UNIVERSITY OF LEEDS

INEQUALITIES IN ACTIVE TRAVEL IN ENGLAND

AN ANALYSIS BASED ON THE FIRST THREE YEARS OF THE ACTIVE LIVES SURVEY 2016/2018

"A dissertation submitted in partial fulfilment of the requirements of the MSc in Data Analytics and Society, University of Leeds"

Eugeni Vidal Tortosa

Student ID: 201081646

29. 08. 2019

Supervisor: Dr. Robin Lovelace

Abstract

This dissertation explores demographic, socioeconomic, and geographical inequalities in active travel in England, and analyses to what extent distance travelled, hilliness and temperature contribute to these disparities. Data for the period 2015–18 was extracted from the Active Lives Survey. Logistic regression models were fitted and Relative Risks (RRs) computed to examine potential inequalities by sex, age, ethnicity, area deprivation, education, and urban/rural classification. Multiple linear regression models were used to examine the association between distance travelled, hilliness, and temperature and the inequalities found at the local authority level. The likelihood of walking travel was higher among people who were female, young, from deprived areas, with a higher level of education and from urban areas. Cycling travel tended to be disproportionately used by male, young, white, with a high level of education and urban populations. Distance travelled, hilliness, and temperature were found to have a significant impact on certain active travel inequalities. Distance was negatively associated with the RR for age 55+ (vs. age 16-64) for walking. Hilliness was negatively associated with the RR female (vs. male) and with the RR for low/med. education (vs. high) for cycling. Temperature was positively associated with the RR female (vs. male) for cycling, but negatively associated with the RR for most deprived area (vs. least), and with the RR for low/med. education (vs. high) for both, walking and cycling. In conclusion, remarkable socioeconomic inequalities in active travel were found, particularly in cycling. In addition, distance, hilliness, and temperature were found to affect to a certain extent some of these inequalities. Individual-oriented policies aimed at reducing the negative impact that these factors have on the travel behaviour of specific groups and areas, might help to reduce the existing inequalities, and consequently contribute to overcome health inequalities. Directions for future research are provided.

Contents

1 Introduction

Regular physical activity (PA) reduces the probability of several chronic diseases (e.g., cardiovascular disease, diabetes, cancer, hypertension, obesity, depression, and osteoporosis) as well as premature death (Warburton, 2006). For this reason, the World Health Organisation (WHO) recommends getting at least 150 minutes of moderate-intensity aerobic activity per week (WHO, 2018).

Active travel (AT), i.e. walking or cycling for transport, is a good way to achieve this goal, as it is an activity that can be done daily, free (or very cheap) and easily integrated into our daily life (Public Health England, 2018). However, no people from all genders, ages, backgrounds or areas travel actively with the same frequency. For different reasons (physical, social, financial, etc.), some tend to do it more than others, which generates inequalities in the benefits that these activities provide.

The United Kingdom is one of the countries of the EU with lower physical activity index (the 22nd out of 28) (2018). This is, in part, because of its high car dependency. Few trips in the UK are taken on foot, and much less by bicycle, comparing to most countries nearby (Bassett et al., 2008). In addition, the opportunity to use these modes seems also more unequally distributed than many other European countries (Pucher and Buehler, 2008). However, the potential of active travel to increase levels of physical activity in this country is enormous: more than eight out of ten people live in urban areas where most trips can be cycled or walked, and two out of three trips are less than 5 miles, which is a perfectly acceptable distance to travel on foot or by bicycle (Department for Transport, 2017).

Most of the research in the field of inequalities in AT comes from America and Australia (Day, 2006; Pampel et al., 2010; Pucher et al., 2010; Sallis et al., 2011; Troped et al., 2003). Still, researchers in the UK have begun to reveal which sectors of the British society are more likely to use active modes and what prevents the rest from using them that often. In Glasgow, Ogilvie et al. (2008) found that active travel was associated with being younger, living in owner-occupied accommodation, not having to travel a long distance to work and not having access to a car. In Scotland, Olsen et al. (2017 p. 129) identified "socio-economic inequalities in active travel, but – contrary to the trends for many health beneficial behaviours – with a greater likelihood of active travel in more deprived areas". In England and Wales, Goodman (2013), in an exhaustive study of the 2011 census, identified that cycling at the national level is still more used by deprived populations than by wealthier people. However, the author suggested that the trend is changing and "in the future it may become increasingly concentrated among more affluent groups" (Goodman, 2013 p. 9).Finally, also in England, Goodman and Aldred (2018) found substantial inequalities in the relation of utilitarian and recreational cycling and gender, age, disability, and ethnicity.

More research to better understand the prevalence of walking and cycling among demographic, socioeconomic and geographic subgroups, and particularly, the causes that create such inequalities is needed. Understanding these interactions is important for developing public policies and plan cities to overcome effectively group-specific barriers in active travel, and inequalities in health and accessibility.

2 Aims

The aims of this study are to:

(1) identify demographic, socioeconomic and geographical inequalities in the use of walking and cycling for travel, and

(2) examine to what extent environmental determinants such as distance travelled, hilliness and temperature influence on the existence of these inequalities.

3 Methods

3.1 Active Lives Survey dataset

The Active Lives Survey (ALS) is a biannual survey conducted by Ipsos MORI for Sport England, a non-departmental public body under the Department for Digital, Culture, Media and Sport (DCMS), that contains participation, frequencies, and duration of physical activity of adults aged 16+ in England (Ipsos MORI, 2017; Ipsos MORI, 2018; Ipsos MORI, 2019). Its responses are collected using Computer-assisted web interviewing (CAWI) online questionnaires and paper self-completion questionnaires. The ALS includes any physical activity done for health, sport, fitness or leisure, but also walking or cycling for travel. It has a significant sample size, around 200,000 participants per year, and it is designed to achieve a minimum of 500 interviews in most local authorities, which allows to perform analysis up to this regional level. Response rates to the survey have consistently been ~25% (Ipsos MORI, 2017; Ipsos MORI, 2018; Ipsos MORI, 2019).

For this study, the last three year of ALS data available were pooled, from November 2015 to November 2018. The distribution and consistency of all variables was analysed to identify any anomalous values or variables with a high proportion of missing responses.

After excluding 9% of participants with missing data and a few inconsistencies in the personal characteristics variables, a final sample size of 534,108 adults aged 16+ and 36 variables was used.

3.2 Response variables

The ALS questionnaire asks respondents the time they usually spent on the physical activities they did, including walking and cycling for travel. From this question, two binary response variables were created: (1) walking travel, and (2) cycling travel. Each of these variables takes the value of 1 for those respondents who did 150 minutes or more on walking travel or cycling travel per week (which reflects the current recommendation of PA that adults should accumulate per week), and 0 for those who did not. Notice that walking and cycling for leisure or sport would not be included in these variables. Dividing by days, this would be 30 minutes per working day, which means that in this measure for walking and cycling, the majority of active commuters will be included. According to the latest National Travel Survey (NTS) (Department for Transport, 2018), the average trip walking is 16 minutes and 24 cycling. If we take into account that this is only one way, the averages per commute are around 32 minutes for walking and 48 for cycling. A total physical activity response variable was also created to compare with AT.

