UCL DEPARTMENT OF GEOGRAPHY

YEAR 2020-21

MODULE CODE:	**GEOG0114**
MODULE NAME:	**Principles of Spatial Analysis**
COURSE PAPER TITLE:	**Research on obesity prevalence in England**
WORD COUNT:	**1423**
CODE REPOSITORY LINK:	https://github.com/AnniHuo/GEOG0114

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Introduction

Obesity has close relationship with plenty of health risks in both developing and developed countries, becoming a serious issue in society. According to previous studies, the socioeconomic inequalities in adiposity have been recognized and investigated in countries worldwide. Among them, Asiseh & Yao (2016) have identified the relationship between income and obesity, affected by the variation of personal preferences on basic living expenditure and life quality improvement. Similarly, Costa-Font, Hernández-Quevedo & Jiménez-Rubio (2014) also mentioned that unhealthy lifestyle related to obesity is often disproportionately concentrated around the deprived regions. In addition, Ersoy et al. (2005) indicated employment status, education level could be seen as the major influence factors of obesity. Proposed by Cohen et al. (2006), people suffered from obesity might also probably be relevant to the neighboring physical and social environments, such as walkability, accessability to recreational facilities and crime.

However, the different results of socioeconomic influence on males and females are gradually emphasized. García Villar & Quintana-Domeque (2009) mentioned the income only negatively affect women's obesity. Besides, Davillas & Benzeval (2016) also emphasized the existence of more significant pro-rich inequalities appear in females in obesity studies, related to different perceptions of financial strain and material deprivation and education. In that case, the differences between the influence of different characteristics on males and females is significant to be understood, therefore, reasonable suggestions and policies in preventing obesity and corresponding socioeconomic inequality could be recognized. Therefore, this essay aims to analyze the obesity condition of males and females in England, and compare the influence of education investment, income status and crime on them. Based on the results of obese people distribution, spatial autocorrelation analysis and statistical correlation analysis, several recommendations will be promoted.

Data and Methods

The applied main dataset is from NHS Digital (2020), called statistics on obesity in England, covering the obesity cases classified by hospitals from 2009 to 2019. The observations have been clearly organized based on gender and local authorities of England. According to Figure 1, the dataset witnesses the increasing trends of obesity prevalence in England for males and female, and the growing gap between them. In that case, it seems significant to investigate the obese people distribution and gender differences. The following analysis will use the obese population data from 1 April 2018 to 31 December 2019. Other sociodemographic datasets have been sourced from Office of National Statistics, including crime and justice dataset (Office of National Statistics, 2019), gross disposable household income dataset (Office of National Statistics, 2018), and school expenditure dataset (GOV.UK, 2019).

