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Associations of active commuting with body fat and visceral adipose tissue: A cross-sectional population based study in the UK

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ABSTRACT

The promotion of active travel (walking and cycling) is one promising approach to prevent the development of obesity and related cardio-metabolic disease. However the associations between active travel and adiposity remain uncertain. We used the Fenland study (a population based-cohort study; Cambridgeshire, UK, 2005–15) to describe the association of commuting means with DEXA measured body fat and visceral adipose tissue (VAT) among commuters (aged 29–65 years; n = 7680). We stratified our sample into those living near (within five miles) and far (five miles or further) from work, and categorised commuting means differently for each group reflecting their different travel options. Associations were adjusted for age, education, Mediterranean diet score, smoking, alcohol consumption, test site and either self-reported physical activity or objective physical activity. Among those living near to work, people who reported regularly cycling to work had lower body fat than those who only used the car (adjusting for self-reported physical activity: women, −1.74%, 95% CI: −2.27% to −0.76%; men, −1.30%, −2.26% to −0.33%). Among those who lived far from work, people who reported regular car-use with active travel had lower body fat (women; −1.18%, 95% CI: −2.23% to −0.13%; men, −1.19%, −1.93% to −0.44%). Findings were similar for VAT and when adjusting for objectively measured physical activity instead of self-reported physical activity. In conclusion, active commuting may reduce adiposity and help prevent related cardio-metabolic disease. If people live too far from work to walk or cycle the whole journey, incorporating some active travel within the commute is also beneficial.

1. Introduction

The global epidemic of obesity and type 2 diabetes may in part be mitigated by the adoption of healthier lifestyles, including being more active (Wareham, 2014). Public health strategies to promote physical activity have had limited success to date (Das and Horton, 2012). Shifting travel patterns away from car-use and towards walking or cycling has been proposed as one means to enable large numbers of adults to be more active (Centres for Disease Control and Prevention, 2010).

While widespread adoption of active travel, and particularly active commuting, may have considerable potential to reduce obesity and the incidence of related cardio-metabolic disorders (Bassett et al., 2008), there still remains considerable scientific uncertainty concerning the nature and strength of associations between different modes of travel and adiposity.

Existing studies may not have adequately adjusted for dietary behaviour or other forms of physical activity. They have variously not adjusted for diet (Berglund et al., 2016; Gordon-Larsen et al., 2009; Larouche et al., 2016; Laverty et al., 2013; Lindström, 2008; Martin et al., 2015; Mytton et al., 2016; Wojan et al., 2015), characterised only part of the diet (e.g. fruit and vegetable intake) (Flint et al., 2014; Laverty et al., 2015; McKay et al., 2015; Millett et al., 2013; Rissel et al., 2014), or used measures that may be less appropriate (e.g. energy intake) (Flint and Cummins, 2016). Dietary energy intake tends to be poorly measured and much of the intra-participant variation may be accounted for by differences in physical activity (Willett and Stampfer, 1998). While several studies have adjusted for leisure-time physical activity (Flint et al., 2014; Flint and Cummins, 2016; Gordon-Larsen et al., 2009; Larouche et al., 2016; McKay et al., 2015; Millett et al., 2013; Mytton et al., 2016; Rissel et al., 2014) only three have explicitly adjusted for occupational physical activity (Gordon-Larsen et al., 2009; McKay et al., 2015; Mytton et al., 2016) and no study has adjusted for

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objectively measured physical activity.

Existing studies have also tended to consider 'usual' mode of travel to work (Berglund et al., 2016; Flint et al., 2014; Laverty et al., 2015, 2013; Lindström, 2008; Martin et al., 2015; Millett et al., 2013; Rissel et al., 2014), comparing car-use with walking and cycling. This may result in a biased comparison, because people who live near to work (and therefore could cycle or walk all the way) may be systematically different from those who live far from work (and therefore could not). For many commuters, it is also a somewhat uninformative exposure measure. Adopting walking or cycling as a 'usual' mode of travel is not practical for longer commutes. In the UK and the US commuting distances have been increasing (Kneebone and Holmes, 2015; Office for National Statistics, n.d.). The average point-to-point distance from home to work in the UK is 10 miles with over half of commutes being > 3 miles (Office for National Statistics, n.d.). While it is still possible to be active on a long commute by combining car or public transport use with walking or cycling, these patterns of commuting are seldom studied (Flint and Cummins, 2016).

Few studies have tested whether there is a dose-response relationship between active commuting and adiposity (Flint and Cummins, 2016; Laverty et al., 2013; Martin et al., 2015), which might support causal inference. All studies have reported associations for body mass index (BMI) (Berglund et al., 2016; Flint et al., 2014; Flint and Cummins, 2016; Gordon-Larsen et al., 2009; Larouche et al., 2016; Laverty et al., 2015, 2013; Lindström, 2008; Martin et al., 2015; McKay et al., 2015; Millett et al., 2013; Mytton et al., 2016; Rissel et al., 2014; Wojan et al., 2015), with some using self-reported BMI·(Berglund et al., 2016; Laverty et al., 2013; Lindström, 2008; Martin et al., 2015; Mytton et al., 2016; Rissel et al., 2014; Wojan et al., 2015) Few studies have described associations with measures that are more salient for metabolic disease, e.g. percentage body fat and waist circumference (Flint et al., 2014; Flint and Cummins, 2016; Larouche et al., 2016; Laverty et al., 2015).

