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Factors influencing active travel to primary and secondary schools in Wales

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ABSTRACT

This paper examines the factors associated with active travel to school on an average (typical) school day in Wales and contrasts these findings between primary and secondary school children. The analysis was based on data for 4206 primary school children (4–12 years of age) and 3203 adolescents (12–19 years of age) collected as part of the 2013/2014 and 2014/2015 waves of the National Survey for Wales. Logistic regression estimates showed that living within less than one mile from the school, parents' frequency of walking and cycling and residing in an urban area were positively associated with active travel to both primary and secondary schools. Children's age, mother's unavailability and home ownership were negatively associated with active travel to primary school. Gender differences were only identified in the secondary school trips with female adolescents being less likely to walk to school than males. Findings point to the importance of 'beyond-the-school' active-travel campaigns and intervention programmes aimed at involving parents in encouraging walking and cycling to school.

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Active travel to school; primary school; high school; walking; youth; UK

1. Introduction and background

In 2012, the World Health Organisation (WHO) reported that 170 million children (10%) under the age of 18 years were estimated to be overweight or obese worldwide (Lobstein, Baur, and Uauy 2004, cited in; World Health Organisation 2012). Obesity has been associated with a number of diseases such as type 2 diabetes, cardiovascular disease and different types of cancer (American Institute for Cancer Research and World Cancer Research Fund 2007; Buttitta et al. 2013; Laverty et al. 2013; Ottova et al. 2011). In addition, overweight children may also incur psychological problems negatively affecting their quality of their life; for example, due to teasing, lower self-esteem or discrimination (Black et al. 2014; Ottova et al. 2011; Riazi et al. 2010; Wille et al. 2010).

Since the 1970s, the number of overweight children has been increasing across many countries (World Obesity Federation 2014). In the United Kingdom (UK), the highest level of childhood obesity is found in Wales where in 2012, 15% of children were overweight and 19% were obese, respectively (Public Health England 2015; Welsh Government 2015d). Recent projections estimate that the proportion of obese children in Wales could reach 25% by 2050, if no action is taken (Welsh Government 2015d).

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There is evidence that active travel can reduce the risk of being overweight and its associated health consequences (Laverty et al. 2013). One of the initiatives to tackle childhood obesity is by promoting active travel (walking and cycling) to school (World Health Organisation 2012). Such initiatives also arise as a response to a dramatic decline of active travel to school and a substantial increase of commuting children by car across many countries. In Wales, for example, during the period 1971–2011, the use of private motorised transport for commuting to work has doubled, whereas walking decreased by almost half and cycling remained constant at only about 2% (Goodman 2013). Such trends may be explained by the remarkable increase of car ownership in the country; for example, UK Department for Transport data show that car ownership increased by 43% between 1994 (1.006 million cars) and 2011 (1.437 million cars) (Department for Transport 2013). Understanding which factors are associated with active travel to school may help to identify interventions to promote active travel to school.

A large body of evidence documented in a series of literature- (e.g. Panter, Jones, and van Sluijs 2008; Sirard et al. 2005) and systematic-reviews (e.g. Brunton et al. 2003; Faulkner et al. 2009) shows that empirical studies offer a wide array of findings, which either cannot be generalised or are inconsistent. Given the size of evidence and to save space, we present key findings of a selection of the most recent studies on active travel to school in Appendix 1. Inconsistencies across studies may be due to study design limitations including availability of recent or directly relevant survey data to study active travel (e.g. Mitra and Buliung 2015), measurement bias and cross-country variations (McDonald et al. 2011). Finally, the majority of the studies concentrate on the United States (US) and only recently studies contrast differences between primary and secondary school children (Mitra and Buliung 2015).

Differences may also exist because of different variable specifications. For example, among physical environmental factors (see Appendix 1), distance has been the key determinant of active travel to school across all studies. However, differences are observed in the specification of what may be an acceptable distance to encourage walking or cycling to school. For example, in a recent analysis of Scottish data, Waygood and Susilo (2015) reported that children were more likely to walk or cycle if they lived within 0.78 km (0.5 miles) from their school. On the other hand, van Goeverden and de Boer's (2013) study in Flanders (Belgium) and the Netherlands considered a 'cut-off' point of 3 km for cycling, whereas for walking D'Haese et al. (2011) and Christiansen et al. (2014) defined 'cut-off' points at 1.5 km in Belgium (c. 1 mile) and 4 km in Denmark, respectively.

Some studies find an association between active travel to school and the factors listed in Appendix 1 and others do not. Moreover, physical and environmental variables may be captured in different ways – for example, parent perceptions vs. physical measures. For example, parents' road safety perceptions in some studies were significantly associated with active travel to primary and secondary schools across a number of US cities (Carlson et al. 2014; Chillón et al. 2014) whereas Babey et al. (2009) reported that parents' road safety perception was not associated with travel to secondary school in California. Babey et al. (2009), Jensen (2008), Waygood et al. (2015), Chriqui et al. (2012) and Buliung et al. (2011) reported significant associations between active travel and objective measures of road safety and related physical and non-physical interventions including safe routes to school, school travel plans and walking school buses.

