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تقييم العلاقة المكانية بين المدارس الحكومية ومطاعم الوجبات السريعة في دولة الكويت باستخدام نظم المعلومات الجغرافية

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ملخص:

هدف الدراسة: يعتبر تجمع الوجبات السريعة من أكثر العوامل التي تؤثر على السمنة لدى الأطفال. تبحث هذه الدراسة إلى تقييم وفهم العلاقات المكانية بين المدارس الحكومية ومطاعم الوجبات السريعة في الكويت باستخدام نظم المعلومات الجغرافية. **المنهجية**: تم استخدام نطاق التغطية وأداة منطقة الخدمة على ثلاثة مستويات 500 متر، 1000 متر، 1،500 متر لفحص وتقيم إمكانية وصول مطاعم الوجبات السريعة إلى المدارس. وكذلك تم استخدام نموذج الانحدار الخطي الموزون لتقيم العلاقات المكانية بين مطاعم الوجبات السريعة والمدارس الحكومية. **النتائج**: نتائج الدراسة تشير إلى أن هناك نسبة عالية من المدراس توجد بالقرب من مطاعم الوجبات السريعة سواء عن طريق أداة نطاق التغطية أو أداة منطقة الخدمة. تشير أيضا نتائج نموذج الانحدار الخطي الموزون إلى علاقة مكانية قوية بين مطاعم الوجبات السريعة والمدارس الحكومية. **الخلاصة:** إن استخدام هذه الأدوات الجغرافية المكانية له دور في تقيم العلاقة المكانية بين المدارس الحكومية ومطاعم الوجبات السريعة وهذا بدوره قد يساعد صناع القرار للبدء باتخاذ قرارات عن طريق سن لقوانين والتي قد تحد من تشغيل مطاعم الوجبات بمسافات قريبة من المدارس.

المصطلحات الاساسية: نظم المعلومات الجغرافية، مطاعم الوجبات السريعة، السمنة، التحليل المكاني، البيئة الغذائية

Assessing the Spatial Relationship between Public Schools and Fast Food Restaurants in Kuwait by Using Geographic Information System

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Abstract:

Objectives: Clustering of fast food restaurants is one of the biggest factors that affect childhood obesity. This study examines the spatial relationship between public schools and fast-food restaurants in Kuwait by using a geographic information system (GIS). **Methods:** Buffer and Service Area tools were used at three levels 500, 1,000, and 1,500 meters around fast food restaurants locations to examine the accessibility of schools to fast food restaurants in the study area. Geographically weighted regression (GWR) was also performed to assess the spatial relationship between the fast food and public schools. **Results:** The study results show a higher percentage of schools that have access to fast food restaurants for both the Buffer and Service Area tools. The GWR results shows also high correlation between fast food and public schools. **Conclusion:** The use of these geospatial tools could be effective an effective way to assess the spatial relationship between public schools and fast food restaurants; this, in turn, could help the policymakers adapt the necessary measures and lawmakers adopt potential regulations that might limit fast food restaurants from operating near or close to schools.

Keywords: GIS, Fast food, Schools, Obesity, Geospatial analysis, Food environment

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Introduction

Obesity is a major public health problem that affects both children and adults (World Health Organization, 2018). Overweight and obesity are related to major public health issues such as diabetes, hypertension, heart attack and some types of cancers (Kopelman, 2007). There are many complex factors associated with obesity, such as income, education level, food environment, lack of physical activity, and other factors (McEntee & Agyeman 2010).

In the last decade, much of the literature focused on the application of geographic information system (GIS) on the food environment including the availability of fresh food versus fast food and its effect on human health (Moore, Roux, & Brines, 2008; Wilkins, Morris, Radley, & Griffiths, 2017). A wide variety of methods and tools has been used that leverage various GIS techniques. This enabled many professionals including geographers, public health officials, and policy makers to understand the effect of food availability and environments in terms of their spatial distribution and other associated factors (Davis & Carpenter, 2009). Unhealthy food environments could lead consumers to choose unhealthy food options, which could lead to obesity. Understanding the spatial relationship could help identify the factors that may contribute to increasing trend of obesity where fast food is easily available and popular, especially near schools. A recent study on public health policy in Canada reported that in provinces that banned fast food services on school property, obesity rates dropped substantially (Leonard, 2017). Another study confirmed that Fast food restaurants that are within a short walking distance from schools could expose the children to poor-quality food environments in their school neighborhoods (Austin el al., 2005). Another study on proximity of fast food restaurants near schools found that students with fast food restaurants near to their schools consumed fewer servings of fruit and more servings of soda (Davis & Carpenter, 2009). In New Zealand, a study found that within walking proximity to schools there were high density of fast food restaurants and convenience stores especially in deprived areas (Day & Pearce, 2011). A recent study in Quebec, Canada, found that exposure to more than two fast food restaurants within a radius of 750 meters to schools was associated with higher consumption of fast food (Cutumisu el al., 2017). Furthermore, A study in Santa Clara County, California,