3.3 Explanatory variables

3.3.1 Individual-level variables

Explanatory variables at the individual-level include five personal characteristics: gender (male/female), age (16–34, 35–54, 55-74, 75+), ethnicity (white/non-white), level of deprivation of the area where the respondent lived (least, 2nd least, 2nd most, most), level of education (low, medium, high), and area classification (urban/rural).

Table 1 summarises the characteristics of the sample per each of these individual-level variables.

Table 1: Sample characteristics (weighted)

		n	%
Sex	Male	258832	48
	Female	270214	51
Age	16-34	165769	31
	35-54	174173	33
	55-74	140518	26
	75+	48587	9
Ethnicity	White	458193	86
	Non-white	70853	13
Deprivation	Least	120479	23
	Second least	125588	24
	Second most	129652	24
	Most	153327	29
Education	High	219554	41
	Medium	105059	20
	Low	204433	38
Area	Urban	430190	81
	Rural	98856	19

National Statistics Socio-Economic Classification (NS-SEC) was not considered due to a large number of missing values (64,166 NA's). The rest of individual-level explanatory variables were cleaned of missing values. A third category, "others", with 106 cases, was removed from the gender variable. In addition, education was categorised as "low" (levels 1 or 2 (GCSE-level) another type, or no qualified), "medium" (level 3 and equivalents), or "high" (level 4 or above).

3.3.2 Local authority level variables

At the local authority level three environmental characteristics associated with active travel in previous literature were collected: distance travelled, hilliness, and temperature. Distance travelled was represented by distance to work from the census 2011, and it measures the average commute distance in km. Hilliness was taken from the Propensity for Cycle Tool (PCT) open source (Lovelace et al., 2017), and it represents the average of the fast route gradient (%) of commute trips in zone with fast route distance <10km at the MSOA level. Finally, temperature comes from the Met Office and measures the 1981-2010 average temperature in Celsius degrees (°C).

This last variable was available at the county level and (in a few occasions) regional level.

Manual work was needed to assign the appropriate aggregated measure to each of the local authorities.

The spatial distribution of each of the local authority level explanatory variables is shown in Figure 1.

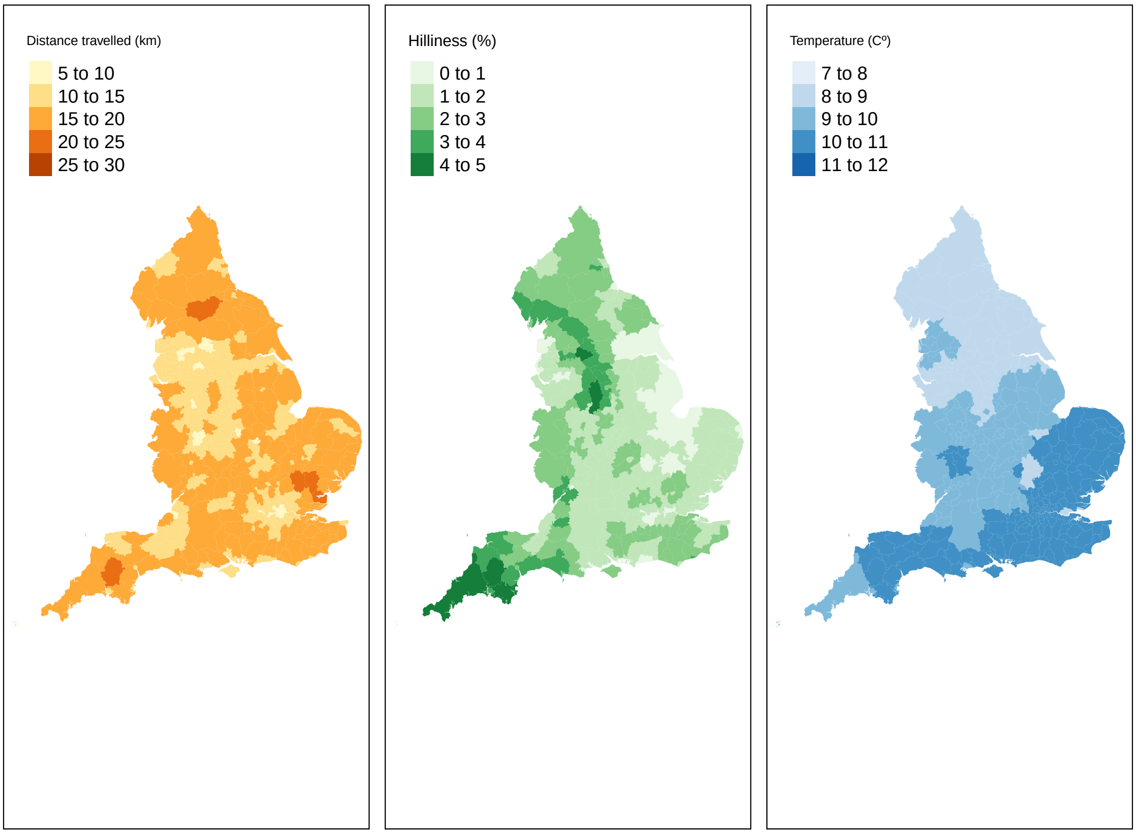

Figure 1: Visualisation local authority level explanatory variables: distance travelled, hilliness, and temperature

Other local authority level variables available such as density, rainfall, car ownership and index of multiple deprivation were considered as potential candidates for the analysis. However, after a collinearity diagnostic using the `VIF` function from the R package `regclass` (Petrie, 2017), were dismissed as were found moderately or highly correlated with one or other of the variables finally included in the study.

Reproducible code with these analyses and the process of cleaning and tidying the data will be made available online, following publication of this research.

3.4 Statistical analyses

To address the first aim, frequencies and proportions of walking travel, cycling travel and total PA for gender, age, ethnicity, level of deprivation, level of education, and area classification in England were presented. Then, multivariate logistic regression models were built and their Relative Risks (RRs) and 95% confidence interval (95%CI) computed. The RRs represent the probability of an event occurring in one group compared to the probability of an event occurring in the other group (Statistics Solutions, 2019). For example, the RR of females in walking travel for the gender group would be the probability that females have to meet the 150 minutes or more per week travelling by walking with respect to males. These RRs were estimated with the R package `epitools` (Tomas, 2017), using marginal standardization adjusted by all the personal variables considered. The standard errors were calculated using the delta method. This was done for each of the outcomes: walking travel, cycling travel, and total PA.