Hypotheses related to physical and environmental factors also vary according to data availability and the geographic scale of analysis. For example, national- or state/region-level analyses find significant associations between active travel to primary and secondary schools and the level of urbanisation, namely urban, suburban vs. rural/not urbanised (e.g. Babey et al. 2009; van Goeverden and de Boer 2013). Other studies are based on measures of land-use mix – for example, the mix of employment and population (Mitra, Buliung, and Faulkner 2010) or parents' perceptions regarding adequate walking and cycling infrastructure (Panter et al. 2010b; Susilo and Liu 2015; Waygood and Susilo 2015). Finally, Waygood and Susilo (2015) found that living with 'friendly people in the neighbourhood' was not associated with active travel to primary school in Scotland. However, other forms of social capital such as social control have been associated with active travel to school. McDonald, Deakin, and Aalborg (2010), for example, found that children whose parents reported high levels of social control were more likely to walk or cycle to school. The study was based on a sample of 357 parents residing in the San Francisco Bay Area between 2006 and 2007.

Studies also report on a number of adjustment variables related to child and parent/household characteristics. Child-related variables typically include age and gender and both involve mixed findings. A number of studies indicate that age is a significant factor associated with travel to school – that is, children aged 5–10 years are less likely to walk to school primarily due to safety concerns (e.g. Chillón et al. 2010; DiGuiseppi et al. 1998; Mitra and Buliung 2014). Evidence from a longitudinal analysis of 7690 school-aged children in Canada showed that as children's age increased the likelihood of walking or cycling to school also increased, but it peaked at the age of 10 years and then declined (Pabayo, Gauvin, and Barnett 2011). Susilo and Waygood (2012) also reported that 10–14-year-olds in Japan were less likely to be chauffeured on a given day (including school trips) when compared with their 5–9-year-old counterparts. However, 10–14-year-olds were more likely to participate in a higher number of car trips relative to 15–19-year-olds. By contrast, evidence from Australia showed that pupils aged 11–12 years were equally less likely to walk when compared to pupils aged 5–6 years (Timperio et al. 2006).

Gender has also been reported as an important factor to be taken into consideration both for children and adolescents, especially for the design of interventions (Panter et al. 2011). In many cases, there are slight or insignificant differences between boys and girls when travelling to primary school (McDonald et al. 2011; Mitra and Buliung 2015), whereas male adolescents are more likely to walk or cycle than female adolescents (Babey et al. 2009; Emond and Handy 2012). Interestingly, Susilo and Waygood (2012) found that girls in Japan were less likely to be chauffeured by car for their daily trips compared with boys.

Inconsistent results with regard to household characteristics such as, family income, parental education and employment and parental use of active-travel modes are probably due to differences across countries. de Vries et al. (2010) reported that the results of studies conducted in the US frequently differ from those conducted in Europe. Also, Panter et al. (2010a) argued that the results from studies conducted in the US can be different than those in Australia. An example is the relationship between income and active travel to school. McDonald et al. (2011) found that American pupils of households earning over $100,000 per year were more likely to walk or cycle to school than those whose parents

earned less than $30,000 per year. In the Scottish study by Waygood and Susilo (2015) income was not significantly associated with active travel and was not retained in the final models. On the other hand, Silva et al. (2011) found that children in high-income households in Brazil were less likely to walk or cycle to school. In the absence of income data, some studies have used housing tenure (e.g. owner occupied, rented and social housing) as a measure of socio-economic status. For example, DiGuiseppi et al. (1998) reported that children living in owner-occupied accommodation in Camden and Islington, London, were twice as likely to travel to school by car than children living in rented or housing-association accommodation. Finally, there has been little evidence on how parents' own use of active-travel modes may be associated with children and adolescent active travel and active travel to school, in particular.

Given variations on how different factors are measured, differences in findings and lack of evidence in the some cases, it is important to report findings from other countries, especially those with high prevalence of overweight and obesity. Therefore, the primary contribution of this paper is that it reports evidence on active travel to school in Wales, a country with very high childhood obesity rates using nationally representative data. In particular, the study examines how travel behaviour of Welsh primary school children and adolescents is associated with physical/environmental factors, child and parent characteristics. The study also contrasts differences between primary school children and adolescents as some case studies in the US and Canada have highlighted differences when children enter secondary school (McDonald 2006; Mitra and Buliung 2015).

2. Data

Data from the National Survey for Wales (NSW) for 2013/2014 and 2014/2015 were used in this study (Welsh Government 2015b, 2015c). The NSW is a repeated cross-sectional survey based on probability sample design, which has been conducted between 2012 and 2015. The NSW is a key source of information for the Welsh Government on the views and circumstances of people in Wales. Each year, approximately 14,500 individuals over the age of 16 years are surveyed using face-to-face interviews; topics and related questions include education, health and transport (Welsh Government 2014, 2015c).

The 2013/2014 and 2014/2015 waves are the only ones to include data on travel to primary (4–12 years of age) and secondary (12–19 years of age) schools over the previous year from the day the survey was conducted. It is therefore worth highlighting that the survey data include the child's age at the time of the survey hence the age of secondary school children may in some cases exceed the 18 years of age and the age of some primary school children may be 13 years. Also, because the mode choice question was formulated as 'usual mode' over the past 12 months', a child in the age of 11/12 years would have answered questions about travel to both primary and secondary schools, again depending on the time survey was conducted.

3. Explanatory factors and statistical analysis

The explanatory factors in this study were classified into: (1) moderating (child/adolescent age and gender), (2) physical/environmental factors, (3) parent/guardian and household characteristics and (4) other factors, namely the quarter and year of the data collection.

The above variable classification was guided by data availability and findings from the literature review in Appendix 1. The selection of variables was also informed by Panter, Jones, and van Sluijs's (2008) theoretical framework on active travel to school, which was developed through an extensive review of findings across the subject areas of transport, planning and promotion of health and physical activity.

