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Transport and child well-being: An integrative review

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ABSTRACT

Understanding children's travel is an important part of drawing a complete picture of over-all well-being in society. Children's active travel to school, independent travel, transport and physical activity, and crashes have been reviewed, yet it may not be a complete picture. If research on children's travel has the ultimate goal of improving children's well-being, there is currently no general synthesis on the research linking transport and child well-being. This integrative review asks, "what evidence is there that transport affects child well-being?" It organizes the findings by two key measures: the domain of well-being and the transport means-of-influence. The five main domains of child well-being are: physical, psychological, cognitive, social, and economic. The three means of transport influence are: as access, intrinsic, or external. Findings are identified as being consistent, inconsistent, or one-off (e.g. only one study). The results show that transport plays a role in all domains of children's well-being. Most benefits identified are associated with active travel and independent travel. Most negative impacts are associated with traffic. While numerous one-off results exist which suggest that there may be many other impacts, research that repeats prior work is needed to support or refute these such results. Finally, potential relationships between transport and well-being are suggested.

1. Introduction

Research on the links between transport and well-being of adults has gained traction in the past few years (e.g. Reardon and Abdallah, 2013). Unfortunately, research on the relation with child well-being is not available from one source, but is rather dispersed over many studies. There is a considerable body of research and reviews from the past decade that seeks to *explain* children's travel and reviews of such research exist (e.g. Sirard and Slater, 2008). However, the *reason* for studying children's transport is not always clear as transport planning is often based on the value of time, a metric that includes travel for work or travel's relationship with an individual's income (though this approach is being contested) (Ettema et al., 2011; Jain and Lyons, 2008). These metrics are based more on adults than children. Children do not work and have no "value of time", so one previous justification for children's travel research was the increasing dependence of children on parents for travel. Framing children's travel in this way negates their autonomy and increases the chauffeuring burden on the parent (e.g. Hillman et al., 1990). The chauffeuring burden could be quantified through the value of time of the parent.

One method of reducing the chauffeuring burden would be autonomous travel. This has the additional benefit of including active travel (either as one component, or the complete trip). One of the first papers to suggest that active travel might play an important role in children's daily physical activity was by Tudor-Locke et al. (2001). The research on active travel gained momentum as questions surrounding obesity began to emerge. A recent review examined whether there was a clear relationship between autonomy, active travel, and weight status (Schoeppe et al., 2013). Autonomous travel's positive contribution to physical activity was supported, though the relationship with obesity was not clear. With respect to explaining the likelihood of autonomous travel, a previous review of autonomous travel examined the methods used in such research and suggested a more complete behavioural model (Mitra, 2013).

A non-economic concern was raised with respect to traffic danger. The World Health Organisation produced a report showing that globally motor vehicles were the number one cause of death for individuals under the age of 25 (Toroyan and Peden, 2007). With road traffic crashes, impacts such as property damage or physical harm are often measured. However, although such reports

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mention that impacts apart from physical harm exist such as psychological impacts, they are not detailed.

While the economic and physical well-being attributes of children's travel have been studied and reviewed, the current body of transport research does not address how transport influences many facets of well-being beyond physical activity and road traffic crashes. As a primary goal of planning is to improve the well-being of society, the question here is: *what evidence is there that transport affects child well-being more holistically*?

Previous research has looked at child well-being or quality of life. Such research focused on transport (Hillman, 1993), the built environment (Lennard and Lennard, 2000), children in urban environments (Davis and Jones, 1996), or children and planning (Matthews and Limb, 1999; Gilbert and O'Brien, 2005). The first (Hillman, 1993) is an edited book containing a collection of articles that deal with many of the topics to be addressed in this review. Lennard and Lennard (Lennard and Lennard, 2000) take an architectural approach relating many of their arguments to social and community interaction, amongst others. Davis and Jones (Davis and Jones, 1996), focus on the differences between needs, perceptions, and affordances between children and adults in urban settings. Finally, Matthews and Limb (Matthews and Limb, 1999) convincingly argue that much of Western planning focuses on the needs of one group, "white, ableist, adult, male, middle-class." Gilbert and O'Brien (Gilbert and O'Brien, 2005) make a similar argument. They highlight that planning focuses on the needs of adults, which likely leads to a system where children are more and more dependent on adults for their transport. Taken together, those books and articles make coherent arguments for improving transport planning with respect to children's well-being, but often lack references to support their assertions. This review will help fill that gap by providing an overall view of the research literature dealing with impacts of transport on child well-being.

2. Conceptual framework

2.1. Defining well-being

Well-being is a commonly used, but ill-defined term (Pollard and Lee, 2003; Dodge et al., 2012). Pollard and Lee (2003) explain that depending on the field of research it can refer to happiness, self-esteem, standard of living, or lack of depression. Those authors suggest that the following definition is the most useful: well-being is "a multidimensional construct incorporating mental/psychological, physical, and social dimensions." Dodge et al. (2012) conclude their article by defining well-being (or wellbeing) through a framework that balances resources and challenges in the three primary domains of psychological, physical, and social. In such, they discuss the importance of challenges to avoid personal stagnation. In Pollard and Lee's review (Pollard and Lee, 2003), which focused on children's well-being, they further suggest cognitive well-being (for example intellectual or learning related) and economic (primarily related to the economic situation of the household to which the child belongs). For each domain, the authors provide a list of measures that were used. That list is used in this review to identify obvious omissions for transport related impacts.

2.2. How transport affects well-being

How transport influences child well-being is a critical piece to consider. We propose that transport affects well-being through at least three means-of-influence (Fig. 1): as access, intrinsic (i.e. during travel), and external (i.e. transport by others). The original, and perhaps most common, approach is to examine transport as a means of access (e.g. to school). The second would be what impacts

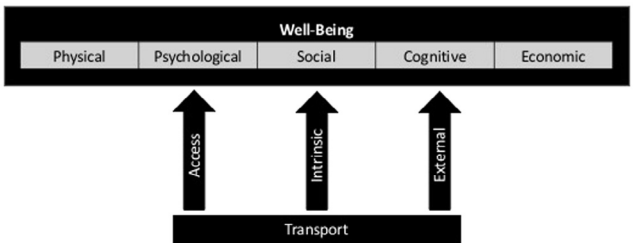

Fig. 1. Conceptual framework of child well-being and the three means of impact through which transport can affect them.

exist during travel whether they are intrinsic (e.g. active travel) or potential (e.g. a crash not caused by others[1]). The third would be the impacts that accrue to the child due to society's transport behaviour (e.g. noise and air pollution; crashes caused by others1). The impacts on child well-being in this review will be categorised by those three means of impact.

The objective of this review is to find what different relationships between transport and child well-being exist. Previously reviewed areas such as explaining trips to school (e.g. Mitra, 2013; Pont et al., 2009) or the potential for active travel to contribute to a child's physical health (e.g. Schoeppe et al., 2013) are summarized, but are not discussed extensively as such discussions exist in those reviews. Literature related to those areas were eliminated from the papers reviewed in this work. The intention is to create a resource for the general state of knowledge on the topic of transport and child well-being.

The findings are organised by the conceptual framework displayed in Fig. 1. As shown, the transport influences are first organised by the relevant domain of well-being identified by Pollard and Lee (2003), and then by the means-of-influence by transport. If similar findings occur, these are termed "consistent findings" meaning that some corroboration exists. The term "inconsistent" is used for findings that do not support each other. For example, one article reports a correlation, while another finds no correlation. In many cases, associations are found, but are not tested or reported in other papers found through this review. In those cases, the term "anecdotal" is used for these one-off findings.

Consideration to cultural-specific findings is given as well. Two reports with the same finding from the same country would imply country-consistent findings. Reports from culturally similar (e.g. Canada, the USA, Australia, New Zealand) would imply cultural-consistent findings. Consistent findings across divergent cultures would imply more universally consistent results. Thus, consistent findings are identified as either culturally specific or international.

3. Method

This is an integrative review. An integrative review differs from other types of reviews (e.g. systematic, meta-analysis) as it allows for the combination of quantitative and qualitative research (Whittemore and Knafl, 2005). It differs from systematic reviews that use explicit quality criteria to summarize and synthesize empirical data, or meta-analysis reviews that use statistical analysis to combine evidence from multiple primary studies. Integrative reviews differ from meta-synthesis reviews that aim to interpret and present a number of qualitative studies. Transport research encompasses a vast range of methods that include quantitative

[1] To help explain our approach to the difference between a crash not cause by others and a crash caused by others, let us take the example of a bicycle crash in two different situations. A child crashes their bike trying to do a jump would be a crash not caused by others. A child on a bicycle who is hit by a non-attentive driver is a crash caused by others.

and qualitative results, and to exclude qualitative research when dealing with less-quantifiable aspects of travel would limit the potential of this review to address its research question. The objective of an integrative review is to bring together past research and to identify obvious gaps by summarizing the findings of numerous studies that address a particular problem or phenomenon. In such reviews, all relevant literature on the problem or topic should be included. The purpose of this integrative review is to summarize evidence on interactions between transport and child well-being rather than giving a critical analysis of the literature.

To enhance the rigor of this type of review, the literature search process is described, along with inclusion and exclusion criteria. There are no gold standards of how to measure quality in reviews, and for integrative reviews the inclusion criteria will relate to the sampling frame (Whittemore and Knafl, 2005).

The primary source of papers was the Web of Science Core Collection. The search was composed of these keywords: in title: *child**; within the topic: *(travel OR transport* or mobilit*) NOT (organ OR gene* OR membrane OR obesity OR plasm* OR joint*)*. The search was repeated with FRANCIS (humanities and social sciences) and the International Bibliography of the Social Sciences. No limit to the year of publication was given. Due to the search words, the papers found had an English title and at least an English abstract. However, papers in French, German, Japanese, Norwegian, Spanish and Swedish were read and included where relevant. The search was last conducted on 7 January 2016.

3.1. Eligibility criteria

Following the search by keywords described above, papers were initially selected following these criteria:

1) Paper related to children's local travel (as opposed to inter-city or international travel) or to the impact of transport on children;
2) Paper was not explaining mode use by built environment, parent's attitudes/values, socio-economic measures (reviews exist);
3) Paper was not primarily examining the role of active transport, or transports role on physical activity or obesity (reviews exist);
4) Paper does not relate to physical impacts of crashes (reviews exist).

