

Self-proxy agreement and weekly school travel behaviour in a sectarian divided society

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ABSTRACT

Proxy reports from parents and self-reported data from pupils have often been used interchangeably to identify factors influencing school travel behaviour. However, few studies have examined the validity of proxy reports as an alternative to self-reported data. In addition, despite research that has been conducted in a different context, little is known to date about the impact of different factors on school travel behaviour in a sectarian divided society. This research examines these issues using 1624 questionnaires collected from four independent samples (e.g. primary pupils, parent of primary pupils, secondary pupils, and parent of secondary pupils) across Northern Ireland. An independent sample *t* test was conducted to identify the differences in data reporting between pupils and parents for different age groups using the reported number of trips for different modes as dependent variables. Multivariate multiple regression analyses were conducted to then identify the impacts of different factors (e.g. gender, rural–urban context, multiple deprivations, and school management type, net residential density, land use diversity, intersection density) on mode choice behaviour in this context. Results show that proxy report is a valid alternative to self-reported data, but only for primary pupils. Land use diversity and rural–urban context were found to be the most important factors in influencing mode choice behaviour.

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1. Introduction

The increased rate of car trips to and from schools, at the expense of active commuting, has underpinned the growth of research on active commuting since the late 1990s. This paradigm shift in school transport research is due to the association with multiple policy issues such as health (e.g. obesity, safety), economy and environment (e.g. congestion), and personal development (e.g. enhancement of spatial and social knowledge) (DiGiuseppi et al., 1998; Fyhri and Hjorthol, 2009; Fyhri et al., 2011; Hinckson et al., 2011; Joshi et al., 1999; Yeung et al., 2008). As a result, efforts have been made to identify factors that reinforce active commuting to school. However, this resurgence has also led transport researchers to rely more on the use of proxy reports from parents for various reasons (e.g. perceived inability of pupils to provide self-report, ethical consideration). Despite the reliance on proxy reports, few studies to date have examined the validity of proxy reports used in the identification of school travel behaviour (Evenson et al., 2008; McDonald et al., 2011; McMinn et al., 2011; Mendoza et al., 2010; Rowe et al., 2010).

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Proxy reports have been gathered using different types of survey instruments including questionnaires (Fyhri and Hjorthol, 2009; Joshi et al., 1999; Schlossberg et al., 2006; Yeung et al., 2008), travel diary surveys (Fyhri and Hjorthol, 2009; Mitra et al., 2010), interviews (Faulkner et al., 2010), and focus groups (Christie et al., 2011; Lang et al., 2011). Although proxy reports have been used to identify school travel behaviour for both primary (Joshi et al., 1999; Yeung et al., 2008), and secondary pupils (Fyhri and Hjorthol, 2009; Schlossberg et al., 2006); most of the studies that aimed at validating the use of proxy reports in school transport have focused on primary school children only. Evidence in other research fields has shown that the validity level is much lower for secondary age children (Harakeh et al., 2006). Moreover, validation studies to date are mostly found in the USA (Evenson et al., 2008; McDonald et al., 2011; Mendoza et al., 2010), with a few exceptions in Europe (McMinn et al., 2011) and in Australia (Kite and Wen, 2010). This, therefore, limits the external validity and generalisation of the results globally given the contextual dependency of the validity of proxy reports (Robitail et al., 2007). In addition, the results reported in different validation studies are not conclusive, and sometimes conflict. For example, some studies identified a high level of validity of proxy reports (McDonald et al., 2011; Mendoza et al., 2010); whereas others found a low level of validity (Evenson et al., 2008; Rowe et al., 2010). Again, almost all of these studies used data collected from parent–child

dyads for the assessment of validity. Although the dyadic approach has a long tradition and merits in validation, it is also subject to a number of weaknesses (e.g. interdependency in reported data) (Kenny, 1996). As a result, the need for the confirmation of validation results based on data from independent sample has been highlighted in the literature (Smith et al., 2005, 2007).

Based on proxy reports or self-reports (or a combination of both), numerous studies have identified factors affecting travel mode choice behaviour to schools (Davison et al., 2008; Sirard and Slater, 2008). These factors can be grouped into: (a) individual/household characteristics (e.g. age, sex, car ownership); (b) school characteristics such as the availability of parking spaces, school participation in a specific programme (e.g. school travel plan – STP, safe routes to school – SRTS, walking school bus – WSB, walk-to-school); (c) neighbourhood characteristics (e.g. multiple deprivation, urban form); and (d) temporal characteristics (e.g. morning, afternoon). Despite the identification of a multiplicity of factors that have influenced mode choice behaviour for school children, very little or no research has investigated the relevance of these factors on school travel behaviour in a sectarian society. However, sectarian division has been identified to have a strong role in influencing adult travel behaviour (Community Relations Council for Northern Ireland, 2000; Goldhaber and Schnell, 2007).

Based on the above discussion, the objective of this research is twofold: first, to test the validity of parental proxy reports for different age groups using data from independent samples in a sectarian society; and second, to identify travel mode choice behaviour patterns of pupils at different ages in the same context using Northern Ireland (NI) as a case study. A detail review of literature is conducted in Section 2 focusing on both the psychometric properties (e.g. validity) of survey instruments and the determinants of school travel behaviour. Section 3 justifies the rationale for choosing NI as a case study. Section 4 discusses the data and methods employed in this research to reach the above objectives. Results of this research and their interpretation are discussed in Sections 5 and 6 concludes this research.

2. Literature review

2.1. Research on the evaluation of psychometric properties of proxy report

Although self-report by subjects has been identified as the most preferred method, researchers have often relied on one person to inform them about the characteristics and behaviours of another person (Agnihotri et al., 2010; Wagmiller, 2009). This reliance on proxy reports depends on many factors including: (a) the cost associated with obtaining data from all members in a group and the consequent reliance on the 'primary decision maker' e.g. National Travel Survey in the UK; (b) level of difficulty associated with collecting data from those respondents who are unable to report reliably (e.g. infant) or who are sometimes inaccessible; and (c) the need to obtain confidential data which respondents do not like to share (e.g. drink-driving behaviour), etc. (Beck et al., 2012; Department for Transport, 2006; Wagmiller, 2009). However, given that the proxy reports are obtained from a third person, they are susceptible to bias and inaccuracies. Possible sources of bias include: halo effects (i.e. response influenced by impression); acquiescence bias (i.e. tendency of 'yea-saying' such as 'yes', 'true' or 'often'); framing effects (i.e. how the question is phrased); social desirability (i.e. faking good to give socially acceptable answer); and end-aversion (i.e. tendency to avoid the end-points of a response scale) (Smith et al., 2005). Inaccuracies imply that errors are made because of a lack of knowledge or insufficient motivation to provide

correct answers. For instance, a good relationship enables people to gather information about each other and for that reason report more accurately. Similarly, people with poor cognitive functioning have more difficulty providing accurate answers than those with good cognitive abilities (Mandemakers and Dykstra, 2008). Although specific techniques exist to minimise a particular bias (e.g. response scales based on specific, concrete behaviours, can help to reduce halo effects), an assessment of the psychometric properties of different instruments used to collect proxy data is a common practice.