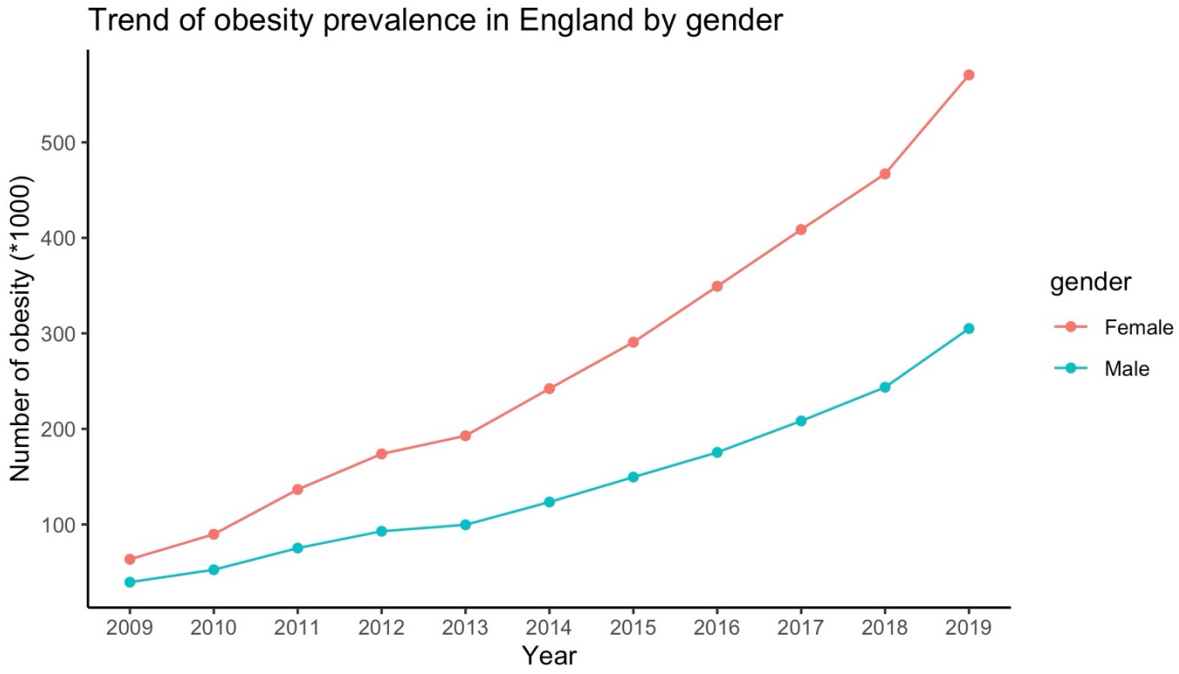

Figure 1: The trend of obesity prevalence in England by gender (Source: Author's own)

At the beginning, it is necessary to provide an overview of the obese people distribution in England, in order to identify the regions with high-level of obesity and the similarities and differences between male and female groups. After that, Global

Moran's I test will be employed for the data to identify whether there is a clustering phenomenon among the whole England. For detailed analysis, Local Moran's I statistics will be obtained, and the specific locations of clustering occurrence could be identified. In that case, the regions that need more support have been recognized. The final step is to conduct statistical correlation analysis to observe the influence of education investment, income and crime on obesity for males and females. Based on the results, reasonable suggestions are able to be provided.

Results and Discussion

Obese people distribution in England

By plotting choropleth maps, people excess weight by local authority in England can be observed. To avoid the influence of sparsely populated rural areas, the statistics of obesity density is calculated by dividing obese cases by population. From Figure 2, the obese population density distribution in England could be obtained calculated by obese people per 100,000 population. Generally, gender obesity inequity could be observed. However, the obesity prevalence trends of these local authorities seem similar for different genders. To be specific, the regions with high-level of obesity include Nottinghamshire, Northamptonshire, York which need more support, while the regions with relatively low-level of obesity include Leeds, Sheffield and West Berkshire, similar for male and female groups.