More than 271 papers were selected through this process and then reviewed. They were then grouped by theme: accessibility (8); autonomy (40); environmental (3); experience of travel (22); health (43); mode choice (18); quality of life (13); safety (76); social (15); spatial maps (8); noise (9); and other (16). Next, the papers were classified by their relation to one of the child well-being domains (see Fig. 1, based on Pollard and Lee's (2003) categorisation). After removing the papers that were not within the objective of the study, a total of 93 papers were retained.

The papers come from 19 different countries. Of the papers cited, 37 relate to European countries, 19 relate to North America, 18 relate to Oceania, 7 relate to Asia, one each from Iran and Peru, and the remaining 10 are reviews.

4. Review results

Each section briefly introduces the domain of well-being and gives examples of relevant measures. At the end of each section, findings are summarized with consistent and contradictory findings highlighted. A table is given listing relevant measures for the domain from Pollard and Lee (2003) along with the measures found in the review or potentially relevant measures where none were found. Those lists are not exhaustive; most likely other relevant measures exist.

4.1. Physical

Indicators from the physical domain include health compromising behaviours, exercise, or safety-related behaviour (Pollard and Lee, 2003). As mentioned, this review did not seek out articles on relations recently reviewed such as active travel (and its associations with overall physical activity and obesity) (e.g. Panter et al., 2008; Schoeppe et al., 2013) or crashes (Toroyan and Peden, 2007). However, a short summary of that work is given in the relevant transport means-of-influence section.

4.1.1. Transport as access

Transport allows individuals to reach activities that facilitate physical activity such as active play, sports, or recreation. A recent review found that active travel was consistently associated with more leisure activities and independent (or autonomous) mobility with more physical activity (Schoeppe et al., 2013). Children's independent mobility (CIM) was positively associated with everyday structured exercise (Page et al., 2010). As well, for boys, CIM was positively associated with the likelihood of play, of structured exercise, and active commuting. For girls, it was only associated with active commuting [ibid].

Access to health services is a key constituent of transport for well-being. For parents without cars, transport problems were identified as one of five key barriers to accessing health services in the US (Grineski, 2008). The transport system and public transport are not fundamentally designed with such needs in mind, which ultimately could influence the choice to visit a hospital, or limit the choice of hospital to those hospitals with better non-car access.

Finally, Davis and Jones (1997) argued that the lack of access, sense of insecurity and fear are likely more serious health problems than declining participation in organised sports in the UK. Related to that finding, families in rural areas mentioned transport and opportunities for participation as barriers to physical activity (Smith et al., 2010). In that study, low-income families had similar problems.

Consistent findings: active travel is positively associated with leisure activities; CIM is positively associated with physical activity.

4.1.2. Intrinsic influences through transport

With respect to decreases in physical activity and increases in weight problems, recent research on child well-being has focused considerable attention on active travel. Schoeppe et al. (2013) reported that a positive association was found between active travel and physical activity. However, evidence supporting a link between active travel to school and weight status was "evident but ... inconsistent". Thus, active travel can have a positive impact on physical activity, but its role in weight status is not clear.

Panter et al. (2008) examined environmental determinants on active travel. They found that active travel was positively associated with social interactions, active travel facilities, neighbourhood urban form, shorter route distance, and safety of the route. Improving the likelihood of such behaviour was influenced by physical aspects (infrastructure, distances), social relations, and safety.

Air quality relates to children's respiratory diseases and has been examined both for in-vehicle and a result of vehicle use. In-vehicle air quality can relate to exhaust, but also by another passenger's behaviour. Smoking in vehicles can expose children to significant second-hand smoke even if the window of the smoker is half-open (Sendzik et al., 2009).

Air quality in school buses was found to be worse than at bus stops or drop-off zones at schools in the USA (Behrentz et al., 1995). If the windows are closed on the bus, the air quality is affected most by the bus's exhaust. If the windows are open, then the air quality is affected most by the context of the surrounding traffic. Children on school buses inhale more than 100 times more bus exhaust than people who live by a school bus route (Marshall and Behrentz, 2005). These studies point to an issue with the motor type and route choice for school buses.

Consistent findings: active travel contributes to daily physical activity.

Inconsistent findings: active travel to school is not consistently associated with higher weight status.

4.1.3. External influences of transport

Traffic danger is a safety concern for many parents and relates to the measure of safety-related behaviour. A WHO review (Toroyan and Peden, 2007) found that road traffic crashes are a serious public health issue globally, with low-income countries being particularly affected. Globally, crashes are the leading cause of death for those under 25, with males more commonly involved in collisions. In low income countries the victims are more likely to be vulnerable road users, whereas in wealthy countries it is young male drivers. From that review it is not clear whether children in developed countries where walking is high and motor use is low are safer than the inverse in terms of population impact. However, a recent study found that the death rate per capita for child pedestrians was roughly equal in Japan and Canada, but children are much more frequently killed in motorised vehicles in Canada leading to a per capita death rate roughly three times that of Japan (Waygood et al., 2015).

The majority of air pollution in urban environments is attributed to vehicular emissions (Seaton et al., 1995; McNabola et al., 2009). Although those papers state this, they do not reference studies that demonstrate this. However, the majority of childhood asthma costs are due to traffic-related pollutants in California, US (Brandt et al., 2012). During the Atlanta Olympics, children's visits to hospitals for acute asthma cases significantly dropped when congestion was restricted and managed for the Olympics (Friedman et al., 2001). Air pollutants associated with increased child respiratory treatments are (Beatty and Shimshack, 2014): particulate matter 10 μm or less in diameter (PM10), carbon monoxide (CO), and ozone (O_3). As well, nitrogen dioxide (NO_2) from freeways was found to be associated with asthma in children (Gauderman et al., 2005), though the association was found for living close to freeways. No association was found for the amount of traffic. Traffic-related air pollution by homes and schools may contribute to the development of asthma (McConnell et al., 2010). High traffic flows related to reduced air quality are linked to areas where low income groups live in California (Gunier et al., 2003) and in Canada (Chaudhuri, 1998) suggesting a problem of environmental justice (Pabayo et al., 2012), where those not responsible for the pollution are suffering the negative externalities of those who are creating the traffic.

Increased blood pressure is one of the more common associations between traffic noise and children's health. A review (Paunovic et al., 2011) of epidemiological studies found that road traffic is positively associated with an increase in blood pressure in children. Systolic pressure was found to be higher, and heart rates were also higher for children in noisy residences (Belojevic et al., 2008). In a paper published after the review by Paunovic et al. (2011), the blood pressure of children with bedrooms that face busy streets was found to be higher (Liu et al., 2013). Related to blood pressure, a review of transport noise on health and cognitive development found that it affects cardiovascular disease and catecholamine secretion. Hypertension and sleep disturbance were also related to the prevalence of traffic noise, though adaptation may exist (Clark and Stansfeld, 2007).

"Lead is a well-known toxin, and its neurotoxic impact on children is strongly associated with problems that are extremely costly to society, including learning deficits, socialization, violent behaviour and other health problems" (Mielke et al., 2010). Those impacts relate also to children's cognitive and social well-being. In Peru, where leaded gasoline was still used, it was linked to higher blood-lead levels in children (Naeher et al., 2004). An Australia paper found that lead being transported in trucks covered by tarpaulins was not associated with higher levels of blood level content in children (Mak et al., 2003). Another paper related to lead looked at the legacy impact of lead contained in gasoline between 1927 and 1994 in eight urbanized areas of California (Mielke et al., 2010). That paper details how to identify problem areas, thus allowing for authorities to prioritize cleaning of lead dust from soil in locations where children congregate.

The relation between transport and childhood leukaemia has recently been reviewed in two articles, with a third conducting a meta-analysis. The first review found that residential traffic exposure during the postnatal period was associated with childhood leukaemia (Boothe et al., 2014). The second supported the finding of the previous and emphasized the role of benzene (Filippini et al., 2015). Finally, a meta-analysis examined studies of benzene from traffic density and traffic-related air pollution. The summary relative risk was reported to be 1.48 for childhood leukaemia (Carlos-Wallace et al., 2016). Earlier studies (Reynolds et al., 2002; Reynolds et al., 2004) in the USA examined the exposure to traffic with rates of all childhood cancer. The first (Reynolds et al., 2002) examined children under the age of 15 in California in 1988 to 1994. It found a very small positive association between high traffic density and all cancers, leukaemias, and gliomas. As the relationship was found to be small, the authors argued that the rates were not higher in high traffic areas. The second (Reynolds et al., 2004) focused on children under the age of five who had cancer and used controlled match subjects to test the influence of road density and traffic density. That paper did find a higher instance of central nervous system (CNS) tumours in areas with high traffic density, but with no evidence of a dose response. Those findings have recently been supported with increased risks found for central nervous system primitive neuroectodermal tumour (PNET) and medulloblastoma (von Ehrenstein et al., 2015). In all cases where relationships were found, it was for children under the age of six.

Consistent findings: Crashes as the main cause of death of children and youth around the world; positive associations between traffic emissions and asthma; traffic noise and increased blood pressure; traffic and childhood leukaemia; traffic and central nervous system tumours.

4.1.4. Summary of physical well-being relations

Positive influences on children's physical activity were found through active travel and CIM, by the means-of-influence access and intrinsic (Table 1). However, external influences of traffic such as emissions, noise, and traffic density are shown to have clear and serious negative effects on children's physical well-being in the form of various cancers and tumours.

The lower number of one-off[2] relationships (four) as compared to consistent results suggests that this domain of well-being is well-studied. However, there remain results (see Table 1) to be corroborated and interactions that have not been studied[3].

[2] One-off is used in this article to refer to a finding that is not corroborated by a second study.

[3] Or at least were not found through the search.

Table 1
Relevant measures of physical well-being and their association with transport (Acc = access; Intr = intrinsic; Ext = External).

