WEB MATERIAL

Associations of Public Transport Use with Cardiometabolic Health: A Systematic Review and Meta-Analysis

Richard Patterson, Elizabeth Webb, Thomas Hone, Christopher Millett, and Anthony A. Laverty

Table of Contents

Web Appendix 1 – Search terms used in Medline (Ovid)

Travel Term

1. exp railroads/
2. ((Public adj transport*) OR commute OR commuting OR bus OR buses OR coach OR coaches OR train OR trains OR rail OR subway* OR metro OR tram OR trams OR underground OR (public adj transit) OR (mass adj transit) OR (active adj travel) OR (active adj transport)).mp
3. 1 or2

Outcome Terms

Diabetes

4. exp Diabetes Mellitus, Type 2/
5. (MODY or NIDDM or T2D*).mp.
6. (non insulin* depend* or noninsulin* depend* or noninsulin?depend* or non insulin?depend*).mp.
7. ((typ? 2 or typ? II or typ?2 or typ?II) adj2 diabet*).mp.
8. ((late or adult* or matur* or slow or stabl*) adj2 onset adj2 diabet*).mp.
9. or/4-8
10. exp Diabetes Insipidus/
11. diabet* insipidus.mp.
12. 10 or 11   (combines the two diabetes insipidus)
13. 9 not 12   (search for diabetes terms, not the insipidus terms)

Dysglycaemia

14. exp glucose intolerance/ or exp insulin resistance/ or exp blood glucose
15. ((glucose adj intoleran*) or (insulin adj resistan*) or (blood adj glucose) or (plasma adj glucose) or (metabolic adj syndrome) or glyc?emia).mp.
16. 14 or 15

Dyslipidemias

17. Exp dyslipidemias/ or exp triglycerides/ or exp cholesterol/ or exp lipoproteins/
18. (dyslipid?aemia* or tr?glyceride* or cholesterol* or hdl* or ldl* or lipoprotein* hyperlipid* or hyperlip?emia* or hypercholesterol* or hypercholester?emia* or hyperlipoprotein?emia* or hypertrigl?cerid?emia*).mp.
19. 20 or 21

Obesity

20. exp Obesity/ or exp overweight/ or exp body mass index/ or exp waist-hip ratio/ or exp Waist-height ratio/ or exp Waist circumference/ or exp Adipose tissue/
21. (obesity or overweight or (body adj mass adj index) or bmi or (body adj fat) or adiposity or (body adj weight)).mp
22. 20 or 21

Hypertension

23. exp Hypertension/ or exp Blood Pressure/
24. exp Hypertension/ or exp Blood Pressure/
25. ((blood adj pressure) or hypertens$).mp.
26. 23 or 24 or 25

CVD

27. cardiovascular diseases/ or exp heart diseases/ or exp vascular diseases/

28. cerebrovascular disorders/ or exp brain ischemia/ or exp carotid artery diseases/ or exp dementia, vascular/ or exp intracranial arterial diseases/ or exp "intracranial embolism and thrombosis"/ or exp intracranial hemorrhages/ or exp stroke/
29. (coronar$ adj2 (disease$ or event$)).mp.
30. (cerebrovasc$ or cardiovasc$ or angina$ or stroke or strokes).mp.
31. (myocardi$ adj2 (infarct$ or ischaemi$ or ischemi$)).mp.
32. (morbid$ adj3 (heart$ or coronar$ or ischaem$ or ischem$ or myocard$)).mp.
33. (vascular$ adj2 (peripheral$ or disease$)).mp.
34. (heart$ adj2 (disease$ or attack$)).mp.
35. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34

Mortality

36. Exp mortality/
37. (mortal* or death or fatal).mp

38. 36 or 37
39. 13 or 16 or 19 or 22 or 26 or 35 or 38
40. 3 and 39
41. limit 40 to (english language and humans)