The aim of this study was to contribute new evidence to support causal inference by testing the associations between active commuting (making meaningful comparisons between commuting patterns) and objective measures of adiposity (body fat and visceral adipose tissue) in a large study with detailed characterisation of physical activity (including objective measures) and dietary patterns.

2. Methods

2.1. Study settings and data collection

We used data from the Fenland study (ISRCTN72077169), an ongoing population-based cohort study of adults aged 29–65 years in Cambridgeshire, UK. Briefly, volunteers (n = 12,434) were recruited from general practice lists between 2005 and 2015. On entry to the study all participants were invited to attend one of three clinical research facilities, where they completed a general questionnaire (sociodemographic characteristics, general health, dietary patterns, smoking and alcohol consumption), a food frequency questionnaire (FFQ) and the Recent Physical Activity Questionnaire (RPAQ) (Besson et al., 2010). At this visit, body composition was assessed by dual-energy X-ray absorptiometry (DEXA; Lunar Prodigy Advanced fan beam scanner; GE Healthcare). After their visit each participant completed up to six days of objective physical activity monitoring by combined heart rate and movement sensing (measured by Actiheart®) (Brage et al., 2005). The study was approved by the Cambridge Local Research Ethics Committee. All participants gave written informed consent.

2.1.1. Physical activity and food frequency questionnaire: psychometric properties

The RPAQ asked about physical activity in the past four weeks across four domains: at home, occupational, transport and leisure. It was based on the previously validated EPIC-Norfolk Physical Activity Questionnaire 2 (EPAQ2) (Wareham et al., 2002). Estimates of time in vigorous activity and total physical activity energy derived from the questionnaire have been shown to correlate well with objective measures of physical activity (Besson et al., 2010). Repeated estimates of overall and domain-specific physical activity from the questionnaire have been shown to have good agreement. While the individual questions that we made use of have not been validated, the questions on leisure time activity and occupational activity were based on Minnesota Leisure Time Physical Activity Questionnaire and Tecumseh Occupational Physical Activity questionnaire, which have been validated elsewhere (Ainsworth et al., 1993; Richardson et al., 1994; Wareham et al., 2002).

The 130 item FFQ was originally developed for use in the EPIC-Norfolk study (O'Connor et al., 2015). It has been shown to have good ability to rank individuals based on intake of nutrients or food groups (e.g. correlation with weighted dietary records of 0.4–0.6 as well as showing correlation with biomarkers indicative of dietary intake) (Bingham et al., 2008, 1997).

2.2. Exposure measure: commuting

Commuting mode was assessed in the RPAQ, with the question "how did you normally travel to work?" Participants could indicate one or more modes of travel (car/motor vehicle, works or public transport, bicycle, and walking) and a frequency for each (always, usually, occasionally or never).

Our aim was to categorise participants to enable comparisons reflecting real-world choices that commuters might face, reflecting the constraints on travel choice imposed by a long commute (Dalton et al., 2013). We stratified our sample based on distance to work. We assumed those who lived within five miles of work could, in principle, walk or cycle all the way to work, whereas those who lived further from work would use a car or public transport.

Stratifying the sample in this way, we categorised participants who lived within five miles of work into one of five commuting patterns (car only, regular walking, regular cycling, car-use with occasional walking, car use with occasional cycling), and those who lived five miles or further from work into one of three patterns (car-use, public transport, car-use with active travel). Post-hoc, given the differences observed between cycling and walking, we re-classified those living five miles or further from work into one of four categories to test separate associations for cycling, walking and public transport use that was not associated with either (see Methods Supplement).

2.3. Outcomes: body fat and visceral adipose tissue

Percentage body fat and volume of visceral adipose tissue (VAT) were estimated from the DEXA scan using Encore software (v14.10.022) (De Lucia Rolfe et al., 2010). Percentage total body fat was estimated using a three-compartment model (fat mass, fat-free mass, and bone mineral mass). The software used an inbuilt algorithm to determine visceral adipose tissue (cm^3) within the android region (the region outlined by iliac crest and with a superior height equivalent to 20% of the distance from the top of the iliac crest to the base of the skull).

Estimates of VAT derived from DEXA scans have been shown to have good agreement with gold-standard estimates from CT scan (Micklesfield et al., 2012). Because the distribution of estimates of VAT was highly skewed, these were transformed using a square root function.

2.4. Inclusion and exclusion criteria

We only included participants who were employed and reported regular travel to work (i.e. reported using at least one mode of travel either 'usually' or 'always'). Exclusion (and inclusion) criteria are