The three main psychometric properties of a survey instrument are: reliability, validity and responsiveness (Smith et al., 2005). Reliability is the degree to which an instrument is free from error, produces stable, and repeatable results; and includes: internal consistency, test–retest reliability, inter-rater reliability, and parallel forms reliability (i.e. agreement between two or more alternative forms of the same measure e.g. short/long). Validity is the extent to which an instrument measures what it is intended to measure. Researchers generally investigate three types of validity of proxy report in different fields: content (i.e. content of an instrument is supported by the literature); criterion related (i.e. reported data are valid against a 'gold standard'); and construct validity. Construct validity, again, can be classified into: convergent (agreement between similar measures), discriminate (disagreement between dissimilar measures), and known group differences (ability to distinguish the differences that are known between groups). Responsiveness is the degree to which an instrument is able to detect significant change over time. Numerous studies have examined the psychometric properties of proxy reports in various fields e.g. psychology (Smith et al., 2007), quality of life (Robitail et al., 2007; Warner-Czyz et al., 2009), smoking behaviour (Harakeh et al., 2006), physical activity (Gao et al., 2006), job satisfaction (Flannery et al., 2012) and transport safety (McPeck et al., 2011; Rosenbloom and Wultz, 2011). Although many of these studies have reported an acceptable level of agreement, an opposite finding is also common in the literature (Ardon et al., 2012; Gao et al., 2006; Telford et al., 2004).

The school transport literature mainly focuses on the evaluation of two psychometric properties of proxy reports: reliability and validity. However, given the focus of this research, the paper reviews only the validation of proxy reports of previous studies. McDonald et al. (2011) have assessed the validity of a parental survey instrument as used in the SRTS programme in the USA against in-class student tally data. This study used data from 262 parent–student dyads. The in-class tally data was collected from two elementary schools in Charlotte. Using kappa statistics, this study found high convergent validity ($\kappa > 0.75$). However, this study calls for the assessment of variability by mode as their sample was heavily featured by motorised travellers. Mendoza et al. (2010) have also assessed the validity of the SRTS travel survey instrument using data from 81 parent–student (4th grade) dyads in Houston. Using kappa statistics, this study found high convergent validity ($\kappa = 0.87$) in the reported data. Evenson et al. (2008), on the other hand, have conducted a validity analysis of a new survey instrument with seven questions using weekly data collected from 28 parent–student (elementary school) dyads in North California. This research employed two different measures for the assessment of validity: kappa coefficient for categorical/nominal variables; and intraclass correlations coefficients (ICCs) for continuous variables. Although this study found relatively lower agreement on the total number of walking trips made in a week ($\text{ICC} = 0.55$), other variables showed substantial agreement between parent and child reports. The authors have mentioned that since both the student and parental measures relied on self-report, so errors from these methods might be correlated. Forman et al. (2008) have investigated the convergent validity a new instrument

aiming to assess the barriers (17 items) that youth encounter while walking to specific destinations. This study collected data from 189 parent–adolescent dyads in Boston, Cincinnati and San Diego. Using principle component analysis of the items, this study identified 3 barrier sub-scales (e.g. environmental, psychological, and safety). Validity assessment of the reported data has been conducted in these sub-scales for three types of destinations (e.g. park, shop, and school). This study reported an initial evidence of validity of the reported barriers (ICC: 0.69–0.73 for parks, 0.46–0.68 for shops, and 0.74–0.78 for school).

Apart from the above American studies, Kite and Wen (2010) have investigated the convergent validity of proxy report (travel survey) in Sydney using data from 839 parent–student (primary) dyads. Based on the reported total number of trips in a week by different mode, this study calculated Spearman's rho correlation coefficients for each mode. They found high validity for journey to school by car (0.765), and walk (0.765); and journey from school by car (0.717), and walk (0.748). Weaker correlations have been reported for public transport and other modes in this study. Steven-son (1996) validated children's ($n = 100$) self-reported (interviews) exposure to traffic using two techniques in Perth: 'moving observer' (a person observing the student while travelling); and pedestrian diaries. Based on the findings from both measures, this study concluded that children's self-reported 'habitual exposure' data is a valid measure of his or her actual exposure in the road environment. Rowe et al. (2010) conducted a convergent validity analysis of a questionnaire on walking to school in Scotland which comprised of 14 variables. Using data from 115 parent–student (elementary) dyads, this study found only a moderate correlations in the reported data between the instruments ($r = 0.31$). In another study in Scotland, McMinn et al. (2011) investigated the criterion validity of a travel survey instrument. They collected data on time spent walking to and from school using the travel diary which was assessed against pedometer data (i.e. a gold standard) collected from the students. This work found no significant difference in the reported data between instruments.

The above review confirms the weakness of previous studies as identified in Section 1. The reviews also verify that parental proxy report is a valid alternative to the collection of data for elementary/primary school children globally with only a few exceptions. The validity of self-reported data against a gold standard signifies that primary school children are able to report their travel behaviour accurately and that this can be one of the most reliable sources of data.

2.2. Determinants of school travel behaviour

A number of theoretical frameworks have been constructed which explain mode choice behaviour to schools. These include the: social–ecological model, McMillan framework, and ecological and cognitive active commuting framework (McMillan, 2005; Sirard and Slater, 2008). Amongst these, the social–ecological model is widely used. This model explains the importance of different factors including individual/household, school, neighbourhood; temporal, etc. influencing the choice of transport mode. Using the ecological and cognitive active commuting framework, a number of studies have reported that students from low socio-economic backgrounds are more likely to use active modes of transport whereas students from a white racial background are less likely to walk and cycle (Braza et al., 2004; Harten and Olds, 2004; McMillan, 2007; Merom et al., 2006). Higher levels of household income and increased car ownership are consistently associated with lower rates of walking and cycling (Pont et al., 2009). Zwerts et al. (2010) found that boys and senior students are more likely to make independent journeys in Flanders, Belgium. An individual's attitudes and perceptions have also been identified as playing a

significant role in choosing the school transport mode. Using qualitative data, Faulkner et al. (2010) identified two stages in mode choice decision making in Toronto. These included: (a) choice between walking and driving which depended on travel time/distance, and (b) the choice between walking alone and accompanied which depends on the perception of safety. However, Lee and Tudor-Locke (2005) found, these decisions are usually made by mothers in households. Christie et al. (2011) found that despite high levels of bicycle ownership (77%) in disadvantaged areas of England, only 2% of students cycled to school due to perceptions of safety and risk (e.g. stranger danger, road safety). However, Fyhri and Hjorthol (2009) found that the perception of risk and safety is a significant factor only from the perspective of parents but not from the perspective of students.

