Journal of Transport & Health 1 (2014) 295–304

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Modelling the potential impact on CO_2 emissions of an increased uptake of active travel for the home to school commute using individual level data

Nick Bearman *, Alex D. Singleton

Department of Geography and Planning, School of Environmental Sciences, University of Liverpool, Gordon Stephenson Building, 74 Bedford Street South, Liverpool L69 7ZQ, United Kingdom

ARTICLE INFO

Available online 11 November 2014

Keywords:
Home to school commute
Active travel
Criterion distances
Walking
Cycling
Norfolk

ABSTRACT

Active travel for the home to school commute is an ideal opportunity to improve pupil's physical activity levels. Many studies have looked at how pupils travel to school and the motivating factors behind these decisions. This paper applies an innovative methodology to model each pupil's individual route to school and then evaluates how different policy changes could increase the uptake of active travel. The changes are quantified in terms of the proportion using active travel, CO_2 emissions and criterion distances: a method of measuring how far pupils are willing to travel using a certain mode of transport. Findings suggest that the greatest reduction in CO_2 and increase in health benefits can be made by encouraging more primary school pupils to use active travel and targeting schools with existing low levels of active travel.

1. Introduction

There are important positive health benefits associated with undertaking physical activity, and active travel (e.g. walking or cycling) has been linked in numerous studies to positive outcomes such as increased life expectancy, reduced risk of obesity and lower rates of heart disease (Cohen et al., 2014; Faulkner et al., 2009; Harrison et al., 2011). Active travel has the potential to fulfil UK government recommended levels of physical activity of 150 min of moderate intensity activity per week for adults (Department of Health, 2011). This could be completed during some commutes, for example, walking two 1 mile journeys or cycling two 3 mile journeys daily would satisfy the recommended levels of physical activity for adults (Cohenet al., 2014). Higher levels of physical activity are recommended for children depending on their age (Department of Health, 2011), but travelling from home to school provides an ideal opportunity to fulfil such daily requirements (Harrison et al., 2011).

However, in the past 40 years, levels of active travel have decreased across all groups (Faulkner et al., 2009), and this trend has been acutely observed in school pupils (McMillan, 2007; Trang et al., 2012). The adoption of less sustainable and more polluting forms of travel have impacts over a range of scales on public health, the environment and their interaction. At the local level, this will include direct health impacts as a result of lower levels of physical activity (Faulkner et al., 2009), however, the majority of the research studies on children in this area are cross-sectional rather than interventional, so it is not possible to show direct health impacts from decreasing active travel (Schofield and Badland, 2005). A small number of studies show an increase in the number of kilocalories expended by children who actively commute to school, and a decrease in body weight, but the overall evidence is not compelling (Faulkner et al., 2009). This is in contrast to adult studies, where the health benefits of physical activity are well understood (Baker et al., 2014). Indirect health impacts from lower levels of physical activity are more widely studied, as increased exposure to pollutants including NO_x and $PM_{2.5}$ results in further health impacts, including poor metabolic health (Ekelund et al., 2007), skeletal problems (Prentice et al., 2006) and respiratory issues (McConnell et al., 2010). Furthermore, increased traffic congestion around school premises concentrates greater emissions within these localities (McConnell et al., 2010; Mohai et al., 2011), and additionally increases danger to school children from traffic accidents (Collins and Kearns, 2001). Such impacts also cumulate at the global scale, with CO_2 and water vapour emissions having impact on climate

* Corresponding author. Tel.: +44 151 794 1355.
E-mail addresses: n.bearman@liverpool.ac.uk (N. Bearman), alex.singleton@liverpool.ac.uk (A.D. Singleton).

http://dx.doi.org/10.1016/j.jth.2014.09.009

change; the health implications of which already have considerable evidence (McMichael, 2006). CO_2e (carbon dioxide equivalent) is regularly used as a measure for the impact of all greenhouse gases (IPCC, 2007 Table 2.14) including in figures used by the UK central government (DEFRA, 2012). It is estimated that the home to school commute in England contributes 658k tonnes of carbon each year (DCFS, 2010), and therefore there are potentially substantial environmental benefits for pupils to adopt more sustainable travel behaviours.

Due to the regularity with which pupils travel to and from school, their mode of travel has been shown to have a significant impact on their total physical activity levels (Harrison et al., 2011). Furthermore, those exercise habits formed during childhood have been shown to influence behaviour in later life (D'Haese et al., 2011; Tudor-Locke et al., 2001), and as a result, if exercise through active travel on the commute to school is encouraged, this can augment those immediate benefits with potential longer term health impacts related to adulthood behaviour change. The importance of active travel within this setting is not new, and a number of initiatives, such as school travel plans (STP) and walking buses have been developed in order to encourage more active travel. Walking buses were first established in Canada in 1996, and have since spread to a range of countries across the world including New Zealand, Canada, the US, Denmark and the UK (Kingham and Ussher, 2007; Mackett et al., 2003; Mendoza et al., 2012). They are designed to encourage more children to walk to school by providing a safe, supervised route. In England, a national policy was adopted of developing school travel plans (Department of Education, 2010) to provide support for increasing active travel. Given that local authorities are primarily responsible for school education, the implementation levels of STPs varied across the country, and the effectiveness of STPs on promoting active travel has been argued as limited (Department of Education, 2010; Rowland et al., 2003).