Measure	Relationships where found
Health compromising behaviours/ Health promoting behaviours; exercise; physical health	Acc: Active travel associated with more leisure activities[R,INT]; CIM with more physical activities[R,INT]; CIM with more structured exercise[A]; lack of access and decreased participation[A] Intr: Active travel is associated with greater physical activity overall[R,Int]; physical structure[S]; vitamin E[S] Ext: collision related death or serious injury[R,Int]
Physical manifestations of stress	Ext: Traffic noise is associated with high blood pressure[R,INT]
Physical manifestations of illness	Intr: Active travel is inconsistently related to obesity[R,IF]; Ext: High traffic density is associated with childhood asthma[CF,INT]; high traffic density is associated with childhood leukaemia for children under 6 years old[R,INT]; exposure to traffic and blood-lead in countries which continue to have leaded fuel[A]
Nutrition	Acc: Food deserts and access to healthy choices[S]; Int: Walking and digestion[S]
Safety-related behaviour	Ext: Vulnerable road users[R,Int]; driver behaviour[R,Int]
Physical abuse	Intr: Personal security[S]
OTHER	Acc: Access to health services[A] Intr: Air quality in cars[A]; School bus interior vehicle air quality was found to be worse than at bus stops[A]

R = review; S = suggested; CF = consistent findings; IF = inconsistent findings; A = anecdotal; Int = International; CS = country-specific.

4.2. Psychological

The psychological domain includes indicators that pertain to emotions, mental health, and mental illness. Psychosocial perspectives fall within the psychological domain. Measures include anxiety, depression, anger, stress, autonomy, life satisfaction, happiness, positive/negative affect, self-esteem and stress management (Pollard and Lee, 2003).

4.2.1. Transport as access

The importance of the influence of a destination's activity on psychological measures such as subjective well-being have been studied for adults (e.g. Bergstad et al., 2012), and there is some suggestion that similar results would be found for children. Enjoyment was found to be more associated with the destination type than what mode children used to get there (Barker, 2006).

As will be shown later in the section on social well-being, children desire to meet with friends. The ability to access those friends may be linked to higher CIM (see later section). Conversely, the psychosocial measure of loneliness was associated with lower CIM (Pacilli et al., 2013).

Consistent: No corroborating studies were found.

4.2.2. Intrinsic influences through transport

In Denmark, route choice and modal choice were associated with "affect management" (that is, managing one's emotions) by both children and adults, where the individual would choose a route or a mode for its associated positive affect (e.g. more relaxing, less stressful, safer, etc.) (Jensen et al., 2014). This might suggest that people make choices based on anticipated affect, thus limiting any variation between modes. That logic was somewhat confirmed in a prior study in Sweden that examined activation and valence (e.g. feeling happy/sad) during the route to school and found no significant effects by mode (Westman et al., 2013). However, a study from Canada (Ramanathan et al., 2014) that examined positive and negative emotions related to the trip to school found that most parents and children report positive emotions, but that children who use active modes (AT) and their parents report statistically more positive emotions. Parents of children who use passive modes were more likely to report negative emotions. A second Swedish study (Westman et al., 2015) showed that travel by car and longer travel negatively affect children's satisfaction with travel. Results showed that travel by school bus or active mode were felt to be of higher quality. In the Netherlands (Kopnina and Williams, 2012), affective associations to cars had a wide variation.

In a study of children's emotions during travel, it was found that the walk to school can emotionally prepare children for the day and that the return walk from school allows them to de-stress (Murray and Mand, 2013). They also reported that the school bus can be an "emotional battleground". Engaging in solitary activities during travel made children feel stressed (Westman et al., 2015).

Autonomous travel can likely give children a sense of control and self-esteem. In Toronto, Canada, children who frequently used bicycles were found to have higher feelings of self-esteem and control (van Vliet, 1983). As well, being able to relate to others is an important part of developing relationships and a functioning society (Eisenberg and Miller, 1987). Bicycling was found to make children more empathetic (e.g. the ability to understand and share the feelings of another) (Endoh, 1997).

4.2.2.1. Experience of travel – psychological domain. The experience of travel could affect psychological well-being if the experience is enjoyable, stressful, or other such emotional impacts. Walking was associated with different emotional reactions. A Malaysian study (Yatiman et al., 2012) on children in rural areas reported that walking autonomously to and from school resulted in feelings of excitement, joy, challenge and fear (of imaginary monkeys and ghosts). In an urban setting, children in Belgium also highlighted that experiences on route while walking and cycling were positive factors associated with those modes (Zwerts et al., 2010). Children's appreciation of their walk positively increased with the amount of vegetation present and the lower width of roads (Watanabe et al., 1988).

Personal comfort varies by mode and children reported that they liked being shielded from weather in cars (Barker, 2006). Similarly, the comfort of cars was a positive aspect for girls in Belgium (Zwerts et al., 2010).

Consistent findings: Positive experiences while walking; lower stress with walking

Inconsistent findings: Relationship between mode to school and measures of affect.

4.2.3. External influences of transport

Traffic noise can affect psychological well-being. Annoyance was recorded in several articles (Clark and Stansfeld, 2007; Babisch et al., 2012; van Kempen et al., 2009), though Babisch et al. (2012) noted that children report annoyance less than adults. Borderline or abnormal values were even found for the emotional system scale (e.g. fears, worries, clingy, unhappy) (Tiesler et al., 2013) where traffic noise was found on the least exposed side of a house.

The physical impact of collisions is recorded through fatalities and injuries, but their negative impacts on well-being are not limited to those physical ones. One third of children involved in a collision reported psychological problems when questioned four to seven months after the event (Ellis et al., 1998). Most related to tra-

vel avoidance, 38% had travel anxiety, and 17% had nightmares or other sleep difficulties. The parents in this study also became more protective, restricting their child's mobility (thus potentially limiting the well-being benefits of CIM), and creating conflict. In a second study of children who had been involved in collisions, the majority of them were found to have psychological problems (Bryant et al., 2004) such as re-experiencing the event up to six months after. About one-fifth had post-traumatic stress disorder, a third had travel avoidance, a third had travel anxiety, and nearly half had social impairment. Sleep disturbance was reported for less than 10% after two weeks.

Consistent findings: A positive association between traffic noise and annoyance; travel avoidance, travel anxiety, and sleep difficulties, and parents restricting CIM after collisions.

4.2.4. Summary of psychological domain

Transport was found to influence children's psychological well-being (Table 2) in both the short-term (e.g. experiences, activation) and the long-term (e.g. as a result of road traffic crashes). The majority of these influences were related to the external influence of transport (traffic noise and collisions), while two positive associations were found for walking (positive experiences and reduced stress). The collision results could be termed "country-specific" findings as both studies were from the UK. However, it is unlikely that children would not be psychologically affected in different geographic or cultural settings.

An inconsistent finding was found for the association of positive or negative affect with mode. The two studies were conducted in Canada and Sweden, with a much larger sample in Canada (5423 versus 206). In the Canadian study, the questions related to how the child generally got to school, whereas in the Swedish study it related to the trip just completed (the morning commute to school). The two methods are not directly comparable. Whether the child's immediate experience differs from experiences in general may be a matter for future research.

Nine different one-off relationships were identified, as compared to five consistent findings, suggesting that more effort to replicate findings is required.

Table 2
Relevant measures of psychological well-being and their association with transport (Acc = access; Intr = intrinsic; Ext = External).

Measure	Relationships where found
Anxiety	Ext: Post-collision, children had travel anxiety[CF,CS]; Post-collision, children had travel avoidance[CF,CS]
Emotional problems	Intr: Managing emotional outcomes related to transport mode choice[A]; The school bus as an emotional battleground[A]
Fearfulness	Ext: Fear of traffic danger[S]
Loneliness	Acc: Lower CIM was associated with loneliness [A]
Negative affect	Intr: Passive mode users were more likely to be associated with negative emotions[A]
Nightmares	Ext: Sleep problems or nightmares due to collisions[CF, CS]
Recurrent memories of bullying	Intr: Bullying during travel[S]
Stress	Intr: Being passive during travel increased stress[CF]; post-collision post-traumatic stress disorder[A]; time-dependent (e.g. punctual arrival) stress[S]; restoration[S]
Attachment	Intr: Place attachment[S]
Autonomy	Ext: Restricted CIM following a collision[CF,CS]
Happiness	Intr: Travel by car and longer trips were negatively associated with trip satisfaction[A]
Life satisfaction	Acc/Intr/Ext: Life satisfaction[S]
Positive affect	Acc: positive affect from access to a destination that brings positive affect[A] Intr: Enjoyment and walking[CF,Int]; positive affect related to active modes[IF];
Self-esteem	Intr: Self-esteem was associated with bicycling[A]
OTHER	Ext: Annoyance from traffic noise[CF,Int]

R = review; S = suggested; CF = consistent findings; IF = inconsistent findings; A = anecdotal; Int = international; CS = country-specific.

4.3. Cognitive

The cognitive domain includes indicators that are considered intellectual or school-related in nature. Examples include concentration, school behavioural problems, cognitive ability, and academic achievement (Pollard and Lee, 2003).

4.3.1. Transport as access

The outdoors is an important developmental environment and independent travel by children gives them greater opportunities for growth and exploration (Björklid, 2004). Some children may prefer to travel by car (Barker, 2009), but in numerous countries children who travel by car lament the loss of experiences they might gain through exploration (Barker, 2009; Mitchell et al., 2007; Tranter and Pawson, 2001). Larger activity spaces relate to the potential to explore and boys in Australia who had a bicycle at home to ride and girls who had CIM had larger activity spaces (Villanueva et al., 2012).

Consistent findings: Exploring is desirable and is not associated with car travel.

4.3.2. Intrinsic influences through transport

A child who is more alert or awake may be more prepared to learn and concentrate. In Sweden, children who cycled to school had higher activation (e.g. more alert, awake) at school than children who came by car (Westman et al., 2013). Related to this, research in neuroscience finds that walking for twenty minutes was associated with greater cognitive control and academic achievement for preadolescents (Hillman et al., 2009). A later study by Westman et al. (2015) found that social activities and smartphone use during travel had a positive relationship with performance (here a word-fluency test) at school.

For children's cognitive abilities, studies that examined spatial mapping by children examined their capabilities and the content of the images. Children who travelled by walking or public transport were found to have better overall spatial maps (Ahmadi and Taniguchi, 2007). In another study, the mode of travel was found to have no relation, but CIM had a positive relation on non-school journeys (Joshi et al., 1999). Related to that, children with greater CIM covered larger areas on a mapping exercise (Villanueva et al., 2012). In an earlier study, the spatial scale and amount of detail provided related to the child's usual mode, though no further details were given to clarify this relationship (van Vliet, 1983).