Among the *physical and environmental factors* considered was distance to school, which was defined by three intervals: (a) less than 0.78 km (0.5 miles); (b) 0.78–1.6 km (0.5–1 mile) and (c) greater than 1.6 km (1 mile). The selected distance intervals were in line with the categories introduced in the NSW questionnaire and were measured according to the parents' perception of the average distance between their home and the school. We also grouped children and adolescents into two groups based on whether they lived in rural Wales (vs. urban and suburban). Parent (guardian) perceptions about the local area were captured by two five-point Likert-scale questions: (a) 'belonging to local area' and (b) 'people treating each other with respect'. *Parent (or guardian) and household characteristics* included the number of children and whether the household sought support for problems with debt in the previous 12 months. We also included factors related to mothers' (or female guardians') availability – by creating the dummy variable 'mother in full-time employment', parent (or guardian) education level ('highest education qualification)' and whether 'parents had a limiting long-standing illness, disability or infirmity'. Family culture towards walking and cycling was captured by the frequency of parents' walking and cycling per week introduced as (a) cycling and (b) walking at least 1–2 times week, respectively. Finally, the housing tenure variable classified children and adolescents into three groups: (a) living in owner-occupied home, (b) social housing and (c) rented accommodation.

Logistic regression modelling examined the association between active travel to primary and secondary schools and the above mentioned physical/environmental, parent/guardian and household characteristics. The analysis was conducted within the Complex Samples Add-On Module on IBM SPSS Statistics 23. The Complex Samples Module was used to take into account the survey design and produce confidence intervals for the survey data (Welsh Government 2015a). Considering the cross-sectional nature of the samples we introduced dummy variables to capture potential differences across survey waves and the year of the survey (2013/2014 or 2014/2015). Preliminary analyses were based on estimating separate logistic regression models for each of the explanatory factors while each run controlled for the age and gender of the child and adolescent in the primary and secondary school samples, respectively.

4. Results

4.1. Exploratory analysis

Table 1 the characteristics of the children, adolescents, primary respondents and household in the sample. As shown in Table 1, there were 4206 primary school children and 3203 adolescents in the combined sample of the 2013/2014 and 2014/2015 waves of the NSW, respectively. The majority of respondents lived in urban areas in owner-occupied accommodation. Most parents stated that they were working and more than a third had higher education qualification in both the primary and secondary school samples.

Table 1. Descriptive statistics in the primary and secondary school samples in Wales.

	Primary school ($N = 4206$) (4–12-year-olds)	Secondary school ($N = 3203$) (13–19-year-olds)
Children characteristics		
Gender		
Females	49.3%	50.1%
Age		
4–6	37.9%	
7–9	34.5%	
10–12	27.5%	
12–13		43.2%
14–16		25.9%
17–19		7.1%
Parent/guardian and household characteristics		
In employment	74.4%	77.2%
Has a limiting long-standing illness, disability or infirmity	14.6%	19.0%
Highest educational qualification		
Levels 4–8 (certificate, diploma of higher education, bachelor's degree, master's or doctorate)	37.9%	35.9%
Levels 1–3 (GCSE, diploma, A-level or equivalent)	53.6%	53.7%
No qualification	8.5%	10.5%
Frequency of cycling		
Every day	1.1%	0.6%
Several times a week	3.0%	2.0%
1–2 times a week	3.2%	3.2%
No active travel by bicycle	92.7%	94.2%
Frequency of walking		
Every day	24.6%	21.4%
Several times a week	26.0%	23.5%
1–2 times a week	20.5%	20.9%
No active travel by walking	28.9%	34.2%
Housing tenure		
Owner-occupied	62.1%	70.6%
Social housing	18.7%	17.2%
Private rented	19.2%	12.1%
Residing in an urban area	76.8%	73.3%
Travel mode to/from school		
Cycle/walk	36.2%	25.8%
Bus/train	7.9%	39.7%
Car	40.6%	21.1%
Combined modes (car and bus; car and walk, etc.)	15.3%	13.3%
Active/Inactive travel mode to/from school		
Active	36.2%	25.8%
Inactive	63.8%	74.2%
* Includes combined modes (car and bus; car and walk, etc.)	13.7%	7.9%

In terms of active travel, although most parents did not cycle (92.7% in the primary and 94.2% in the secondary school samples) half of the parents stated that they walked several times per week or every day.

The dependent variable was the choice between active (walking and cycling) and non-active travel modes to school on a typical day. Active-travel was defined as parents' (or guardians') indication that the usual mode to/from school was solely walking or cycling whereas non-active travel included car, public transport as well as combinations of active and non-active travel modes such as car and walking or bus and walking. Overall, as shown in Table 1, 36.2% of children and 25.8% of adolescents solely walked or cycled to primary and secondary schools, respectively. Out of the 63.8% of primary school children who used non-active travel modes to/from school, 13.7% of those reported using a combination of non-active or active and non-active modes (e.g. car and bus; car

and walk). In the case of adolescents, 74.2% of the sample travelled by non-active travel modes with 7.9% of that proportion who used a combination of non-active or non-active- and active-travel modes.