Web Table 1. Additional characteristics of included studies

First Author, Year (Reference No.)	Exposure	Comparator	Outcome Definition	Sample Selection
Brown, 2008 (1)	Whether rode TRAX light-rail in the 2 weeks prior to being interviewed at time 1 and time 2. Ridership groups: almost half the respondents were continuing riders (45.8%, n = 22; six had no car access) who reported riding TRAX in the previous two weeks at both Time 1 and Time 2. New riders were the 22.9% (n = 11; two had no car access) who reported riding TRAX only at Time 2, when the new, closer stop opened. A final 31.3% (n = 15; one had no car access) were classified as non-riders. This last group, included two respondents who had ridden TRAX at Time 1 but not at Time 2. Three respondents did not answer the TRAX ridership question.	Direct comparison is not made but non-rider obesity is presented alongside obesity among new and continuing riders.	Objectively measured obesity. Portable stadiometers were used to measure height and scales to measure weight, and calculated body mass index (weight in kilograms divided by height in meters squared). Adult obesity is a BMI >30.	Study notifications were to all residential addresses within one half mile of the new stop, then phoned or visited door-to-door to recruit individual participants and obtain signed consents, as many residents did not own phones. Someone answered the door at 215 of the 496 potentially eligible addresses. From these, 102 participants were recruited, of whom 100 provided accelerometer data for the first measurement period (Time 1). During the second measurement period (Time 2): , 51 of the 100 residents who had complete data at Time 1 were recruited to complete the survey; 47 of these wore the accelerometer again. The remaining did not participate for a variety of reasons: 38 had moved, 1 was too ill, and 10 refused to participate again. Eligible participants included adult Spanish- or English-speakers in the study area who could walk a few blocks.
Brown, 2017 (2)	Any bus, light rail, or commuter rail trips, inside or outside the neighborhood, were included as transit travel; the city's light rail system was extended to the neighborhood in 2013. Transit use across two years resulted in four groups: never, continuing, former, and new riders.	Former and never users of public transit.	Objective change in BMI. Heights and weights were measured using calibrated scales and portable stadiometers, with BMI defined as kg/m^2	Adults were recruited in an area up to 2 km north and south of the complete street renovation area. Eligible adults from randomly sampled blocks included those who could walk a few blocks, spoke English or Spanish, were not pregnant, anticipated remaining in the neighbourhood for a year, gave informed consent, and provided at least 3 days of ≥10 h/day accelerometer wear along with GPS data. This study includes 536 adults with valid data who remained in the study in 2012 and 2013. There were 939 participants at time 1. By time 2, 403 participants were lost to follow-up: 283 participants moved, 77 did not have valid GPS data, 34 refused, and 9 became ineligible

Chen, 2017 (3)	% of state workers commuting by public transportation (U.S. DOT State Transportation Statistics). Lagged 1 year.		1) % state adults whose Body Mass Index (BMI) scores are above 30 (self-reported) 2) % state adults whose Body Mass Index (BMI) scores are between 25 and 29.9 (self-reported) From the CDC data	All 50 states of USA
Flint, 2016 (4)	At both time points, participants were asked "what types of transport do you use to get to and from work?" and were able to select one or more mode This was used to derive two binary variables indicating whether the respondent had experienced one of the following transitions between baseline and repeat assessment: transition from car commuting to active or public transport commuting or transition from active or public transport to car commuting.	Stable car users in change from car analysis Stable AT or PT users in change from AT or PT analysis	Objective change in BMI between baseline and follow-up was the primary outcome for study objectives 2 and 3. Anthropometric measurements were taken by trained staff. Height and weight, was used to derive BMI via the standard formula. Change in BMI was calculated for each individual by subtracting BMI at baseline from BMI at follow-up.	UK Biobank recruited adults aged 40–69 years to 22 regional assessment centres, via National Health Service (NHS) patient registers. The sample of individuals who were present at both baseline and follow-up was refined to include only participants with complete data for all analytic variables at both time points.
Hirsch, 2014 (5)	Euclidean distance between participants' addresses and the nearest bus route. Data were obtained from local planning departments, city governments, and regional entities. Neighborhoods were defined as a buffer around participants' addresses. Primary results are reported for 1-mile buffers. Sensitivity analyses were run with 1/2-mile buffers; results were similar and are not presented.	Those who had unchanged distance to bus stop	Objective BMI (kg/m^2) was calculated from weight measured to the nearest 0.045 kg (0.1 lbs), and height measured to the nearest 0.1 cm. Time-varying WC (cm) was measured at the umbilicus to the nearest 1 cm.	The sample included participants from the Multi-Ethnic Study of Atherosclerosis (MESA), a study of 6,814 US adults aged 45-84 years without clinical cardiovascular disease at baseline. Participants were recruited from six study sites (Baltimore, MD; Chicago, IL; Forsyth County, NC; Los Angeles, CA; New York, NY; and St. Paul, MN). After a baseline examination, participants attended four additional follow-up examinations occurring at approximately 1.5-2 year intervals. Of the 6,814 participants recruited in MESA, 6,027 were accurately geocoded, completed at least one subsequent exam, and were not missing information on obesity outcomes or built environment for the exams they attended. Of these, 521 were missing information on covariates (most missing information on total calories consumed), leaving a final sample size of 5,506.

