[Year]

THE RELATIONSHIP BETWEEN OBESITY AND DEPRIVATION

A COMPARISON OF THREE BOROUGHS OF LONDON

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1. Introduction

According to Department of Health and Social Care (UK), 63% of adults in UK are overweight, and half of them can be classified as obese. Obesity is now being looked at as a serious health threat that not only affects the lives of individuals but can also lead to the burdening of the health services system NHS. Obesity has a direct relationship with several health conditions such as diabetes, cardiovascular diseases, cancer, respiratory diseases, and even mental health conditions such as depression. In the ongoing Covid-19 pandemic, it was found that obesity was a significant predictor in hospitalisation and mortality. More worryingly, it was found that 1 in 3 children in the UK are overweight.

Lifestyle contributes directly to obesity i.e. diet and level of physical activity has a direct impact on obesity. In this regard, the UK government has now initiated various steps to help people lead an active and healthy lifestyle. For example, there is a proposal to ban TV advertisements of high sugar/salt/processed fast foods till 9pm in the night so that children are not tempted. There are proposals to bring out new health apps that help people monitor their physical activity and diets. However, the success of such proposals largely depends on the individual's motivation, and these do not address some of the deeper root causes that is leading to obesity, the community characteristics being one of them. For example, it has been found that people in the most deprived areas of the country are more likely to suffer from obesity compared to people from less deprived areas. Deprived areas are likely to have higher crime rates, higher population density, poor living conditions, and poor access to job opportunities. Poor quality of life can lead to stress and anxiety, which in turn influences obesity. Also, people are more likely to buy processed and pre-packaged foods which have high sugar, saturated fat, and salt content are cheaper than fresh ingredients. The lack of job

opportunities could also mean people have to hustle more than one job, leaving them no time to cook, or indeed pursue any form of relaxation activities.

Keeping this background in mind, the aim of this project is to compare three boroughs of London – **Barking and Dagenham, Richmond upon Thames, and Kensington and Chelsea. Barking and Dagenham** is considered as one of the **most deprived boroughs**, **Kensington and Chelsea** is on a low scale of deprivation whilst **Richmond upon Thames** is the **least deprived** (refer: https://www.mylondon.news/news/zone-1-news/wealthiest-most-deprived-areas-london-17171816). Barking and Dagenham and Richmond upon Thames are considered 'outer London' boroughs whilst the borough of Kensington and Chelsea is considered 'inner London'. These neighbourhoods will be visualised on Foursquare so that environmental comparisons from various perspectives can be made. This is outlined in the next section.

2. Methodology & Data

The comparison of the boroughs will be two-fold – a) to compare and contrast the neighbourhoods using Foursquare, and b) to compare and contrast the people demographics. Both these are discussed in detail in the following sections.

2.1. Geospatial comparison of the three boroughs using Foursquare and Folium choropleth maps

First, by using Foursquare, the top 100 venues in the three boroughs were obtained. By understanding the venue classifications, the quality of the outdoor life of each borough was explored – example, parks, gardens, restaurants, cultural venues etc.

The raw data in the form of CSV files have been obtained from various government/non-government websites and are free to use. The following CSVs were used for the comparisons –

1) Admin areas.csv (Source: https://www.doogal.co.uk/AdministrativeAreas.php)

   This csv lists all the boroughs, their corresponding latitude and longitude, number of postcodes, and number of households within each borough. From this csv, the data regarding the boroughs this project is interested in can be extracted.

2) Richmond upon Thames postcodes (Source: https://www.doogal.co.uk/AdministrativeAreas.php?district=E09000027)
3) Barking and Dagenham postcodes (Source: https://www.doogal.co.uk/AdministrativeAreas.php?district=E09000002)
4) Kensington & Chelsea postcodes (Source: https://www.doogal.co.uk/AdministrativeAreas.php?district=E09000020)

The above three are simple CSVs which give the postcodes of all the wards within each borough, along with the latitude-longitude coordinates of each postcode. These were used for visualising the boroughs using Foursquare API.

Next, it was important to determine how many households in each ward of a borough have access to nature or open space. The data for this came from "Public-open-space-nature-ward_access-to-nature" – this CSV gives ward-wise information on the percentage of houses that have access to outdoor open space and nature. (Source: https://data.london.gov.uk/dataset/access-public-open-space-and-nature-ward). Access to outdoor green spaces such as parks and nature reserves is important for people's mental health and physical well-being. To visualise this data in choropleth maps, a Geojson file "london_boroughs" was used (source: 'https://raw.githubusercontent.com/martinjc/UK-

GeoJSON/master/json/electoral/eng/wards.json). Visualising this data helped explore how many households have the flexibility to lead a healthy lifestyle – for example, access to a park would mean regular walks/jogging/cycling etc. The three neighbourhoods could now be compared on this dimension to understand how deprivation caused by urban architecture also impacts lifestyles.

