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Autonomy as key to healthy psychological well-being: A systematic literature review on children's independent mobility, cognitive and socio-emotional development

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ABSTRACT

Background: Children's independent mobility (CIM), i.e., the autonomous travel and outdoor play without adult supervision, is crucial for child development. The literature on CIM has focused more on its predictors than its outcomes, and few existing reviews have primarily explored its contribution to children's physical well-being. The aim of this review is to analyze studies on the relation between CIM, particularly in (sub)urban neighborhoods, and children's psychological well-being variables.

Methods: A literature search run in nine electronic databases resulted in the selection of a final sample of 23 studies, out of 358 initial relevant hits. Peer-reviewed articles addressing at least one child psychological outcome of CIM, referring to (sub)urban residential areas, and considering children and adolescents from school-age throughout adolescence, were analysed.

Results: The reviewed studies, published between 1999 and 2020, were mainly conducted in Europe and by quantitative design, and most of them focused on the consequences of CIM for children and adolescents up to 15 years old. Findings suggest a prevalence of studies exploring CIM's benefits for their socio-emotional (e.g., lower fear of crime, enhanced sociability) followed by cognitive (e.g., better spatial knowledge) development.

Conclusions: Empirical studies on psychosocial outcomes of CIM are lacking, possibly due to the decline of this activity among children and youth also related to generalised lockdown affecting those specially in (sub)urban neighbourhoods. Moreover, this review shows that psychological benefits of CIM for children have been under looked in the literature and highlights that children's cognitive abilities (ex. spatial cognition) and socio-emotional growth (ex. social interaction skills) may be enhanced through this activity, emphasising the need for more empirical research on this topic.

With increased sedentary modern lifestyles, children are becoming more and more exposed to digital technologies and screen-based activities and engage less in outdoor activities (Mullan, 2019). This, together with factors such as the rising of perceived dangers they can face on the streets (Gülgönen and Corona, 2015; Larouche, 2018), may lead to their constricted autonomous use of outdoor spaces

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(Shaw et al., 2015).

Children's independent mobility (CIM), a concept introduced by Hillman et al. (1990), refers to children's autonomous use of the outdoor living environment, for travel or play, on their own, without adult supervision (Marzi and Reimers, 2018). CIM has not been uniformly defined in the literature and, consequently, it has been measured with several distinct methods (Bates and Stone, 2015; Riazi et al., 2022) and different and overlapping indicators, namely CIM range (i.e., territorial range, how far a child can travel from their home), CIM time (i.e., independent time outside, how much time a child may stay outside of home autonomously), CIM destination (i.e., independent movement to specific destinations) and CIM license (i.e., parental license/allowance to child independent mobility; Sharmin and Kamruzzaman, 2017). Empirical research has frequently focused on the last two (CIM license, mainly, but also CIM destination) whilst the others (CIM range and CIM time) were less explored (Marzi and Reimers, 2018). Most studies have considered CIM as children's autonomous travel to relevant destinations (Pacilli et al., 2013; Shaw et al., 2015), namely school (Ayllón et al., 2019), while others have considered it also in terms of freedom of playing outdoors unsupervised (Alparone and Pacilli, 2012; Qiu and Zhu, 2021).

CIM may benefit children's overall development and well-being, for instance, in promoting their engagement in physical activity, preventing health-related issues (Faulkner et al., 2015; Mackett et al., 2007; Schoeppe et al., 2013), in allowing for social interactions and consequent social bonds to occur (Rogers, 2012), in reducing psychosomatic symptoms (Jackson et al., 2021; Piccininni et al., 2018), and in developing spatial awareness (Cornell et al., 2001). Shaw et al. (2013) found an overall constant decline in CIM. Moreover, the recent COVID-19 pandemic experience of repeated mass home confinement, restricting the use of public open spaces, may have negatively impacted children's (autonomous) outdoor activity participation (Mitra et al., 2020; Pelletier et al., 2021) and consequent subjective well-being (Jackson et al., 2021; Leung and Loo, 2017), particularly for those living in (sub)urban areas, with higher building density and reduced access to nature (Mitra et al., 2020).