To address the second aim, the association between average distance travelled, hilliness, and temperature (predictors) and measures of walking for travel and cycling for travel inequality (outcomes) was analysed at the local authority level. For this, first, we had to convert each explanatory variable in dichotomous. Next, the RRs of gender, age, index of local deprivation, and education were calculated per each local authority. We did not examine ethnicity and urban and rural classification in relation to our second aim, as for cycling travel not all the local authorities contained individuals from each category (white/non-white; rural/non-rural). Then, after analysing the distribution of these potential outcomes, the logs of them were taken to normalise the data. Finally, multiple regression models were built using the logs of RRs measures of walking for travel and cycling for travel inequality as outcomes, and local average distance travelled, hilliness, and temperature as predictors.

Weights provided for the ALS were applied to conduct the analyses in order to reduce the bias in survey estimates. All analysis was done using R and the editor RStudio.

4 Results

4.1 Inequalities in active travel

According to the ALS, between November 2015 and November 2018, over 6 in 10 adults in England (62.8%) achieved 150 minutes of physical activity a week. Almost 2 in 10 (18.9%) did it only by walking for travel, and less than 0.5 in 10 (4.4%) only by cycling for travel. Table 2 shows how these frequencies and proportions were distributed among categories of demographic, socioeconomic, and geographical groups.

Table 2: Number and proportion of respondents who did at least 150 min./week walking for travel, cycling for travel, or by total PA (weighted)

		Walking travel	%	Cycling travel	%	Total PA	%
Sex	Male	47717	18.44	17448	6.74	169633	65.54
	Female	53139	19.67	6244	2.31	165945	61.41
Age	16-34	44931	27.10	10788	6.51	119622	72.16
	35-54	32987	18.94	9581	5.50	115776	66.47
	55-74	19448	13.84	3118	2.22	82914	59.01
	75+	3490	7.18	204	0.42	17266	35.54
Ethnicity	White	83636	18.25	21230	4.63	294109	64.19
	Non-white	17220	24.30	2462	3.48	41469	58.53
Deprivation	Least	19581	16.25	4985	4.14	81226	67.42
	Second least	22444	17.87	5508	4.39	81140	64.61
	Second most	23700	18.28	5667	4.37	82915	63.95
	Most	35131	22.91	7532	4.91	90297	58.89
Education	High	45433	20.69	12830	5.84	155086	70.64
	Medium	23331	22.21	4643	4.42	70999	67.58
	Low	32092	15.70	6219	3.04	109492	53.56
	Urban	88784	20.64	20853	4.85	271756	63.17
	Rural	12072	12.21	2839	2.87	63822	64.56

There are remarkable differences between categories, particularly in cycling travel. Table 3 shows the RRs and their associated 95% CI to compare the probabilities to reach the 150 min./week per categories of groups in each of the activities.

Table 3: Logistic models showing the likelihood of doing at least 150 min./week walking for travel, cycling for travel, or by total PA (weighted)

		Walking travel	Cycling travel	Total PA
Gender	Male	1	1	1
	Female	1.09 (1.07, 1.10) ***	0.35 (0.34, 0.36) ***	0.95 (0.95, 0.95) ***
Age	16-34	1	1	1
	35-54	0.71 (0.70, 0.72) ***	0.83 (0.81, 0.85) ***	0.89 (0.89, 0.90) ***
	55-74	0.55 (0.55, 0.56) ***	0.34 (0.33, 0.35) ***	0.79 (0.78, 0.79) ***
	75+	0.29 (0.28, 0.30) ***	0.07 (0.06, 0.08) ***	0.45 (0.44, 0.45) ***
Ethnicity	Non-white	1	1	1
	White	0.97 (0.96, 0.99) ***	1.99 (1.90, 2.07) ***	1.19 (1.18, 1.20) ***
Deprivation	Least	1	1	1
	Second least	1.07 (1.06, 1.09) ***	1.07 (1.03, 1.10) ***	0.95 (0.95, 0.96) ***
	Second most	1.08 (1.06, 1.10) ***	1.06 (1.02, 1.09) **	0.94 (0.93, 0.95) ***
	Most	1.20 (1.18, 1.22) ***	1.12 (1.08, 1.16) ***	0.87 (0.86, 0.87) ***
Education	High	1	1	1
	Medium	0.96 (0.95, 0.98) ***	0.64 (0.62, 0.67) ***	0.90 (0.90, 0.91) ***
	Low	0.81 (0.80, 0.82) ***	0.57 (0.55, 0.59) ***	0.80 (0.79, 0.80) ***
Area	Urban	1	1	1
	Rural	0.67 (0.66, 0.69) ***	0.65 (0.62, 0.67) ***	1.02 (1.01, 1.02) ***

[a] Significance: *** < 0.001, ** < 0.01, * < 0.05

[b] RRs estimated from logistic regression models. All RRs in the table are mutually adjusted for all the variables in the table

The results show small differences in likelihood in walking travel and total physical activity by gender. Females tend to walk more for travel, and reach less often the 150 min./week doing the total PA than males. However, women are only one third (RR 0.35, 95% CI 0.34 to 0.36) as likely to do at least 150 min./week by cycling travel as men.

By age, there is a steady trend for all the activities: the older the population the less they meet guidance recommendations. Even so, the difference in walking travel, and especially in cycling travel is greater than for the total PA. The decline in cycling travel in people between 55 and 74 is remarkable (RR 0.34, CI 95% 0.33 to 0.35), and in people over 75 dramatically substantial (RR 0.07, 95% CI 0.06 to 0.08).

Disparities for walking travel and total PA in ethnicity are minimal. White population tend to meet recommendations less by walking travel and more by total PA than non-white population. However, the gap between white and non-white population when referring to cycling travel is remarkable. White people do twice 150 min./week or more by cycling travel than non-white population.

The level of deprivation of residence of the respondents has a positive influence on active travel, for both walking and cycling; but a negative influence on the total PA. This shows that, compared with non-deprived populations, a considerable amount of the physical activity that most deprived populations do is by daily travelling.

Level of education is gradually influential for both active travel activities and total PA. People with higher levels of education are more likely to meet health recommendations by active modes, but also by other physical activities than those with lower levels of education. Again, the differences are higher in terms of cycling travel (RR 0.57, 95% CI 0.55 to 0.59).

Finally, as for urban/rural classification, the disparities are substantial. The urban areas have a higher likelihood to do 150 min./week or more travelling by active modes than people from rural areas (RRs for walking travel 0.67, 95% CI 0.66 to 0.69, and 0.65, 95% CI 0.62 to 0.67, for cycling travel). As expected, no big differences are observed for overall physical activity in this case.

But, why do these differences exist? In the next section, the potential influence that distance travelled, hilliness, and temperature may have on the variance of RRs shown here is examined.

4.2 Relationship between environmental correlates and active travel inequalities

Distance travelled, hilliness, and temperature have some significant impacts on the level of inequalities identified in walking travel and cycling travel at the local authority level (table 4).