found that fast food restaurants were clustered around schools and those neighbourhoods had higher rates of obesity (Nixon & Doud, 2011). In another study, fast food restaurants seemed to be located around schools in lower-income neighbourhoods compared to higher-income neighbourhoods (Engler-Stringer, Shah, Bell & Nazmeen, 2014). The built environment characteristics also play a role in terms of the body mass index (BMI); a study in London, UK, revealed that the presence of fast food restaurants within walkable distance around schools was associated with higher BMI scores (Gilliland el al., 2012).

This paper studies the spatial relationship between public schools and fast food restaurants in the urban areas of Kuwait. According to Waldo Tobler (1970), the first law of geography suggests that everything is related to everything else. However, things that are closer to one another are more closely related than things that are distant from each other (Tobler, 1970). This means that manmade or physical environments are more closely related to features that are near them. In this case, fast food restaurants that are close to public schools might tempt students to choose unhealthy foods. Furthermore, an unhealthy food environment that is closed to schools might affect the students who live in these neighborhoods. The hypothesis of this study is based the idea of clustering or non-clustering of fast food restaurants around public schools. The paper uses GIS techniques to assess the spatial relationship between fast food restaurants and public schools in Kuwait's urban areas. In addition, the study aims to estimate the percentage of schools that have access to fast food restaurants to examine whether they have an unhealthy food environment. Furthermore, this paper studies the spatial relationship between fast food restaurants and public schools using a geographically weighted regression tool. To these ends, the study used the buffer analysis and network analysis tools in ArcGIS 10.4.

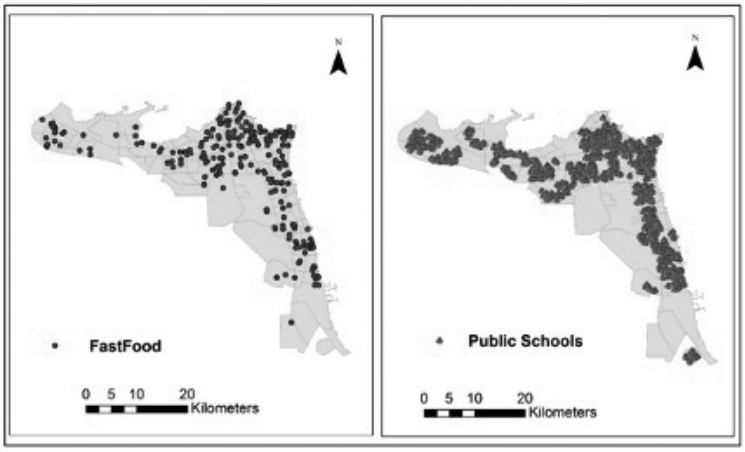
Study area:

The study area (Figure 1) of this research is Kuwait urban area where almost all the population of Kuwait live. According to the latest statistics from the Public Authority of Civil Information in June, 2019, Kuwait has a population of 4,651,009; 30.4% of which are Kuwaitis, while 69.6% are non-Kuwaitis. In Kuwait, there are six governorates, namely Al-Asmiah, Hawalli, Mubarak Al-Kabeer, Ahmadi, Jahra, and Farwaniya.

Figure 1. Study Area and Kuwait Governorates

Data source: The map was created by the author

Figure 2. Spatial distribution of public schools and fast food restaurants



Source: The map was created by the author

Data preparation:

The data was gathered and collected from the Public Authority of Civil Information in 2018, and it was geocoded using the X and Y coordinates and added to the ArcGIS. In the study area, 327 points represented fast food restaurants, which were distributed in various locations in the urban area. Public schools accounted for 776 schools across the selected urban area. According to Collins dictionary, fast food is defined as hot food, such as hamburgers and chips, which is served quickly after you order it. Fast food restaurants were selected based on their popularities worldwide. In this study, only fast food restaurants that had ten or more locations in Kuwait were selected.

