ministry of Health indicated that, in Kuwait, 41.7% and 35.7% of adult males and females were overweight, whereas 52.4% and 37.2% of females and were obese (WHO, 2014).

Methods

Study Area

The study area included urban areas in Kuwait at the district level. Almost all of the inhabitants of Kuwait live in urban areas; therefore, these areas were the focus of study. The distribution of participants and fast food restaurants are shown in Figure 1.



(A) (B)

Figure 1. Spatial distribution of study participants and fast food restaurants in the study area

Data Preparation

Body Mass Index Data

The prevalence of obesity was determined from a survey distributed to students of Kuwait University from March to April of spring 2017. The sample included 735 students, most of whom were female. Females accounted for 504 participants, whereas males accounted for 231 participants. According to the office of the vice president for planning

at Kuwait University, female accounts for 73.5% and that is why most participants were female because most students of Kuwait University are female (Office of the vice president for planning, 2017). The BMI was used in this study as an indicator of obesity. In the survey, the participants were asked to provide information regarding their weight and height and, from this information, the BMI index was calculated. In addition, the participants were asked to provide their living location at the district level.

Spatial Data

Three layers of spatial data were used in the present study and analyzed in the GIS software ArcMap 10.2.2. The first layer was the demarcation of urban areas at the district level. The second layer contained the BMI scores for all participants (735) based on their spatial location. The BMI scores were then aggregated at the district level. The third data layer contained the locations of fast food restaurants. Fast food restaurants include restaurants that sell mostly unhealthy food or high calories intake, such as McDonalds, KFC, Hardees, Pizza hut, Burger king *etc*. These data were gathered from the Public Authority of Civil Information of Kuwait.

Data Analysis

The obesity data were statistically and spatially analyzed based on the BMI categories. Specifically, the BMI data were aggregated at the district level to distinguish areas with high BMI scores. Only BMI scores greater than 25 were used because this study focused on overweight and obese individuals. The BMI scores were calculated from participants' heights and weights using the following equation:

Eq.1

$$BMI = \frac{Wright\ (kg)}{Height^{m2}}$$

Additionally, the relationship between the location of BMI scores and the location of fast food restaurants was spatially analyzed using the hot spot analysis tool in ArcMap. This tool identifies statistically significant spatial clusters of high values that are called hot spots and low values that are called cold spots. One advantage of using this tool is the ability to visualize the distribution of areas associated with high values of a certain variable, even when these values are not statistically significant

(Penney, T. L., Rainham, D. G. C., Dummer, T. J. B., & Kirk, S. F. L., 2014). However, the hot spot tool also identifies areas of high values that are statistically significant. Accordingly, hot spot analysis is a useful tool for identifying clusters with respect to a particular phenomenon. The hot spot analysis was performed using the following equation:

Eq.2

$$G_i^* = \frac{\sum_{i=1}^{n} \omega_{i,j} x_j \; - \; \bar{X} \sum_{j=1}^{n} \omega_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} \omega_{i,j}^2 - (\sum_{j=1}^{n} \omega_{i,j})^2 \right]}{n-1}}}$$

The hot spot analysis was also performed for fast food restaurants to identify areas of hot and cold spots with many or few restaurants, respectively. Then, the hot spots of overweight, obese, and fast food restaurants were compared to evaluate whether these hot spots were located in the same urban areas.

Results

The prevalence of obesity (BMI greater than 30) among participants was 13.7%, and the prevalence of overweight (BMI between 25 to 30) was 21%. Both overweight and obese individuals accounted for 34.8% of participants (Table 1).