The multiple benefits of CIM for children's health and development, together with the unsettling decrease of its frequency among younger generations, exacerbated by the restrictive measures imposed by COVID-19 (Mitra et al., 2020), may explain the growing research interest on CIM, resulting in several empirical studies and literature reviews published on this topic. However, most of them have highlighted the effect of multiple factors on CIM, namely at the individual, family (or interpersonal), and environmental (social and physical) levels (Badland et al., 2016; Lee et al., 2021; Marzi et al., 2018; Mitra, 2013; Qiu and Zhu, 2017; Riazi et al., 2022; Sharmin and Kamruzzaman, 2017). While most of such reviews initially considered CIM in terms of independent travel, more recent ones considered it as autonomous outdoor play (OP; Boxberger and Reimers, 2019; Lambert et al., 2019; Lee et al., 2021).

At the individual level, a child's gender, age, and perceived competence for autonomous movement have been considered. In general, boys seem to be usually granted more freedom to independently move around or play outdoors than girls (Fyhri and Hjorthol, 2009; Lee et al., 2021; Mackett et al., 2007; Pacilli et al., 2013; Stone et al., 2014), maybe for parents' enhanced social fears in relation to their daughters (Alparone and Pacilli, 2012). Older children seem also to be granted higher autonomy of movement (Marzi et al., 2018; Schoeppe et al., 2013), especially in urban contexts (Fyhri and Hjorthol, 2009; Johansson, 2006; Mackett et al., 2007). Race and ethnicity are positively associated with CIM; as reported in a review by Riazi et al. (2022) in previous studies children from non-minority groups were found to be allowed more independent mobility than those from minority groups. Increased child and parental confidence in children's agency to move around independently seems to be associated with higher CIM (Alparone and Pacilli, 2012; Ayllón et al., 2019; Veitch et al., 2017; Villanueva et al., 2013).

At the family (or interpersonal) level, parents' age, gender, socioeconomic status, and parenting style were previously shown to affect CIM (Marzi et al., 2018; Pacilli et al., 2013; Qiu and Zhu, 2017; Veitch et al., 2017). Moreover, the perceptions parents hold about local dangers for children, mainly related to social and traffic issues, are the main negative correlates of CIM (Alparone and Pacilli, 2012; Carver et al., 2014; Faulkner et al., 2015; Larouche, 2018; Qiu and Zhu, 2021; Veitch et al., 2017).

Finally, at the social environment level, strong parental relationships in the neighbourhood may strengthen CIM (Prezza et al., 2001). With reinforced neighbourhood social ties and perceived sense of community, perceptions of local danger and child capabilities may, respectively, decrease or increase (Prezza et al., 2005). Besides, parenting social norms and neighbourhood socioeconomic status may also predict CIM (Badland et al., 2016; Fyhri and Hjorthol, 2009; Veitch et al., 2017; Villanueva et al., 2013).

On the other hand, at the built environment level, proximity to relevant destinations (e.g., schools, parks, or a friend's home), presence of good quality green areas, neighbourhood density, degree of urbanisation, existence of walking infrastructures and traffic calming attributes are often cited in the literature associated to CIM (Broberg et al., 2013; Fyhri and Hjorthol, 2009; Lambert et al., 2019; Lin et al., 2017; Marzi et al., 2018; Mitra, 2013; Qiu and Zhu, 2021). For example, living in dead-end streets and in areas with lower land use mix strongly enhanced CIM (Sharmin and Kamruzzaman, 2017).