Figure 1 shows the percentage of active commuting to primary and secondary schools by unitary authority, an administrative unit for local government in Wales. Between 42% and 52% of children in the areas of Cardiff, Newport, Caerphilly, Conwy, Flintshire and Wrexham walked or cycled to primary school. The proportion of children across Blaenau Gwent, Monmouthshire, Torfaen, Vale of Glamorgan and Cynon who actively commuted to primary school ranged between 33% and 41%. Twenty (20%) to 32% of children cycled or walked to primary school across Bridgend, Neath Port Talbot, Swansea, Pembrokeshire, Carmarthenshire Rhondda, Merthyr Tydfil, Powys, Gwynedd, Isle of Anglesey and in Denbighshire. Finally, in Ceredigion less than 20% of children walked or cycled to primary school. As also shown in Figure 1, the highest percentage of children who cycled and walked to secondary schools was found in Cardiff (44.7%) and the second highest proportion was in the Vale of Glamorgan (33.6%). For a large number of unitary authorities, active travel to secondary school ranged between 20% and 32%, namely across the areas of Newport, Torfaen, Monmouthshire, Blaenau Gwent, Caerphilly, Cynon, Bridgend, Swansea, Pembrokeshire, Gwynedd, Conwy, Isle of Anglesey, Denbighshire, Flintshire and Wrexham. Finally, less than 20% of children walked or cycled to school in Neath Port Talbot, Carmarthenshire Rhondda, Powys, Merthyr Tydfil and Ceredigion.

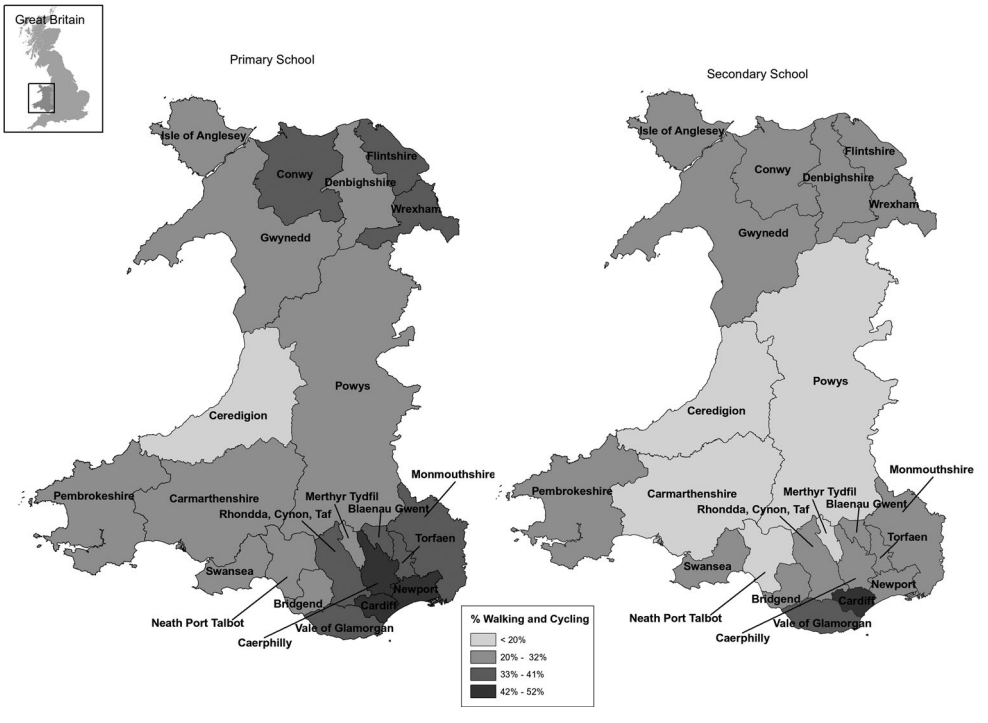

Figure 1. Active travel to primary and secondary school by unitary authority.

4.2. Factors associated with active-travel to school in Wales

Table 2 presents results from separate logistic regression models one for each explanatory factor (e.g. distance to school) and each time controlling for child/adolescent age and gender in both the primary and secondary school samples (nb: age and gender coefficients are not reported in Table 2).

4.2.1. Physical/environmental factors

Shorter (self-reported) distance to primary and secondary schools was positively associated with active travel to school. Children and adolescents who lived under 0.5 miles (0.78 km) or between 0.5 and 1 mile (0.78–1.6 km) from the school were more likely to walk or cycle to/from school than those living farther than 1 mile (1.6 km).

Also, children and adolescents who lived in rural areas were less likely to walk or cycle to school. On the other hand, parents' perceptions of 'belonging to local area' and 'feeling that people treat each other with respect' were not significantly associated with active travel to/from school.

Table 2. Logistic regression models of factors associated with active travel to school adjusted for child/adolescent age and gender.

