Impacts of Housing and Community Environments on Children’s Independent Mobility: A Systematic Literature Review

Lingyi Qiu*, Xuemei Zhu

Department of Architecture, Texas A&M University
3137 TAMU, College Station, TX 77843-3137, USA; lingyi1106@tamu.edu, xuemeizhu@tamu.edu

Abstract

Rationale: Homes and communities are the most important spaces where people live, work, and recreate on a daily basis. They are especially impactful for children, who have limited mobility and rely more on their immediate surroundings. Limited studies have linked housing and community environments with children’s independent mobility (CIM), implying potential influences on child development. But recent decades have witnessed a steep decline in CIM, while it is unclear what the specific environmental barriers are and how design can help.

Objectives: This systematic review examines the literature about environmental correlates of CIM and discusses its implication for future design.

Methods: Based on an online search via multiple databases, this study identified and reviewed 42 articles about environmental correlates of CIM and relevant theories. Study characteristics and findings about the environment—CIM associations were reviewed and summarized to inform the development of a conceptual framework and design suggestions.

Results: CIM is related to not only parents’ and child’s individual factors (e.g., age, gender, and socioeconomic status) but also environmental and social factors. Environmental correlates include community walkability, aesthetics, and safety; home type and location; and community-home relationships. Social factors include neighbourhood deprivation, social cohesion, and parenting social norms. Design suggestions include providing abundant destinations within walking/cycling distance, improving traffic safety, and creating child-friendly spaces for disadvantaged children.

Conclusion and Discussion: This study identified environmental correlates of CIM and proposed design suggestions for promoting CIM. Further studies are needed in more countries and should build on a socio-ecological framework addressing multi-level factors.

Keywords: Housing; Community; Environment; Children; Independent mobility

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1. Introduction

Children are our future. It is our responsibility to provide child-friendly environments for them to live, play, and grow in. Children’s independent mobility (CIM) refers to children’s moving around in neighbourhoods without adults’ accompany [1]. It associates with children’s physical, mental, and social development [2-6], and helps to create a stronger sense of community [7].

Independent mobility used to be normal experiences among children decades ago. However, it has shown a steep decline in recent years, which partially accounts for the decrease of children’s physical activity and the rising obesity epidemic [8, 9].

Some previous studies have identified the significant impacts of physical environmental factors such as nature, destination accessibility, walkability, and safety on CIM. Other research has discussed the influences of factors in other domains, including personal factors (e.g., parents’ socioeconomic status and children’s own characteristics) and social factors (e.g., neighbourhood deprivation and parenting social norms). But there are limited numbers of systematic reviews of relevant studies or summary about state of knowledge in this area. This study expects to provide a more comprehensive synthesis of relevant literature, and thereby, a more complete understanding of the impacts of physical environment on CIM. It also provides design suggestions to help guide child-friendly housing and community design to improve CIM.

2. Methods

2.1. Search strategy

The systematic review was conducted between October 2016 and March 2017, following the Preferred Reporting Items for Systematic Review and Meta Analyses
guidelines from Canada [10]. Literature search was conducted through the Texas A&M University Library website and the Endnote software’s online search function. Seven most relevant databases in different domains were searched, including: Urban Studies and Planning, Social Sciences Full Text, Psychology and behavioral sciences collection, PsynINFO, Anual Review, MEDLINE Complete, and MEDLINE (PubMed). Studies were selected if they are peer reviewed empirical studies on correlates of CIM or relevant literature review, and written in English. Reports, briefs, letters, and editorials were excluded. Studies focusing on larger geographic scale beyond the community level were also excluded. Publications before the year of 2000 were excluded because CIM has shown a steep decline in recent years.

Keywords used for the search included children, independent mobility, physical activity, community, housing, and environment, and a total of 273 articles were identified. After deleting duplicates and a review of the titles and abstracts, 238 papers remained. A further review of the full text identified 42 articles for an in-depth systematic review.

2.2. Data extraction

Main characteristics were extracted from each study. They include the first author, title, year of publication, journal of publication, study design, sample characteristics (e.g., sample size, gender, age, race), study location and settings, confounding variables, measurements of variables, statistical analysis, results, and conclusions.