2.2. Demographic comparisons

Demographic details for each borough included characteristics such as population density, median household incomes, average annual incomes for males and females, rate of prevalence of childhood obesity, percentage of adults (17 and above) who have diabetes, preventable mortality rates etc. These exhaustive details were obtained from "London Borough Profiles" CSV (Source: https://data.gov.uk/dataset/248f5f04-23cf-4470-9216-0d0be9b877a8/london-borough-profiles-and-atlas). This data was used to visualise comparative bar graphs of the three boroughs, and also to analyse regression plots to understand the relationship between income, childhood obesity, and diabetes rate in the community on preventable mortality. It also analysed the relationship between income and childhood obesity, to understand if economic status impacted children's (and subsequently lifelong) health.

By exploring and analysing the data in these raw CSVs, and visualising the results appropriately, we can make well-informed comparisons between the least deprived and most deprived boroughs of London. These insights can be used to make important suggestions to health officials, urban architects, and policy makers regarding tackling environmental root causes of obesity.

https://github.com/ft-interactive/geo-data/blob/master/uk/london/london-wards-2014.geojson

https://skgrange.github.io/data.html - geojson files of London borough boundaries

3. Results

(From an administrative perspective the neighbourhoods in UK are divided as follows – each Borough is divided into wards, and each ward contains numerous postcodes.)

3.1. Findings from geospatial comparisons

3.1.1. Top venues in the three boroughs – a comparison

The latitude and longitude of the three boroughs were extracted using Nominatim. Using Folium, all the three boroughs were visualised on a map of London. Since the boroughs are a collection of wards, by visualising all the postcodes, the shape and size of the borough could be understood.

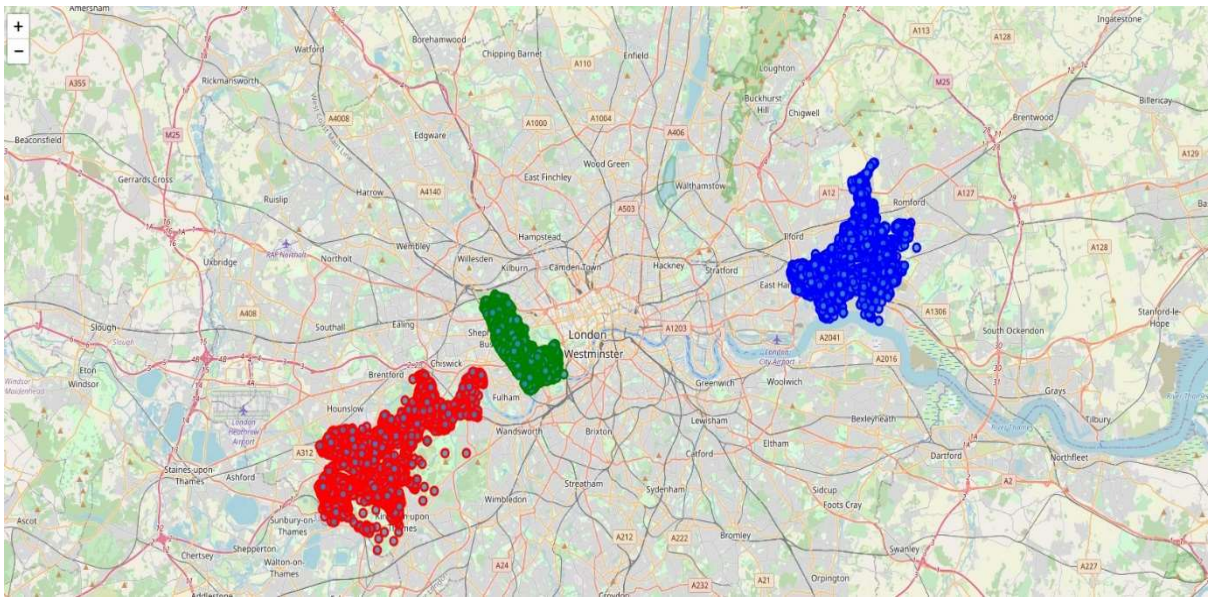

Figure 1: Visualisation of the three boroughs on London map

In this map, the **blue** cluster is **Barking and Dagenham**, the **red** cluster is **Richmond upon Thames**, and the **green** cluster is **Kensignton and Chelsea**. As is evident, Kensignton upon Chelsea is in the heart of London and is considered 'inner London'. Richmon Upon Thames, although a part of 'outer' London, is close to the city. Barking and Dagenham is a distance away from London.