Research has shown that the level of walking and cycling increased significantly in those schools that participated in specific programmes that were designed for them, compared to those schools that did not participate in any such programmes including: STP (Hinckson et al., 2011); SRTS (McDonald, 2008), WSB (Lang et al., 2011; Mendoza et al., 2009).

Numerous neighbourhood determinants of active commuting to and from school have been investigated and have been identified as having a significant impact. Amongst these, distance from home to school has consistently been reported as a significant factor (DiGiuseppi et al., 1998; Mitra and Buliung, 2012; Pont et al., 2009; Schlossberg et al., 2006; Timperio et al., 2006; Zwerts et al., 2010). Block density (Lin and Chang, 2010; Mitra and Buliung, 2012), net residential density (Dalton et al., 2011; He, 2011; Lin and Chang, 2010), and land use diversity (McMillan, 2007) have all been shown to have a positive association with active commuting. He (2011) reported that an identical increase in residential density increased the probability of walking or biking by 1.09%. However, inconsistencies in research findings were also found to exist in the literature. For example, a number of studies found that a positive association exists between intersection density and the use of active transport mode to schools (Dalton et al., 2011; Schlossberg et al., 2006); whereas others have reported a negative association between these two (Lin and Chang, 2010; Timperio et al., 2006). Active commuting is negatively associated with cul-de-sac (dead end) density (Schlossberg et al., 2006) and travel routes that cross busy roads (Timperio et al., 2006).

The spatial characteristics of areas (e.g. urban, suburban, and rural) have been shown to influence active commuting. Mitra et al. (2010) analysed the spatial concentration of active commuters to school in Toronto and found that they are more concentrated in urban and inner suburb areas than in outer suburbs. They observed that urban pupils not only made more active trips to schools, and this mode choice behaviour was also more temporally stable in urban areas compared to inner suburb and outer suburb areas. Seasonal variations in cycling to school have also been reported. Muller et al. (2008) found that students with car availability switch from bike to car at shorter distances in winter than those with no car available who switch from bike to public transportation in Germany.

3. Sectarian division and its impact on school (transport) in Northern Ireland (NI)

NI has a long history of sectarian violence between Protestants (aligned to Unionist/Loyalist) and Catholics (aligned to Nationalist/Republican) religious groups (Community Relations Council for Northern Ireland, 2000; Hughes et al., 2007). The first recorded riot between these groups took place in 1813 when the number of immigrant Catholics grew sharply due to the Industrial Revolution (Jones, 1960). This violence intensified gradually and reached its

peak in the late 1960s when each group began to perceive themselves to be vulnerable minorities and tended to move house in search of greater security provided by residing amongst the relevant ethnic group both within and between areas (Boal, 1982; Doherty and Poole, 1997). In addition, a shift from urban to rural areas – to live with like minded people – has been documented by many researchers in this period (Murtagh, 1999; Stockdale, 1991).

Poole and Doherty (1996) studied residential segregation patterns in 39 Northern Ireland towns using 1981 census data and found symmetrical patterns of residential isolation: towns in eastern NI have higher Protestant isolation indices while those in western NI have higher Catholic isolation indices. This work also found that 17 towns out of the 39 were highly segregated in terms of dominance and contained 78% of the province's population (Poole and Doherty, 1996). Fig. 1 illustrates that this pattern still exists in today's society (calculated at the output area (OA) level based on the 2001 census data). OA is the smallest administrative unit used to collect census data in NI (5022 in total). The Cluster and Outlier Analysis (Anselin Local Moran's I) tool was used in ArcGIS to generate Fig. 1 based on the literature (inverse distance conceptualisation of spatial relationship with 9 km distance band) (Anselin, 1995; Lloyd and Shuttleworth, 2012; Mitchell, 2005). Generally, it is estimated that 35–40% of Protestants and Catholics live in communities divided along ethno-sectarian lines and the trend

has increased in recent years (Hughes et al., 2007). However, this does not necessarily mean that these highly segregated towns are a homogenous entity, rather that spatial segregation of ethnic communities can be found within a town (Doherty and Poole, 1997). It has been estimated, using data from the 1991 Census, that 45% of the population of the Belfast Urban Area live in highly segregated neighbourhoods, i.e. with more than 90% of one religion or another (Community Relations Council for Northern Ireland, 2000).

The resultant spatial segregation thus acted as an integrating force within each group; and consequently group specific unique activity-travel behaviour patterns have been developed due to increased spatial separation of homes, workplace, shops, and schools between the groups (Community Relations Council for Northern Ireland, 2000). For example, Cooper et al. (2001) found that despite availability of proximate opportunities, most households are prepared to travel long distances to the workplace, shopping centres and schools if the proximate opportunities are located within the sphere of an opposite group. This puts further pressure on the provision of opportunities in order to meet the needs of either group. A good example of this is the provision of education in Northern Ireland. Education in NI remains largely segregated; with children either attending Catholic maintained schools or de facto Protestant controlled schools (McGlynn, 2007; Pickett, 2008). The Rural Community Network (2001) observed that separate schools for Protestants and Catholics has often meant there are two schools