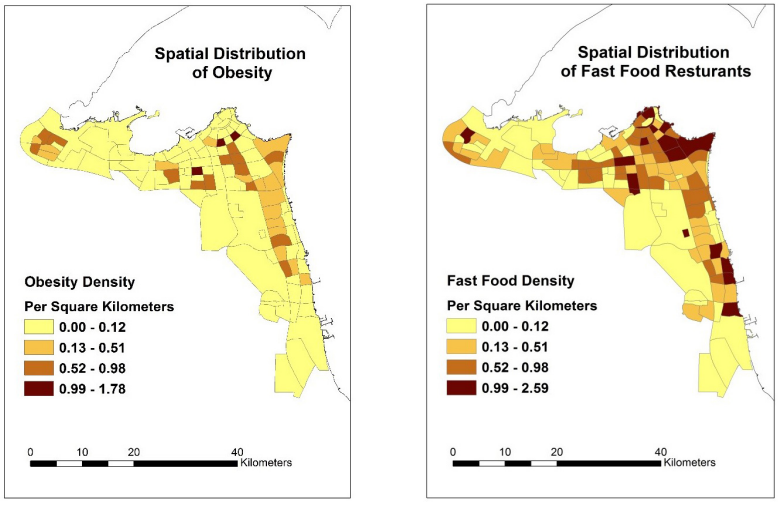
Table (1)
BMI scores for all participants from March to April 2017

	Number	**%**
Underweight	47	6.39
Normal weight	432	58.77
Overweight	155	21.08
Obese	101	13.74
Total	735	100

The BMI data were aggregated at the district level to distinguish areas of high overweight and obesity then compare these areas to the spatial distribution of fast food restaurants. As shown in Figure 2, the density of fast food seems to be higher than the density of obese

individuals. To distinguish whether the spatial distribution of obesity and fast food restaurants was random or clustered together, the spatial autocorrelation tool (Global Moran's *I*) was used. This tool helped to distinguish the degree of clustering in the spatial distribution of obesity and fast food restaurants. The results showed that obese people were randomly distributed, whereas fast food restaurants were clustered, as shown in Figure 3. The spatial distribution of fast food seems to be concentrated near the coastal downtown area. In the study area, there were 26 districts that had more than 5 fast food restaurants.

Another GIS tool used in this study was the buffer tool. The buffer analysis tool was used to create polygons, or buffers, of 500 meters around the fast food restaurants. Then, the percentage of obesity within the buffers was calculated. The findings showed that within 500 meters of fast food restaurants, 33% of participants were of normal weight, 30% were overweight, and 43% were obese. The difference between the percentage of normal weight and obese individuals was 10%, and the percentage of obese people was higher than the other BMI categories. This could indicate that the closer one lives to fast food restaurants, the higher the chance that one becomes obese. The effect of geography could thus play a role in increasing the rate of obesity.



(A) (B)

Figure 2. Spatial distribution of obesity and fast food restaurants per square kilometer at the district level

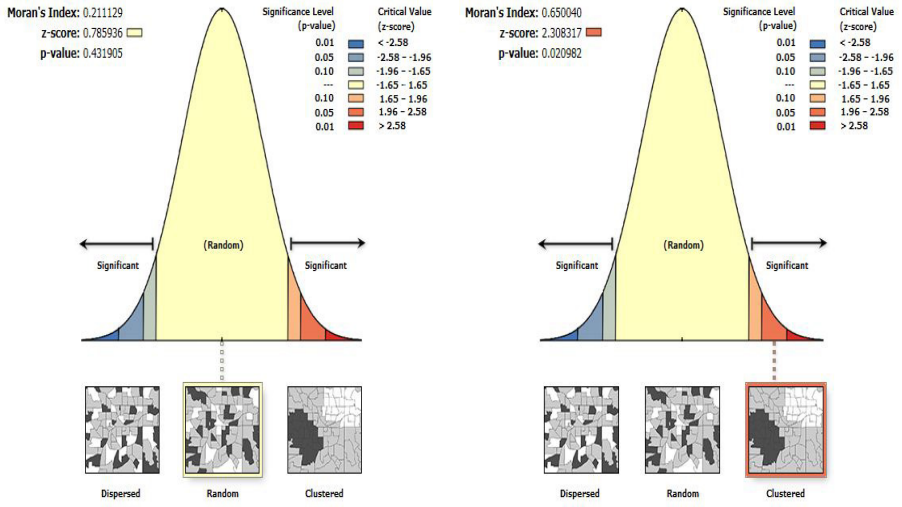


Figure 3. Spatial autocorrelation results (Global Moran's *I*) for the distribution of obese individuals and fast food restaurants. A random distribution was found for obese people and a clustered distribution for fast food restaurants.