Table 4: Association between average distance to work, hilliness, and temperature (predictors) and measures of walking for travel and cycling for travel inequality (outcomes) at the level of the local authority

	Distance travelled	Hilliness	Temperature
RR female (vs. male) for:			
Walking travel	-0.00 (-0.00, 0.00)	-0.01 (-0.02, 0.00)	-0.02 (-0.03, -0.00) *
Cycling travel	0.00 (-0.01, 0.01)	-0.06 (-0.10, -0.03) ***	0.10 (0.04, 0.15) ***
RR age 55+ (vs. age 16-54) for:			
Walking travel	-0.01 (-0.01, -0.00) ***	0.00 (-0.01, 0.01)	0.01 (-0.01, 0.02)
Cycling travel	0.00 (-0.02, 0.02)	-0.07 (-0.14, 0.01)	0.03 (-0.09, 0.14)
RR for most deprived area (vs. least):			
Walking travel	-0.00 (-0.00, 0.00)	-0.00 (-0.01, 0.01)	-0.02 (-0.04, -0.01) **
Cycling travel	-0.00 (-0.01, 0.00)	0.01 (-0.02, 0.04)	-0.07 (-0.11, -0.02) **
RR for low/med. education (vs.high):			
Walking travel	-0.00 (-0.01, 0.00)	0.00 (-0.01, 0.01)	-0.02 (-0.04, -0.01) ***
Cycling travel	0.01 (0.00, 0.02) *	-0.05 (-0.08, -0.03)***	-0.08 (-0.13, -0.04) ***

[a] Significance: *** < 0.001, ** < 0.01, * < 0.05

[b] Distance = Average local distance to work, Hilliness = Average MSOAs fast route gradient (%) of commute trips in zone with fast route distance <10km, Temperature = Average 1981-2010 local temperature

A significant negative association is observed between the local average distance to work and the RR age 55+ (vs. age 16-54) for walking travel. This means, the representation of older populations for walking travel decreases in local authorities where people make longer distances to work. Distance to work is found also slightly significantly associated ($p < 0.05$), this time positively, with the RRs for low/medium education (vs.high) in cycling travel.

Hilliness is significantly negative correlated with RR female (vs. male) for cycling travel. In other words, the more hilly is an area, the higher is the gap between females and males in cycling travel in favour of males. A similar effect seems to have hilliness for the RR for low/medium education (vs.high).

Finally, temperature seems to be the most influential environmental correlate of all. It is slightly significantly ($p < 0.05$) negative associated with the RR female (vs. male) for walking, but significantly positively associated with the same RR for cycling, i.e, the representation of females in colder areas is higher for walking but lower for cycling. Temperature is also found significantly ($p < 0.01$) negative correlated with the RRs for most deprived areas (vs. least) for both walking and cycling travel; and significantly negative correlated for low/medium education (vs. high education) also for both, walking and cycling travel.

5 Discussion

5.1 Principal findings

The first aim of this study was to identify demographic, socioeconomic and geographical inequalities in the use of walking and cycling for travel. Remarkable inequalities among categories of groups have been found, particularly for cycling travel.

Women tend to walk for travel slightly more than men has been found. This is consistent with the results of the National Travel Survey (NTS) of England. According to the NTS, in 2016 women did 17% more trips by walking than men on average (Department for Transport, 2018). However, this does not seem to be a global pattern. A recent study carried out with smartphones which measured physical activity at the global scale found that worldwide there is a significant gap in favour of males in the average steps walked per day (Althoff et al., 2017). The gap found between females and males for cycling travel is substantial. Females are only one third (RR 0.35, 95% CI0.34 to 0.36) as likely to do at least 150 min./week by cycling travel as men. These results are also supported by the NTS which reported that in 2016 in England men cycled three times more often than women on average. Authors generally agree that in countries where cycling levels are low, like in the UK, males tend to cycle substantially more than women; however, in countries where cycling is popular such as the Netherlands or Denmark, women cycle the same or even more than men (Aldred et al., 2016; Heinen et al., 2010; Bonham and Wilson, 2012; Garrard et al., 2012). In this line, Goodman and Aldred in a recent study in England (2018) found that in English local authorities where cycling prevalence is higher, gender inequality was minor. Some studies have pointed out to the lack of safe infrastructure as one of the main reasons for this disparity, as there is evidence that women are more concerned about safety issues associated with cycling than men (Garrard et al., 2008; Aldred et al., 2016; Twaddle et al., 2010).

Similarly to previous studies in the UK (Brainard et al., 2019; Goodman and Aldred, 2018), this study has found a gradual negative influence of age with active travel, for both modes; although the difference is greater for cycling travel. This finding seems reasonable as walking and cycling represent an effort that increases by aging. However, in terms of cycling, some authors found evidence that the prevalence of cycling has also a positive influence on the number of elder people cycling for travel. In other words, in countries where cycling is popular the difference in ages for utility cycling is smaller or almost nonexistent (Fishman et al., 2015; Harms, 2007; Goodman and Aldred, 2018).

The inequalities found between white and non-white populations in cycling travel is substantial. A similar gap was reported by Goodman and Aldred (2018) in England. Unlike for gender and age, ethnic inequalities do not seem to be affected by cycling prevalence of the area. In the Netherlands and Denmark, where cycling is popular, ethnic minorities seem to cycle less than natives (Harms, 2007; Heinen et al., 2010); whereas in the United States, where cycling is marginal, ethnic minorities and immigrants are the main utility cyclists (Smart, 2010).

According to results, the poor (populations from most deprived areas) in England walk and ride bicycles for travel more often than wealthier populations. Similar conclusion draw other papers from the UK (Olsen et al., 2017; Brainard et al., 2019; Goodman, 2013; Public Health England, 2017). This may be explained because people from most deprived areas tend to be more “captive” of active modes of transport, i.e. have less or no chance to use public or private motorised vehicles on their mobility. As the last report of the NTS (2018) argues, the location of more deprived areas, usually in urban areas, might also be part of the explanation. Notice, however, that most deprived population walk and cycle more for travel, but less for leisure or sport (Department for Transport, 2018; Goodman and Aldred, 2018). The fact that these populations are the main users of AT, and that AT is one of their greatest sources of physical activity, strengthens the argument that the improvement of the active modes facilities (cycleways, walkways, pedestrian crossings, etc.) for AT in deprived areas is of significant importance. The promotion of AT among these populations can help to overcome health inequalities - research has shown that low-income populations have a poorer health condition and lower life expectancy than wealthier populations (National Academies of Sciences, and Medicine, Engineering, 2017; Public Health England, 2017) -, but also solve other difficulties that these particular populations face in their daily life such as inaccessibility to certain services or social exclusion.