By querying the respective dataframes, it was found that Barking and Dagenham has 17 wards, Richmon upon Thames and Kensington and Chelsea have 18 wards each – so from an administrative perspective, all three boroughs are similar in size.

Next, in order to explore each of the three boroughs, the top 100 venues of each borough were determined using Foursquare API. The json file with the query results was then passed into a dataframe, which was cleaned to have four columns as follows –

[19]:

	name	categories	lat	lng
0	Central Park	Park	51.559560	0.161981
1	Capital Karts	Go Kart Track	51.531792	0.118739
2	The Eva Hart (Wetherspoon)	Pub	51.570460	0.130342
3	Harrow Lodge Park	Park	51.555648	0.197926
4	Costa Coffee	Coffee Shop	51.576890	0.179497

Figure 2: Snapshot of dataframe with Venue categories

This procedure was followed for all the three boroughs. It was determined that Barking and Dagenham has 44 unique venue categories, Richmond upon Thames has 40 unique venue categories, and Kensington and Chelsea has 58 unique venue categories.

Next step was to compare all three boroughs – for this it was important to understand the number of venues of a given category in a borough. In order to do so, a single dataframe was

designed that took inputs from the individual borough results (as shown in above figure), so that we have a count of each venue category across the three boroughs as shown below –

Out[29]:

Borough categories	Barking and Dagenham	Kensington and Chelsea	Richmond upon Thames
American Restaurant	1.0	1.0	0.0
Argentinian Restaurant	0.0	1.0	1.0
Art Gallery	0.0	1.0	0.0
Art Museum	0.0	1.0	0.0
BBQ Joint	0.0	0.0	1.0
Bakery	2.0	6.0	3.0
Beer Bar	0.0	0.0	1.0
Beer Garden	0.0	0.0	1.0
Bookstore	1.0	3.0	2.0
Boxing Gym	0.0	1.0	0.0
Brazilian Restaurant	1.0	0.0	0.0

Figure 3: Snapshot of venue categories across boroughs

This table helps us understand the boroughs better in terms of the leisure life of the communities. These results were visualised in a bar graph below.

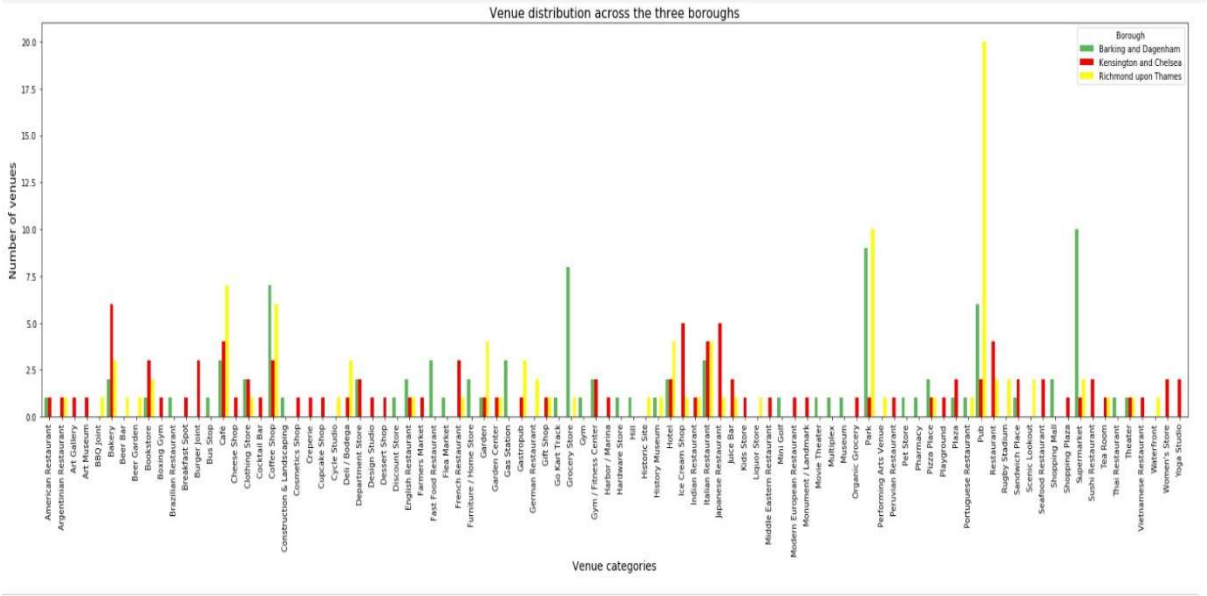

Figure 4: Bar graph of venue distribution

The following table has been extracted from the results to show some of the significant venue categories.