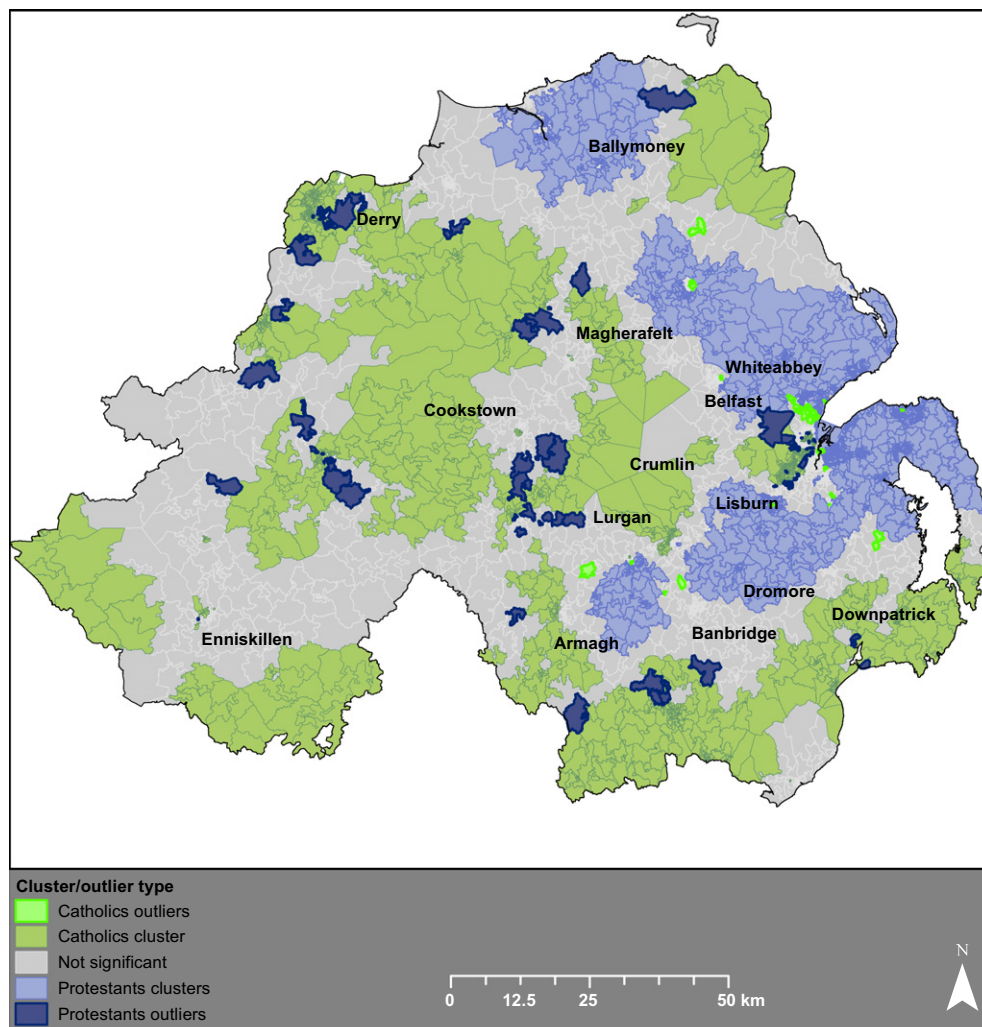


Fig. 1. Spatial cluster/outlier analysis showing residential segregation of different religious groups in NI (based on 2001 census data).

in areas where otherwise there might only be one. Although attempts have been made to integrate education through the development of integrated schools since 1981, only 6.6% (21,051) attend integrated schools (Department of Education, 2011e). This phenomenon has been described as voluntary integration by parental consent (McGlynn, 2007). At present, 321,717 students are enrolled in different schools (e.g. nursery, primary, secondary) in NI of which 120,415 (37%) are from a Protestant background and 163,693 (51%) are from a Catholic background. However, 79% (95,528) of those from a Protestant background are attending controlled schools whereas 88% (144,839) of those from Catholic background are attending maintained schools (Department of Education, 2011e). This signifies the extent of religious segregation that still exists in the education system even after a decade long peace process.

Like education, the provision of transport services has also been severely affected by 'the troubles'. Evidence shows that despite being located within areas of the same religion, groups avoided activities in these locations if they needed to travel through areas occupied by groups of the opposite religion (Community Relations Council for Northern Ireland, 2000). As a result, the use of public transport services, which usually followed routes across areas of both religions, has dropped significantly due to the fear of crime on public transport. Consequently, the so called public 'black taxi' services have emerged which follow strictly confined corridors connecting the segregated areas of each group (Community Relations Council for Northern Ireland, 2000; Wu and Hine, 2003). Partially due to this, despite the provision of free school transport services in NI, the number of car journeys to schools have significantly increased (Hine, 2009). Fears of bullying and sectarianism make some children feel unsafe and also create serious worries for many parents as reported in Hine et al. (2006, p.92): 'when they see the uniform and know what school the children go to, sometimes things are thrown at them, stuff taken off them and abuse shouted at them'. Burns (2006) reported that 40% of primary school pupils and 30% of post-primary pupils had experienced bullying and sectarianism in schools; and this trend is continuing (Department of Education, 2011c). Department of Education (2011c) also reported that 10.8% of bullying took place during school journeys for primary pupils whereas the rate was reported to be 6.6% for secondary school pupils. Burns (2006) also reported that pupils attending controlled schools got bullied at a higher rate (83%) than those attending in other schools. Currently, school children are eligible for transport assistance in circumstances where they enrol at a school which is beyond the qualifying walking distance from home (two miles for primary pupils or three miles for post-primary pupils) and has been unsuccessful in gaining a place at all suitable schools located within these ranges (Department of Education, 2011b). Despite free transport services to schools, the growing number of car journeys to schools is now a major policy concern in NI.

4. Data and methods

4.1. Survey instruments

Data used in this research were originally collected as a part of the Safer Journeys to School project commissioned by the Northern Ireland Commissioner for Children and Young People (NICCY) and General Consumer Council Northern Ireland (Hine et al., 2006). Different survey instruments were used to collect data e.g. peer to peer workshops, focus groups with parents and pupils, electronic survey of key stakeholders in the statutory and voluntary sectors, and questionnaire surveys of pupils and parents. Only data obtained from the questionnaire survey is reported in this paper. The questionnaires developed consisted of three versions. For the

school pupils, two versions were distributed: one for primary school pupils with a shorter version containing few basic questions; and a longer version for secondary school pupils. The same basic information was contained in both versions, but it was felt that the younger children would have difficulty completing the full questionnaire and providing all other information collected from secondary pupils. The questionnaires were completed in class under the supervision of teachers. A longer version of the questionnaire was also developed for parents and completed at their homes. Parents were asked to provide information on their children's travel to and from school. They were instructed to answer questions about only one of their children attending school. In the shorter version of the questionnaire, pupils were asked to indicate the different modes (e.g. car, bus, taxi, train, walk, and cycle) they used in a week to go to school and their frequency of usage (e.g. everyday, 4 days in a week, 3 days in a week, 2 days in a week, 1 day in a week, and never). They were also asked to answer the above questions for their return journeys to home. Using the answers from these questions, the total number of trips made by each pupil in a week was calculated for each mode. In addition, the questionnaire also contained questions related to reasons for using their chosen modes or reasons for not using certain modes (multiple response set). Although additional data were collected from secondary pupils and from parents of both primary and secondary pupils, these are not reported in this paper.

4.2. Data

Twenty five schools from across NI were selected based on stratified random sampling techniques and a total of 1687 questionnaires were collected from pupils (1394) and parents (293). Amongst these, 50 questionnaires were collected from pupils from a special school which were excluded from further analysis. In addition, 13 of the remaining questionnaires were found to be incomplete and were also excluded. The remaining 1624 (293 from parents and 1331 from pupils) questionnaires from 24 schools were retained for further analysis (Fig. 2). Therefore, the sample sizes in this research were found to be representative of previous research as indicated in Section 2. Table 1 outlines the sample characteristics of the survey which were also found to be representative of the school population in Northern Ireland. There are 1096 schools in NI (excluding special, hospital and other independent schools) of which 223 (20%) schools are secondary and the remaining are primary schools (Department of Education, 2011d). Separate sets of schools were chosen in order to administer the questionnaires for primary pupils (614 questionnaires), secondary pupils (717 questionnaires), parents of primary pupils (150 questionnaires), and parents of secondary pupils (143 questionnaires). Therefore, the data reported in these questionnaires were obtained from independent samples.