1. CIM related to children's development and well-being

Empirical evidence exists on the association between CIM and child's cognitive growth, which concerns the development of cognitive competences for a positive interaction with the spatial-physical environment. For instance, Cornell et al. (2001) found that children who walked more towards the limits of their home range, up to which independent mobility was allowed, selectively recalled environmental features with good landmark qualities. On the contrary, travelling passively to significant places (e.g., school), i.e., with the bus or the car, may limit children's spatial awareness and deteriorate distance estimation (and orientation) in regard to landmarks (Tezel, 2011) as well as decrease their wayfinding abilities (Fyhri and Hjorthol, 2009; Johansson et al., 2020).

The idea of environmental cues capturing children's attention relates to the concept of place affordances (Gibson, 1979). It refers to psychological relational properties perceived by the person when interacting with the environment, i.e., instantly detectable functions that environmental features induce to the person (Gibson, 1979). Previous work suggests that the place affordances approach is

particularly relevant in child studies, provided that children use and see places in a fundamental way when interacting with the world (Heft, 1988). Kytä (2004) further suggests that, in contact with perceived affordances, children may actualise them. Specifically, a perceived affordance refers to the detected opportunity in the environment for an action to occur (e.g., a raised horizontal surface may afford a place for sitting or climbing up), whereas an actualised affordance refers to detecting such function and adapting the behaviour in a fit between the individual's intentions (sitting or climbing) and characteristics (height, age) and the functional opportunities offered by that environmental cue (i.e., the raised horizontal surface). Nonetheless, for this actualization to happen, children must be allowed to autonomously interact with their living environment. Thus, an ideal child-friendly environment may be one where children are granted high freedom to explore, and that in turn provides them with safe, inviting, and complex settings for their preferred activities. In sum, a practical place, one that promotes child independence by allowing for spontaneous social activities to occur, thus encompassing children's autonomy and capability together with places' affordances (Garau et al., 2018).

This leads us to the relevance of CIM for the child's socio-emotional development, which covers those aspects concerning the acquisition and improvement of relational skills. In fact, according to previous studies, children's independent mobility in a place helps them establish and develop relationships with significant others there, besides their family (Prezza et al., 2001), thus contributing to their sense of community and place attachment (Prezza and Pacilli, 2007). Besides, having friends and developing friendships is crucial for children's mental health and well-being (Asher and Paquette, 2003). A previous study suggested a negative association between the frequency of outdoor play and the prevalence of psychosomatic symptoms (e.g., depression, irritability, and sleeping difficulties) among adolescents, particularly girls (Piccininni et al., 2018). Similarly, Jackson et al. (2021) found evidence on the effectiveness of participation in outdoor activities in promoting adolescents' subjective well-being, particularly in developing resilience towards health-related stressors such as COVID-19.

2. Aim of the present review

Very few reviews seem to have been published so far on the relation between CIM and child's development and well-being. Schoeppe et al. (2013) reviewed fifty-two studies focusing on the relation between independent mobility, active travel (AT; to school and leisure destinations), and physical activity. The authors found only four studies exploring the association (mainly positive) between CIM and physical activity, whereas the majority showed a consistently positive connection between the latter and children's active travel (i.e., under adult supervision). Moreover, a more recent review showed transport contributing to all child well-being domains. The authors found that most benefits for children's well-being were related to active travel (AT) and independent travel (CIM), whereas most negative effects were associated with traffic (Waygood et al., 2017b).

However, to the best of our knowledge, so far, no comprehensive overview of the literature has been published exploring the relation between CIM and child psychological development and well-being. The main purpose of this review is to analyze the literature about the relation between CIM, hereby considered as independent travel and/or outdoor play, and children's psychological well-being, particularly in (sub)urban neighbourhoods, where children's freedom of movement outdoors may be more restricted. Following Pollard and Lee (2003) suggestions, we have considered psychological well-being as a broad term, encompassing both cognitive (i.e., learning-related) and socio-emotional (i.e. mental and social) facets of well-being. As such, this review aims to identify cognitive and socio-emotional outcomes of CIM presented in the available empirical research on this topic.