Borough	Barking and Dagenham	Kensington and Chelsea	Richmond upon Thames
Venue categories	Number of venues		
Parks	9	1	9
Gardens	1	1	4
Pubs	6	3	21
Supermarket	10	1	2
Gyms/Fitness centres	4	2	0

It is to be noted that although Kensington and Chelsea has only 1 park compared to the other two boroughs, being in the heart of London it has greater and wider access to many of London's parks, gardens, and leisure venues. In terms of social life Richmond upon Thames far outstrips the other two boroughs with 21 pubs – this not only reflects on an active leisure life, but also hints at a higher employment rate in the F&B/hospitality industry. This in turn indicates that a good amount of revenue is generated from leisure sector in Richmond upon Thames. On the other hand, the presence of 10 supermarkets in Barking and Dagenham indicates that the demographics may have more young families with children. However, number of venues are meaningless if access to the facilities are not feasible. For example, gyms and fitness centres may be cost prohibitive, and may not be suitable for all age groups. In this regard, access to nature i.e. parks and gardens becomes very important. This is illustrated below.

3.1.2. Comparison of access to open spaces/nature in the three boroughs

Three dataframes corresponding to the three boroughs were modelled based on the 'public open spaces' csv file. The dataframes for each of the wards is displayed below.

	Ward	Latitude	Longitude	% homes with deficient access to nature
0	Abbey	51.537349	0.085575	2
1	Alibon	51.553493	0.141954	72
2	Becontree	51.549360	0.143736	17
3	Chadwell Heath	51.575203	0.137052	64
4	Eastbrook	51.553493	0.153209	0
5	Eastbury	51.544944	0.129347	6
6	Gascoigne	51.534517	0.088173	6
7	Goresbrook	51.539078	0.139307	8
8	Heath	51.553493	0.141954	91
9	Longbridge	51.540502	0.090788	4
10	Mayesbrook	51.550835	0.125404	0
11	Parsloes	51.549442	0.132748	30
12	River	51.553298	0.139556	0
13	Thames	51.542387	0.129390	23
14	Valence	51.556204	0.129839	60
15	Village	51.544323	0.156218	0
16	Whalebone	51.556334	0.150157	98

Figure 5: Barking and Dagenham – ward-wise deficiency in access to nature

	Ward	Latitude	Longitude	% homes with deficient access to nature
0	Barnes	51.472674	-0.246758	0
1	East Sheen	51.454596	-0.321284	0
2	Fulwell and Hampton Hill	51.427065	-0.351236	9
3	Ham, Petersham and Richmond Riverside	51.452903	-0.314674	0
4	Hampton	51.449508	-0.324227	30
5	Hampton North	51.421612	-0.370053	8
6	Hampton Wick	51.450992	-0.314082	2
7	Heathfield	51.463955	-0.305095	3
8	Kew	51.450065	-0.328766	38
9	Mortlake and Barnes Common	51.469284	-0.264402	0
10	North Richmond	51.450065	-0.328657	42
11	South Richmond	51.444876	-0.332278	20
12	South Twickenham	51.432668	-0.333833	0
13	St Margarets and North Twickenham	51.442518	-0.333046	2
14	Teddington	51.450392	-0.314624	13
15	Twickenham Riverside	51.450065	-0.330453	0
16	West Twickenham	51.437110	-0.334172	0
17	Whitton	51.452579	-0.357943	35

Figure 6: Richmond upon Thames - ward-wise deficiency in access to nature

	Ward	Latitude	Longitude	% homes with deficient access to nature
0	Abingdon	51.497993	-0.191005	0
1	Brompton & Hans Town	51.492346	-0.173129	3
2	Campden	51.501842	-0.198586	0
3	Chelsea Riverside	51.488258	-0.168466	24
4	Colville	51.514572	-0.206045	1
5	Courtfield	51.491995	-0.173405	0
6	Dalgarno	51.522135	-0.213811	0
7	Earl's Court	51.491040	-0.189865	0
8	Golborne	51.508646	-0.201179	25
9	Holland	51.501900	-0.198586	0
10	Norland	51.506281	-0.200185	28
11	Notting Dale	51.514572	-0.204769	67
12	Pembridge	51.510988	-0.203227	6
13	Queen's Gate	51.507486	-0.201179	0
14	Redcliffe	51.490392	-0.173919	0
15	Royal Hospital	51.491215	-0.164931	0
16	St. Helen's	51.518783	-0.218070	1
17	Stanley	51.490539	-0.174530	17