MacDonald, 2010 (6)	Light-rail use was assessed during the follow-up (exposure) [following light-rail construction] interview through a question that asked respondents if they used light-rail to commute to work on a daily basis. A dichotomous indicator was created representing whether or not the respondent used LRT to commute to work.	Full time workers who did not use the LRT after it opened.	BMI was calculated in kg/m^2 using self-reported height and weight. Respondents with a BMI≥30 were coded as obese.	Data were collected on a sample of individuals living in Charlotte, NC near the site of the South Corridor Light Rail (LRT) line. Subjects were selected through phone sampling based on census tract addresses within a 1-mile radius of the LRT line before it started operating. The survey sample frame included household telephone numbers in the GENESYS database. A single adult member of each household was selected based on the individual with the most recent birthday. Approximately 839 adult household members were recruited to participate in a baseline survey before the opening (pre) of the LRT (45% response rate). A total of 498 respondents (60%) were re-interviewed after the LRT system became operational (post). Only subjects who maintained continuous residency in the catchment area were re-interviewed. The main observable cause of attrition from the baseline sample was for renters who moved out of the catchment area. The overall response rate at follow-up was 87%, with only 3% (n=20) refusals.
Martin, 2015 (7)	Switching commute mode: Participants reported their usual main mode of travel to work at t0, t1 and t2. For each wave, participants were categorised as using active modes of travel ('walking' or 'cycling'), public transport ('bus/coach', or rail: 'train' or 'underground/ metro'), or private motor transport ('car or van', 'car/ van passenger' or 'motorcycle'). Participants who reported using 'other' modes of travel were excluded from analysis.	Those who continued with the same private motor transport. Those who continued with the same PT mode	Change in self-reported BMI between t0 and t2. BMI in each wave was calculated by dividing self-reported weight by the square of self-reported height. Where height differed between waves, baseline height was used.	The BHPS is a nationally representative sample of households. Self-reported height and weight were in only two waves: t0, n=15 791 and t2, n=15 392. Data from these two waves and an intermediate wave t1, were used in these analyses. The sample used in the analyses (n=4056) was selected from the original BHPS sample at t0 (n=15 791). Participants eligible for inclusion in the analyses were those aged over 18 years who reported socioeconomic and health status characteristics and who reported their usual main mode of travel to work, height and weight at t0 and t2.

Park, 2017 (8)	Proximity to LRT line. Different buffer zones used, 3, 5 and 10 miles.	Residents of areas of Houston remote from the new LRT line. Outside the 10 miles buffer and a separate comparator was a Northwest region control area.	Mortality data were obtained from the Texas Department of State Health Services Center for Health Statistics for 2002–2005. Data were extracted concerning the number of daily deaths due to stroke [World Health Organization's International Classification of Diseases, 10th revision (ICD-10) code I60–I69].	Mortality data were obtained and decedents whose residences at the time of death were near the LRT— whose information was extracted using the 3-, 5-, and 10-mile buffers surrounding the LRT— were selected as the LRT exposure group. Two control groups, unaffected by the intervention, the first of which was those whose residences at the time of death consisting of 67 census tracts that are distant from the LRT. The second group was those whose residences at the time of death were outside the 10-mile buffer area falling within Harris County.
Sun, 2017 (9)	Self-reported distance to the nearest bus stop (km)	Those who had unchanged distance to bus stop	Change in self-reported BMI: calculated by the height and weight respondents reported	Twenty five provincial administrative units which account for 95% of the Chinese population (excluding Hong Kong, Macao and Taiwan) are covered by the survey sample of CFPS. Two periods of data which were gathered in 2010 and 2012, respectively are available. Since data on the built environment is from 2010, data for BMI and other variables come from 2012. This study focuses on the urban sub-sample. Deleting missing data, the sample for final analysis contains 8028 individuals distributed among 259 sub-districts of 127 districts and counties.
Webb, 2012 (10)	Data on usage of public transport have been collected at all four waves of ELSA. In the 2002 and 2004 waves, the question 'Do you use public transport. a lot, quite often, sometimes, rarely, or never?' was used, and in the 2006 and 2008 waves, the question was 'How often do you use public transport. every day or nearly every day, two or three times a week, once a week, two or three times a month, once a month or less or, never'. To ensure comparability across waves, binary variables were created, classifying individuals into users and non-(never) users of public transport at each time point.	Non-PT users	Body mass index (BMI), waist circumference, and total and central obesity. The 2004 and 2008 waves of ELSA included nurse visits to participants, from which measured height, weight and waist circumference are available, allowing BMI to be calculated for these years. Obesity was defined in two ways: as a BMI ≥30 kg/m^2 and as a waist circumference of ≥102 cm among men and ≥88 cm among women.	Data were drawn from ELSA, a nationally representative sample of over 50s living in England. The sample originally drew >11 000 people aged 50 years and older from the 1998, 1999 and 2001 Health Surveys for England, who were surveyed in 2002, with three further waves of data collection in 2004, 2006 and 2008.