According to the rural urban classification of settlements in NI, 3 of the schools surveyed (12%) were located in rural areas (e.g. Desertmartin primary school, Magherafelt; Armagh Integrated College; Ballymacrickett primary school, Crumlin) (Fig. 2) (NISRA, 2005). These are representative considering the fact that only one fourth of the NI pupils attend schools located in rural areas (Table 1) (Department of Education, 2011a). These rural schools were chosen according to their religious attachments and sampled as: 1 maintained, 1 controlled, and 1 integrated. Fig. 2 provides the number of questionnaires that were collected from each of these schools. Although this shows a larger representation of data from the eastern board (Belfast) of NI, this is justified given that around 20% of the NI pupils attend schools located in Belfast only. The type of management (or religious affiliation) associated with the surveyed schools included: 9 maintained, 6 controlled, and 9 integrated. The data collected from integrated schools are overly

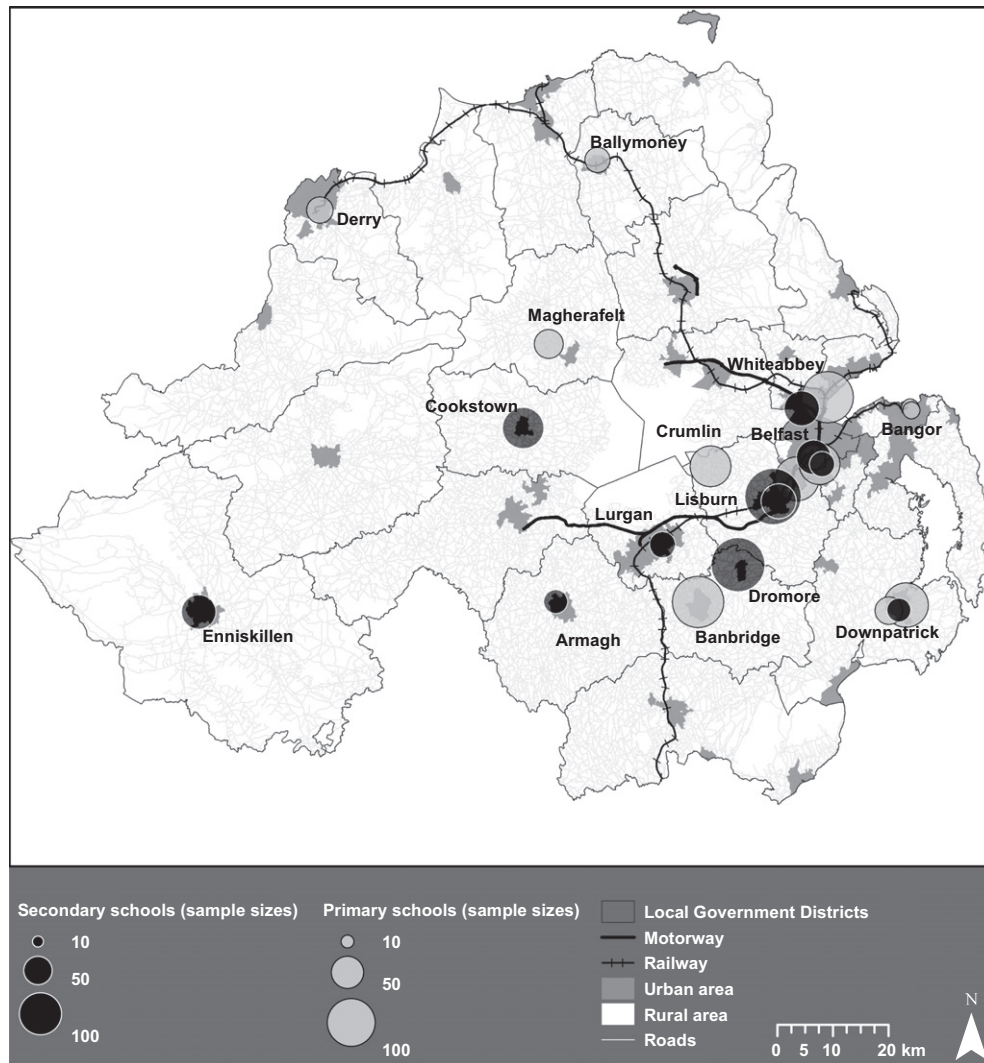


Fig. 2. Spatial distribution of the surveyed schools by type and sample sizes.

Table 1
Sample characteristics.

Variables	Pupil questionnaire		Parental questionnaire		Combined sample		2010/11 School census
	Sample sizes	%	Sample sizes	%	Sample sizes	%	%
<i>School type</i>							
Primary	614	46.1	150	51.2	764	47.0	51
Secondary	717	53.9	143	48.8	860	53.0	49
<i>Gender</i>							
Boys	738	55.4	141	48.1	879	54.1	–
Girls	593	44.6	152	51.9	745	45.9	–
<i>Area type</i>							
Urban	1251	94.0	218	74.4	1469	90.5	75
Rural	80	6.0	75	25.6	155	9.5	25
<i>Management type</i>							
Protestant	732	55.0	71	24.2	803	49.4	40
Catholic	362	27.2	75	25.6	437	26.9	46
Integrated	237	17.8	147	50.2	384	23.6	6.6
Total	1331	100.0	293	100.0	1624	100.0	100 (321,717)

represented in this research. Further investigation shows that this is particularly true for the parental survey data from secondary school. As a significant correlation exists between school management type and the religious backgrounds of pupils as indicated in Section 3, no religious data was collected at the individual level

in this research. In addition, 98% of the school children are white racial background in NI, and as a result, this ethnic dimension was not considered for further investigation in this research (Department of Education, 2011a). No household level data (such as household income, car-ownership) were collected as part of this



Fig. 3. Network connectivity levels of two school neighbourhoods in Belfast.

research. As discussed in Section 2.2, individual/household characteristics have a greater impact on school travel behaviour. A lack of consideration of these variables is, therefore, a major limitation of this study.