In contrast to the results obtained for the populations of the most deprived areas, the higher the level of education, the greater the use of active travel seems to be. Goodman and Aldred (2018) using the Active People Survey from 2011 to 2015 (a previous version of the ALS), found a similar result for both recreational and utility cycling at the national level. However, when looking within local authorities, they found that this relationship remained for recreational cycling, but not for utility cycling. According to them, this national result for utility cycling turned out to be driven by an ecological association. Within local authorities, there was no evidence that more educated people were more likely to cycle than less educated people. In the US, Plaut (2005) associated College Education with greater propensity to use non-motorised modes, while Handy and Xing (2011) did not find any association. In Canada, Winters et al. (2007) found a lower education associated with lower likelihood of cycling.

It seems evident that, as this study reports, urban areas are more active in terms of transport than rural areas. The proximity of services and amenities in cities and towns, but not in villages, affects positively utility walking and cycling (Freeman et al., 2013; Ewing et al., 2014). In denser urban areas, distances between destinations are shorter, and consequently, journeys can be done more easily on foot or by bicycle. Olsen et al. (2017) in Scotland and Fishman et al. (2015) in the Netherlands also found higher use of active modes in urban than in rural areas.

The second aim of this study was to examine to what extent distance travelled, hilliness and temperature can influence on the existence of the inequalities previously identified. All these environmental factors have been found to have a significant impact on certain active travel inequalities.

Greater distance travelled implies more time and effort during the journey, which may differ between individuals, and can consequently create disparities among categories of groups. This study found a significant negative association between the local average distance to work and the RR age 55+ (vs. age 16-54) for walking travel. This finding is consistent with previous research (O'Hern and Oxley, 2015; Cerin et al., 2017) and reasonable, considering that by aging physical activity becomes more effortful. Other publications found a negative influence of distance travelled in females for walking and cycling. For instance, Nelson et al. (Nelson et al., 2008) found in Ireland that the odds of active commuting to school were 36% greater for males compared to females. However, Heinen et al. (2011) found no interaction between gender and distance to work for cycling.

Researchers agree on the negative effect of hilliness in walking and especially in cycling (Pikora et al., 2003; Heinen et al., 2010; Parkin et al., 2008; Rietveld and Daniel, 2004). But is the impact of topography on walking or cycling greater for some categories of groups than for others? This study found that both the RR of female (vs male) and the RR of the low/medium education (vs.high) were greater in hilly areas than in flatter areas. The first finding is consistent with Delmelle and Delmelle (2012), who reported that women were more likely to report topography as a barrier for active modes than men. However, Grudgings et al. (2018) and Fyhri and Fearnley (2015) found no evidence that women were more influenced than men by hilliness when cycling. No literature was found about the interaction of hilliness with a lower educated population. If the level of education is taken as a proxy of income, one explanation to this association could be the impact that different quality of bikes between socioeconomic groups could have in steep areas. Disadvantaged socioeconomic populations tend to use bicycles of lower quality, which could greatly affect their performance on hilly and abrupt terrains.

Research on the impact that weather may have on active travel is scarce. Although several authors have already indicated that it could be of great importance (Saneinejad et al., 2012; Clark et al., 2014). In fact, in this study, temperature has been found the most influential of the three factors analysed. It turned out to be positively correlated with cycling travel among women, and negatively with walking and cycling among people from more deprived areas and with lower levels of education. The positive correlation whit cycling among women suggests a higher sensitivity of them to lower temperatures. This link has not been reported in other articles, although it could be related to the finding that Heinen et al. did in a study on choice cycling commute in the Netherlands (2011). They found that women were less likely to cycle to work in the dark. In England, the areas with lower average temperature tend to be the areas in the north (see Figure 1), where it also gets dark earlier in the winter. Consequently, the gender inequality could be caused by darkness, by temperature or by both variables at the same time. This also suggests that there might be seasonal patterns in cycling inequalities, at least in terms of gender, where the warmer and lighter seasons increase the likelihood of women using bicycles. No literature has been found to explain the negative correlations between temperature and walking and cycling among people from more deprived areas and with lower levels of education. One suggestion is that, as previously mentioned, disadvantaged populations tend to be more active-mode "captive" (Golub, 2016); consequently, they walk or cycle more often under cold and adverse weather conditions than non-deprived populations. Ogilvie et al. (Ogilvie et al., 2008) found, in a study in a deprived urban population, a clear correlation between not having a car and active travel. This may also explain, at least in part, why most research (Goodman and Aldred, 2018; Harms et al., 2014) have found that low-income populations use active modes more for transport than for recreational purposes.

5.2 Implications of the study

This study leads us to examine the magnitude of active travel inequalities across demographic, socioeconomic and geographic groups in England. This may help to develop individual-oriented policies for those categories of groups who according to the findings of the study need more support in the promotion of active modes. Research has found evidence that targeted behaviour change programmes are the most effective way to promote a modal shift (Ogilvie, 2004, @winters_policies_2017). The study also reports to what extent the environmental correlates distance travelled, hilliness and temperature (all factors generally under-researched) have an influence on the identified inequalities. This may provide guidance on which areas require more action and what are the best solutions to minimise the negative effect that these factors might have on the travel behaviour of the targeted subgroups. The impact of distance travelled can be improved, for instance, by implementing transport planning and land-use policies (Nazelle et al., 2011) such as locating services or amenities at walking distance of where people who are more affected by distance live. Policies cannot change hills or temperature but can, for example, promote electric bicycles or provide better-quality bicycles in steeper areas for those who are more affected by hilliness; or find ways to make active travel more comfortable in colder or darker areas for those who are more sensitive to low temperatures or dark spaces (e.g. by improving street lighting, shortening time trips, promoting warmer clothing for cycling, etc.).

5.3 Research limitations

This study has a few noteworthy limitations. Firstly, the data used from the ALS is self-reported which implies a potential risk of bias assessment. A systematic review (Prince et al., 2008) comparing direct versus self-report measures for assessing physical activity in adults found out that, self-report measures of physical activity were both higher and lower than directly measured levels of physical activity. In their comparison "trends differed by measure of physical activity employed, level of physical activity measured, and the gender of participants" (Prince et al., 2008 p. 1). Secondly, some individual level variables of great importance for travel behavior such as car or bicycle ownership could not be included in the analyses because they were not available in the ALS. To examine the influence that these variables have on the travel behavior of the different demographic, socioeconomic and geographical groups would have improved the research, especially with regard to the analysis of active travel among the socioeconomic disadvantaged groups. Thirdly, the sample size of the ALS data allowed a minimum level of analysis per area of local authority district. This made no possible to perform the analyses at a larger scale such as Middle Layer Super Output Areas (MSOA) or Lower Layer Super Output Areas (LSOA), which would have made easier to explore certain geographical variables collected at this scale. For instance, we could have add car ownership at this scale. Fourthly, due to time constraints, neither relevant local authority level variables such as infrastructure, land use mix, road safety data, etc. were included in the analyses. Considering the influence that according to research these variables have on travel behaviour, their inclusion would have made stronger the policy impact of this study. Finally, as mentioned in the section of methods above, the information provided by the MET office, temperature average, was at the county level and (in a few occasions) regional level. With no time constraint, this variable could have been obtained directly from each of the existent weather stations. This would have given greater accuracy and greater rigor to this particular analysis.