Methods

The current study examines the spatial relationship between fast food restaurants and public schools in the Kuwait urban area. The Buffer Analysis tool was used around each fast food restaurant, with three buffer zones at 500 meters, 1000 meters, and 1,500 meters. The Buffer Analysis tool creates polygons around input features; in this case, the input was the location of fast food restaurants at a specified distance. Within each buffer zone, the number of public schools was estimated. The percentage of schools in close proximity to fast food restaurants was calculated by using Select by Location tool, available in ArcGIS. This provided an estimate of the number of schools that fell within each buffer zone from fast food restaurant locations.

The analysis was performed by using the Service Area tool in the ArcGIS Network Analyst extension. The Service Area tool uses the road networks to measure the distance around each facility; in this case, the input was fast food restaurants. The Service Area tool was used at three zones (500 meters, 1,000 meters, and 1500 meters) to compare the Buffer Analysis and the Service Area tool.

To assess the spatial relationship between fast food restaurants and public schools, a geographically weighed regression (GWR) tool was performed. The usage of (GWR), the local spatial statistical technique in GIS, was in the last decade useful to assess the spatial relationship in social and health sciences (Matthews & Yang, 2012). GWR is a spatial model used in GIS that identifies the locations of high or low correlation between the dependent variable and independent variable. In this study,

the dependent variable was the number of fast food restaurants in each district in the study area, while the independent variable was the number of schools in each district. The results of applying GWR was presented as a map that showed the adjusted for each district. The range of the adjusted is from 0 to 1. The closer number to 1, the stronger correlation.

Analysis and Results

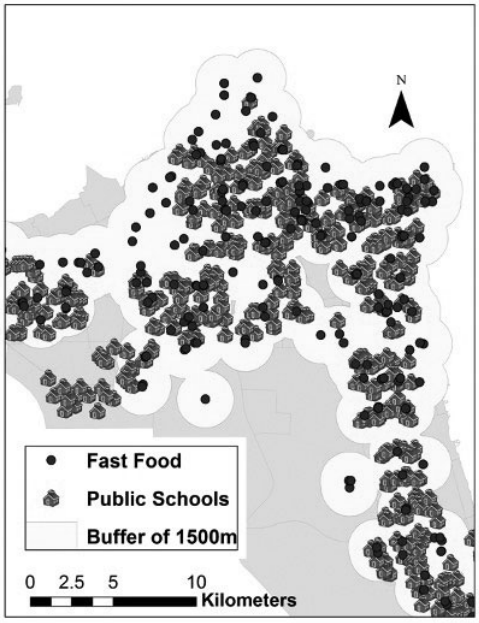
The results of the Buffer Analysis indicate that within 500 meters buffer zone around fast food restaurant, there were 329 public schools, which accounted for 42.4% of the public schools in the study area. At the 1,000 meter buffer zone, the number almost doubled, accounting for 602 public schools. In terms of percentage, the second buffer zone accounts for 77.5. %, which means that 77.5% of public schools in the study area have at least one or two fast food restaurants within a range of 1,000 meters. The last buffer zone (1,500 meters) accounted for 692 public schools with a percentage of 89.2%. At a distance of 1,500 meters, more than 90% of public schools had fast food restaurants located nearby (See Table 1). On the other hand, the results of the Service Area tool were different in comparison to the Buffer Analysis. In the 500 meters service area zone, about 20.10% of schools in the study area had one or more fast food restaurants located nearby. The percentage was 54.89% for the 1,000 meter zone and 77.5% for the 1,500 meter service area zone.

Table 1.

Number of public schools having one or more fast food restaurants nearby, using Buffer and Service analysis tools

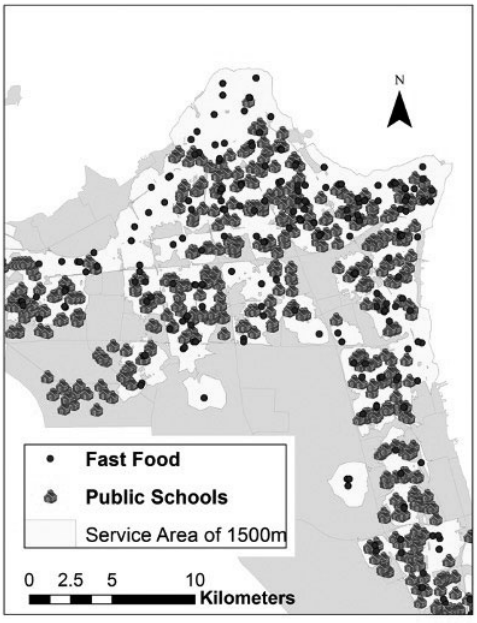
Zones	Number of Public Schools (Buffer Analysis)	%	Number of Public Schools (Service Area Analysis)	%
500 meters	329	42.4	156	20.10
1000 meter	602	77.5	426	54.89
1500 meter	692	89.2	602	77.5