4.3. Methods

4.3.1. Derivation of neighbourhood level indicators

A number of neighbourhood level factors have consistently been identified (e.g. deprivation, net residential density, land use diversity, intersection density, and cul-de-sac density) as having significant impacts on mode choice behaviour both in this context (Hine et al., 2012; Kamruzzaman et al., 2011), and elsewhere as discussed in Section 2.2. These factors were derived/obtained using data from secondary sources. Geo-referenced school location data was used to extract the multiple deprivation rank¹ of the neighbourhoods from the Northern Ireland Multiple Deprivation Measure 2010 (NISRA, 2010). Net residential density was measured using the number of residential building footprints located within a unit area of residential zoned lands (e.g. number/hectares) (Frank et al., 2005). A variety of measures exist to calculate land use diversity in the lit-

erature including an entropy based measure, destination based measure, proxy based measure, perceived diversity measure, etc. (Cerin et al., 2007; Duncan et al., 2011). All these measures have both strengths and weaknesses and are discussed by Brown et al. (2009). This research used the Simpson's diversity index – an index used in the spatial ecology literature to calculate the biodiversity of habitats (Simpson, 1949). Unlike other measures, this method takes into account both the richness and evenness of land uses. Richness measures the number of different types of land uses present in an area whereas evenness compares the similarity of different land uses (i.e. whether the existed land uses are equally present). The following formula was used to calculate land use diversity index in which the higher value represents more diversity of land uses (value ranges from 0 to 1) (Simpson, 1949):

$$\text{Land use diversity} = 1 - \sum(a/A)^2 \quad (1)$$

where a is the total area of a specific land use category (e.g. residential) presents within a neighbourhood and A represents the total area of all land use categories in the neighbourhood. The building footprint feature class spatially represents 13 types of land uses of buildings. These were reclassified into six main classes (e.g. residential, commercial, industrial, social, offices, and recreational) following Kamruzzaman and Hine (2010) and were used to calculate the

¹ A lower rank means higher deprivation.

diversity level for each school neighbourhood. Intersection density was measured based on the number of 3 or more way intersections located within a unit area of the neighbourhood (e.g. number/hectares) whereas cul-de-sac density was calculated using the number of dead ends located within a unit area of the neighbourhood (e.g. number/hectares) (Fig. 3). However, a stronger correlation was found to exist between intersection density and cul-de-sac density, as a result, cul-de-sac density was excluded from further analysis as they both represent street connectivity level of a neighbourhood (Stangl and Guinn, 2011).

4.3.2. Validation of proxy reports

Unlike previous school transport research that has predominantly used data from parent–student dyads for the convergent validity of proxy reports, this study collected data from four independent samples (primary pupils, parents of primary pupils, secondary pupils, and parents of secondary pupils). Also, the collected ‘number of trips’ data are continuous in nature (count data to be more specific). As a result, independent sample *t* tests were conducted in SPSS in order to investigate whether the proxy report is a valid alternative to self-reported data for different age groups using the reported number of trips for different modes as dependent variables. The *t* test method has frequently been used in the literature in order to evaluate the discrepancies between self-reports and proxy reports (Robitail et al., 2007; Warner-Czyz et al., 2009). As mentioned earlier, data collected from parents of secondary school children were found to be overrepresented by integrated schools. As a result, the sample data for secondary schools were standardised by school management type in order to make them more representative. Consequently, the validity of proxy report was further investigated based on the standardised sample in STATA (version 11.1) using the [pweight = weight variable] option. This enables examination of whether the two results are different.

4.3.3. Identifying determinants of school travel behaviour in NI

Determinants of mode choice behaviour were identified only for those modes that were found to have a larger share of the overall commuting behaviour and included car, bus, and walk. Analysis shows that the reported numbers of trips in these modes are significantly associated with each other for different age groups. As a result, multivariate multiple regression (simultaneous equation model) analyses were conducted with three dependent variables. This analysis, therefore, takes into account the correlations of the dependent variables (Washington et al., 2010). Two multivariate multiple regressions were estimated, one for each age group (e.g. primary and secondary), which in turn estimated six models in total, one for each of the three modes and one for each of the age groups. Only the statistically significant ($p < 0.1$) explanatory factors for at least one outcome variable were retained in the models upon refinement of an initial starter specification that included all seven explanatory factors (e.g. gender, area type, management type, multiple deprivation, net residential density, land use diversity, and intersection density). Calculations were carried out using STATA (version 11.1).

5. Results

5.1. Descriptive statistics

On average, each individual reported 9.7 trips in a week. It was expected to have 10 trips per individual in a week considering five schools days in a week and two trips in a day (to and from school). However, the non-attendance rate in NI schools ranges between 5% and 8% (Department of Education, 2011a). Therefore, the 9.7 trips

in a week might represent the authenticity of reported data. Table 2 outlines the number of trips made by pupils using different modes in a week which are classified according to the respondent type for this research. Despite differences between the groups (which are discussed in detail in the following section), on average 50% of the trips were made by the car, followed by bus (27%) and walk (23%). Pupils rarely used the bicycle and taxi whereas none of the groups reported train as a mode of travel either to or from school. Data shows that a lack of a train station close to pupils' home location is the main reason (80%) for not using it. The main reasons for not using taxis were cited as no taxi service near or readily available to their place of residence (46.1%) with slightly less (40.6%) stating that they simply did not want to use a taxi. The main reason for not cycling was found to be longer travel time (61.2% pupils and 71.4% of parents stated this).

The stated reasons for using the car are simply because pupils want to use it. Given the importance of this reason, a further refinement in the instrument is necessary in order to decompose the underlying factors associated with this. Other reasons for using the car were found to be its speed and comfort, as shown in Table 3. A lack of public transport was not identified as a main cause of using the car in this research. With regard to reasons for not using the car, the majority stated that this was because pupils did not want to use the car (59%) with 30% stating that there is no car in their household (Table 3). 42% of the respondents reported that they used car in both ways, 9% used only for travelling to schools, and 1% used only for returning home. This, it was stated, is because many pupils are often ‘dropped off’ by parents on their way to work and make other arrangements for the homeward journey. This, it seems is mainly because those parents are at work and cannot collect the children after school (McDonald, 2008). A number of factors were identified that influenced to use the bus including the proximity of services (53%) followed by parental (51%) and pupils' (42%) willingness, and a lack of private transport in household (30%). On the other hand, amongst those who never used the bus, a majority of them (73%) mentioned that students do not want to use the bus followed by lack of services (24%) within reach and unreliability (21%) of the services. The length of journeys on foot was cited as the main reason (97%) for not walking to and/or from school. This finding is, therefore, similar to that reported in previous research studies (DiGiuseppi et al., 1998; Schlossberg et al., 2006; Zwerts et al., 2010). However, unlike previous research, safety issues or stranger danger do not feature prominently as reasons for preventing or prohibiting walking/cycling to and from school in this research.

5.2. Modal split: self-reported data vs. proxy reports

Comparison of the reported number of trips by different modes, using an independent sample *t* test, revealed no significant differences between primary pupils and their parents (Table 2). This finding is similar to that reported in previous studies as discussed in Section 2. However, unlike the studies that used data from parent–student dyads, this research utilised independent samples to validate the usability of proxy reports in a sectarian divided society. The findings in this research, therefore, advances the generalisation of results in a broader sense, that is, that parental proxy reports are a valid method for collecting school travel data for primary pupils. Specifically, the findings suggest that the parental proxy report is valid for primary pupils irrespective of their contexts. From this perspective, the results found on the validity of proxy reports for secondary school pupils can also be justified particularly when there is little literary evidence of this in transport research.