3. Results

This section first summarizes the main study characteristics and the theories and conceptual frameworks applied or proposed in these studies. It then reviews and summarizes the correlates of CIM, which are grouped into domains of personal, social, and physical environmental factors.

3.1. Main study characteristics

Among 42 selected articles, there are 35 (83%) cross-sectional studies, 1 (2%) longitudinal study, 4 (10%) literature reviews, and 2 (5%) case studies (Table 1). The majority (79%) were published between 2010 and 2017. Most studies were conducted in Europe (43%) and Oceania (38%); and in urban or suburban settings (69%). The sample size ranged from 40 to 1830.

Table 1: Main characteristics of reviewed studies

<table>
<thead>
<tr>
<th>Study Characteristics</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Publication Year</strong></td>
<td></td>
</tr>
<tr>
<td>2010-2017</td>
<td>33 (79%)</td>
</tr>
<tr>
<td>2000-2010</td>
<td>9 (21%)</td>
</tr>
<tr>
<td><strong>Study Design</strong></td>
<td></td>
</tr>
<tr>
<td>Cross-sectional</td>
<td>35 (83%)</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Literature Review</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Others</td>
<td>2 (5%)</td>
</tr>
<tr>
<td><strong>Region of Study</strong></td>
<td></td>
</tr>
<tr>
<td>U.S./ Canada</td>
<td>7 (17%)</td>
</tr>
<tr>
<td>Europe</td>
<td>18 (43%)</td>
</tr>
<tr>
<td>Oceania</td>
<td>16 (38%)</td>
</tr>
<tr>
<td>Asia</td>
<td>1 (2%)</td>
</tr>
<tr>
<td><strong>Study Setting</strong></td>
<td></td>
</tr>
<tr>
<td>No specific/ General</td>
<td>10 (24%)</td>
</tr>
<tr>
<td>Urban/ Suburban</td>
<td>29 (69%)</td>
</tr>
<tr>
<td>Rural</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Both Urban and Rural/Mixed</td>
<td>3 (7%)</td>
</tr>
<tr>
<td><strong>Sample Size (For Reviewed Empirical Studies)</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;500</td>
<td>15 (43%)</td>
</tr>
<tr>
<td>500-1000</td>
<td>9 (26%)</td>
</tr>
<tr>
<td>&gt;1001</td>
<td>11 (31%)</td>
</tr>
<tr>
<td><strong>CIM Measures (For Reviewed Empirical Studies)</strong></td>
<td></td>
</tr>
<tr>
<td>Subjective Measures</td>
<td>30 (86%)</td>
</tr>
<tr>
<td>Objective Measures</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Mixed Measures</td>
<td>5 (14%)</td>
</tr>
</tbody>
</table>

3.2. Theoretical basis and conceptual frameworks

This review also examined theories and conceptual frameworks in the reviewed articles to identify relevant ones that can inform a better understanding about the topic. Social-ecological model is the most commonly used theory in identified studies. Researchers from diverse disciplines also proposed several conceptual frameworks for different CIM modes.

Since the late 1980s, researchers have adopted the social-ecological model into health promotion research, shifting from an over-emphasis on individual responsibility to a comprehensive perspective addressing multi-level correlates of health behaviour, as well as the interactions among different levels [11-13]. This model was later extended as a guiding theory for health promotion from the community level [13, 14]. In the 42 reviewed studies, 13 either directly applied the socio-ecological framework or showed the influence of this theory in their concept and study design.

In addition, several conceptual frameworks for correlates of CIM were proposed in previous studies. One study examined British children’s use of community environments and proposed a conceptual model with nested “ranges” of activity spaces, which emphasizes
the fact that children do not spend their time equally within all places around their neighbourhoods [15]. Three ranges—habitual range, frequented range, and occasional range—are defined by spatial and temporal differences in children’s use of their immediate surroundings. This model (Figure 1) was later adopted in a study in Canada, which used global positions systems (GPS) to detect children’s activity spaces and examine their neighbourhood activity and mobility [16].

A recent study [17] proposed a systems model (Figure 2) that addresses comprehensive interrelationships among multiple factors, while providing flexibility in tailoring the model to diverse settings. Factors in the framework were categorized into five levels based on the socio-ecological theory, including policy and society norms, neighborhood, household, individual, and behavior levels.