5.4 Directions for future research

Based on the results and limitations of this study, the following future research is suggested. First, to explore the effect that other environmental variables such as active modes facilities (infrastructure), network connectivity, traffic volumes, road safety data, etc. may have on the active travel inequalities. This can help to answer questions such as: are active travel inequalities in terms of age affected by the level of connectivity of the pedestrian networks, or are women in reality more concerned about safety issues associated with cycling than men? In a recent piece of research, Althoff et al. (Althoff et al., 2017) found, for instance, that some aspects of the built environment such as the walkability of a city were associated with a smaller gender gap in active travel. Another aspect that may be worth it to examine in the future is the trend of the inequalities identified. In the first draft of this study, an analysis of the tendency was conducted, however, the changes between the three years available were often mixed (positive between the first two years, negative between the other two or vice-versa) and inconclusive. In a few years, with more ALS available, will make more sense to conduct this type of analysis. This could help to prioritise interventions, and assess whether the policies that are being implemented are being effective in overcoming inequalities or the opposite. Finally, it would be also interesting to analyse inequalities among the most vulnerable groups, i.e, those who have more difficulty in achieving physical activity through other means, using combinations of personal characteristics. To explore, tor example, active travel inequalities among females from deprived areas, or among elder populations from rural areas. In line with this, it would be useful to conduct a study of similar characteristics of this one, but focused on the young populations using the Active Lives Children Young People (Active Lives CYP). The Active Lives CYP is a survey conducted by Sport England using the same method as the ALS, but focused only on young populations (Sport England, 2019). The promotion of active travel among the young is particularly important, since is at these ages when it is easier to create good habits for an active adult life. In addition, the data on obesity and sedentarism among the young in the UK (almost 1 in 5 children are overweight or obese when they start primary school, rising to 1 in 3 when they start secondary school (RCPCH, 2019)) claim for more research and policies to tackle the situation.

6 Conclusions

Remarkable inequalities in active travel between demographic, socioeconomic and geographical groups in England were found. The disparities were particularly high for cycling travel. Walking travel was found to be more common among people who were female, young, from deprived areas, with a higher level of education and from urban areas. Cycling travel tended to be disproportionately used by male, young, white, with a high level of education and urban populations.

Distance travelled, hilliness, and temperature were found to have a significant impact on the active travel inequalities of certain socioeconomic groups. Distance was negatively associated with the RR for age 55+ (vs. age 16-64) for walking travel. Hilliness was negatively associated with the RR female (vs. male) and the RR for low/med. education level (vs. high) for cycling travel. Temperature was positively associated with the RR female (vs. male) for cycling, but negatively associated with the RR for most deprived area (vs. least), and the RR for low/med. education (vs. high) for both, walking and cycling.

These findings might be useful to develop individual-oriented policies aimed at reducing the impact that these environmental factors have on the travel behaviour of specific groups and areas, and this way, reduce existing inequalities in active travel, and consequently, contribute to overcoming health inequalities.

More research should be conducted to examine the interaction between the built environment and active travel inequalities. This might have a strong policy impact. More specific research on the existing active travel inequalities among those who have more difficulty in achieving physical activity through other means is also needed.

References

Aldred, R., Woodcock, J. and Goodman, A. 2016. Does More Cycling Mean More Diversity in Cycling? *Transport Reviews*. [Online]. **36**(1),pp.28–44. [Accessed 18 November 2018]. Available from: http://www.tandfonline.com/doi/full/10.1080/01441647.2015.1014451.

Althoff, T., Sosič, R., Hicks, J.L., King, A.C., Delp, S.L. and Leskovec, J. 2017. Large-scale physical activity data reveal worldwide activity inequality. *Nature*. [Online]. **547**(7663),pp.336–339. [Accessed 24 August 2019]. Available from: http://www.nature.com/articles/nature23018.

Bassett, D.R., Pucher, J., Buehler, R., Thompson, D.L. and Crouter, S.E. 2008. Walking, Cycling, and Obesity Rates in Europe, North America, and Australia. *Journal of Physical Activity and Health*. [Online]. **5**(6),pp.795–814. [Accessed 18 August 2019]. Available from: https://journals.humankinetics.com/view/journals/jpah/5/6/article-p795.xml.

Bonham, J. and Wilson, A. 2012. Chapter 3 Women Cycling Through the Life Course: An Australian Case Study *In*: *In Cycling and sustainability*. Emerald Group Publishing Limited. Emerald Group Publishing Limited, pp. 59–81.

Brainard, J., Cooke, R., Lane, K. and Salter, C. 2019. Age, sex and other correlates with active travel walking and cycling in England: Analysis of responses to the Active Lives Survey 2016/17. *Preventive Medicine*. [Online]. **123**,pp.225–231. [Accessed 25 July 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0091743519301197.

Cerin, E., Nathan, A., Cauwenberg, J. van, Barnett, D.W. and Barnett, A. 2017. The neighbourhood physical environment and active travel in older adults: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*. [Online]. **14**(1),p.15. [Accessed 25 August 2019]. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/s12966-017-0471-5.

Clark, A.F., Scott, D.M. and Yiannakoulias, N. 2014. Examining the relationship between active travel, weather, and the built environment: A multilevel approach using a GPS-enhanced dataset. *Transportation*. [Online]. **41**(2),pp.325–338. [Accessed 24 August 2019]. Available from: http://link.springer.com/10.1007/s11116-013-9476-3.

Day, K. 2006. Active Living and Social Justice: Planning for Physical Activity in Low-income, Black, and Latino Communities. *Journal of the American Planning Association*. [Online]. **72**(1),pp.88–99. [Accessed 11 November 2018]. Available from: http://www.tandfonline.com/doi/abs/10.1080/01944360608976726.

Delmelle, E.M. and Delmelle, E.C. 2012. Exploring spatio-temporal commuting patterns in a university environment. *Transport Policy*. [Online]. **21**,pp.1–9. [Accessed 27 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0967070X11001399.

Department for Transport 2017. Cycling and Walking Investment Strategy.,p.38. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/603527/cycling-walking-investment-strategy.pdf.

Department for Transport 2018. Walking and Cycling Statistics, England: 2016.,p.28. Available from: https://www.gov.uk/government/statistics/walking-and-cycling-statistics-england-2018.

Ewing, R., Meakins, G., Hamidi, S. and Nelson, A.C. 2014. Relationship between urban sprawl and physical activity, obesity, and morbidity – Update and refinement. *Health & Place*. [Online]. **26**,pp.118–126. [Accessed 27 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S135382921300172X.

Fishman, E., Böcker, L. and Helbich, M. 2015. Adult Active Transport in the Netherlands: An Analysis of Its Contribution to Physical Activity Requirements F. Criscuolo, ed. *PLOS ONE*. [Online]. **10**(4),p.e0121871. [Accessed 8 April 2019]. Available from: https://dx.plos.org/10.1371/journal.pone.0121871.