Table 2 indicates that a significantly huge difference exists in the reported data between secondary pupils and parents of sec-

Table 2

Reported number of trips by different groups in a week by mode and their differences.

	Primary pupil	Primary parent	Primary pupil vs. primary parent ^b		Secondary pupil	Secondary parent	Secondary pupil vs. secondary parent ^b		
			<i>t</i>	Mean difference			<i>t</i>	Mean difference	<i>t</i> (based on standardised sample)
Car	6.84	7.28	−1.195	−0.44	2.41	5.63	−8.627 ^a	−3.22	−5.93 ^a
Bus	0.40	0.38	0.319	0.02	5.14	1.79	11.513 ^a	3.35	7.59 ^a
Walk	2.44	2.33	0.267	0.10	1.96	2.04	−0.249	−0.08	−0.86
Bicycle	0.04	0.00			0.01	0.00			
Taxi	0.14	0.00			0.01	0.00			
Train	0.00	0.00			0.00	0.00			
Total	9.86	9.89			9.53	9.46			

^a Coefficients are significant at the 0.05 level.^b Coefficients are not calculated for some modes due to non-response.**Table 3**

Reasons for (not) using the car to and from schools (multiple response set).

Reason for using the car	Count	Column N%	Reason for not using the car	Count	Column N%
Students want to use the car	679	97.8	Students do not want to use the car	268	59.3
Students feel safe	0	0.0	Students feel unsafe	0	0.0
It is fast	673	97.0	Students do not like it	0	0.0
Bad weather	464	66.9			
Parents want me to use the car	461	66.4	Parents do not want me to use the car	50	11.1
Safest way of travel	431	62.1			
Comfortable way of travel	627	90.3			
No alternative exists	116	16.7			
Public transport is not suitable	114	16.4			
Other	32	4.6	Other (e.g. no car)	137	30.3

ondary pupils when transport modes were the car and the bus. Further analyses using the standardised sample show similar results despite the *t* statistics showing a slight reduction in the differences when compared to the original sample (Table 2).

Generally, parents reported a higher rate of car usage (60%) than pupils (25%). A significantly reduced level of bus usage was reported by the parent (19%) compared to that for pupils (54%) in a week (Table 2). Hine (2009) has shown that historically the rate of car usage for secondary pupils in NI varies between 22% and 25% whereas the rate of bus usage varies between 55% and 58%. Therefore, the self-reported number of trips by car and bus sit in between these figures. As a result, the validity of parental proxy reports for secondary school pupils can be questioned; at least, for these modes because there are no significant differences in the reported number of walk trips between the survey instruments. However, considering the research findings reported in other research fields, these findings were expected. Shapiro (2004) has indicated that unlike younger kids, when children grew up, parents do not closely monitor their activities. As a result, parents report inaccurately (Mandemakers and Dykstra, 2008). This finding suggests that unlike primary school pupils, care must be taken with sample selection when an analysis focuses on senior pupils because a proxy report is no longer a valid method of data collection for this age group particularly when it is required to analyse car or public transport usage. Nevertheless, the reporting of an equal number of walk trips to and from school implies that an exception can be made in terms of sample selection when analysis focuses on just active modes of transport e.g. walk in this case.

5.3. Multivariate regression analysis results

Distinct patterns of travel behaviour associated with primary and secondary pupils were identified in the above sections. Generally, primary school pupils rely more on the car and on foot for travelling to and from school, whereas secondary pupils rely more

on the bus. This section reports the regression analysis results showing the factors that significantly affect mode choice behaviour of these two groups separately. Since the proxy report for primary school pupils were found to be representative of self-reported data, as a result, the data reported by both primary school pupils and parents of primary school pupils were merged together for the regression analysis. Therefore, the sample sizes for this regression analysis became 764 (614 pupils + 150 parents). As a significant difference exists in the reported data between secondary school pupils and their parents, only the self reported data were analysed in the regression models for secondary pupils (sample sizes 717). The tests for the overall model indicate that the two multivariate models (primary and secondary) are statistically significant, regardless of the type of multivariate criteria used (e.g. Wilks' lambda) (Table 4). In addition, each of the three univariate models (e.g. bus, car, and walk) was also found to be statistically significant for both age groups. Despite the significance of the models caution must be taken when interpreting the results due to their limited explanatory powers. However, the explanatory powers of both the car and walk models for primary school pupils, and the car and bus models for secondary school pupils are quite favourable in comparison with previous research (Tal and Handy, 2010).

Table 4 shows that girls, both in primary schools and in secondary schools, made significantly fewer trips using the car and significantly more trips on foot than boys. The findings show that a one unit change in this variable (i.e. from boys to girls) is expected to reduce by 0.61–0.76 car trips in a week and increase a similar number of walk trips. This finding is surprising considering the fact that most studies have previously found an inconsistent relationship between gender and walking to schools. Whereas some studies reported that males are more likely to walk other studies found no correlation between gender and walking (McDonald, 2012). However, this finding is similar to that reported by Leslie et al. (2010) in the Australian context. They reported with surprise that having a higher/medium level of community disorder influenced females

Table 4

Multivariate multiple regression analyses results showing the mode choice behaviour of pupils.

	Model 1 (primary pupil and primary parent)						Model 2 (secondary pupil)					
	Car		Bus		Walk		Car		Bus		Walk	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Girls (ref: boys)	−0.61	−2.07 ^a	−0.01	−0.12	0.71	2.40 ^a	−0.76	−2.72 ^a	0.00	0.00	0.60	2.51 ^a
Rural (ref: urban)	3.72	6.97 ^a	−0.36	−2.63 ^a	−3.46	−6.45 ^a	−5.05	−4.91 ^a	7.606	6.38 ^a	−1.99	−2.25 ^a
Management type												
Protestant controlled (ref)												
Catholic maintained	0.23	0.51	0.20	1.79 ^b	−0.38	−0.85	−0.72	−1.58	0.35	0.66	1.24	3.16 ^a
Integrated	–	–	–	–	–	–	4.72	3.99 ^a	−8.03	−5.86 ^a	3.70	3.64 ^a
Net residential density	–	–	–	–	–	–	0.05	2.85 ^a	−0.10	−5.01 ^a	0.03	2.01 ^a
Land use diversity	7.26	6.19 ^a	0.04	0.12	−7.62	−6.46 ^a	18.96	4.81 ^a	−32.62	−7.15 ^a	10.23	3.02 ^a
Intersection density	−0.42	−1.21	−0.34	−3.87 ^a	0.98	2.83 ^a	−3.11	−2.80 ^a	4.98	3.87 ^a	0.44	0.46
Multiple deprivation rank	0.00	0.27	−0.00	−3.27 ^a	0.00	0.37	0.02	4.56 ^a	−0.04	−7.26 ^a	0.01	3.52 ^a
Constant	4.26	4.03 ^a	1.22	4.56 ^a	4.37	4.12 ^a	−23.05	−3.50 ^a	53.78	7.05 ^a	−15.75	−2.78 ^a
F		13.85 ^a		4.50 ^a		15.79 ^a		11.99 ^a		21.13 ^a		5.47 ^a
R ²		0.09		0.03		0.11		0.12		0.19		0.05
Wilks' lambda (F)						7.02 ^a						12.17 ^a
Lawley–Hotelling trace (F)						6.87 ^a						11.40 ^a
Pillai's trace (F)						7.15 ^a						12.94 ^a
Roy's largest root (F)						16.18 ^a						31.73 ^a
N						764						717