Figure 3. *Buffer analysis of 1,500 meters around fast food restaurants.*



Source: The map was created by the author

Figure 4. *Service area analysis of 1,500 meters around fast food restaurants*



The analysis was also performed at the governorate level (Figure 1) to see the differences between each of the governorates in terms of the availability of fast food around schools. The initial analysis was performed by using the Buffer Analysis tool for the three zones mentioned above (500 meters, 1,000 meters, and 1,500 meters). At a distance of 500 meters, 65% of schools in the Hawalli governorate had fast food restaurants nearby (Table 2), which means that 65% of public schools that are located in Hawalli governorate had one or more fast food restaurants within a range of 500 meters. The Jahra governorate had the fewest fast food restaurants around public schools, with 26%. At a distance of 1,000 meters, the results were similar in terms of the highest and lowest. 96% of public schools in the Hawalli governorate had one or more fast food restaurants nearby, while in the Jahra governorate the percentage was 59.5%. At the third level (1,500 meters), Al-Asimah had 92%, the highest percentage, while the lowest was in the Jahra governorate at 75% (Table 3).

The Service Area tool was also used at the governorate level to see the difference between the governorates in terms of access to fast food restaurants. The results of the Service Area tool were different from those of the Buffer Analysis tool. At the 500 meter zone, Hawalli had 32%, the highest percentage, while the lowest was in the Jahra governorate with a percentage of 10.68%. At the 1,000 meter service area zone, Hawalli had 75%, again the highest percentage, while the lowest was again in the Jahra governorate at 37.4%. At the third level (1500 meters) the highest governorate was in Al-Asimah at 92%, while the lowest was in Jahra at 75%. (Table 3).

Table 2.

Percentage of public schools having one or more fast food restaurants in each governorate

(Buffer Analysis)			
Governorate Name	**500 meters**	**1000 meters**	**1500 meters**
Al-Asmiah Governorate	43%	82%	92%
Hawalli Governorate	65%	96%	100%
Mubarak Al-Kabeer Governorate	50%	90%	100%
Ahmadi Governorate	31%	66%	84%
Jahra Governorate	26%	59.5%	78%
Farwaniya Governorate	40%	76.9%	80.4%

Table 3.
Percentage of schools having one or more fast food restaurants in each governorate

(Service Area)			
Governorate Name	**500 meters**	**1000 meter**	**1500 meter**
Al-Asmiah Governorate	23%	58%	92%
Hawalli Governorate	32 %	49.6%	75 %
Mubarak Al-Kabeer Governorate	21%	64%	85%
Ahmadi Governorate	14 %	46.2%	70.4%
Jahra Governorate	10.6%	37.4 %	58.7%
Farwaniya Governorate	18.4%	50%	75%

The results of applying GWR are based on the results of adjusted which was 0.65, which means that 65% of the variation in the dependent variable could be explained by the variation in the independent variable. In order to trust the GWR model, the spatial distribution of the residuals should be randomly distributed (Figure 4). The results of GWR show a higher correlation between fast food restaurants and schools in some areas of the study area. As shown in Figure (5), red areas districts represent locations of high correlation between the dependent and independent variable, while blue areas represent lower correlation. Some districts in the study area have a local of 0.79. Most of the higher correlation between fast food restaurants and public schools are located in the east side of the urban area, while the south and west side of the study area have lower correlation. The reason why there is high correlation in the east side could be related to the high density population and the smaller districts.

Figure 4. *Spatial distribution of residuals for GWR model (Created by ArcGIS 10.4)*