Figure 7: Kensington and Chelsea - ward-wise deficiency in access to nature

It can be observed that in Barking and Dagenham, out of 17 wards, 5 of them have over 50% deficiency in access to nature, with Whalebone recording 98% of households in the ward have deficient access. That is, 29% of wards in Barking and Dagenham has deficient access to nature. In comparison, in Kensington and Chelsea only one ward with a 68% deficiency in access to nature, whilst no ward in Richmond upon Thames recorded >50% deficiency in access to nature. From another perspective, we can say that only 23% of the wards in Barking and Dagenham have good access to nature; it is 38% in Richmond upon Thames, and over 50% in Kensington and Chelsea have good access to nature.

This was visualised on choropleth maps as shown below – here, the darker the colour the lesser access to nature.

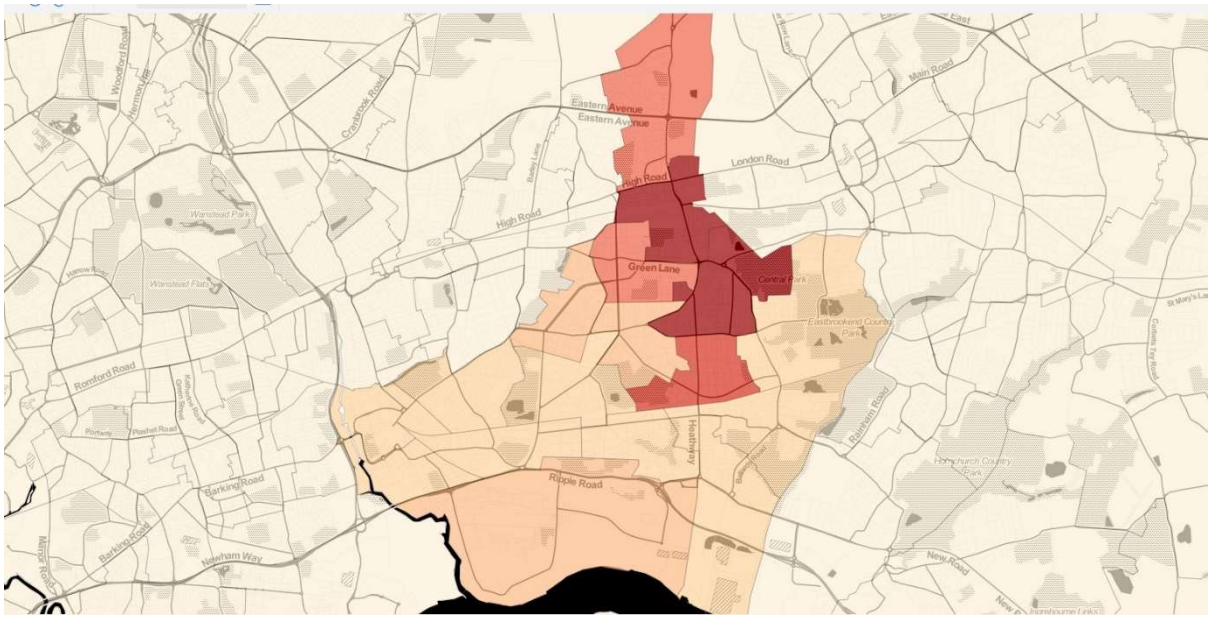

Figure 8: Barking and Dagenham - Deficiency in access to nature

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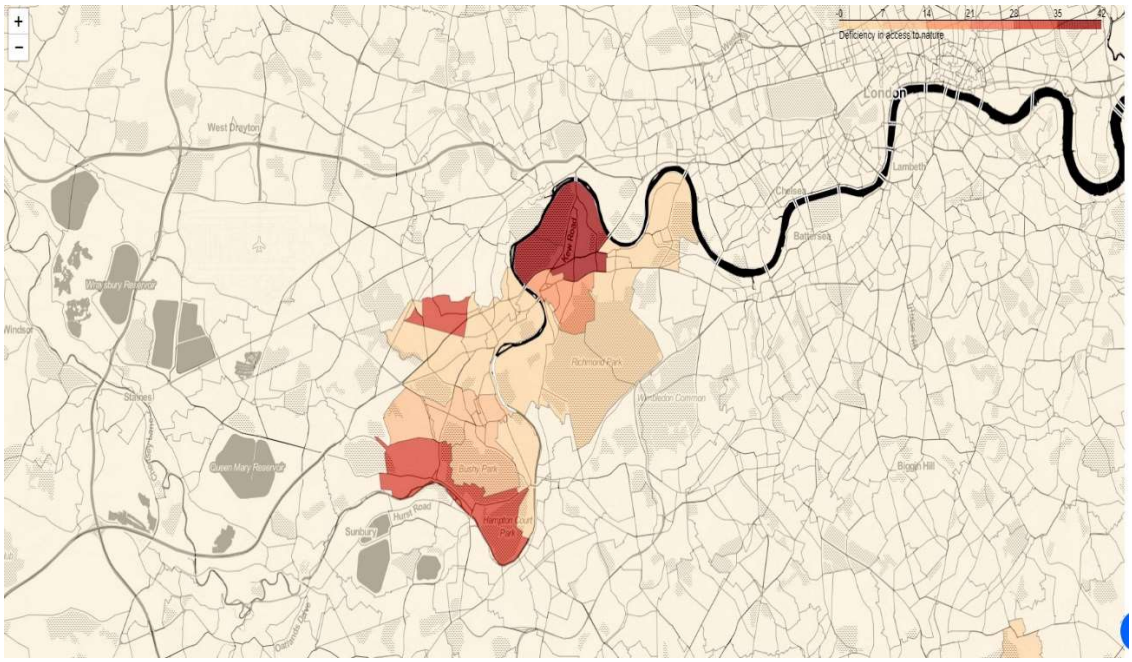

Figure 9: Richmond upon Thames - deficiency in access to nature