Web Table 2

Study	Representativeness of the Exposed Cohort[6]	Selection of the Non-Exposed Cohort	Ascertainment of Exposure	Demonstration That Outcome of Interest Was Not Present At Start of Study	Comparability of Cohorts on the Basis of the Design or Analysis (Adjustment Variables)	Assessment of Outcome	Was Follow-up Long Enough for Outcomes to Occur?	Adequacy of Follow-up of Cohorts
Brown, B.et al. 2009	C	A	B	B	B	A	A	47%
Brown, B.et al. 2017	C	A	B	A	B	A	A	65%
Flint, E.et al.	B	A	B	A	A	A	A	21%
Hirsch, J.et al.	B	A	A	A	B[a]	A	A	68%
MacDonald, J.et al.	C	A	B	A	B	C	A	60%
Martin, A.et al.	A	A	B	A	B	C	A	88%
Park, E.et al.	C	B	A	B	B	B	A	n/a
Webb, E.et al.	A	A	B	A	B	A	A	?
Chen, C. et al.	A	A	B	A	A	C	A	n/a
Sun, B. et al.	C	A	B	A	A	C	A	?

See Web Appendix 2 for adapted Newcastle-Ottawa Scale criteria.

a – Adjusts for transport walking.

Web Appendix 2 - Newcastle-Ottawa Quality Assessment Scale: Cohort Studies

<u>Note</u>: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Selection

1) <u>Representativeness of the exposed cohort</u>
    a) truly representative of the average ____Person____ (describe) in the community ✸
        BHPS & ELSA
    b) somewhat representative of the average ___Person_____ in the community ✸
        MESA & UK Biobank
    c) selected group of users eg nurses, volunteers
        Includes: those selected based on proximity to public transport and a study using only urban residents.
    d) no description of the derivation of the cohort

2) <u>Selection of the non exposed cohort</u>
    a) drawn from the same community as the exposed cohort ✸
    b) drawn from a different source
    c) no description of the derivation of the non exposed cohort

3) <u>Ascertainment of exposure</u>
    a) secure record (eg surgical records) ✸
    b) structured interview ✸
    c) written self report
    d) no description

4) <u>Demonstration that outcome of interest was not present at start of study</u>
    a) yes ✸
    b) no

Comparability

1) <u>Comparability of cohorts on the basis of the design or analysis</u>
    a) study controls for _Physical activity__ (select the most important factor) ✸
    b) study controls for any additional factor ✸ (This criteria could be modified to indicate specific control for a second important factor.)