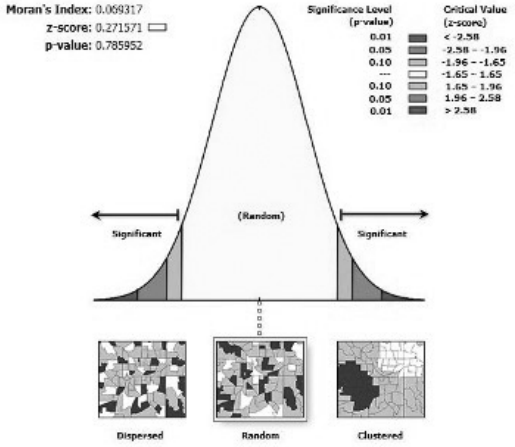
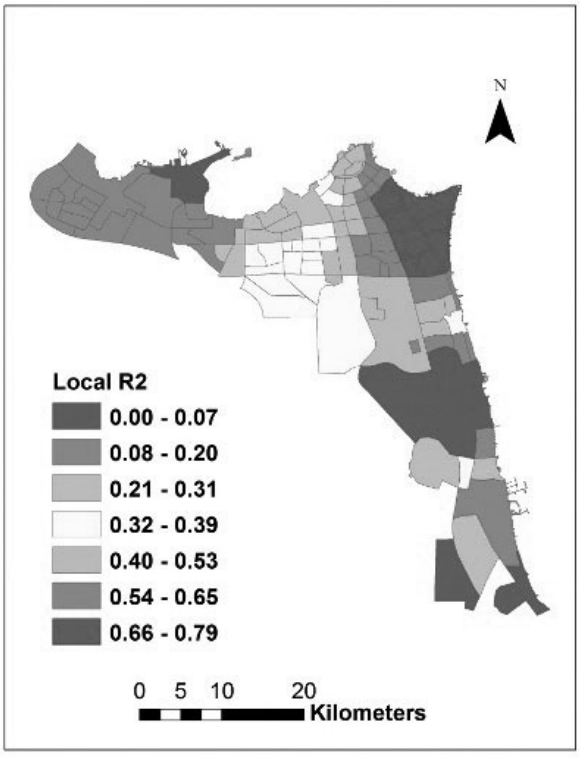


Figure 5. *Results of Geographically weighted regression*



Source: The map was created by the author

Discussion and conclusion:

The findings of this study are in line with other studies in which fast food restaurants seem to be clustered around schools (Nixon & Doud, 2011; Cutumisu el al., 2017). As is evident from the results, a high percentage of public schools have access to fast food restaurants located within a walkable distance. The spatial distribution of fast food restaurants indicates a high percentage of fast food restaurants were located around schools. This indicates that the built environment and the access to fast food in a school neighbourhood in part of the urban area of Kuwait were unhealthy; therefore, the chances of students becoming obese will increase because of the higher chance of consumption from those fast food restaurants. In addition, the neighbourhood and residents living around schools having access to fast food restaurants will face similar risks regarding the unhealthy environment. The eating habits of people in those neighbourhoods could be unhealthy; this habit may develop in childhood and continue throughout their lives (Nicklaus, Boggio, Chabnet, & Issanchou, 2005; MikkilÌ el al., 2005).

One of the biggest challenges in assessing the spatial relationship between fast food restaurants and public schools was deploying the right method and tool. Using the Buffer Analysis tool, 77.5% of schools had at least one or more fast food restaurants located at a distance of 1,000 meters; however, the Service Area tool indicated 54.89% of schools had fast food restaurants within the same range. These differing outcomes could affect the decision-making process for policymakers. The advantage of using the Service Area tool is that it calculates the distance using the street network, which makes sense because people move from place to place using the streets. The Buffer Analysis, on the other hand, calculates the distance by using a straight line from the feature without giving credit to streets networks.

The output of both the Buffer Analysis and Service Area tools indicated a high percentage of schools that had access to fast food restaurants; however, the buffer analysis results indicated that the percentage was higher. Another concern is that most of these fast food restaurants have a home delivery option, which makes unhealthy food even more reachable to the consumers.

The results of GWR tool also shows a higher correlation between fast food restaurants and public schools. This indicates that areas with

high local have higher access to fast food restaurants as some areas have a correlation of 0.79. In addition, the food delivery option in Kuwait is a very common practice by food vendors and restaurant services. Some of those fast food restaurants can deliver the food within a distance of 30 to 60 minutes in most of the districts in Kuwait, which increases the chances of more home delivery orders by the customers. Due to the lower prices of fast food, it appears to be affordable to the public (Powell, 2009).

The application of GIS to assess the spatial relationship between schools and fast food restaurants is very useful in the context of geographical studies, especially with a focus on health-related issues and the environments. Mere visualization of the spatial distribution of a phenomenon may not be sufficient to assess the spatial relationship. Thus, applying different GIS tools and comparing the outputs could help the decision-makers to adopt better policies, including making laws by the legislature. The future direction of this research will focus on BMI index of students and local residents to assess the clustering of fast food restaurants in comparison to the areas where consumers have access to fast food restaurants, to explore the effect of distance from fast food restaurants on eating habits and on obesity prevalence.

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