Figure 10: Kensington and Chelsea - deficiency in access to nature

It can be visually ascertained from the maps that wards in Kensington and Chelsea have far better access to nature compared to the other two boroughs, despite the latter having 9 parks each. This indicates that the parks may not be accessible to everyone.

3.2. Findings from demographic comparisons

This analysis involved examining the factors that affect preventable mortality rates i.e. deaths in the community from preventable causes. For this, the data from all the London boroughs were considered to get better prediction models. The grid below shows the linear regression plots.

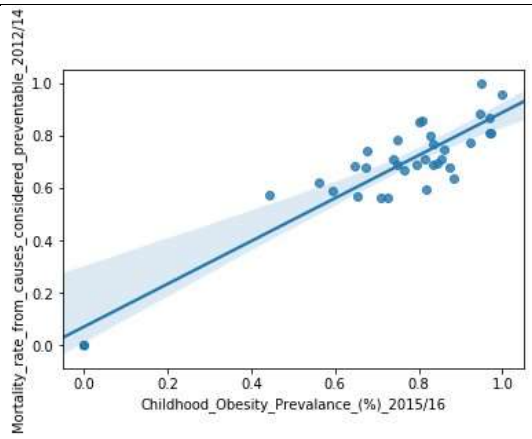

Figure 11: Relationship between childhood obesity and preventable mortality - R2 score = 0.8276786281016186

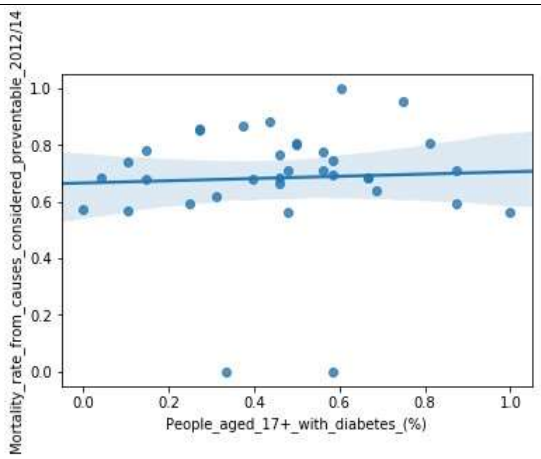

Figure 12:Relationship between adult diabetes and preventable mortality – R2 score= 0.002283369568838012

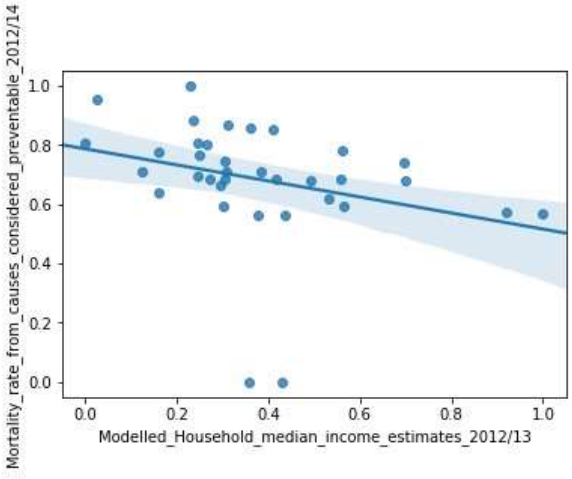

Figure 13: Relationship between income and preventable mortality – R2 score = 0.08420796870379299