According to the hot spot analysis for analyzing the spatial distribution of overweight, obesity, and fast food restaurants, the results showed that the distribution of overweight individuals was not statistically significant, as shown in Figure 4. The red areas represent districts of high values surrounded by districts of high values, while the blue areas represent districts of low values surrounded by districts of low values. For overweight individuals, the hot spots were not clustered to the same extent as those for obesity and fast food restaurants. The results of the hot spot analysis for obesity showed several clustered districts (indicated in red) surrounded by additional districts with high obesity values. The final map shows the results of the hot spot analysis for fast food restaurants. Notably, fast food hot spots were located in several areas of the same districts where obesity hot spots were located. At a 99% confidence level, six districts corresponded with both obesity and fast food hot spots: Rumaithiyah, Surra, Salwa, Jabriya, Shaab, and Bayan.

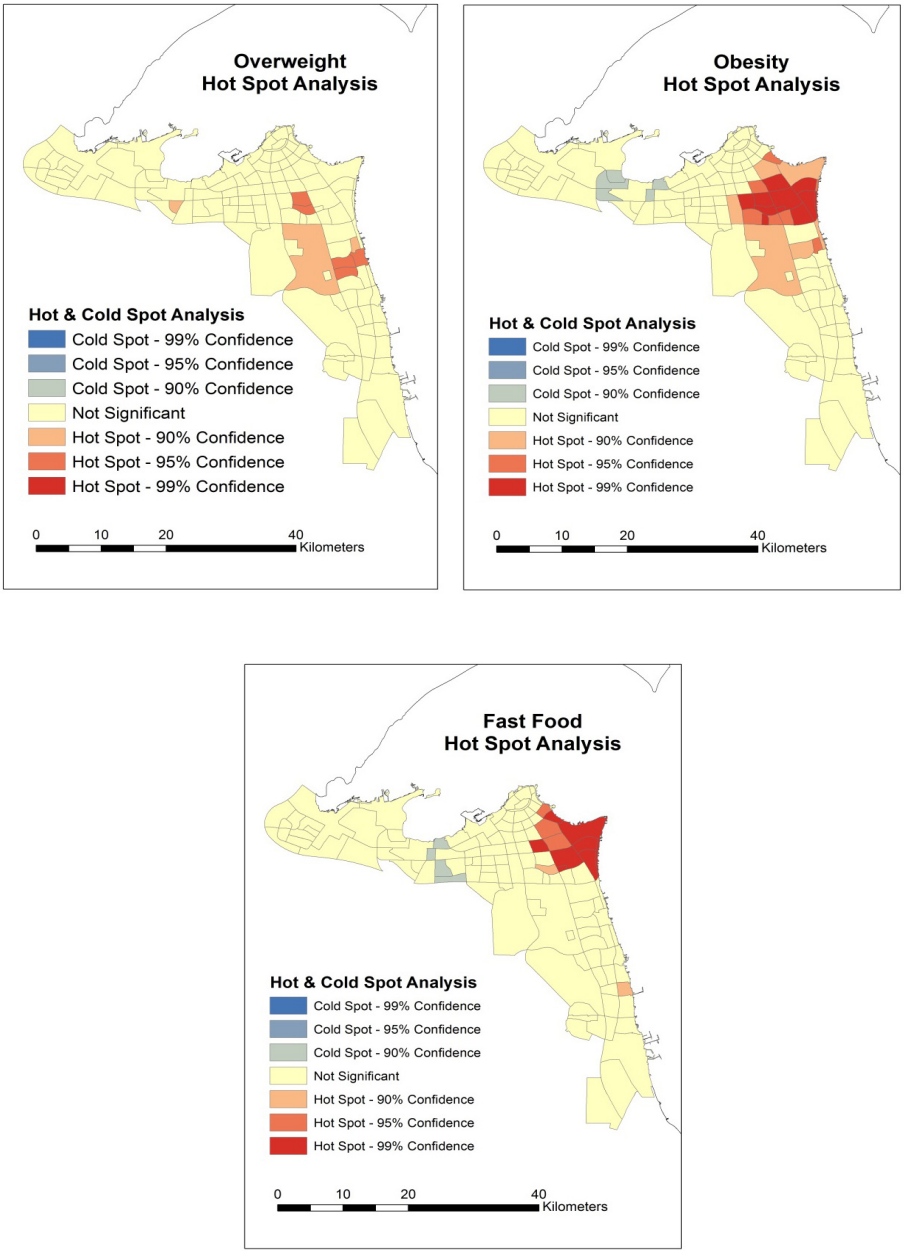


Figure 4. Hot spot analysis for the distribution of overweight and obese individuals and fast food restaurants

Discussion

The spatial distribution of obesity among students of Kuwait University was investigated using GIS techniques such as Moran's index, the buffer tool, and hot spot analysis. These spatial analyses enabled us to determine and understand the relationship between the spatial distribution of obesity and fast food restaurants. The analysis of obesity data involved three steps: data collection, data preparation, and spatial analysis. The spatial distribution of obesity and fast food restaurants was investigated based on density in each district. Moran's index was used to identify whether the spatial distribution was clustered or randomly distributed. The spatial distribution of fast food tends to be clustered, while the spatial distribution of obesity was randomly distributed. The buffer tool was also used to create 500-meter buffers around fast food restaurants and to then calculate the percentage of obesity within these buffers. It was found that the buffer areas around fast food restaurants had a high percentage of obesity (43%) compared to the overall percentage of obesity documented in our survey. The hot spot analysis tool thus showed that obesity hot spots tend to be located close to fast food hot spots.