Outcome

1) <u>Assessment of outcome</u>
    a) independent blind assessment ✸
    b) record linkage ✸
   c) self report
    d) no description

2) <u>Was follow-up long enough for outcomes to occur</u>
    a) yes (select an adequate follow up period for outcome of interest) 6mo ✸
    b) no

3) <u>Adequacy of follow up of cohorts</u>
    a) complete follow up - all subjects accounted for ✸
    b) subjects lost to follow up unlikely to introduce bias - small number lost - > _50_ % follow up, or description provided of those lost) ✸
    c) follow up rate < 50% (select an adequate %) and no description of those lost
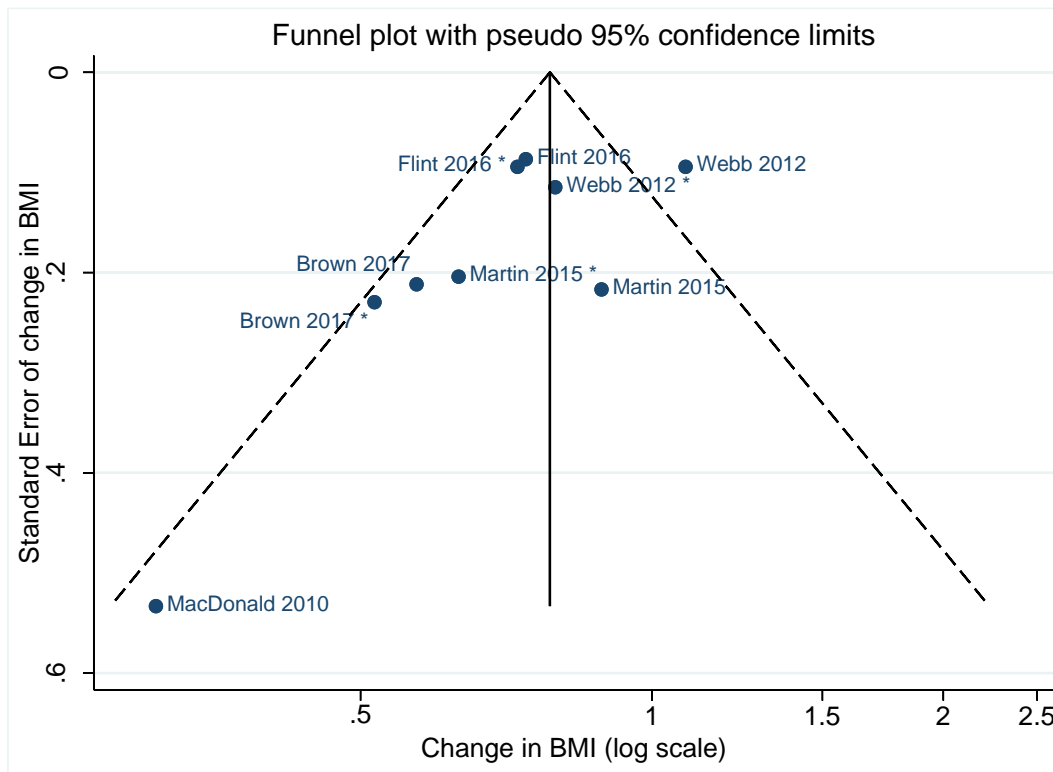   d) no statement