Another recent review explored the impact of housing on children’s development and proposed a conceptual framework (Figure 3) that links several housing features to children’s health outcomes from a broad ecological scope [18].

In another Canadian study, based on a literature review on independent mobility and school transportation, a conceptual framework (Figure 4) was proposed to explain children’s school travel behavior. Multiple levels of influences on CIM and mode choice for school transportation are considered, including external influences of natural and policy contexts, urban environment, household, and intrapersonal characteristics of the child [19].
3.3. Variables examined in the reviewed studies

This section summarizes definitions and measurements of CIM used in previous studies, as well as their findings about correlates of CIM. It refers to the social-ecological model and grouped the variables into three categories, including (1) physical environment factors, (2) individual factors, and (3) social factors.

3.3.1. Definitions and measurements of children’s independent mobility

Children’s independent mobility was originally defined as *independent travel and unsupervised* play by Hillman,
Adams [1] in his book “One false move”. As summarized later by Kytta [6], there are three types of definitions used in studies on CIM. The first definition considers CIM as the gear range and distance that children can move around independently from their home. In the second definition, CIM was identified as the mobility licenses that are issued by parents to permit children to move around individually in the environment. The degree of a mobility license reflects parents’ concerns about and decision-making on CIM. The third definition reflects the level of children’s actual mobility by asking them to record their activities (e.g. mobility diaries) within a certain period of time.

The measurements of CIM can be classified into quantitative and qualitative ones. Quantitative measurements are often based on Global Position Systems (GPS) or GPS-based apps on cell phones. They can capture geography-related variables like distance, ranges and active spaces. For example, as discussed earlier, one Canadian study measured children’s neighbourhood activity space by using portable GPS [16].

In most studies, qualitative methods are adopted due to the complexity of data identification and extraction when using quantitative measures from GPS devices or GPS-based apps. Such qualitative measurement methods included surveys, interviews, focus groups, and child or parent drawn maps. These measurements are seen more often in studies on parents’ reported mobility licence for children and children’s self-reported mobility. One study used interactive online-mapping software to measure CIM and travel modes to destinations [20].

A couple of studies combined quantitative and qualitative measures. One study published in 2011 discussed the potential of using mixed methods, combining ethnographic fieldwork with GPS technology and an interactive survey to study children’s mobility patterns, and identified that as a valid triangulation method that can enhance data quality [21].

3.3.2. Physical environment factors related to CIM

Physical environmental correlates of CIM can be grouped into three levels, including community level, housing level, and community-housing relationships. Table 2 summarizes key physical environmental variables identified from the review.

1) Community level

In the community level, significant correlates include community walkability, neighbourhood aesthetics, perceived safety, residential density, access to public transport, and level of urbanization. Also some of these variables interact with others.
Table 2: Summary of key physical environmental correlates of CIM*