Spatial clarity in mapping was linked with bus use and spatial knowledge was linked with walking with parents (the possible explanation being that parents discuss the surroundings with their children as they walk) (Ahmadi and Taniguchi, 2007). However, in an earlier study no relation was found with mode for environmental knowledge, though spatial knowledge did increase with parental escorting (Joshi et al., 1999). Boys were found to have lower spatial knowledge (Ahmadi and Taniguchi, 2007), but travel longer distances. Age was positively associated with increased environmental knowledge (Matthews, 1984).

4.3.2.1. Experience of travel – cognitive domain. Child psychologist Kegerreis (1993) describes the mental and emotional developments possible through independent travel. In that work, she talks about the need to take responsibility for action or inaction, for success or failure. By using their own resources, children learn to cope with new experiences. These experiences can be seen in an Australian study (Witten et al., 2015) on children in deprived inner city

areas (typically a mixed measure of low socio-economic measures) who talked about walking independently and becoming more confident and discovering routes to avoid undesirable locations. They further spoke of gaining experience in assessing risks and taking action.

For Kegerreis the trip home from school is a time for children to explore (see Hosoda and Nichide, 2009), take small risks, test boundaries, and do mildly dangerous things, which are important for their development. Children in Finland (Kullman, 2014) were fascinated with aspects unobserved by adults: crumpled paper, ice, tree branches, engaging with different textures and inclines, running up and down things, and sliding on ice. The children were using their environment to explore and learn. That reflects previous assertions that trips are a play activity and a chance to explore (Tranter and Pawson, 2001). In Japan, children's movement suggested exploring when taking the train to and from school. Using GPS, the children who commuted by train were observed to have moved in a slower and more leisurely way when on foot travelling to/from the station than those commuting by bus or *only* on foot (i.e. they did not use public transport). The return trip from school by the train commuters was marked by irregular speeds demonstrating that there was more to the walk than just walking (Hosoda and Nichide, 2009). Trips solely by foot had irregular speeds after school as well, but were quick and direct in the morning (Ibid). For children who used the bus, they moved quickly in the morning, and then slowly after school.

Kegerreis continues with aspects of observation where the children see more of the adult world, observing and learning how to act or handle themselves in different situations; when one is escorted, the experience is not the same, as the responsibility lies with others. In New Zealand (Carroll et al., 2015), children talked of experiences on the street such as looking at other people, gardens, graffiti, shop displays and cafes. In Australia (Romero, 2011; Romero, 2010), some children wished to walk alone (19%) and the most common reason for that (36%) was to have fun (related to psychological well-being), followed by being able to dictate the duration and having time to think (29%). In Finland Kullman (2010), trips to school included transitional geographies and children would employ the slightest possible variations to create experiences. In Romero's studies (Romero, 2011; Romero, 2010), the categories for the most fun thing during a trip were: experiencing the natural environment (38% of walkers versus 21% in cars), social pursuits (23% of those in cars), buildings, car activity, solitary pursuits, and people activity. Discussions and activities during travel were also seen as important (Barker, 2009).

Consistent findings: Increased spatial knowledge and being accompanied by parents; observing and exploring the world around them through walking/CIM.

Inconsistent findings: Relationships between better spatial maps and greater spatial knowledge with mode of transport.

4.3.3. External influences of transport

Related to academic achievement, traffic noise affects both reading speed and basic mathematic exercises, though reading comprehension and mathematical reasoning were not affected (Ljung et al., 2009). In that study, irrelevant speech did not affect those measures suggesting that traffic noise is a greater problem than such noise.

Most relationships with spatial maps that were examined dealt with the mode used and demographic measures such as age and gender. However, traffic danger and social insecurity were both found to be negatively linked with spatial knowledge (Ahmadi and Taniguchi, 2007).

Table 3
Relevant measures of cognitive well-being (from Pollard and Lee, 2003) and their association with transport (Acc = access; Intr = intrinsic; Ext = External).

Measure	Relationships where found
Concentration	Intr: Walking alone and having time to think[A]
Academic achievement	Ext: Traffic noise negatively affects reading speed[A]; reading comprehension was not affected by traffic noise[A]; basic mathematic exercises were negatively affected by traffic noise[A]; math reasoning was not affected by traffic noise[A]
Cognitive ability	Intr: Being alert (activation) was associated with cycling to school[A]; modal relationships with spatial mapping were: better[INT, IF], levels of detail[A], increased knowledge with walking[INT, IF], clarity (+ for bus)[A]; Intr: increased spatial knowledge through travel with parents[CF,INT]; CIM was associated with covering more area on spatial maps[A]
OTHER: Learning from one's environment/life experiences*	Intr: CIM and walking were associated with exploring one's environment[CF,Int]; positive learning experiences with walking and CIM[CF,Int]

R = review; S = suggested; CF = consistent findings; IF = inconsistent findings; A = anecdotal; Int = international.

4.3.4. Summary of cognitive domain

Consistent findings related to cognitive well-being were limited to: exploring while travelling other than by car; increase spatial knowledge and being accompanied by parents; observing the world around them through walking/CIM (Table 3).

For the inconsistent findings with respect to spatial mapping (Ahmadi and Taniguchi, 2007; Joshi et al., 1999), both used free-recall maps, the ages of the children were similar (9–13 versus 7–12) as were the sample sizes (75 versus 93). The latter paper (Ahmadi and Taniguchi, 2007 by date of study) cited the former and followed the same general approaches. However, a number of differences can be observed: research domain (engineering Ahmadi and Taniguchi, 2007 versus psychology (Joshi et al., 1999), the measures applied (landmarks and route accuracy versus picture type, loops, landmarks), the trips considered (only home-school; home-school and non-school), the modes considered (non-motorised, bus, car versus walking, car), geographic/cultural context (Tehran, Iran versus two country townships in the UK), built environment (linear versus curvilinear). Any number of these differences might explain the results. For example, the linear nature of the development in Iran may be easier to draw, the inclusion of bus travel, the measure of route accuracy, etc. The positive side is the similarities (age, free-recall mapping, sample sizes) that tried to limit the differences between the studies. The only way to gain better insight would be to have studies that match as close as possible these existing studies.

There were 24 one-off relationships, with 11 of those related to spatial mapping. Considerable potential exists here, but the lack of repeated research questions and methods limits the strength of the arguments.

4.4. Social

The social domain includes indicators such as *anti*-social behaviour, peer problems, participation in cultural activities, relationships with others, social skills, and socioeconomic status (Pollard and Lee, 2003).

Social well-being is perhaps less appreciated, or obvious, than physical well-being, but improvements to society and social interactions are nonetheless important. For example, social relation-

ships were found to have a higher impact on mortality than alcohol consumption, physical activity, BMI (obesity), and air quality; it had a similar impact as smoking; and the impacts were not found to be age-dependent (Holt-Lunstad et al., 2010). Thus, social relationships are important for health.

4.4.1. Transport as access

Trips for social reasons are common for adults, and are likely common for children too (Sener and Bhat, 2007). CIM was positively associated with knowing where to get social interaction (Lim and Barton, 2010) or having more local peers (Carver et al., 2005). In a study of discretionary social activities, children in urban settings (as opposed to suburban or rural) were more likely to participate without other family members, which was attributed to likely better conditions for CIM (Sener and Bhat, 2007). However, the direction of the relationship is not clear: is it that having social relationships within CIM distances stimulate CIM travel, or having CIM allows one to meet new people and establish more social contacts?

When children travel independently outside of their local areas however, they are put in situations where they must deal with unknown adults (e.g. paying the entrance fee at a swimming pool) that conflict with the "don't talk to strangers" message that they are often taught in the UK (Milne, 2009). This could lead to feelings of anxiety.

Parents way wish to "park" children in safe places (e.g. play in a park, not on the road), but children may not be stimulated by such places (Davis and Jones, 1996). This may be contrary to what is often discussed for children's development, but the experience of children in inner city Los Angeles (Banerjee et al., 2014) highlighted that children liked commercial establishments more than parks and recreational locations, as they are convivial places with social interaction. The children enjoyed the presence of others and the chance to "bump into friends." This reflects findings from an earlier study (Berg and Medrich, 1980) where children wanted to live near shops. In New Zealand (Carroll et al., 2015) a study of children's experiences in the city found that children desire to have friends close-by, places to play and a range of amenities to access. In the USA, a study that looked at travel to discretionary activities found that for children in urban areas (as opposed to suburban or rural) were more likely to participate in shopping or active recreation, suggesting that they had better access to such activities (Sener and Bhat, 2007).

In some situations, children must rely (mostly) on parents for their mobility. Parents may view low-density, car-oriented residential developments as desirable, but this has the effect of marooning children and forcing dependence (Davis and Jones, 1996). Children who preferred to travel with a parent, as opposed to independently, mentioned needing to get to a social activity (Romero, 2010). Earlier research on different neighbourhood types found that children in suburban areas uniformly disliked having to rely on parents to make "trips" to meet friends (Berg and Medrich, 1980). In those low-density areas, travel by car was most common, and socializing was more planned and formal, was less likely to be with a group, and less likely to have a range of ages. Those issues were thought to be related to problems of independent mobility restrictions (ibid).

Consistent findings: The desire to meet friends locally.

Inconsistent findings: Resenting reliance on parents for social trips and preferring travel with parents as it relates to social trips.

4.4.2. Intrinsic influences through transport

Interacting during travel is very desirable among children. In Scotland, adolescent girls spoke of walking as an opportunity to be with friends and socialize (Kirby and Inchley, 2013). The most important aspect of travelling for children in a Belgian study, was the social aspect (Zwerts et al., 2010); the social aspect was more valued by girls than boys. In Australia (Romero, 2011; Romero, 2010) and in the UK (Murray and Mand, 2013), trips were associated with meaningful experiences such as talking with friends. In a study of children in inner city communities in Australia (Witten et al., 2015), it was found that despite problems such as "weird" adults, the children valued being out and about alone as it was a chance to hang-out with friends, to have fresh air, to feel happy, not being embarrassed by being in the company of their parents, and to simply be independent. Westman et al. (2015) found that engagement in social activity during travel resulted in the children reporting that the trip was of higher quality than if they were alone or using their smartphones.