^a Coefficients are significant at the 0.05 level.^b Coefficients are significant at the 0.1 level.

to make more walk trips from schools, and therefore, this finding is more relevant to the NI context. There are virtually no differences in the level of bus usage between male and female pupils.

A higher number of car trips, a lower number of trips on foot, and using the bus were found to exist for primary school pupils attending schools located in rural areas. However, the rate of car use for secondary pupils attending rural schools was found to be significantly lower than their urban counterparts because of a greater reliance on the bus. Like primary pupils, secondary pupils attending school in rural areas also made fewer trips on foot.

Religion was found to be a significant factor in the choice of travel mode to and from school for secondary school pupils only. Table 4 shows that Catholics were more likely to walk and their rate of car use and bus use did not vary significantly from those pupils who attended controlled schools. Pupils who attended integrated schools were found to rely more on foot and the car at the expense of the bus compared to their counterparts in controlled schools.

Both primary and secondary pupils living in advantaged neighbourhoods made significantly fewer trips using the bus. No difference was found to exist for primary school pupils living between advantaged and deprived neighbourhoods in terms of making trips using the car and walk. However, secondary school pupils who lived in a deprived neighbourhood made fewer walking trips. This could be due to the fact that deprived neighbourhoods have a higher level of crime and pupils living in these neighbourhoods avoided walking due to reasons of personal safety. This finding is similar to that reported elsewhere in the UK and in other contexts (Christie et al., 2011; Leslie et al., 2010).

Although net residential density was not identified to be a significant factor for primary school pupils, this was found to have significant impact for secondary school pupils. Secondary school pupils living in higher density areas were more likely to walk. A higher level of land use diversity decreased the level of walking for primary pupils. In contrast, a higher diversity increased walking for secondary pupils. Primary pupils, instead, relied more on the cars in a highly diverse neighbourhood probably due to the fear of stranger danger. A similar result was found for secondary pupils despite their higher level of walking – perhaps at the expense of bus trips. Like the findings reported elsewhere (Schlossberg et al., 2006), intersection density positively impacted on walking for pri-

mary school pupils although such an association did not exist for secondary school pupils.

6. Conclusion

This research examined two relatively unexplored themes in the literature. By investigating convergent validity of proxy reports from independent samples for different age groups, this research verifies the widely identified conclusion that parental proxy reports are a valid alternative to self-reported data even in a highly segregated society. However, this validity was found to be limited to primary school children only in this research. The analyses presented using the collected datasets show that parental proxy reports for secondary school pupils are over reported for the car and underreported for the bus. However, given that this research utilised independent samples for the assessment of validity, as a result, it calls for a further investigation on this assessment using the widely used dyadic approach. Despite the invalidity of parental proxy reports using both original and standardised samples for secondary school, the result should be read with caution; and further research should seek to verify this using a truly representative sample. Nevertheless, the validity of proxy reports on children's mode choice to and from school for primary school pupils has a significant implication for studies involving primary school pupils because data collection from primary school pupils can sometimes be cumbersome for different reasons such as ethical approval. In addition, the issue of non-reporting and collection of data whilst maintaining sample integrity can be tackled with relative ease when data are collected from parents than pupils (Kite and Wen, 2010). The findings of this research demonstrate that proxy reports for secondary school pupils can also be an effective method if analysis focuses on just walking. This finding is also significant considering the changing nature of school transport research in recent years which focuses more on active transport.

Secondly, this study identifies the determinants of school mode choice behaviour for different age groups in a sectarian divided society by applying multivariate multiple regression technique. The models capture 3–19% of the variance in the reported number of trips for different modes associated with different age groups. Clearly, there are potentially many other factors that may help to

explain mode choice behaviour, including journey distance, school characteristics, household socio-demographics, or other unknown factors. The extent to which these known and unknown omitted factors are correlated with included covariates may influence the coefficients reported here. Further research should seek to include these factors and improve upon the explanatory power of the model presented here. Nevertheless, the factors that were identified to have significant impacts in influencing the mode choice behaviour are justified based on findings from previous studies.

Sectarian division was identified as having an insignificant impact on mode choice behaviour for primary school pupils. All religious groups in primary schools relied mainly on the car. This is possibly due to the fact that primary school pupils encounter a higher level of bullying and sectarianism during school journeys (Department of Education, 2011c), and as a result, 'pupils want to use the car' or 'parents want them to use the car'. Sectarianism is, therefore, a hindrance in the way of securing good health, developing social and spatial knowledge through using active transport to school for primary school pupils in NI. A higher level of bullying and sectarianism in controlled schools could also act as a barrier to use active transport for secondary school pupils attending controlled school as they made a significantly fewer trips on foot (Burns, 2006). A lower level of bus usage by secondary pupils attending integrated schools is probably due to the fact that integrated schools are sparsely located in Northern Ireland, and as a result, scheduling of bus services to these schools is difficult which prompted pupils to rely more on the car. However, evidence from this research shows that pupils attending an integrated school would be more willing to walk if these schools were located within walking distance from their home. These findings suggest that there is room for the promotion of active travel choices amongst Protestants' children attending secondary schools. In addition, the provision of more integrated schools could be a way forward to lessen the anti-social behaviour (e.g. bullying) and consequently to promote the use of more sustainable transport options in NI.

Despite sectarian division was found to be an important factor in this context, findings show that land use diversity is the most significant factor in influencing the choice of transport mode for both primary and secondary pupils. Rural–urban context is, yet, another major factor for both groups. Other urban form variables were also found to be associated with mode choice behaviour. The findings, therefore, support the global resurgence of compact urban development and healthy cities planning focusing on urban design and active transport. However, the findings of this research suggest that a careful selection of land use based interventions is required to promote walking because not all interventions will have identical impacts for all age groups; rather, they sometimes impact in opposite directions (e.g. land use diversity).

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