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Measurement Type</th>
<th>Association with CIM</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community level</td>
<td>Walkability</td>
<td>O</td>
<td>(+)</td>
<td>Villanueva et al. (2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Girl (+)</td>
<td>Villanueva et al. (2013)</td>
</tr>
<tr>
<td></td>
<td>Crime safety</td>
<td>PP</td>
<td>(-)</td>
<td>Noonan et al. (2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(x)</td>
<td>De Meester, Van Dyck, De Bourdeaudhuij, and Cardon (2014)</td>
</tr>
<tr>
<td></td>
<td>Perception of neighbourhood risk</td>
<td>CP, PP</td>
<td>(-)</td>
<td>Loebach and Gilliland (2016)</td>
</tr>
<tr>
<td></td>
<td>Residential density</td>
<td>O</td>
<td>(-)</td>
<td>Broberg, Salminen, and Kytt (2013)</td>
</tr>
<tr>
<td></td>
<td>Increase of urbanization</td>
<td>O</td>
<td>(-)</td>
<td>Goodman, Jones, Roberts, Steinbach, and Green (2014)</td>
</tr>
<tr>
<td></td>
<td>Neighbourhood aesthetics</td>
<td>PP</td>
<td>(-)</td>
<td>Lopes, Cordovil, and Neto (2014)</td>
</tr>
<tr>
<td></td>
<td>Presence of specific local destinations</td>
<td>O</td>
<td>Boy (+)</td>
<td>Villanueva et al. (2013)</td>
</tr>
<tr>
<td></td>
<td>(i.e., recreation venues and retail shops)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing level</td>
<td>Housing type (Public vs. private)</td>
<td>O</td>
<td>(+)</td>
<td>Whitzman and Mizrachi (2012)</td>
</tr>
<tr>
<td></td>
<td>Single family housing</td>
<td>O</td>
<td>(+)</td>
<td>Broberg et al. (2013)</td>
</tr>
<tr>
<td></td>
<td>Located on a busy road</td>
<td>PP</td>
<td>(-)</td>
<td>Villanueva et al. (2013)</td>
</tr>
<tr>
<td>Community-Housing relationship</td>
<td>General independent mobility range from home</td>
<td>PP, O</td>
<td>(-)</td>
<td>Schoeppe, Duncan, Badland, Rebar, and Vandelanotte (2016)</td>
</tr>
<tr>
<td></td>
<td>Distance of play places from home</td>
<td>CP, O</td>
<td>(-)</td>
<td>Zhou, Li, and Larsen (2016)</td>
</tr>
<tr>
<td></td>
<td>Home-school distance (&lt;1,600km vs. &gt;1,600km)</td>
<td>O</td>
<td>(+)</td>
<td>Loebach and Gilliland (2016)</td>
</tr>
</tbody>
</table>

*aCP, children’s perceptions; O, objective measures; PP, parents’ perceptions; b(+) positive association; (-), negative association; (x), non-significant association; CIM*: CIM’s definitions and modes are different in reviewed studies.

The perception of environment is related to multi-level factors and the underlying mechanic is still unclear. Further studies are needed in this area.

Findings about the impact of residential density on CIM are inconsistent. Researchers from Finland found that dense urban environments encouraged CIM, but did not support active transport [35]. Other researchers conducted a study in Turku, Finland and found positive associates between residential density and children’s active travel to and from school, but that conflicted with findings in another study in Finland [36].

Other significant variables have also been reported in a few studies. Negative correlates include neighbourhood aesthetics, increased urbanization, and inner-city neighbourhood street features [29, 30, 37]. Access to public transport was identified as a positive correlate [38].

2) Housing Level

A limited number of studies focused on the relationship between housing and CIM specifically. Variables that have been examined included housing types, housing location, and housing density.
Housing types have shown significant impacts on CIM. One study from Sweden reported boys living in a house had less fear and higher independent mobility than those living in an apartment, but no significant difference was reported in the case of girls [39]. Researchers from Auckland, New Zealand concluded that single-family housing helped to promote both CIM and active transportation, and higher-density housing seldom provided child-friendly environments [30]. Another study in Melbourne, Australia interviewed 40 children and reported that children in public housing had higher levels of independent mobility compared to children in private housing. Researchers from Italy also found out that children living in apartments with courtyards and near parks and newly-built communities reported higher independent mobility [40]. In addition, lower CIM was observed among children living in housing along a busy road [26].

One review article summarized housing characteristics that affect children’s physical, social, mental development; behavioural outcomes; as well as school achievement and economic attainment. Six features were reported, including physical housing quality, crowding, residential mobility, homeownership, subsidized housing and unaffordability [41]. However, only hazardous physical housing environment and crowding have been reported to have a strong relationship with children’s health. CIM plays an important role in children’s physical, mental, and social development. But it is unclear whether those housing characteristics have specific correlations with CIM and what the underlying mechanisms may be. In sum, existing studies reported some inconsistent findings on the impact of housing characteristics on CIM. More empirical studies are also needed in this area.

3) Community—housing relationship

Variables concerning community-housing relationship included general independent mobility range from home, distance of play spaces from home, distance of school from home, and types and numbers of destinations within the neighbourhood.