The finding of this study support those of other studies that have related increased obesity with the location of fast food restaurants. Although the results of this study are consistent with other studies, the present study area has several unique characteristics that may have affected the results. Kuwait is not a large country and is characterized by economic abundance. We found that people spend the high amounts of money on high-end restaurants, even though these restaurants are often located far away (so delivery services are used). The average annual expenditure on restaurants was more than $2.5 billion. This spending has affected the relationship between sites of obesity and fast food restaurants. The findings of this study may have valuable implications. For example, we noticed that the samples were more clustered near areas with greater numbers of fast food restaurants. The interaction between the location of students' living areas and fast food was obvious: Obesity and overweight increase near areas with more fast food restaurants. However, we should add something important: Most respondents were from the younger generation, between the ages of 18 and 23. These young people receive an income from the Kuwaiti government, increasing their

purchasing power. Also, students may be dependent on fast food restaurants for reasons of convenience.

In this study, we did not investigate the reasons causing obesity, which may be related to several different factors, including high calorie intake, education level, income, or the effect of geography (Dinsa, Goryakin, Fumagalli, & Suhrcke, 2012). In this study, we focused on the effect of geography, and we linked the spatial distribution of obesity to the spatial distribution of fast food. However, this does not mean that everyone who lives close to fast food is obese, and other factors beyond the effect of geography may lead to obesity. Furthermore, in Kuwait, most fast food restaurants have a delivery option, meaning that even those who live far from fast food may consume fast food because of the low cost of delivery.

In the future, we will collect more data on income and education level and aim to link such data with the prevalence of obesity. By collecting data spatially, we can also examine geographic disparities in obesity, income, and education level using different GIS techniques.

Conclusion

Obesity is a public health issue in Kuwait and other developing countries. Therefore, studying obesity from different perspective, such as a geographic perspective, is essential for understanding this public health issue. This study focused on visualizing the spatial distribution of obesity among students of Kuwait University and comparing it with the spatial distribution of fast food restaurants by applying different GIS techniques. The study found that hot spots of obesity largely overlapped with hot spots of fast food restaurants or were located nearby. By using GIS techniques, we can understand the public health issue of overweight and obesity from different perspectives, such as the geographic perspective.

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