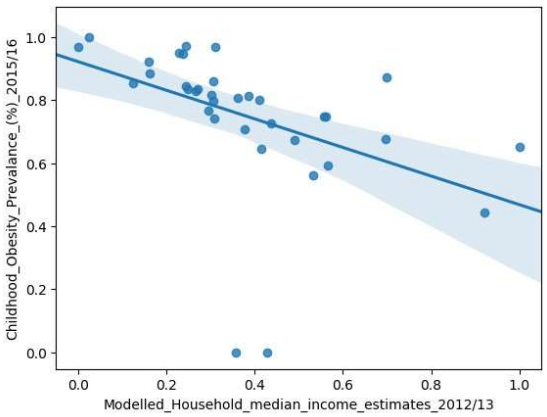

Figure 14:Relationship between childhood obesity and income – R2 score = 0.19125305657012093

From the above plots, it can be surmised that there is a strong linear relationship between childhood obesity prevalence and preventable mortality. We can detect a marginal relationship between income and mortality, where there is a decrease in mortality rates as income increases. Similarly, we can see that childhood obesity rates are higher at lower

income marks. Since childhood obesity in turn has a strong relationship with preventable mortality, we can conclude that income plays a large part in obesity and health issues.

Next, the three boroughs were compared for the above specific factors.