	Primary school (4–12-year-olds) Coeff. [conf. intervals]	Secondary school (13–19-year-olds) Coeff. [conf. intervals]
Physical/environmental factors		
Distance to school		
Under 0.5 miles	3.748 [3.435, 4.061]**	4.487 [4.058, 4.916]**
0.5–1 mile	2.382 [2.061, 2.702]**	3.077 [2.761, 3.394]**
More than 1 mile	Reference	
Household lives in rural Wales	−0.840 [−1.033, −0.647]**	−1.282 [−1.551, −1.012]**
Perceptions about the local area		
Belonging to local area	−0.070 [−0.185, 0.046]	−0.102 [−0.263, 0.059]
People treating each other with respect	0.088 [−0.028, 0.204]	−0.003 [−0.140, 0.135]
Parent/guardian/household characteristics		
Number of children	0.183 [0.091, 0.276]**	0.116 [0.019, 0.214]**
Used services of any organisations providing advice and support for people having problems with debt in last 12 months	0.420 [0.106, 0.735]**	−0.059 [−0.453, 0.335]
Female employed full time	−0.539 [−0.702, −0.376]**	0.102 [−0.104, 0.308]
Higher education qualification (Levels 4–8)	−0.451 [−0.627, −0.275]**	−0.226 [−0.448, −0.004]**
Active travel by bicycle at least 1–2 times a week	0.579 [0.277, 0.881]**	0.448 [0.040, 0.857]**
Active travel on foot at least 1–2 times a week	0.934 [0.744, 1.123]**	0.696 [0.458, 0.933]**
Having a limiting long-standing illness, disability or infirmity	0.466 [0.249, 0.683]**	0.057 [−0.202, 0.316]
Housing tenure		
Owner occupied	−0.648 [−0.863, −0.434]**	−0.240 [−0.552, 0.072]
Social housing	0.467 [0.217, 0.718]**	0.281 [−0.073, 0.635]
Private rented	Reference	
Other		
Data collected in January–March	Reference	
Data collected in April–June	−0.023 [−0.208, 0.162]	0.190 [−0.053, 0.433]
Data collected in July–September	0.175 [−0.015, 0.364]*	0.098 [−0.138, 0.335]
Data collected in October–December	0.148 [−0.046, 0.342]	−0.336 [−0.591, −0.081]**
Data collected in 2013–2014	0.138 [−0.023, 0.300]*	0.008 [−0.200, 0.215]
Data collected in 2014–2015	Reference	

** $p < .05$; * $.05 < p < .10$.

4.2.2. Parent/guardian and household characteristics

Children and adolescents who had siblings were more likely to walk or cycle to school. This effect was captured through the 'number of children' variable. Children in families that either experienced financial problems or their parent/guardian had a limiting long-standing illness, disability or infirmity were more likely to walk to/from the primary school. However, these two variables (financial problems and ill health or disability of parent/guardian) were not significantly associated with adolescents' active-travel to secondary school. Also, a child's mother (or female guardian) employed full-time reduced the child's likelihood to walk or cycle to school. Both children and adolescents were more likely to walk or cycle to school if their parents walked or cycled at least 1–2 times per week. Finally, housing tenure was only significantly associated with active travel to primary school, but not for travel to secondary school. In particular, primary school children in owner-occupied homes were less likely to walk or cycle to school than those living in private rented accommodation. On the other hand, the likelihood of walking or cycling to primary school increased if pupils lived in social-housing accommodation.

4.2.3. Other factors

With regard to season and survey-year variations, we found that primary school children surveyed in the periods between July–September and October–December were more likely to walk or cycle relative to those children surveyed in the period between January and March (reference category), but these effects were only significant at the 90% level of confidence. On the other hand, secondary school children were less likely to walk to school if they were surveyed between October and December. A marginally significant difference was found between the two survey years; children surveyed during the year 2013/2014 were more likely to walk or cycle than those surveyed in 2014/2015 (reference category).

4.3. Active travel to school: combined-factor models

Table 3 shows associations of combined-factor models for active travel to primary and secondary schools. Variable and model specifications in the combined-factor models took into account the estimation results in Table 2 and any insignificant effects detected in the initial combined-factor-model runs. With regard to the child's age, we found significant effects across age groups in the primary school samples; children of younger age (4–6 and 7–9 years of age) were less likely to walk or cycle to school when compared with children between 10 and 12 years of age. No significant associations across age groups were detected in the secondary school sample. Also, differences between male and female adolescents' active travel to school remained in the combined model.

The distance to school, level of urbanisation (rural vs. urban), number of children, parents' weekly walk and cycling frequencies remained significantly associated with active travel to both primary and secondary schools. On the other hand, significant associations observed in the univariate models (which were only adjusted for age and gender, see Table 2) such as households who sought support due to financial problems and a parent with higher education qualification (e.g. university degree) were no longer significant in the combined-factor models. Also, children living in owner-occupied homes were less likely to walk or cycle to primary school than those in social housing and private

Table 3. Logistic regression models of active travel to primary and secondary school.

	Primary school (4–12-year-olds) Coeff. [conf. interval]	Secondary school (4–12-year-olds) Coeff. [conf. interval]
Intercept	−3.079 [−3.611, −2.547]**	−2.759 [−3.469, −2.049]**
Physical/environmental factors		
Distance to school		
Under 0.5 miles	3.711 [3.389, 4.032]**	4.511 [4.069, 4.954]**
0.5–1 mile	2.320 [1.996, 2.645]**	3.015 [2.686, 3.343]**
More than 1 mile	Reference	Reference
Household lives in rural Wales	−0.407 [−0.657, −0.157]**	−0.967 [−1.298, −0.636]**
Child characteristics		
Age group		
4–6 years	−0.586 [−0.868, −0.305]**	N/A
7–9 years	−0.312 [−0.583, −0.041]**	
10–12 years	Reference	
12–13 years	N/A	−0.088 [−0.603, 0.427]
14–16 years		0.104 [−0.372, 0.580]
17–19 years		Reference
Gender (Female)	−0.067 [−0.278, 0.144]	−0.413 [−0.705, −0.120]**
Parent/guardian/household characteristics		
Number of children	0.166 [0.044, 0.288]**	0.150 [0.002, 0.298]**
Female employed full time	−0.326 [−0.538, −0.113]**	0.054 [−0.242, 0.350]
Active travel by bicycle at least 1–2 times a week	0.737 [0.290, 1.183]**	0.766 [0.218, 1.313]**
Active travel on foot at least 1–2 times a week	0.495 [0.269, 0.721]**	0.595 [0.241, 0.949]**
Having a limiting long-standing illness, disability or infirmity	0.393 [0.107, 0.679]**	0.016 [−0.385, 0.416]
Housing tenure		
Owner occupied	−0.583 [−0.861, −0.304]**	−0.209 [−0.633, 0.215]
Social housing	0.272 [−0.063, 0.607]	0.198 [−0.308, 0.705]
Private rented	Reference	
Other		
Data collected in January–March	Reference	
Data collected in April–June	0.083 [−0.201, 0.367]	0.107 [−0.282, 0.496]
Data collected in July–September	0.249 [−0.042, 0.540]*	−0.190 [−0.563, 0.183]
Data collected in October–December	0.224 [−0.070, 0.519]	−0.176 [−0.622, 0.271]
Data collected in 2013–2014	0.250 [0.039, 0.461]**	0.125 [−0.180, 0.429]
Data collected in 2014–2015	Reference	
McFadden Pseudo R^2	0.346	0.437
Number of observations in the sample (unweighted)	3834	2857