Having friends as trip companions is important to children. In Switzerland (Fuhrer and Quaiser-Pohl, 1999), a study of travel by 10, 12, and 14 year olds found that trips with friends was most common for 12 year olds. Children who walked mentioned talking with friends as an important experience, versus children in cars who spoke of being "safe from strangers" (Romero, 2010). In that study, companions were often a desirable attribute of a trip (50%) and 83% of the reason given for wanting to travel independently was to freely engage in conversation with friends or siblings. Separation from friends was seen as a negative aspect of car travel (Barker, 2006). Streets in urban New Zealand were seen as a place to walk and talk with friends and observe the world, however, children also experienced being "told off" for being too loud when they were laughing on their scooters (presumably with friends) (Carroll et al., 2015). Around the world, socializing is an important feature of travel for children.

Associations exist between children's travel and social capital. In a review of active travel, Panter et al. (2008) found that it was positively associated with social interactions (waving or saying hello to neighbours). Children's autonomy (e.g. CIM) was associated with creating neighbourhood social capital (Weller and Bruegel, 2009).

What mode a child uses can influence the frequency of incidental social connections. Waygood and Kitamura (2009) found that CIM and seeing a known person during travel increased with population density, though a relationship was not directly demonstrated. However using the same data set, walking and independent trips were found to be positively associated with seeing a *known* person during the trip (Waygood and Friman, 2015). Trips by car or bicycle were negatively associated. For seeing people in general, travel by foot or bicycle and CIM were positively associated with seeing people in general during the trip, while travel by car was highly negatively associated (Waygood and Friman, 2015).

Social interaction can also be with family members during travel. For trips in cars, it was found that children want a location within the vehicle where their parents can intervene when disputes arise between siblings (Barker, 2009). The choice of seats was also found to lead to power struggles and conflicts (Barker, 2006).

Consistent findings: Desire social interaction during travel; social interaction during travel is associated with walking; CIM and active travel are related to community connections.

4.4.3. External influences of transport

One measure of social well-being listed by Pollard and Lee was *parent-child relations* (Pollard and Lee, 2003). One study found that time spent on one's work commute by the parents did not diminish time spent with children, which the authors suggested demonstrated how important that activity is to parents (Whitehead-Frei and Kockelman, 2010). However, in a study on raising children that were under five years old in outer suburbs of the Australia

(Andrews, 2010), many difficulties were raised including the negative effect on children by the father's long commute.

The walkability of a neighbourhood has been studied for children's travel and relationships with their social well-being were found. In a study of children's representations of their daily lives (Holt et al., 2008), children in low walkable neighbourhoods depicted more cars and more supervised play which may limit the child's ability to develop conflict resolution skills. Children in highly walkable neighbourhoods depicted more peer interaction. Those findings related to an older study of children's play where the less urban (and what would now likely be termed less walkable) the area, the more distances restricted social interactions to planned occasions rather than spontaneous ones (Berg and Medrich, 1980).

Traffic was also found to be a general deterrent. In a study of children's play patterns in the USA (Berg and Medrich, 1980), traffic was found to be a barrier to access as it consumed the street (e.g. prevented children from playing on the street) and limited children's active space near their home. In that study, mobility was the topic discussed with the most interest by the children, as they felt that traffic constrained their autonomy to play and socialize. An article on children's social capital and well-being discussed important influences beyond the child's control such as traffic, but also how much freedom (e.g. CIM) they have to engage with their local community (Morrow, 1999).

The study of children's experience's in inner city Los Angeles (Banerjee et al., 2014) found that residential streets were most often mentioned as being disliked (76%) or unsafe (74%) due to social incivilities and traffic concerns. Negative experiences included streets with fast moving cars, freeways, and underpasses. Children in urban New Zealand (Carroll et al., 2015) liked walking and talking in the street, but did not like traffic.

Consistent findings: Less walkable areas restricted children's play to planned events; children did not like traffic as it limited social interaction.

4.4.4. Summary of social domain

For the social domain, children were consistently found to highly desire social interaction. The consist findings were: access to friends, social interaction during travel, social interaction being associated to walking, CIM and active transport relating to greater community connections, a general dislike of traffic as it limited social interaction, and areas that limited CIM limited spontaneous social interaction (Table 4).

An inconsistent finding was found between some children preferring travel with their parents (Romero, 2010), to others resenting their dependence on parents for transport (Berg and Medrich, 1980). The studies were respectively conducted in Sydney, Australia with children aged 9 to 11 and in Oakland, USA with children aged 11 and 12 years. It may be that the younger children in the Australian study do not desire independence to the same extent as the slightly older children. The Oakland study was larger (764 versus 178), but both studies had a diversity in urban settings and used qualitative methods (interviews). The era of the study may play a role as well, with the Sydney study published in 2010 and the Oakland study published in 1980; what is normal and children's expectations may have changed over those 30 years. The research questions were different though, with the Oakland study focusing on play and play patterns, whereas the Sydney study looked at trips to school with a desire to improve the enjoyment of walking to school. Thus, in the Sydney study, children were considering a different situation, and the use of cars may have been seen by many children as how they access their social activities. This might be related to the activity being more important than the means of getting there.

Table 4
Relevant measures of social well-being and their association with transport (Acc = access; Intr = intrinsic; Ext = External).

Measure	Relationships where found
Negative life events	Ext: Crashes[R, Int]
Peer problems	Intr: Intimidation/bullying/assault[S]
Family relations; parent-child relations	Intr: parent-child interaction during travel[S] Ext: Parents time with children was not affected by commuting time[A];
Participation in cultural events	Acc: Access to cultural events[S]
Relationship with peers	Acc: CIM increasing access to friends[A]; isolation[S] Intr: Desirable attribute of travel[CF,Int]; walking as a time for interaction[CF,Int]; CIM as an occasion for peer interaction[CF,Int]; social interaction is desirable during travel[CF,INT], social interaction is associated with walking[CF,INT]; Ext: traffic limited play and social interaction[CF,INT];
Social skills	Intr: Learning from community observation while travelling[S]; Ext: supervised play in low density[CF,INT]
Social support	Intr: Social capital is increased with CIM[A]; community relations positively linked to walking[A]; community incidental interactions higher for walking[A]; public space use[S]

R = review; S = suggested; CF = consistent findings; IF = inconsistent findings; A = anecdotal; Int = International.

Numerous examples can again be found of one-off relationships (6), though for this domain, there was more consistency with findings (7).

4.5. Economic

In the review by Pollard and Lee (2003), the economic domain of well-being lists only *child support* as a measure. For transport, this could be interpreted as caregivers providing time and money to facilitate access to opportunities, or it could be interpreted as how the transport system supports (or limits) children's mobility and access. As such, independent travel (travel not demanding significant parental time) is included in this section. The issues of parental time loss were also raised by Hillman et al. (1990) in their seminal work on children's independent travel. Parental time loss due to chauffeuring and CIM are not mutually exclusive, as a highly autonomous child may still need to be chauffeured for certain trips, thus the two are treated separately. Most of the articles relating to this domain focused on identifying what measures were associated with CIM. As the focus of this review is on what evidence is there that transport influences child well-being, only a summary of a previous review on that area is given. Before that, relevant papers on children and parental time are introduced.

4.5.1. Transport as access

A study that highlighted the differences between the mother's involvement in children's transport in a transit-oriented development (TOD) in comparison with auto-oriented development, found that the type of trips with parental accompaniment were typically family-oriented in the TOD area, as opposed to many more chauffeuring (serve-child) trips in the car-oriented one (Waygood, 2009). This is likely related to findings on differences between mothers with independent children who practiced more personal leisure than mothers who had to chauffeur children and sacrificed their own leisure time to do so (Mattsson, 2002).

Likely related to the reduced burden on parents, benefits from active travel, and other potential benefits, sufficient research has been carried out on explaining CIM. The consistent findings reported in Mitra's (2013) review for transport as access are: chauffeuring increased if parents viewed driving as convenient

and socially acceptable; reduced distances to destinations were positively associated with increased CIM. Mitra (ibid) also reported findings on active school travel as a proxy for CIM, but those are not reported here as the focus of this section is purely on studies that examined CIM directly.

Consistent: chauffeuring increased if parents viewed driving as convenient and socially acceptable; reduced distances to destinations and increased CIM.

4.5.2. Intrinsic influences through transport

As mentioned above, independent travel is positively linked with a number of child well-being domains such as social (social connections and interactions), physical (access to physical play and active transport), cognitive (exploration and play), and economic (reducing time burden on parents). *Autonomy* is itself a measure of psychological well-being and experiencing while travelling autonomously were positively (and consistently) associated with increased travel satisfaction.

The study that highlighted the differences between the mother's involvement in children's transport in a transit-oriented development (TOD) in comparison with auto-oriented development, found that mothers in the TOD-based metropolitan area spent around fifteen minutes a day travelling with children, versus the more than one hour in the other (Waygood, 2009). This would suggest a considerable larger time cost on the parents.

In Mitra's review (Mitra, 2013), the consistent relationships found for the intrinsic impacts from CIM were: parents who acknowledged the importance of active travel and the child's social interaction.

Consistent: parents who acknowledged the importance of active travel and the child's social interaction.

4.5.3. External influences of transport

In a study on raising children that were under five years old in outer suburbs of cities in Australia (Andrews, 2010), many difficulties such as the limited transport choices due to the built environment, and little possibility of walking or cycling to school, increased the demands on the parents' available time. However, these problems were not seen as a barrier to living in such areas.

In Mitra's review (Mitra, 2013), the external impacts of transport on CIM were: parental confidence in the child's road safety skills; increased age of child was associated to an increase in CIM; concern over traffic or personal safety decreased CIM.

Consistent: parental confidence in the child's road safety skills; increased age of child and increased CIM; concern over traffic or personal safety decreases CIM.

4.5.4. Summary of economic domain

An argument could be made that external impacts due to traffic (e.g. crashes, asthma, etc.) could have economic implications for the child's family. The distraction or stress from traffic noise may lower the child's school performance, which may have implications for their future economic success. However, no papers were found during this process that quantified those issues.

As in other sections, the results are limited to the influence of transport on the measure. Therefore, many of the consistent findings in Mitra (2013) are not given here, as they relate to explaining CIM from other perspectives (e.g. social norms and values or individual attributes (e.g. age)). For the economic domain the consistent findings of transport on well-being were: chauffeuring burden is higher in car-oriented development; child's road safety skills (related to transport context); concern over traffic and lower CIM (Table 5).