One Australian study examined CIM to neighbourhood destinations like schools, friend’s houses, parks and local shops and reported that CIM associated with distances between destinations and children’s home, but were also affected by other factors such as destinations’ specific characteristics (e.g., green space’s types and sizes), perception of safety, and parenting social norms [32]. Another research showed that 8-16 youth live in urban and rural areas with lower socioeconomic status (SES) in Victoria, Australia had greater self-reported independent mobility as shown by more frequent independent visitation to parks through active transport of either cycling or walking [42]. Another Australian study in Melbourne showed that children living in lower SES outer-urban communities had to travel greater distance to access local parks than their counterparts who live in inner-city above-mid SES areas [43]. Villanueva, Giles-Corti [26] explored relationships between access to local destinations and CIM, and also reported general positive correlations. In addition, impacts of certain types of destinations were found to be gender specific in this study. However, their earlier study reported that more local destinations within a small range from neighbourhood (less than 800 m) restricted children’s active space possibly due to increased traffic and strangers [22].

School is a special place among all accessible destinations. Active travel to and from school is a typical mode of CIM, and is positively associated with total level of CIM and decreases possibility of children being overweight [36, 44]. Some studies reported that children are more likely to active travel to school if the distance from home is less than 1.6 kilometres [16]. One article summarized 480 variables that were associated with children’s active school transportation based on a review of 42 studies. It also identified four factors that have the strongest associations with active transportation to school, including distance, income, traffic and crime fears, and parental attitudes and schedules [45]. Some studies have focused on the specific means of active transportation, such as walking, cycling, and taking school bus or public bus. In one study on cycling to school, around 40% of the participants (10-12 year old Belgian children) never cycled to school. Meanwhile, children living in neighbourhoods with better perceived traffic safety or had company (e.g., friends) on the school trip, or had encouragement from parents were more likely to cycle to school [46].

3.3.3. Individual factors related to CIM

Personal factors from both parents and children also play significant roles in influencing CIM. This section summarizes findings about individual factors correlated with CIM in reviewed studies.

1) Parent Level

Parents’ socioeconomic status, age, gender, parenting style, education level, income, employment, occupation, and even language proficiency influence their decision-making on their children’s independent mobility [5, 31, 47]. Some researchers from Australia examined parents’ attitudes on CIM range and found out that parents with lower education level have stricter restrictions for their children’s individual travel distance or outdoor play range, but no relationship has been observed between parents’ age groups and their attitudes about CIM [31, 47]. Mother’s strong neighbourhood relations were identified as a positive correlate of CIM in one Italian study [40]. One study also identified parents’ self-reported physical activity as a...
positive correlate for CIM and suggested further research in this area [27].

2) Child Level

Children’s characteristics like age, gender, language spoken at home, and other sociodemographic factors have shown significant impacts on their independent mobility in many studies [4, 28]. In general, CIM increases with age [1, 40, 48]. A longitudinal study examined and compared independent mobility of children (aged between 7 and 15 years old) in 16 countries, and reported that children under 11 years old have the greatest restrictions on independent mobility from their parents or guardians [49]. Also, boys have been identified to have higher independent mobility because of their own physical characteristics and less concerns about safety issues from parents comparing to girls at the same age groups [5, 25, 29]. Meanwhile, girls and minority children have been reported to be more restricted in terms of neighbourhood activity [28, 50]. Another study claimed that CIM showed a stronger correlation with boys in urban neighbourhoods and girls who live in suburban neighbourhoods [4]. Nevertheless, both boys and girls with more self-confidence in traveling autonomously have been identified larger active space areas around their homes [22]. Furthermore, impact of child’s age interacts with physical environmental features. For example, researchers from Portugal reported that as the level of urbanization increased, the age limit for children to engage in active travel independently also increased [29].

Besides the factors discussed above, children’s siblings and dog ownership also have impacts on their independent mobility. Studies reported that children who have accompany of older sibling of the same gender or a family dog have higher independent mobility for travel to school, local shops, and other more destinations [51, 52]. Additionally, children with high independent mobility were found more often with peers [40].

3.3.4. Social factors related to CIM

Social factors have also been identified as important correlates of CIM. Key variables are neighbourhood SES disadvantage, neighbourhood social cohesion, parenting social norms, and informal social control in neighbourhood.