**$p < .05$; * $.05 < p < .10$.

rented accommodation. However, there were no longer significant differences between the type of accommodation and adolescents' active travel to secondary school. Finally, having a parent with a long-term illness, disability or infirmity was not significantly associated with adolescents' active travel to school. With regard to season and survey-year effects, there was only a marginally significant effect with children who were surveyed in July–September (vs. January–March) and in the period 2013/2014 (vs. 2014/2015) who were more likely to walk or cycle to school. By contrast, adolescents surveyed in the period October–December were less likely to walk or cycle to secondary school.

5. Discussion

This paper examined potential associations of active travel to primary and secondary schools on an average (typical) day in Wales against physical/environmental factors, child/adolescent and parent characteristics.

The key finding of the analyses in this study was that parents' frequency of walking and cycling was positively associated with both child and adolescent active travel (walking and

cycling) to school. This hypothesis has not been frequently tested in the literature but does offer the evidence base to support recent calls advocating the importance of raising parents' awareness to reduce 'child-miles' travelled for school trips (Modeshift 2010). When parents cycled at least 1–2 times per week, the likelihood of their children and adolescents walking or cycling to primary and secondary schools doubled (OR = exp(β)). Also, if parents walked at least 1–2 times per week, the likelihood of active travel to school for primary school children and adolescents increased by 1.6 and 1.8 times, respectively. The results agree with findings reported by McMillan et al. (2006) in the US who also found that the longer parents spend walking the higher the likelihood of their children is to walk or cycle to school. The development of this hypothesis was guided by previous evidence on 'active caregivers-active youth' discussed in activity research; McMillan et al. (2006), however, stressed that the hypothesis has not always been proven. More broadly, such hypothesis may be supported by theories such as Social Learning Theory (Bandura 1971), which postulates that learning is based on observation, retention, reproduction and motivation.

Given that the evidence in the international literature varies across countries, this study offers evidence on how far children and adolescents are prepared to walk or cycle to school in Wales. In particular, perceived distances shorter than 1 mile (c. 1.6 km) between home and school were significantly associated with active travel in both children (4–12 years of age) and adolescents (13–19 years of age). The odds-ratio for primary school children living within 0.5 miles (0.78 km) from their school was 3.7 times (OR = β; for a three-level dummy coded variable) and those living between 0.5 and 1 mile (0.78–1.6 km) the corresponding odds-ratio was 2.3 times more likely to walk or cycle relative to those living over 1 mile. Also, the corresponding odds-ratio for adolescents was 4.5 times more likely to walk or cycle if they lived within 0.5 miles from their school and 3 times if they lived between 0.5 and 1 mile. Waygood and Susilo (2015) also showed that if 10–11-year-olds in Scotland lived shorter than 0.5 miles (0.78 km) from their school they were more likely to walk to school. In a study on children and adolescent travel to school in Toronto, Canada, Mitra and Buliung (2015) reported a distance tolerance between home and school at 400 m; the authors also reported that children and adolescents living farther than 1.6 km (1 mile) were less likely to walk to school. With regard to cycling trips, the study by Godefroy and Morency (2012) on the Island of Montreal, Canada, reported distance thresholds for cycling at 1.99 km for boys and 1.27 km for girls aged 5–12 years. The distance thresholds for cycling in adolescents were estimated at 3.56 km for males and 2.95 km for females. Finally, the study by van Goeverden and de Boer (2013) in Flanders (Belgium) and Netherlands also found significant associations between distance and walking to school but they set the walking distance tolerance at 3 km. These findings suggest that the distance tolerance, primarily for walking, of Welsh children and adolescents was closer to children and adolescents in Scotland and North America than Flanders and the Netherlands.

'Living in rural Wales' was negatively associated with active travel to both primary and secondary schools. Children and adolescents were more likely to actively commute to school if they lived in an urban area relative to a rural area, which was consistent with findings by Panter et al. (2010a) who also suggested that urbanisation was positively associated with active commuting. Another reason could be that parents living in urbanised areas tend to use their car less than parents living in rural areas (Ewing and Cervero 2010; Sun et al. 2009; Susilo and Maat 2007).