Web Figure 1 – Forest plot excluding MacDonald et al.
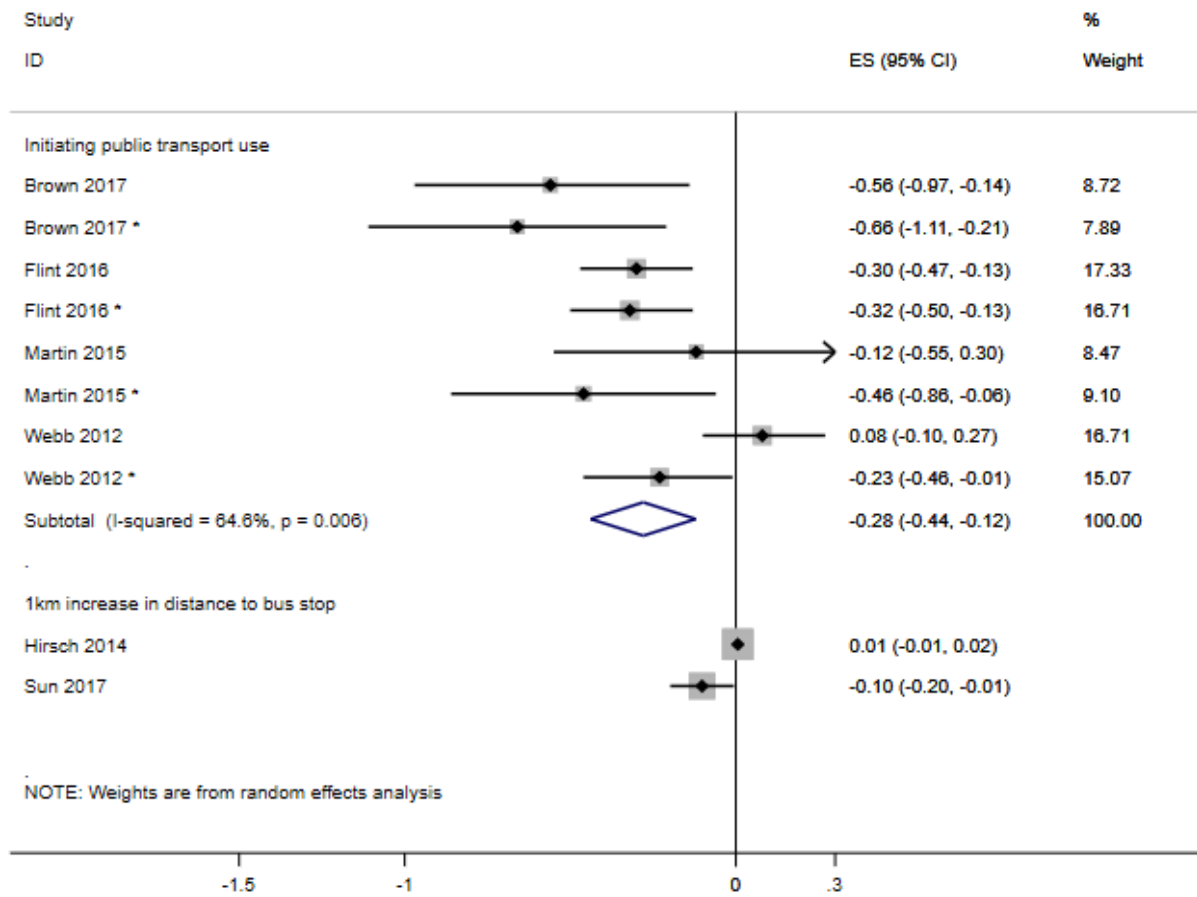
* Changed from public to sedentary transport, sign reversed to allow comparison.

The square surrounding the point estimates represent the weighting given within each analysis.

Web Figure 2 – Funnel plot of studies of change in public transport use and change in BMI.

References

1. Brown BB, Werner CM. Before and After a New Light Rail Stop: Resident Attitudes, Travel Behavior, and Obesity. *J Am Plann Assoc* 2008;75(1):5-12.
2. Brown BB, Tharp D, Smith KR, et al. Objectively measured active travel and uses of activity-friendly neighborhood resources: Does change in use relate to change in physical activity and BMI? *Preventive Medicine Reports* 2017;8:60-6.
3. Chen C, Menifield CE. An ecological study on means of transportation to work and obesity: Evidence from U.S. states. *Transport Policy* 2017;59:174-80.
4. Flint E, Webb E, Cummins S. Change in commute mode and body-mass index: prospective, longitudinal evidence from UK Biobank. *The Lancet Public Health* 2016.
5. Hirsch JA, Moore KA, Barrientos-Gutierrez T, et al. Built environment change and change in BMI and waist circumference: Multi-ethnic Study of Atherosclerosis. *Obesity* 2014;22(11):2450-7.
6. MacDonald JM, Stokes RJ, Cohen DA, et al. The effect of light rail transit on body mass index and physical activity. *Am J Prev Med* 2010;39(2):105-12.
7. Martin A, Panter J, Suhrcke M, et al. Impact of changes in mode of travel to work on changes in body mass index: evidence from the British Household Panel Survey. *J Epidemiol Community Health* 2015;69(8):753-61.
8. Park ES, Sener IN. Impact of light rail transit on traffic-related pollution and stroke mortality. *International Journal of Public Health* 2017:1-8.
9. Sun B, Yan H, Zhang T. Built environmental impacts on individual mode choice and BMI: Evidence from China. *Journal of Transport Geography* 2017;63:11-21.
10. Webb E, Netuveli G, Millett C. Free bus passes, use of public transport and obesity among older people in England. *J Epidemiol Community Health* 2012;66(2):176-80.