Given the prevalence of active travel linked interventions as part of the home to school commute, the environmental and health impacts are correspondingly well studied. However, a number of different methodological approaches are taken to estimate, model or record pupil routes between the home and school, in order to quantify the relationship. These range from straight-line distance measuring, simulated routes within a Geographic Information System (GIS), Global Positional System (GPS) track analysis, self reporting in a diary and self reporting on a map (for example, D'Haese et al., 2011; Harrison et al., 2011; Kerr et al., 2006; Panter et al., 2008).

This paper implements a measure called criterion distances, which represents the cumulative percentage of pupils using a particular mode of transport within a given set of distance bins. The term was initially coined in Ireland by Nelson et al. (2008) and developed in Belgium by Van Dyck et al. (2010) and D'Haese et al. (2011). Using a set of transport data it is possible to explore those thresholds of distance at which modes are likely to swap, and in combination with traditional measures (mean distance, proportion) give an informative overview of travel behaviours. Nelson et al. (2008), Van Dyck et al. (2010) and D'Haese et al. (2011) use the threshold of distance that represents where 85% of pupils commute from as the criterion distance, and this is interpreted as the maximum distance that pupils are prepared to travel by active travel (Van Dyck et al., 2010). Such distances are typically derived empirically, based on an interpretation of distance/mode choice graphs such as those presented in Fig. 1. Along the *x*-axis, a series of bins distribute pupils travelling to school at these distances by their share of transport mode which are plotted as cumulative percentages (*y*-axis). Fig. 1 uses data for Norfolk primary schools ($N=435$) and secondary schools ($N=77$), which will be introduced as our case study region later in this paper. The spike/dip in primary schools at 11–11.5 km is an outlier as a result of the small N at this distance, and in similar national graphs would be smoothed away.

Table 1 provides a summary of a number of different studies looking at the home to school commute from a selection of European countries, as well as data from the "SPEEDY" studies that relate to primary and secondary school commuting for children in a number of schools in Norfolk (Harrison et al., 2014, 2011). The SPEEDY study (Sport, Physical activity and Eating behaviour: Environmental

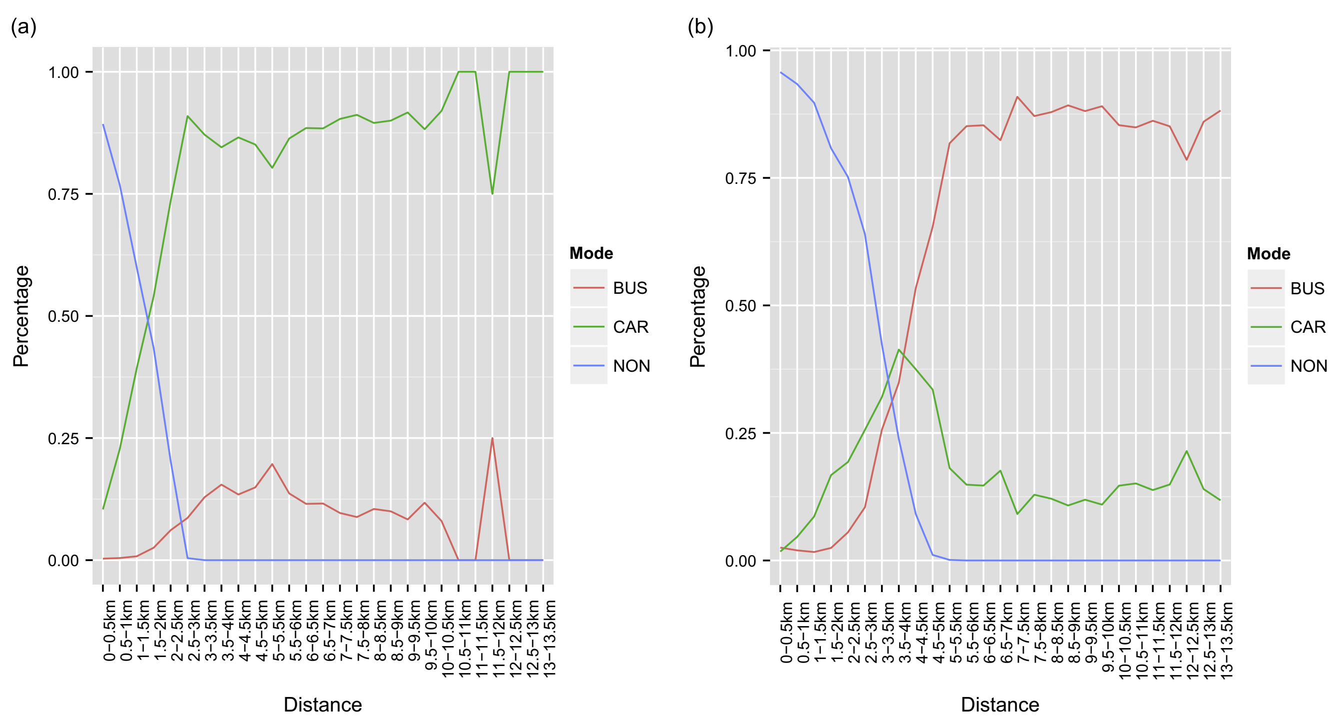

Fig. 1. Distance/mode choice graphs of primary schools (left) and secondary schools (right) home to school travel choices. Notice the difference in importance of the car and bus in primary school and secondary school travel. NON=non-motorised transport (e.g. walking and cycling).