Table 5
Relevant measures of economic well-being and their associations with transport (Acc = access; Intr = intrinsic; Ext = External).

Measure	Relationships where found
Child support	Acc: Reduce parents time burden through CIM[R,CF,Int]; Intr: cost of supporting children's travel[S]; Ext: Car-based travel increases serve-passenger trips[A]; costs incurred due to traffic impacts on well-being[S]

R = review; S = suggested; CF = consistent findings; IF = inconsistent findings; A = anecdotal, Int = International.

5. Overall summary and discussion

This review aimed to answer the question: "what evidence is there that transport affects child well-being more holistically?" The results demonstrate that for all domains of well-being there were consistent (e.g. corroborated) results, and for nearly all domains by each transport means-of-influence. Thus, it can be reasonably stated that evidence exists for a role of transport on each domain of child well-being.

It should be noted that although consistent findings were identified, it cannot be stated that transport is always the cause of the effect. A clear next step would be to examine the literature with consistent results and ask what type of interaction has been found: correlation or causation.

The influences of the results are organised by the transport means-of-influence on the children's well-being in Figs. 2–4. For the transport means-of-influence of access, there were six consistent findings across four (out of five) domains of well-being (Fig. 2). The one exception being the psychological well-being domain. One finding was inconsistent (whether travel with parents for social activities is appreciated or resented is unclear). In total, there were three reviews (two in physical, one in economic) and 27 unique papers that dealt with access.

For transport means-of-influences on well-being during travel (e.g. intrinsic), all of the domains had at least one consistent result (Fig. 3), although here there were three inconsistent findings (AT's relationship with obesity is unclear; the relationship between mode and affect is unclear; better spatial maps and greater spatial knowledge by mode is unclear). In total, there were 46 papers that dealt with impacts during travel.

For transport means-of-influence as an external influence (Fig. 4), the cognitive domain is the only one without a consistent finding. There were no inconsistent findings. In total, there were 35 papers that dealt with the external impacts of transport on children.

There were four inconsistent findings: weight status and active travel; better spatial mapping by mode, and environmental (one's surroundings as opposed to ecological) knowledge with mode; and affective relationships with modes. The possible reasons for these were discussed above. Further research on these, with consideration to the possible reasons for the differences mentioned, would help clarify whether the influence of transport is consistent, whether it is highly context dependent, or merely a statistical coincidence.

The majority of the studies used quantitative analysis (51), with 19 using qualitative, and 12 using mixed methods. The remaining papers were reviews of different types. Not all impacts are easily quantifiable, nor are all impacts known. Qualitative research helps to identify such relationships, which can later be measured in quantitative research. The mixed method studies should be commended for their efforts to quantify measures, but also remain open to less tangible qualities of travel. Advantages and disadvantages of different methods will remain, but the balance found here suggests that neither method is particularly dominant.

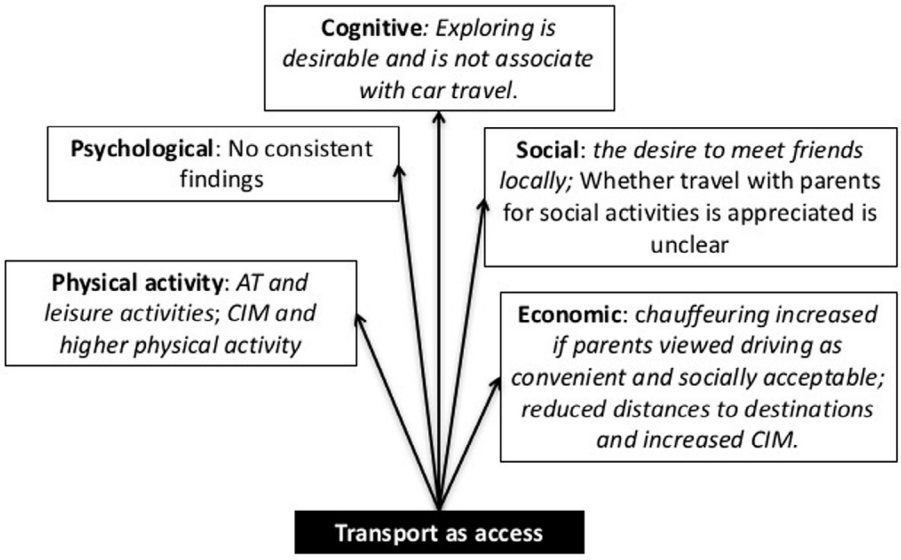

Fig. 2. The consistent findings of transport as access on child well-being.

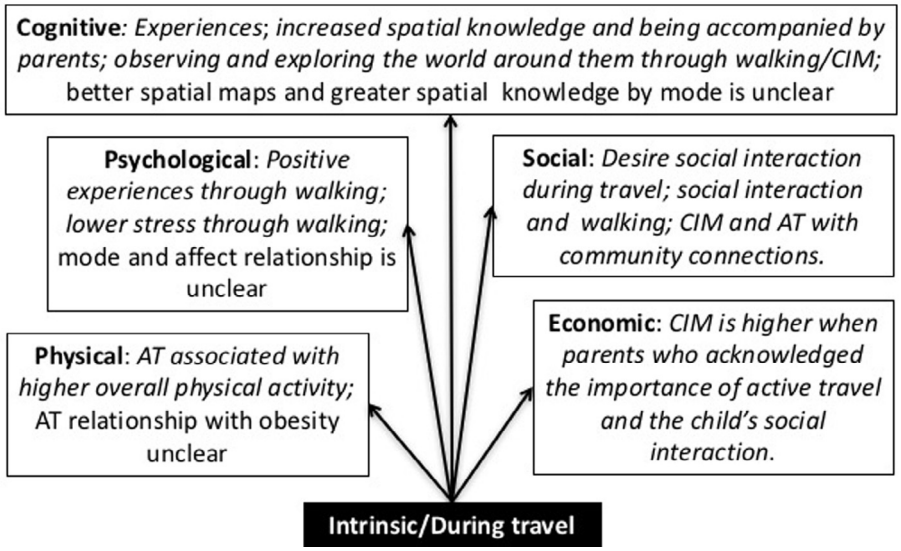

Fig. 3. The consistent findings of intrinsic transport relations for child well-being.

In relation to different methods, there was considerable variation in sample size from under 10 participants to nearly 700,000 hospital incidences. The majority of studies were relatively small with 41 having under 250 respondents (18 fell in the 100–249 range, followed by 16 studies with 10–49, four between 50 and 99, and only three had under 10 participants). Nine papers had between 250 and 499 participants, seven between 500 and 999, and 16 had at least 1000 participants. Depending on the research questions, the high number of papers with under 250 respondents may result in anecdotal results that are not generalizable. However, small studies may have the advantage of allowing for greater innovation and testing before being applied on larger scale projects.

The relationship between what transport options are possible for children are not only dependent on the child, but also their household, neighbourhood, city, and cultural context (e.g. Matthews and Limb, 1999). Previous reviews looked at what explains active travel to school (Sirard and Slater, 2008) or CIM (Mitra, 2013), but as has been pointed out, differences exist between countries, not just the built environment, but also culture (Waygood et al., 2015; Waygood and Kitamura, 2009; Waygood, 2009). It was for this reason that it was important to identify consistent findings across cultures. In our reviewed papers, 49 relate to only Anglo-Saxon countries. Consistent findings across divergent cultures would imply more universally consistent results. For most of the consistent findings reported here, the findings were from different countries. The exceptions were papers examining post-crash psychological impacts (UK).

Of course, considering the results of this review, next steps would also be to question the approach of transport planning. As mentioned in the introduction, the focus of transport planning generally relates to value of time which represents roughly 80% of cost-benefit analysis (e.g. Mackie and Nellthorp, 2001) with some consideration to crash potential. Related to crash potential is the speed at which vehicles travel (e.g. Ewing and Dumbaugh, 2009). Congestion costs are based on speeds being diminished from free

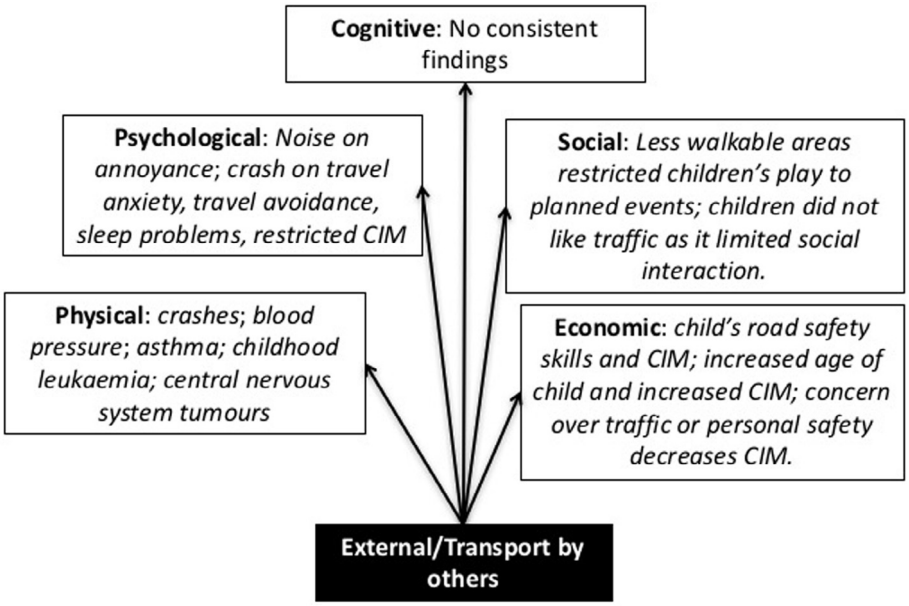

Fig. 4. The consistent findings of external transport relations child well-being.

flow speeds (occasionally with some lowering of this in the calculations) (e.g. Canada, 2006; Goodwin, 2004). From the results presented here, considerable negative impacts are incurred by children through this promotion of high speed and high volume traffic. As previously written, transport planning in many contexts may assume that providing for adults (and thus parents) is providing for children (Davis and Jones, 1996; Matthews and Limb, 1999; Gilbert and O'Brien, 2005). That assumption is not necessarily true as much of children's travel will be local and for independent travel, consideration to active travel and public transport is likely more important than focusing on congestion and value of time. All of those articles (Davis and Jones, 1996; Matthews and Limb, 1999; Gilbert and O'Brien, 2005) argue that the values of adults (congestion and value of time) are imposed upon the (mobility) needs of children, to their detriment. This makes children a "sociospatial marginalized group" (Matthews and Limb, 1999). Davis and Jones (1996) make a similar point, arguing that rather than modifying the built environment, children are forced to make the behavioural modifications to fit within the adult world. An example that they give is where parents (society) teach children to be fearful and careful of traffic, rather than treating the problem by limiting traffic's negative impacts. Certainly it is important for children to understand the danger traffic poses, but it is also important for planning to treat the source of the problem.