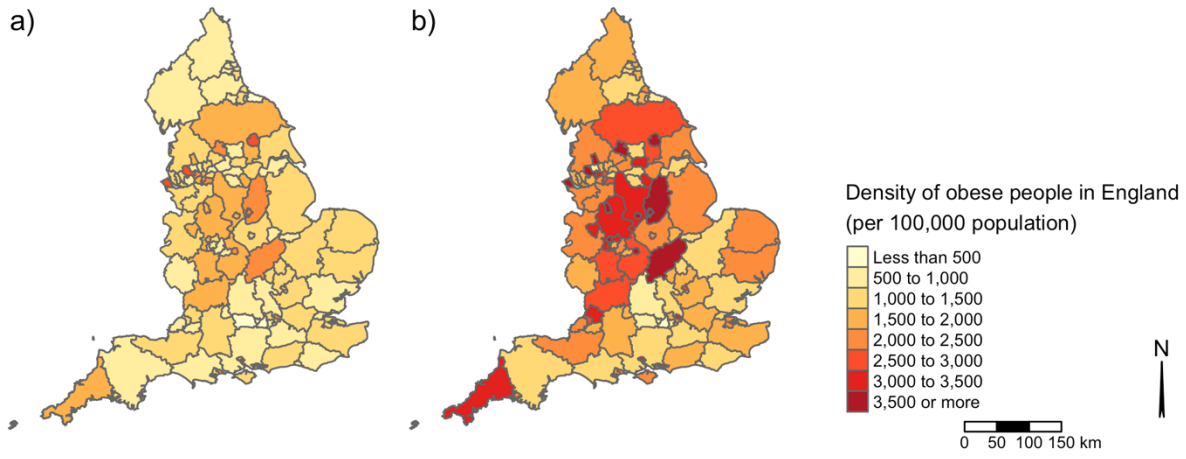

Figure 2: Obese population density distribution in England for a) males and b) females (Source: Author's own)

Spatial autocorrelation analysis of obesity

Considering the spatial lags of variables, variables in neighboring geographical units could be calculated, following the first order queen contiguity strategy, which classifies neighbors of geographical units by the sharing of either point or line segment borders. Followed by that, the research conducted Global Moran's I and Local Moran's I to verify the existence of clustering phenomenon of obesity prevalence. Global Moran's I, as a global spatial autocorrelation measurement for spatial terms (Zhang & Tripathi, 2018), could examine whether obesity phenomena were dispersed, random or clustered. According to Table 1, obese density distributions for males and females all represent clustering (0< Global Moran's I<1), with statistically significant (p-value<0.05) results (getting 0.114 and 0.218 for Global Moran's I test respectively).

Table 1: Global Moran's I and p-value for obese population density (Source: Author's own)

	Global Moran's I	p-value
Obese male density	0.114	0.017
Obese female density	0.218	0.001

In order to specifically recognize the clustering of spatial patterns, the Local Moran's I for obese male and female groups is conducted, which display similar pattern. As presented in Figure 3, high-high patterns could be described as hot-spots, where the local authority and its neighboring authorities all represent serious obesity prevalence. In that case, the obesity clustering at local authority level could be identified. For male obesity, the hot spots are mainly aggregated in Staffordshire and Nottinghamshire, while for female obesity, that also include Derbyshire. These hot spots represent the major local authorities suffered from obesity prevalence which require more political and economic support. In contrast, low-low patterns could be described as cold-spots, where the local authority and its neighboring authorities all represent light obesity prevalence. From Figure 3, cold spots for obese males are

regions surrounding West Berkshire, Hampshire and Oxfordshire, while three more authorities in East Anglia and South East, surrounding London, show cold spots clustering for obese females, which all reflect the relatively suitable policies and socioeconomic environment for people's health in these local authorities. According to London Councils (2020), London has provided policies to prevent obesity prevalence, including creating healthier environment, encouraging the reduction of sugar in products by 20 percent and levying on soft drinks, which might probably be the reason and should be learned.