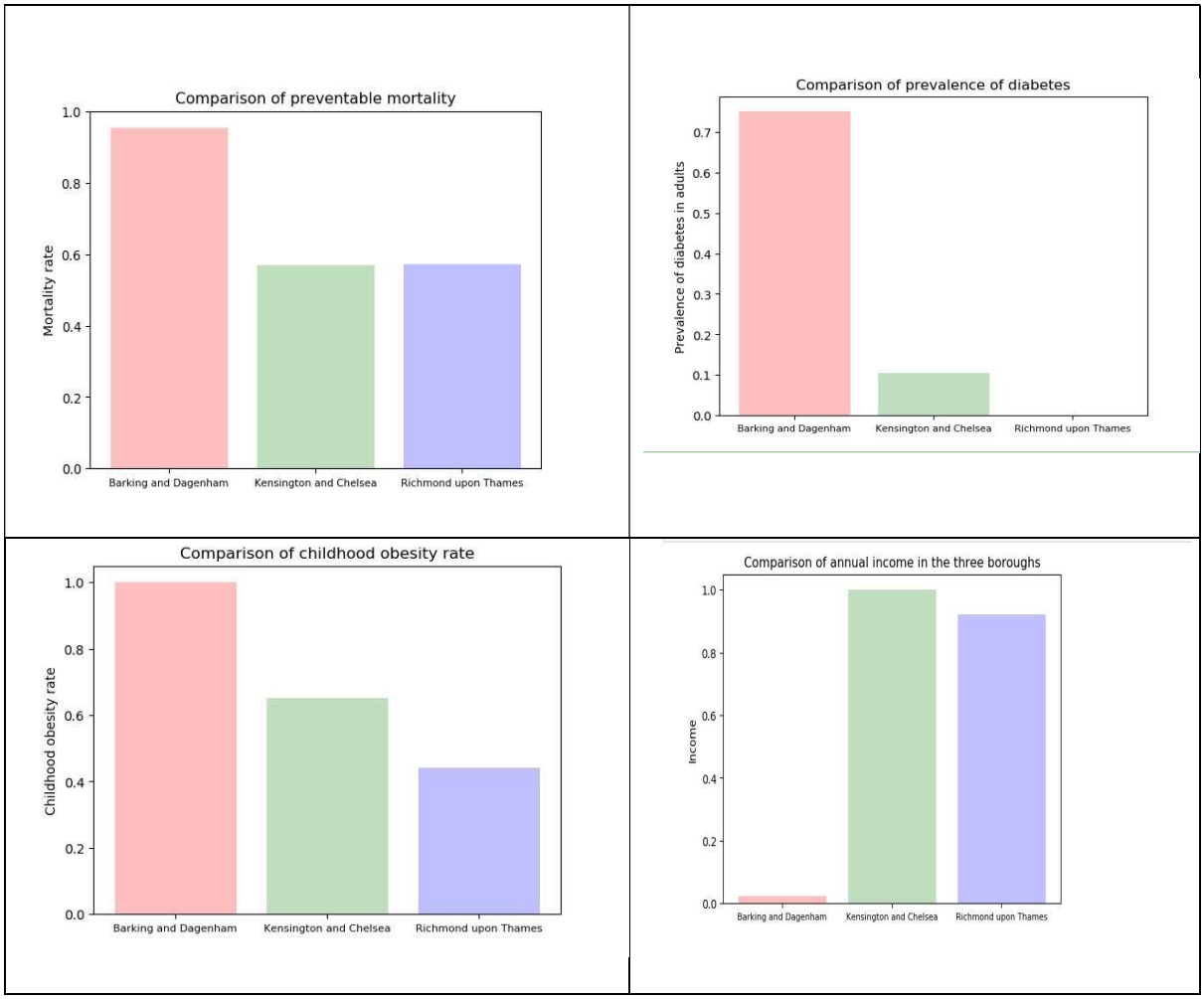

Figure 15: Demographic comparison of the three boroughs

From the above graph grid, it is evident that Barking and Dagenham has significantly higher rates of childhood obesity, preventable mortality rates, and prevalence of diabetes. On the other hand, Barking and Dagenham is significantly lower on the annual income comparison.

4. Discussion

Obesity has many root causes, including genetics, underlying illnesses, lifestyle, dietary habits, and environmental factors. Apart from these causes, studies have found that poor socioeconomic status (SES) is also a causal factor in obesity. For example, it was reported

that a longitudinal study of British participants born in three different years showed that weak socioeconomic status was implicated in higher BMI (Body Mass Index)[1] (refer https://www.bmj.com/content/356/bmj.j163.full). It was posited that lower SES, as in the case of lower income countries, could mean poor nutrition in terms of consuming affordable but highly processed foods[2,3].

Lower SES can also impact mental health by inducing stress, anxiety, depression, and harmful behaviours such as substance or alcohol abuse especially monetary problems[5,6]. Chronic stress in turn is a known contributor towards obesity[7].

In the UK, deprivation of a community or borough is measured statistically through 7 weighted indices – income, employment, education, health, crime, barrier to housing & services, living environment[4]. It was demonstrated through this study that Barking and Dagenham, having scored the lowest on annual household income, rated the highest on all health parameters. This was despite the fact that the borough of Kensington and Chelsea has a much higher population density per hectare. This clearly indicates that obesity and deprivation, both at a family level and at a community level go hand in hand.

1. "Socioeconomic disadvantage is linked to obesity across generations" https://www.bmj.com/content/356/bmj.j163.full
2. "Socio-economic status over the life course and obesity: Systematic review and meta-analysis" https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5433719/
3. "Socioeconomic Status, Risk of Obesity, and the Importance of Albert J. Stunkard" https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4798886/
4. "Indices of deprivation, 2019". https://www.londoncouncils.gov.uk/members-area/member-briefings/local-government-finance/indices-deprivation-2019#:~:text=In%20London%2C%20Hackney%20has%20the,Chelsea%20(ranked%2091st).
5. "Socioeconomic Disparities In Health: Pathways And Policies" https://www.healthaffairs.org/doi/full/10.1377/hlthaff.21.2.60
6. "Socioeconomic Status and Chronic Stress: Does Stress Account for SES Effects on Health?" https://nyaspubs.onlinelibrary.wiley.com/doi/abs/10.1111/j.1749-6632.1999.tb08111.x#:~:text=Low%20SES%20is%20generally%20associated,pathway%20linking%20SES%20and%20health.
7. "Effects of Chronic Social Stress on Obesity" https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3428710/

5. Conclusion

This study explored and demonstrated a strong link between obesity and deprivation by comparing three boroughs of London – Barking and Dagenham (most deprived), Kensington and Chelsea (low-moderate deprivation), and Richmond upon Thames (no deprivation). Based on the findings, it is recommended that urban planners and healthcare policy makers intervene in the following ways –

- Plan urban infrastructure and improve urban transports so that more people have access to open spaces. For example Barking and Dagenham has 9 parks, but a significant percentage of its wards do not have good access to these open spaces.
- Infuse new business development in the borough so that new well-paying opportunities are generated for the socioeconomic upliftment of the borough.
- Healthcare policies should consider proactive, early intervention programs so that childhood obesity is managed in the early stages. This could include designing more children's parks and pools; having more sports competitions for children; ensuring children get nutritious food in school.

Whilst these are not exhaustive solutions, they provide a step in the right direction.