From a transport perspective, children differ from adults in a number of important ways. Matthews and Limb (1999) outline six major distinctions: 1) rhythms of time and space are different; 2) use of land and facilities are different; 3) CIM is restricted due to money, physical capabilities, caretaking conventions, etc.; 4) threats are different (e.g. with air quality); 5) even given the same environment, interpretation and perceptions are different; and 6) they are unable to influence decision-makers. The review carried out here better supports a number of these points from a perspective of child well-being. It demonstrates that children suffer significant well-being impacts due to traffic, that how they view and value transport is not related to congestion and rapid access, and the focus on such adult values is often at the loss of their CIM. It gives further weight to arguments made over twenty years ago on the need for a public health perspective when considering transport and children (Davis and Jones, 1996).

There are limitations to this review. The search terms did not include synonyms of child(ren) such as baby, infant, youth, adolescent, young adult, etc. As well, mode-specific terms were not used such as pedestrian, cyclist, driver, etc. An effort to find related findings to each one-off result was not made, and it is certainly possible that relevant literature exists. The challenge is to take this first such review and continue refining and developing knowledge so that individual decisions, policy, and planning can best support child well-being. Not all relevant articles will have been found as relevant papers may not specifically use the search words applied in their title or abstract. As with all such reviews, the impact of publication bias likely exists. Research that examined a relation, but did not find a statistical association is less likely to be published or even submitted.

5.1. Directions for future research

Very few papers crossed well-being domain boundaries. The exceptions can be seen in Table 6. Thus, very little research has examined more holistic impacts on child well-being and research that aims to examine potentially conflicting impacts would improve planning.

Transport as access relates to the benefits derived from the activity at the destination. Research questions here would need to examine how different travel options and modes relate to access by children to different types of activities that would have an impact on their well-being (whether positive or negative). The destination's activity is important for physical (Page et al., 2010), psychological (Barker, 2006), cognitive (e.g. reaching school (Sirard and Slater, 2008), social (Lim and Barton, 2010), and economic (Mitra, 2013) domains. However, the focus has primarily been on school trips, ignoring other destinations that may contribute to the domains of well-being. Although reviews can be cited here for physical activity, reaching school, or independent travel, *insufficient work has examined the psychological relationships* for transport as access. For that domain, two one-off studies (Barker, 2006; Pacilli et al., 2013) found relationships that could be followed up on. The findings relating CIM to both physical activity and social interaction may well be related: children who can freely access their friends and play, perform both. It would not be a

Table 6
Selected characteristics of publications included in the integrative review.

Citation	Wellbeing domain	Transport relation	Location	Children's ages (years)	N	Data source	Method type
Sirard and Slater (2008)	Physical	Intrinsic	International review	5 to 18	NA	Published articles	Quasi-systematic review (Additional literature outside of search terms and search engines; no clear quality standard)
Hillman et al. (1990)	Economic	Access	UK, West Germany	7 to 15	1015 British; 876 West German	Questionnaire	Quantitative
Schoeppe et al. (2013)	Physical	Access; Intrinsic	International review	3 to 18	NA	Published articles	Systematic review
Mitra (2013)	Economic	Access	International review	5 to 18	NA	Published articles	Literature/narrative review
Toroyan and Peden (2007)	Physical	External; Intrinsic	International report	<25	0	Published articles	Quantitative
Pollard and Lee (2003)	All	NA	International review	2 to 19	NA	Published articles	Systematic review
Pont et al. (2009)	Physical	Intrinsic	International review	5 to 18	NA	Published articles	Systematic review
Panter et al. (2008)	Physical, social	Access; Intrinsic	International review	5 to 18	NA	Published articles	Quasi-systematic (Additional literature outside of search terms and search engines; no clear quality standard)
Page et al. (2010)	Physical	Access	UK	10 to 11	1307	Ht. and wt. measurements, questionnaire, accelerometer	Quantitative
Grineski (2008)	Physical	External	USA	4 to 12	38	In-depth interviews	Qualitative
Davis and Jones (1997)	Physical	Access, Intrinsic, external	United Kingdom	9 to 11 and 13 to 14	468	Semi-structured interviews, focus groups	Qualitative
Smith et al. (2010)	Physical	Intrinsic	Australia	4 to 16	3983	Cross sectional questionnaire	Quantitative
Sendzik et al. (2009)	Physical	Intrinsic	Canada	NA	18	Air-quality instrument	Quantitative
Behrentz et al. (1995)	Physical	Intrinsic	USA	5 to 10	6 buses x 22 runs	1) Pollutant measurements 2) video	Quantitative
Marshall and Behrentz (2005)	Physical	Intrinsic	USA	NA	16	Bus emissions	Quantitative
Waygood et al. (2015)	Physical	#N/A	Canada, Japan	<15	#N/A	#N/A	#N/A
Brandt et al. (2012)	Physical	External	USA	<18	Regional assessment of asthma cases	California Health Interview Survey	Quantitative
Friedman et al. (2001)	Physical	External	USA	one to 16	Events per day over 10 weeks	Acute care visits	Quantitative
Beatty and Shimshack (2014)	Physical	External	UK	2 to 7	682305	Hospital occurrence	Quantitative
Gauderman et al. (2005)	Physical	External	USA	14, 17	208	Air-quality instrument	Quantitative
McConnell et al. (2010)	Physical	External	USA	5 to 7	2497	Questionnaire	Quantitative
Gunier et al. (2003)	Physical	External	USA	<15	All census block groups in California	Traffic count data	Quantitative
Chaudhuri (1998)	Physical	External	Canada	Not specified in text	National assessment	Published articles	Quantitative
Pabayo et al. (2012)	Physical	External	Canada	6 to 8	710	Questionnaire with the parents	Quantitative
Paunovic et al. (2011)	Physical	External	International review	3 to 14	5133	Published articles	Critical review
Belojevic et al. (2008)	Physical	External	Serbia	3 to 7	328	Noise instrument; blood pressure measure; heart rate	Quantitative
Liu et al. (2013)	Physical	External	Germany	10	605	Parent questionnaire, blood pressure	Quantitative
Clark and Stansfeld (2007)	Physical, psychological	External	International review	3 to 10	NA	Published articles	Narrative review
Mielke et al. (2010)	Physical	External	USA	Not clear	NA	Published articles	Quantitative

Table 6 (*continued*)

Citation	Wellbeing domain	Transport relation	Location	Children's ages (years)	N	Data source	Method type
Naeher et al. (2004)	Physical	External	Peru	3 + /- 9.9 living near gas stations & 10.1 + /- 2.1 living distant from gas stations	17 near gas stations; 9 not near	Blood samples	Quantitative
Mak et al. (2003)	Physical	External	UK	<6	167	Dust samples, blood tests	Quantitative
Boothe et al. (2014)	Physical	External	International review	<15	NA	Published articles	Quantitative
Filippini et al. (2015)	Physical	External	International review	<24	NA	Published articles	Quantitative
Carlos-Wallace et al. (2016)	Physical	External	International review	<20	NA	Published articles	Quantitative
Reynolds et al. (2002)	Physical	External	USA	<5	4369	California Cancer Registry	Quantitative
Reynolds et al. (2004)	Physical	External	USA	<15	Occurrence	California Cancer Registry	Quantitative
von Ehrenstein et al. (2015)	Physical	External	USA	<6	43, 34	California Cancer Registry	Quantitative
Bergstad et al. (2012)	Psychological, social	Intrinsic	UK	4 to 11	1006 households	Personal diaries, photographs, in-depth interviews, questionnaires	Mixed
Barker (2006)	Social	0	International review	Not explicit	NA	Published articles	Critical review
Pacilli et al. (2013)	Psychological	Access	Italy	11 to 13	589	Questionnaire	Quantitative
Jensen et al. (2014)	Psychological	Intrinsic	Denmark	2 to 18	45	GPS tracking, mapping and interviews	Mixed
Westman et al. (2013)	Psychological, cognitive	Intrinsic	Sweden	Grade 4 (Sweden)	206	Travel diaries	Quantitative
Ramanathan et al. (2014)	Psychological	Intrinsic	Canada	3 to 15	5423	Questionnaire	Quantitative
Westman et al. (2015)	Psychological, cognitive, social	Intrinsic	Sweden	10 to 15	344	Questionnaire	Quantitative
Kopnina and Williams (2012)	Psychological	Attitudes towards vehicles...	Netherlands	7 to 10	140	Questionnaire, 49 interviews with the children.	Mixed
Murray and Mand (2013)	Psychological, social	Intrinsic	UK	8 to 14	25	self-directed video and film-elicitation and narrative interviews; participant observation, participatory workshops involving drawing, story writing, role-play, watching videos, diary writing and recorded interviews with art workshops along with artists	Qualitative
van Vliet (1983)	Psychological, cognitive	Access; Intrinsic	Canada	14 to 16	148	Questionnaire with children	Quantitative
Eisenberg and Miller (1987)	Psychological	0	International review	four to 18	NA	Published articles	Narrative and meta-analysis
Endoh (1997)	Psychological	Intrinsic, external	Japan	NA	NA	Children's picture books	Qualitative
Yatiman et al. (2012)	Psychological	Intrinsic	Malaysia	9 to 11	54	Drawings, semi-structures interviews, participant observation	Qualitative
Zwerts et al. (2010)	Psychological, social	Access; Intrinsic	Belgium	10 to 13	2546	Questionnaire with parents and children	Quantitative
Watanabe et al. (1988)	Psychological	Intrinsic	Japan	11 to 12	240	Questionnaire	Quantitative
Babisch et al. (2012)	Psychological	External	Germany	8 to 14	1048	Questionnaire	Quantitative
van Kempen et al. (2009)	Psychological	External	UK, Spain, the Netherlands	9 to 11	2844	Questionnaire	Quantative
Tiesler et al. (2013)	Psychological	External	Germany	10	872 (287)	Questionnaire; noise instrument	Quantative
Ellis et al. (1998)	Psychological	Intrinsic	UK	5 to 16	45	Questionnaires (children and parents), interviews	Mixed
Bryant et al. (2004)	Psychological	Intrinsic	England	5 to 16	86 children and 80 parents	Questionnaires (children and parents)	Quantitative
Björklid (2004)	Cognitive	Access, Intrinsic, external	Sweden	12	750 Parents. 47 children	Questionnaires (child and parent)	Quantitative