In terms of children's age, 4–9-year-olds were more likely to actively travel to school relative to older children in the primary school. This finding is in line with the studies by Susilo and Waygood (2012) in the City of Osaka, Japan, and Pabayo, Gauvin, and Barnett (2011) in Canada who also suggested that the likelihood of walking to primary school increased with age but reached a peak at the age of 10–12 years. The active travel to school of adolescents aged between 13 and 17 years of age was no different than those of 17 years of age and older. This finding is in line with Timperio et al.'s (2006) study in Australia who also found that active travel to school was independent from the children's age. These findings were against evidence from the US where younger children were less likely to actively commute to school (Deka 2013).

With regard to gender and active travel to school, findings in the primary school sample were in line with D'Haese et al. (2011) and Pojani and Boussauw (2014), who did not find any significant association with active travel to school. Our findings are also consistent with other 'four-nations' results such as Waygood and Susilo (2015) who did not find any gender differences and did not retain that variable in their final model. In the secondary school sample, findings agreed with Babey et al. (2009), Mitra and Buliung (2015) and Emond and Handy (2012) who also reported that male adolescents were more likely to actively travel to school.

Mother's employment status was classified as 'in employment' and 'not in employment' and was interacted with primary respondent (parent/guardian) being female. This interaction tested whether the female guardian's/mother's employment had any impacts upon the child's active travel to school and was guided by the findings of previous studies which showed that mainly mothers had primary responsibility of the children's commute to school (McDonald 2008; Rosenbloom 1987; Rosenbloom and Burns 1993). This study found that female in employment was negatively associated with active travel to primary school suggesting that children whose mothers were in full-time employment (unavailable) were less likely to actively commute to primary school. The results agreed with McDonald (2008) who also found that 'children whose mothers work full-time and commute to work in the morning were less likely to walk or cycle to school than children whose mothers were not leaving for work in the morning'. This finding was also in line with studies reporting that parental convenience is a significant factor for mode choice to school (Joshi and Maclean 1995; McDonald 2008; McMillan 2007). On the other hand, there was no association between mother's employment and active commuting to secondary school as youth in secondary school are more likely to commute independently.

Another factor reflecting a family's socio-economic status included parental education. Wong et al. (2011) wrote that this variable has not been commonly investigated. Preliminary estimations in this study showed a significant association between parents' education and active travel to school, but this association was attenuated in the combined-factor models. Also, univariate tests showed that children with their parents having higher education qualification were more likely to walk or cycle to school, but again this association was not significant in the combined-factor models. This finding is in line with the Scottish study by Waygood and Susilo (2015) who also found no significant effects between active travel to school and parental education; that is contrary to evidence reported by Emond and Handy (2012) in the US.

Household characteristics such as number of children and housing tenure were significantly associated with active commuting to primary school. The more children in a

household the more likely children and adolescents were to walk or cycle to school. Also, living in an owner-occupied property was negatively associated with active travel to primary school. In the absence of income data, this variable has been introduced as a proxy variable for socio-economic characteristics pointing to the direction that children living in households that could afford owning their home were less likely to walk or cycle to school (Ogilvie et al. 2008). Finally, this finding may interpreted as a proxy for residential density implying that home owners tend to live at lower residential-density (car oriented) areas thus encouraging use of cars to accompany children to school (Waygood 2009). Finally, no association was found between any of the housing-tenure categories and active travel to secondary school.

A key strength of this paper is that it offers previously unexplored evidence to better understand active travel to primary and secondary schools in Wales and thus may inform future policies to encourage active travel to schools. Other strong aspects of this study include its sample size along with the careful survey design and weighting of very recent (2013/2014 and 2014/2015) observations to represent individuals living in Wales. A potential limitation of this study is that the survey responses regarding children and youth travel to school came from the guardians'/parents' perspectives whereas Panter, Jones, and van Sluijs (2008) asserted that youth perceptions also determine active travel to school. Findings of this study suggest that parent perceptions influence children and adolescent active commuting to school, but it might be useful for future studies to collect data from adolescents' perspectives and compare findings. Also, given that the NSW data come from parent/guardian reports may also pose a challenge for like-for-like comparisons with survey data coming directly from children or adolescents. Finally, the analysis was based on a strict classification of bus and walk school trips as non-active trips, though it should be recognised that such trips involve some level of moderate physical activity through walking to and from bus stops to home and school.

6. Conclusion

This paper examined the factors associated with active travel to schools in Wales and contrasted these findings between primary and secondary school children. Findings are quite timely given that The Active Travel (Wales) Act, which became a law in November 2013, has recently set the policy framework towards improving active travel in Wales. The Act 'places a requirement to continuously improve facilities and routes for walkers and cyclists and to prepare maps identifying current and potential future routes for their use. The Act will also require new road schemes to consider the needs of pedestrians and cyclists at design stage' (Welsh Government 2013). Thus, this study provides the evidence base for local authorities to strategically promote cycling and walking not only around schools, but also around residencies. The findings of this study also point towards the development of education programmes aiming at increasing parental awareness and creating active-travel supporting environments.

From a policy perspective, findings highlight the importance of involving parents in encouraging walking and cycling among children. Since there is a relationship between parents' active-travel patterns and children and adolescent active commuting to school, there is scope for 'beyond-the-school' active-travel campaigns and intervention programmes aiming at an overall improvement of family walking and cycling for different

activities. The latter would enable parents to promote and set an example for their children from a young age (Susilo and Liu 2015).