For neighbourhood SES disadvantage, the findings were inconsistent. One UK study examined the difference between high deprivation and medium-to-high deprivation neighbourhoods and their impacts on children’s self-reported independent mobility. Children in high-deprivation areas reported higher independent mobility than children in medium-to-high deprivation neighbourhoods [37]. Similar results were found in another study in Canada [28]. However, Schoeppe, Duncan [31]’s study found no significant association between neighbourhood SES disadvantage and CIM.

In addition, poor parenting social norms (e.g. parents are supposed not to allow children to play alone without adults’ accompany) was reported as a negative correlate of CIM [32], while neighbourhood social cohesion and informal social control in neighbourhood (e.g. parents’ confidence that other residents would look after children move around without adults’ supervision) were positive correlates [31] [25]. One study mentioned above also specifically examined many other social environment factors such as social incivilities, loitering teenagers in public places, dangerous or drunk driving, poor neighbourhood maintenance, graffiti and vandalism etc. but no significant associations with CIM were detected among them [32].

4. Discussion

The decline of CIM has been reported in many developed countries including the U.S. in recent decades. Based on this literature review, we found out that comparing to countries in Europe and Oceania, the number of studies in the U.S. on CIM is small. Even though many researchers have shown interests in this area, few studies on CIM and its relationship with housing and community environments have been found. Therefore, more studies on CIM and the impacts of housing and community environment in the U.S. should be encouraged in the future.

4.1. Potential conceptual framework

Based on the results of this review, the authors proposed a conceptual framework for addressing impacts of housing and community environment as well as other factors on CIM (Figure 5). In this framework, the specific community/housing physical environment will be taken into account as the independent variables, and parents’ decision-making will be the dependent variables. As discussed, parents’ decision-making is a crucial factor that affects their children’s independent mobility. The social environment is a mediator while individual parental factors and children’s characteristics will be considered as confounding variables.

4.2. Design suggestions

Based on findings from this review, the authors also proposed some housing and community design...
suggestions that will help provide more child-friendly environments for the promotion of CIM.

**Provide affluent destinations within walking or cycling distance in community design.** As concluded, the diversity and accessibility to destinations within the neighbourhood and the distance between those places and the child’s home are crucial to CIM. For the future community planning and design, more accessible destinations such as schools, playgrounds, grocery stores, and parks etc., should be provided within a walking/cycling distance to increase the neighbourhood walkability, and consequently, promote children’s independent active travel by walking or cycling.

**Enhance neighbourhood traffic safety.** Neighbourhood safety influences CIM, and could be enhanced through appropriate design solutions. Physical street infrastructure like speed humps could be installed within the neighbourhood to calm traffic. Also, it will be helpful to install crosswalks or other devices to assist child pedestrians or bicyclists to cross busy roads and increase CIM.

**Create specific child-friendly space for disadvantage children.** Referring to findings of the study, children living in high-density housing often lack child-friendly environments to play in freely, while housing with courtyard or near parks has a positive impact on CIM. It is recommended that special play spaces or courtyards be taken into account at the initial planning or design phase of high-density or public housing in SES disadvantaged areas.

5. **Conclusion and limitation of this review**

This review has some limitations that need to be addressed. First, the literature search and selection were conducted by one reviewer that may introduce the bias. Also, due to the diversity in concepts and measurement of CIM, the keywords used for the search in this study may not be broad enough and increase the risk of omitting significant articles.

Despite these limitations, this review helped develop a better understanding about the state of knowledge about environmental factors associated with CIM. Overall, CIM has shown a worldwide decline, and so far, relevant studies are mainly from European and Oceania countries like Finland, UK, Australia and New Zealand. However, children in Europe still remain higher independent mobility than their counterparts from many other countries and areas. In addition, the majority of the studies have been conducted in urban or suburban settings. CIM in rural area is understudied.

CIM is related to immediate housing and community environment. Most of the previous studies examined the physical environments on the neighbourhood level, but only a few studies have considered environments on the housing level. Both children’s and parents’ individual factors and perceptions of their communities affect CIM. Parents’ attitudes and decision-making are crucial to their children’s independent mobility. Future research and practice should employ a comprehensive

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**Figure 5. Potential conceptual framework**
References