(*continued on next page*)

Table 6 (*continued*)

Citation	Wellbeing domain	Transport relation	Location	Children's ages (years)	N	Data source	Method type
Barker (2009)	Cognitive, social	Intrinsic	United Kingdom (UK)	primary school	1006 questionnaires & 23in-depth research	Questionnaire (1006) and in-depth research (23) with travel diaries and photographs taken by children	Mixed
Mitchell et al. (2007)	Cognitive	Access	New Zealand	6 to 7 & 10 to 11	136	Story writing, discussion groups, photovoice	Qualitative
Tranter and Pawson (2001)	Cognitive	Access	Australia	9 to 12	436 children; 297 parents	Questionnaires; focus groups; interviews with principals	Mixed
Villanueva et al. (2012)	Cognitive	Access	Australia	10 to 12	1480 children; 1314 adults	Questionnaire, pedometer (one week), mapping exercise, parents questionnaire,	Mixed
Hillman et al. (2009)	Cognitive	Intrinsic	USA	9 to 10	20	Several cognitive tests	Quantitative
Ahmadi and Taniguchi (2007)	Cognitive	Intrinsic	Iran	9, 11 and 13	75	Questionnaire, sketched maps by children and adults	Mixed
Joshi et al. (1999)	Cognitive	Intrinsic	UK	7 to 12	93	Ability tests (cognitive); mapping; parent questionnaire	Quantative
Matthews (1984)	Cognitive	Intrinsic	England	6 to 11	172	Free-recal mapping	Qualitative
Kegerreis (1993)	Cognitive	Intrinsic	UK	Primary school child	1 fictive	Thought piece	Qualitative
Witten et al. (2015)	Cognitive	Access	Australia	9 to 12	40	Discussion groups	Qualitative
Hosoda and Nichide (2009)	Cognitive	Intrinsic	Japan	11,12,15	3	Questionnaire; GPS	Quantitative
Kullman (2014)	Cognitive	Intrinsic	Finland	7 to 12	23	Observations, participatory picture-making, group discussions; sharing the school trip	Qualitative
Carroll et al. (2015)	Cognitive, social	Access, Intrinsic, external	New Zealand	9 to 12 years old	253 for GPS and trip diary; 140 for walking interviews	Trip diaries, walk-alongs, group discussions, GPS, accelerometers	Mixed
Romero (2011)	Cognitive, social	Intrinsic	Australia	9 to 11	178	Questionnaire; drawings; focus groups; maps; site observations	Qualitative
Romero (2010)	Cognitive, social	Access, Intrinsic	Australia	9 to 11	178	Questionnaire	Quantitative
Kullman (2010)	Cognitive	Intrinsic	Finland	7 to 12	23	Images; active participation; interviews	Qualitative
Ljung et al. (2009)	Cognitive	External	Sweden	12 to 13	187	Written tests (children); noise instrument	Quantitative
Sener and Bhat (2007)	Social	Access, during	USA	5 to 15	1574	2002 Child Development Supplement to the Panel Study of Income Dynamics	Quantitative
Lim and Barton (2010)	Social	Access	USA	11 to 13	19	Ethnographic research method for data generation including conversational interviews, walking-along (neighbourhood walk), mapping and autophotography.	Qualitative
Carver et al. (2005)	Social	Intrinsic, external	Australia	12, 13	347	Child and parent questionnaires	Quantitative
Milne (2009)	Social	Intrinsic	UK	10, 11	375 questionnaires; 17 interviewees; 1 participant observation	Participant observation of children at school with ethnographic participation (primarily at play and lunch times) - Paired and individual interviews with self-selected child participants - Self-completion questionnaires with children	Qualitative
Banerjee et al. (2014)	Social	Access, Intrinsic, external	United States of America (USA)	10 to 12	176 children; 87 parents	Questionnaire, maps	Mixed
Berg and Medrich (1980)	Social	Access, Intrinsic, external	USA	11 and 12 years	764	Child interview, parent questionnaire, follow up interviews	Qualitative
Kirby and Inchley (2013)	Social	Intrinsic	Scotland	11 to 14	27	Focus groups; mapping exercises	Qualitative

Table 6 (*continued*)

Citation	Wellbeing domain	Transport relation	Location	Children's ages (years)	N	Data source	Method type
Fuhrer and Quaiser-Pohl (1999)	Social	Access	Switzerland	10 to 14	184	One-week activity diaries	Quantitative
Weller and Bruegel (2009)	Social	Intrinsic	England	11 to 14	588	Questionnaire, interviews, focus groups. activity sheets	Mixed
Waygood and Kitamura (2009)	Social	Access; Intrinsic	Japan	10,11	264	Questionnaire	Quantitative
Waygood et al. (2015)	Social	Intrinsic	Japan	10,11	425	Questionnaire	Quantitative
Whitehead-Frei and Kockelman (2010)	Social	Intrinsic	Canada, Japan, Sweden	9 to 12	499	Questionnaire	Quantitative
Andrews (2010)	Social	Access	USA	Parents with children under 18	12248	American Time Use Questionnaire (ATUS)	Quantitative
Holt et al. (2008)	Social, economic	Access	Australia	<5	15	In-depth interviews with mother	Qualitative
Morrow (1999)	Social	Access, Intrinsic	Canada	6 to 12	168	Mental mapping	Qualitative
Mattsson (2002)	Economic	Access	Sweden	7 to 17	40 households	Travel diary for each family member and semi-structured interviews to a subsample about chauffeuring habits	Mixed
Mackie and Nellthorp (2001)	Economic	Access	Japan	10, 11	491	Questionnaire, published articles	Quantitative
Ewing and Dumbaugh (2009)	Physical	External	New Zealand	10	1	Traffic accident report	Qualitative

stretch to suggest that this would likely have psychological benefits.

For intrinsic relationships between transport and child well-being, it is perhaps more obvious, or easier, to relate active travel to physical health (Schoeppe et al., 2013). However, consistent findings here suggest that further benefits may be found in travel that relate to psychological (Murray and Mand, 2013; Zwerts et al., 2010), cognitive (Hosoda and Nichide, 2009; Kullman, 2010), and social (Westman et al., 2015; Romero, 2010) domains. In many cases, active travel and CIM allows the children to socialize (related to trips that children rate as higher quality), to explore, observe and experience their environment. Is the focus on speed and value of time potentially reducing these benefits? It's hard to stop and observe a ladybug and create some imaginary story around them if one is rushing along. Children might be viewed as tourists: they want to experience the (new) world around them, and enjoy it with friends. Although consistent, it is *only the intrinsic physical well-being benefits that have been sufficiently explored* to have warranted a review focused on that specific relationship.

Numerous impacts due to external impacts were found which related to physical (e.g. crashes, leukaemia, asthma, blood pressure), psychological (stress, anxiety, annoyance), cognitive (attention and academic performance), social (barrier to social interaction), and economic (traffic danger increasing the use of costlier means of transport) domains. Here, the *cognitive impacts are less well studied* with consistent findings and reviews existing for nearly all the other domains of well-being.

It is likely that there exist other relations to the problem of traffic danger as a limiting factor on CIM and the level of children's road skills required (e.g. how well do they cope with traffic danger). In a situation of no road danger, a child would not need road skills, but as road danger increases, so does the need to have increased safety skills. Paraphrasing a question posed by Hillman et al. (1990): why is it the child who is burdened with the responsibility of road safety when they are not the ones creating it? Obviously, some skills are required, but the question is perhaps to what extent should the emphasis be on the victims (Davis and Jones, 1996; Roberts and Coggan, 1982)?

Considering the application of the findings presented here, there are a number of future directions. One would be to further develop the consistent findings to be incorporated into health impact assessments, whether this be through a monetization of those costs and benefits, or an assessment of morbidity or mortal-

Table 7
Suggested relationships between transport and child well-being that were not evident in this review.

Domain	Measure	Explanation
Physical	Physical structure (bone, muscle)	Related to walking
Physical	Digestion	Related to walking
Physical	Vitamin E	Related to active travel and public transport
Physical	Personal security	Exposure to others
Psychological	Restorative	Walking in restorative environments
Psychosocial	Place attachment	Local travel
Psychological	Life satisfaction	Access to needs, achievement, autonomy
Social	Parent-child interaction	During travel (positive, negative, type, etc.)
Social	Access to cultural events	Access-related
Social	Isolation	Access and autonomy
Social	Learning social skills and behaviour through observation	Local travel and autonomy
Cognitive	Cognitive requirements	Safety related
Economic	Costs of supporting children's travel	Costs vary by mode, distance, needs, etc.

ity impacts such as is seen the health economic assessment tools (Kahlmeier et al., 2011). Other options would be use multi-criteria decision analysis (Munda, 2005) where conflicting attributes are weighted (the attributes and weighting can be decided by a group of experts).

In each domain there were numerous one-off results which suggests two things: one, that numerous other potential relationships exist between transport and child well-being; and two, that value must be placed in attempting to repeat studies to examine whether the findings are consistent or not. On one-off findings, consideration to cultural-specific findings should be given, and studies in different settings will help identify influences that transcend cultures.

As mentioned, the measures presented by Pollard and Lee (2003) were not exhaustive. In many of the domains, we have suggested measures that may be relevant, but did not appear in the reviewed articles. Those measures are repeated in Table 7 with a short explanation.

It is clear from this integrative review that transport has an impact on children's well-being, and we have mentioned a few areas that were not evident in our search (Table 7) which deserve to be investigated. The combination of the requirement for research replication and relations that have not yet been investigated suggest a rich and diverse field of research that we hope to see grow and mature.

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