Freeman, L., Neckerman, K., Schwartz-Soicher, O., Quinn, J., Richards, C., Bader, M.D.M., Lovasi, G., Jack, D., Weiss, C., Konty, K., Arno, P., Viola, D., Kerker, B. and Rundle, A.G. 2013. Neighborhood Walkability and Active Travel (Walking and Cycling) in New York City. *Journal of Urban Health*. [Online]. **90**(4),pp.575–585. [Accessed 3 July 2018]. Available from: http://link.springer.com/10.1007/s11524-012-9758-7.

Fyhri, A. and Fearnley, N. 2015. Effects of e-bikes on bicycle use and mode share. *Transportation Research Part D: Transport and Environment*. [Online]. **36**,pp.45–52. [Accessed 27 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1361920915000140.

Garrard, J., Handy, S. and Dill, J. 2012. Women and cycling *In*: *City Cycling*. MIT Press, Cambridge/London., pp. 211–234.

Garrard, J., Rose, G. and Lo, S.K. 2008. Promoting transportation cycling for women: The role of bicycle infrastructure. *Preventive Medicine*. [Online]. **46**(1),pp.55–59. [Accessed 24 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0091743507003039.

Golub, A. 2016. Is the right to bicycle a civil right? Synergies and tensions between the transportation justice movement and planning for bicycling *In*: *Bicycle Justice and Urban Transformation*. Routledge, pp. 44–57.

Goodman, A. 2013. Walking, Cycling and Driving to Work in the English and Welsh 2011 Census: Trends, Socio-Economic Patterning and Relevance to Travel Behaviour in General H. Zhang, ed. *PLoS ONE*. [Online]. **8**(8),p.e71790. [Accessed 31 March 2019]. Available from: http://dx.plos.org/10.1371/journal.pone.0071790.

Goodman, A. and Aldred, R. 2018. Inequalities in utility and leisure cycling in England, and variation by local cycling prevalence. *Transportation Research Part F: Traffic Psychology and Behaviour*. [Online]. **56**,pp.381–391. [Accessed 1 April 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1369847817302802.

Grudgings, N., Hagen-Zanker, A., Hughes, S., Gatersleben, B., Woodall, M. and Bryans, W. 2018. Why don't more women cycle? An analysis of female and male commuter cycling mode-share in England and Wales. *Journal of Transport & Health*. [Online]. **10**,pp.272–283. [Accessed 27 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S221414051830121X.

Handy, S.L. and Xing, Y. 2011. Factors Correlated with Bicycle Commuting: A Study in Six Small U.S. Cities. *International Journal of Sustainable Transportation*. [Online]. **5**(2),pp.91–110. [Accessed 14 June 2018]. Available from: http://www.tandfonline.com/doi/abs/10.1080/15568310903514789.

Harms, L. 2007. Mobility among Ethnic Minorities in the Urban Netherlands. [Accessed 6 April 2019]. Available from: https://difu.de/publikationen/mobility-among-ethnic-minorities-in-the-urban-netherlands.html.

Harms, L., Bertolini, L. and Brömmelstroet, M. te 2014. Spatial and social variations in cycling patterns in a mature cycling country exploring differences and trends. *Journal of Transport & Health*. [Online]. **1**(4),pp.232–242. [Accessed 6 April 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2214140514000802.

Heinen, E., Maat, K. and Wee, B. van 2011. Day to Day Choice to Commute or Not by Bicycle. *Transportation Research Record: Journal of the Transportation Research Board*. [Online]. **2230**(1),pp.9–18. [Accessed 27 August 2019]. Available from: http://journals.sagepub.com/doi/10.3141/2230-02.

Heinen, E., Wee, B. van and Maat, K. 2010. Commuting by bicycle: An overview of the literature. *Transport Reviews*. [Online]. **30**(1),pp.59–96. Available from: http://www.tandfonline.com/doi/abs/10.1080/01441640903187001.

Ipsos MORI 2017. *Active Lives Survey 2015/2016 Year 1 Technical Report*. Ipsos MORI Social Research Institute.

Ipsos MORI 2018. *Active Lives Survey 2016/2017 Year 2 Technical Report*. Ipsos MORI Social Research Institute.

Ipsos MORI 2019. *Active Lives Survey 2017/2018 Year 3 Technical Report*. Ipsos MORI Social Research Institute.

Lovelace, R., Goodman, A., Aldred, R., Berkoff, N., Abbas, A. and Woodcock, J. 2017. The Propensity to Cycle Tool: An open source online system for sustainable transport planning.,p.24.

National Academies of Sciences, and Medicine, Engineering 2017. Communities in Action: Pathways to Health Equity. *National Academies Press*. [Online]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK425844/.

Nazelle, A. de, Nieuwenhuijsen, M.J., Antó, J.M., Brauer, M., Briggs, D., Braun-Fahrlander, C., Cavill, N., Cooper, A.R., Desqueyroux, H., Fruin, S., Hoek, G., Panis, L.I., Janssen, N., Jerrett, M., Joffe, M., Andersen, Z.J., Kempen, E. van, Kingham, S., Kubesch, N., Leyden, K.M., Marshall, J.D., Matamala, J., Mellios, G., Mendez, M., Nassif, H., Ogilvie, D., Peiró, R., Pérez, K., Rabl, A., Ragettli, M., Rodríguez, D., Rojas, D., Ruiz, P., Sallis, J.F., Terwoert, J., Toussaint, J.-F., Tuomisto, J., Zuurbier, M. and Lebret, E. 2011. Improving health through policies that promote active travel: A review of evidence to support integrated health impact assessment. *Environment International*. [Online]. **37**(4),pp.766–777. [Accessed 27 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0160412011000341.

Nelson, N.M., Foley, E., O'Gorman, D.J., Moyna, N.M. and Woods, C.B. 2008. Active commuting to school: How far is too far? *International Journal of Behavioral Nutrition and Physical Activity*. [Online]. **5**(1),p.1. [Accessed 25 August 2019]. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-1.

Ogilvie, D. 2004. Promoting walking and cycling as an alternative to using cars: Systematic review. *Bmj*. [Online]. **329**(7469),pp.763–0. Available from: http://www.bmj.com/cgi/doi/10.1136/bmj.38216.714560.55.

Ogilvie, D., Mitchell, R., Mutrie, N., Petticrew, M. and Platt, S. 2008. Personal and environmental correlates of active travel and physical activity in a deprived urban population. *International Journal of Behavioral Nutrition and Physical Activity*. [Online]. **5**(1),p.43. [Accessed 3 July 2018]. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-43.

O'Hern, S. and Oxley, J. 2015. Understanding travel patterns to support safe active transport for older adults. *Journal of Transport & Health*. [Online]. **2**(1),pp.79–85. [Accessed 25 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S221414051400084X.