Findings in this study also suggest that changes and investment on the physical environment also influence children and adolescent walking and cycling to school. For example, the 2005 US Federal Transportation Bill created the Safe Routes to School Program to 'enable and encourage children […] to walk and bicycle to school' and 'to make bicycling and walking to school as safer and more appealing transportation alternative' (FHWA 2006). The legislation provided each state's Department of Transportation with funds to improve infrastructure within two miles of elementary and middle schools and to develop safety and encouragement programmes. Over $1.1 billion has been allocated on the programme as part of the original legislation and continuing resolutions as of 30 September 2012 (National Center for Safe Routes to School 2013).

Changes do not always require large investments. Low-cost physical improvements may involve crossing guards, which do not require any structural improvements and appear to be particularly effective in reducing barriers and facilitating safe routes to school (Chriqui et al. 2012). Along these lines, the UK NICE Public Health Guidance 8 provides a lead for further interventions to create safe routes to schools (UK NICE 2008). Demark and the Netherlands, for example, have exhibited high levels of active travel – despite high incomes – while maintaining positive safety records (low casualties). The latter has been primarily the outcome of safety measures including campaigns and physical safe routes (e.g. through traffic calming) to school projects at the municipality (local authority) level (Jensen 2008). Also, another intervention may involve the Walking School Bus concept as a safety measure to mitigate the negative impacts of non-active travel to school (Waygood et al. 2015). Finally, School Travel Plans, largely initiated in 2000s across Europe and Australia, and despite the majority of them being behavioural, do report statistically significant increases in active travel modes (Buliung et al. 2011). Welsh schools have already started implementing school travel plans and future work could involve testing correlations between schools with and without travel plans in Wales and their impacts upon active travel to school.

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Appendix 1. Summary of recent studies and significant associations with active travel to school (walking and cycling).

Factor group	Factor	Authors (year)	Study area	Primary school	Secondary school
Physical/ environmental	Distance	Waygood and Susilo (2015)	Scotland, UK	10–11-year-olds [+] if shorter than 0.78 km	[na]
		Mitra and Buliung (2015)	Toronto, Canada	11-year-olds [+] if shorter than 400 m [–] if longer than 1.6 km	14–15-year-olds
		van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds [–] Netherlands [–] Flanders	13–17-year-olds [–] Netherlands [–] Flanders
	Safety	van Kann et al. (2014)	Netherlands	5–12-year-olds [+] only for 9–12-year-olds	
		Chillón et al. (2014)	US	4th and 5th grades [–] defined as a group of perceived barrier factors	[na]
		Carlson et al. (2014)	Baltimore, Maryland, Washington, DC, Seattle-King County US	[na]	12–16-year-olds [+] perceived pedestrian safety
		Babey et al. (2009)	California, US	[na]	12–17-year-olds [ns] parental self-perception of safety [+] objective safety characteristics (traffic, pedestrian safety)
	Season/Weather	van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds [–] low temperatures are more likely to encourage car instead of walk trips to primary and secondary school	13–17-year-olds
		Chillón et al. (2014)	US	4th and 5th grades [–] weather as perceived by parents (combined with safety)	
	Level of urbanisation	van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds [+] across different levels of urbanisation; ref. 'not urbanised'	13–17-year-olds
		Babey et al. (2009)	California, US	[na]	12–17-year-olds [–] suburban and urban areas; ref. 'urban'
	Land-use mix	Mitra, Buliung, and Faulkner (2010)	Greater Toronto Area, Canada	[na]	11 years and older [–] employment to population ratio
	Lack of pavement and lack of cycle paths	Panter et al. (2010b)	County of Norfolk, UK	9–10-year-olds [–] based on parents' reports	[na]
	Traffic is slow or safe	Waygood and Susilo (2015)	Scotland, UK	10–11-year-olds [–] parental perception; noted as non intuitive	[na]
	Friendly people in the neighbourhood	Waygood and Susilo (2015)	Scotland, UK	10–11-year-olds [ns]	[na]

Child	Age	van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds	13–17-year-olds
				[–] across Primary and Secondary Schools in the Netherlands and Flanders	
	Gender	Mitra and Buliung (2015)	Toronto, Canada	11-year-olds	14–15-year-olds
				[ns]	[+] males
		Babey et al. (2009)	California, US	[na]	12–17-year-olds
					[+] males
		Emond and Handy (2012)	Davis, California, US	[na]	Grades 10–12
					[-] females
Parent/guardian	Household size	van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds	13–17-year-olds
				[–] Flanders > 3 km from home;	[–] Flanders and Dutch ≤3 km;
				[–] Dutch;	[ns] Flanders and Dutch >3 km
				[ns] Flanders ≤3 km from home; ref. >5 members	ref. >5 members
	Car ownership	van Goeverden and de Boer (2013)	Netherlands and Flanders	5–11-year-olds	13–17-year-olds
				[–] Dutch and Flanders	[–] Dutch and Flanders ≤3 km
					[ns] Dutch and Flanders >3 km
		Yu and Zhu (2013)	Austin, Texas, US	[+]	[na]
	Low-income families	Babey et al. (2009)	California, US	[na]	12–17-year-olds
					[+]
	Holding a driver's license with access to a car	Emond and Handy (2012)	Davis, California, US	[na]	Grades 10–12
					[–]
	Parental unavailability	Mitra and Buliung (2015)	Toronto, Canada	11-year-olds	14–15-year-olds
				[+]	[+]

Note: [+] represents 'positive and significant association'; [–] represents 'negative and significant association'; [ns] represents 'not significant'; [na] not available.