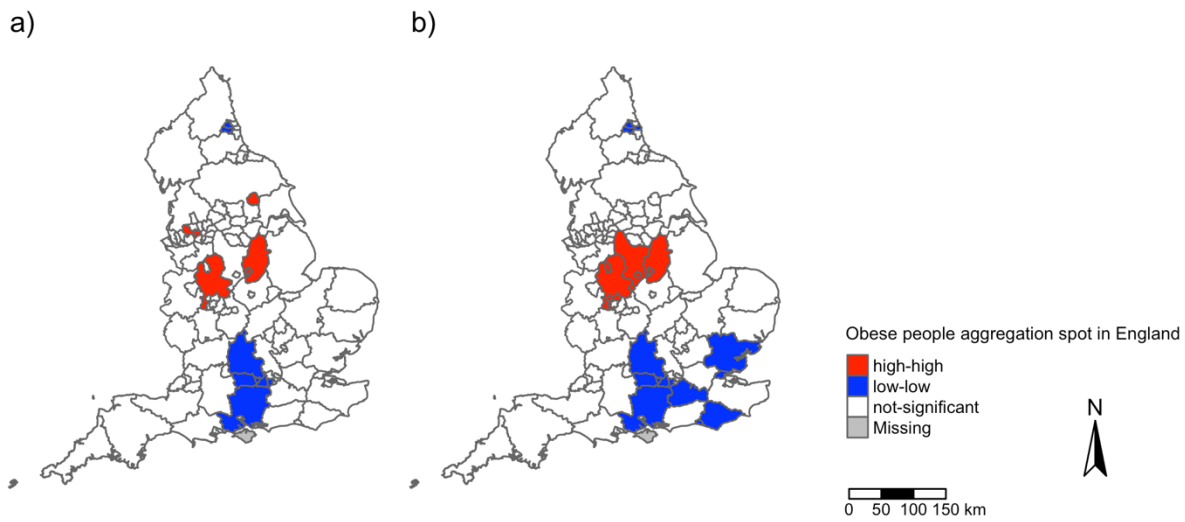

Figure 3: Obese population aggregation spot in England for a) males and b) females (Source: Author's own)

Statistical correlation analysis of obesity

After identifying the regions requiring support, it is also significant to recognize the influence of relevant characteristics on the occurrence of male and female obesity prevalence. Table 2 and 3 express the statistical correlationship between male and female obesity and related characteristics respectively. Overall, education investment and personal income all represent negative relationship with obesity prevalence for both groups, while crime number shows positive relationship, which validate the previous research results to some extent. Therefore, corresponding

economic and social support (such as incentives and policy power) should be emphasized, especially in the obesity hot-spots regions mentioned above. By comparing male and female groups, the education investment effects are similar for men and women. However, income level and crime condition all have more influence on female, accounting for -0.15 and 0.37 respectively, while male income has little effect on their obesity, accounting for -0.03. Besides, the mean weekly income of women is almost less than men by 200 pounds (see Table 4). Also mentioned by Appleby (2019), the pay gap favoring males has increased to 94 percent in England by 2019. Therefore, it might be necessary for local governments to provide policy support and rectify gender discrimination in jobs, otherwise women's low wage level and its more serious impact on obesity would further increase the health risks.

Table 2: Statistical correlation between male obesity and related characteristics (Source: Author's own)

	OM	EI	MI	CN
obese male (OM)	1.000			
education investment (EI)	-0.079	1.000		
male income (MI)	-0.030	-0.343	1.000	
crime number (CN)	0.245	-0.020	-0.153	1.000

Table 3: Statistical correlation between female obesity and related characteristics (Source: Author's own)

	OF	EI	FI	CN
obese female (OF)	1.000			
education investment (EI)	-0.059	1.000		
female income (FI)	-0.154	-0.030	1.000	
crime number (CN)	0.368	-0.020	0.004	1.000

Table 4: Weekly income gap between men and women (Source: Author's own)

	min	median	mean	max
men	432.0	649.5	675.2	1523.8
women	314.6	446.9	462.5	941.9

Conclusion

In conclusion, the essay has provided an overview for obesity prevalence in England by gender. First, the obesity density distribution maps were displayed, which show the obesity distribution and the gap between male and female groups. After that, Global Moran's I statistics was conducted to prove the existence of clustering pattern. To be specific, Local Moran's I for local authorities was plotted, which indicates the specific regions which require more support or done well. Finally, correlation analysis was applied to verify what suggested in previous studies and provide more understanding of different influence of education investment, personal income and crime number on male and female obesity. In the result and discussion part, several suggestions have also been emphasized, including learning from regions with better performance, such as London, and generating reasonable policies to mitigate gender pay gap. Since this essay only focused on the factors most frequently mentioned in previous literature, there are other characteristics not been considered. For example, the accessibility and affordability of related services might influence the occurrence of obesity in local regions, which should be investigated more in future research.

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