Olsen, J.R., Mitchell, R., Mutrie, N., Foley, L. and Ogilvie, D. 2017. Population levels of, and inequalities in, active travel: A national, cross-sectional study of adults in Scotland. *Preventive Medicine Reports*. [Online]. **8**,pp.129–134. [Accessed 8 April 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2211335517301432.

Pampel, F.C., Krueger, P.M. and Denney, J.T. 2010. Socioeconomic Disparities in Health Behaviors. *Annual Review of Sociology*. [Online]. **36**(1),pp.349–370. [Accessed 17 November 2018]. Available from: http://www.annualreviews.org/doi/10.1146/annurev.soc.012809.102529.

Parkin, J., Wardman, M. and Page, M. 2008. Estimation of the determinants of bicycle mode share for the journey to work using census data. *Transportation*. **35**(1),pp.93–109.

Petrie, A. 2017. *Package 'regclass'* [Online]. Available from: https://cran.r-project.org/web/packages/regclass/regclass.pdf.

Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K. and Donovan, R. 2003. Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*. [Online]. **56**(8),pp.1693–1703. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12639586.

Plaut, P.O. 2005. Non-motorized commuting in the US. *Transportation Research Part D: Transport and Environment*. [Online]. **10**(5),pp.347–356. [Accessed 7 April 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1361920905000179.

Prince, S.A., Adamo, K.B., Hamel, M., Hardt, J., Connor Gorber, S. and Tremblay, M. 2008. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*. [Online]. **5**(1),p.56. [Accessed 27 August 2019]. Available from:

http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-56.

Public Health England 2018. Cycling and walking for individual and population health benefits: A rapid evidence review.,p.56. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/757756/Cycling_and_walking_for_individual_and_population_health_benefits.pdf.

Public Health England 2017. *Health profile for England: 2017* [Online]. Available from: https://www.gov.uk/government/publications/health-profile-for-england.

Pucher, J. and Buehler, R. 2008. Cycling for Everyone: Lessons from Europe. *Transportation Research Record: Journal of the Transportation Research Board*. [Online]. **2074**(1),pp.58–65. [Accessed 3 July 2018]. Available from: http://journals.sagepub.com/doi/10.3141/2074-08.

Pucher, J., Buehler, R., Bassett, D.R. and Dannenberg, A.L. 2010. Walking and cycling to health: A comparative analysis of city, state, and international data. *American Journal of Public Health*. **100**(10),pp.1986–1992.

RCPCH 2019. About childhood obesity. *RCPCH*. [Online]. [Accessed 28 August 2019]. Available from: https://www.rcpch.ac.uk/key-topics/nutrition-obesity/about-childhood-obesity.

Rietveld, P. and Daniel, V. 2004. Determinants of bicycle use: Do municipal policies matter? *Transportation Research Part A: Policy and Practice*. **38**(7),pp.531–550.

Sallis, J.F., Slymen, D.J., Conway, T.L., Frank, L.D., Saelens, B.E., Cain, K. and Chapman, J.E. 2011. Income disparities in perceived neighborhood built and social environment attributes. *Health & Place*. [Online]. **17**(6),pp.1274–1283. [Accessed 23 April 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1353829211000463.

Saneinejad, S., Roorda, M.J. and Kennedy, C. 2012. Modelling the impact of weather conditions on active transportation travel behaviour. *Transportation Research Part D: Transport and Environment*. [Online]. **17**(2),pp.129–137. [Accessed 24 August 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1361920911001143.

Smart, M. 2010. US immigrants and bicycling: Two-wheeled in Autopia. *Transport Policy*. [Online]. **17**(3),pp.153–159. [Accessed 12 June 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0967070X10000132.

Sport England 2019. Active Lives Children and Young People - Sport England. [Accessed

28 August 2019]. Available from: https://www.sportengland.org/research/active-lives-survey/active-lives-children-and-young-people/.

Statistics Solutions 2019. Relative Risk. [Accessed 5 August 2019]. Available from: https://www.statisticssolutions.com/relative-risk/.

Tomas, J.A. 2017. Package 'epitools'. Available from: https://cran.r-project.org/web/packages/epitools/epitools.pdf.

Troped, P.J., Saunders, R.P., Pate, R.R., Reininger, B. and Addy, C.L. 2003. Correlates of recreational and transportation physical activity among adults in a New England community. *Preventive Medicine*. [Online]. **37**(4),pp.304–310. [Accessed 15 June 2018]. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0091743503001373.

Twaddle, H., Hall, F. and Bracic, B. 2010. Latent Bicycle Commuting Demand and Effects of Gender on Commuter Cycling and Accident Rates. *Transportation Research Record: Journal of the Transportation Research Board*. [Online]. **2190**(1),pp.28–36. [Accessed 27 August 2019]. Available from: http://journals.sagepub.com/doi/10.3141/2190-04.

Warburton, D.E. 2006. Health benefits of physical activity: The evidence. *Canadian Medical Association Journal*. [Online]. **174**(6),pp.801–809. [Accessed 16 August 2019]. Available from: http://www.cmaj.ca/cgi/doi/10.1503/cmaj.051351.

WHO 2018. Global Health Observatory (GHO) data - Prevalence of insufficient physical activity. Available from: https://www.who.int/gho/ncd/risk_factors/physical_activity_text/en/.

Winters, M., Buehler, R. and Götschi, T. 2017. Policies to Promote Active Travel: Evidence from Reviews of the Literature. *Current Environmental Health Reports*. [Online]. **4**(3),pp.278–285. [Accessed 27 August 2019]. Available from: http://link.springer.com/10.1007/s40572-017-0148-x.

Winters, M., Friesen, M.C., Koehoorn, M. and Teschke, K. 2007. Utilitarian Bicycling. *American Journal of Preventive Medicine*. [Online]. **32**(1),pp.52–58. [Accessed 25 January 2019]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0749379706003990.

Appendix Three –Declaration of Academic Integrity

UNIVERSITY OF LEEDS

SCHOOL OF GEOGRAPHY

UNIVERSITY OF LEEDS

DECLARATION OF ACADEMIC INTEGRITY

This form must be completed, signed and attached to every dissertation submitted for a degree in Geography at the University of Leeds.

I have read the University regulations on cheating and plagiarism and I confirm that this piece of work is my own and does not include any unacknowledged work from any other sources.

I understand that the title of this dissertation and my name, as its author, may be included in an on-line catalogue of School of Geography dissertations. Also, that the mark/grade may be recorded on the dissertation when it is stored in the School of Geography. I agree to this.

Signed .... Date 29/08/2019

Surname VIDAL TORTOSA First Names EUGENI

Programme of Study: Postgraduate MSc

MSc in Data and Society

Dissertation title INEQUALITIES IN ACTIVE TRAVEL IN ENGLAND

Dissertation tutor: Dr. ROBIN LOVELACE Word length* 6,049

* Word length - exclude bibliography, appendix, tables, diagrams