3. Method

3.1. The literature search protocol

The review process was defined by a literature search protocol developed by the authors. Following existing guidelines on literature review search, the protocol developed for this review stated 1) the scope of the literature review, 2) the purpose of the literature search, 3) search strategies, 4) eligibility criteria (defined using the SPIDER tool, suggested by (Cooke et al., 2012; see Appendix B), and 5) key search terms (see Appendix A) (Littell et al., 2008).

In order to facilitate the development of a Boolean search string, search terms were broadly defined in the following four groups: 1) children (e.g., child*, adolescent), 2) independent mobility (e.g., "CIM", "independent mobility", "out* play"), 3) urban/neighbourhood context (e.g., neighbourhood, communit*), and 4) child outcome (e.g., development, well-being) (see Appendix A).

3.2. The literature search process and eligibility criteria

Preliminary scope searches were run by combining the search terms in different ways, defining a Boolean search string (see Appendix A). The final search string was used in the comprehensive literature search up between May 18th and July 16th, 2021, with an additional search performed in November 2023, using nine electronic databases agreed among the authors as the most relevant for this topic (Web of Science (ISI), Scopus, and EBSCO databases – Academic Search Complete, APA PsycArticles, APA PsycInfo, Environment Complete, MEDLINE Complete, Psychology and Behavioral Sciences Collection, SocINDEX with Full Text) (Booth et al., 2012).

Eligibility criteria were previously defined in line with the focus of this review (see Appendix B). We defined a time span range of publication from 1990 - year of the emergence of CIM's concept - up to 2020, in order to consider all relevant literature on this topic. Moreover, articles should address at least one child psychological outcome of CIM (considered as unsupervised travel and/or play), and refer to (sub)urban neighbourhood/residential areas, as they were the focus of the PhD research project that originated this review,

and mainly for the beneficial impact of children's immediate outdoor environment on their well-being, highlighted during COVID-19 lockdown particularly in (sub)urban environments (Mitra et al., 2020). Also, considering that CIM is allowed to children mainly since entering school (i.e., 5 or 6 years-old) (Larouche, 2018; Hillman et al., 1990), studies were eligible if they focused on children and adolescents from school-age throughout adolescence, in order not to exclude potentially relevant studies on the psychological benefits of CIM for them. Besides, as the focus of our review is the relation between CIM and psychological outcomes for children, we considered eligible studies including children and youth as the main sample, even though studies including children and caregivers (or parents) could also be considered. Furthermore, the search was international but limited to the English language, and only peer-reviewed journal articles selected. Finally, in order to avoid excluding relevant published studies on this relatively understudied topic (i.e., the psychological benefits of CIM for children/adolescents), all research types of studies (i.e., quantitative, qualitative, and mixed methods) were considered eligible.

The search produced 358 initial relevant hits. The abstracts of the identified papers were read by the first author.

Furthermore, articles that 1) were not written in English, 2) did not include a psychological construct (either a correlate or an outcome) in relation to children's independent mobility (CIM), and 3) were not empirical studies (e.g., reviews, reports), were excluded. Studies were not considered for this review if they referred to children aged below school-age (i.e., less than 5 years-old), based on the fact that independent mobility may not apply to early childhood and preschool as children's movement is fully dependent on adults at that period. However, studies involving multiple ages reporting results for younger children were eligible. Moreover, articles focusing on active mobility (AT) but not on independent mobility (CIM), as well as those referring solely to rural areas and not (sub)urban areas were not eligible.

Full-text versions of 124 articles were retrieved and read through, and the articles that were not aligned with the defined eligibility criteria above mentioned were excluded ($N = 106$). For instance, articles assessing CIM only as an outcome or those only approaching parental psychological correlates of CIM but not child outcomes were excluded. Reading the articles in full and examining the reference lists led to the addition of 5 new hits. An inter-subject analysis of the articles conducted by 3 independent researchers

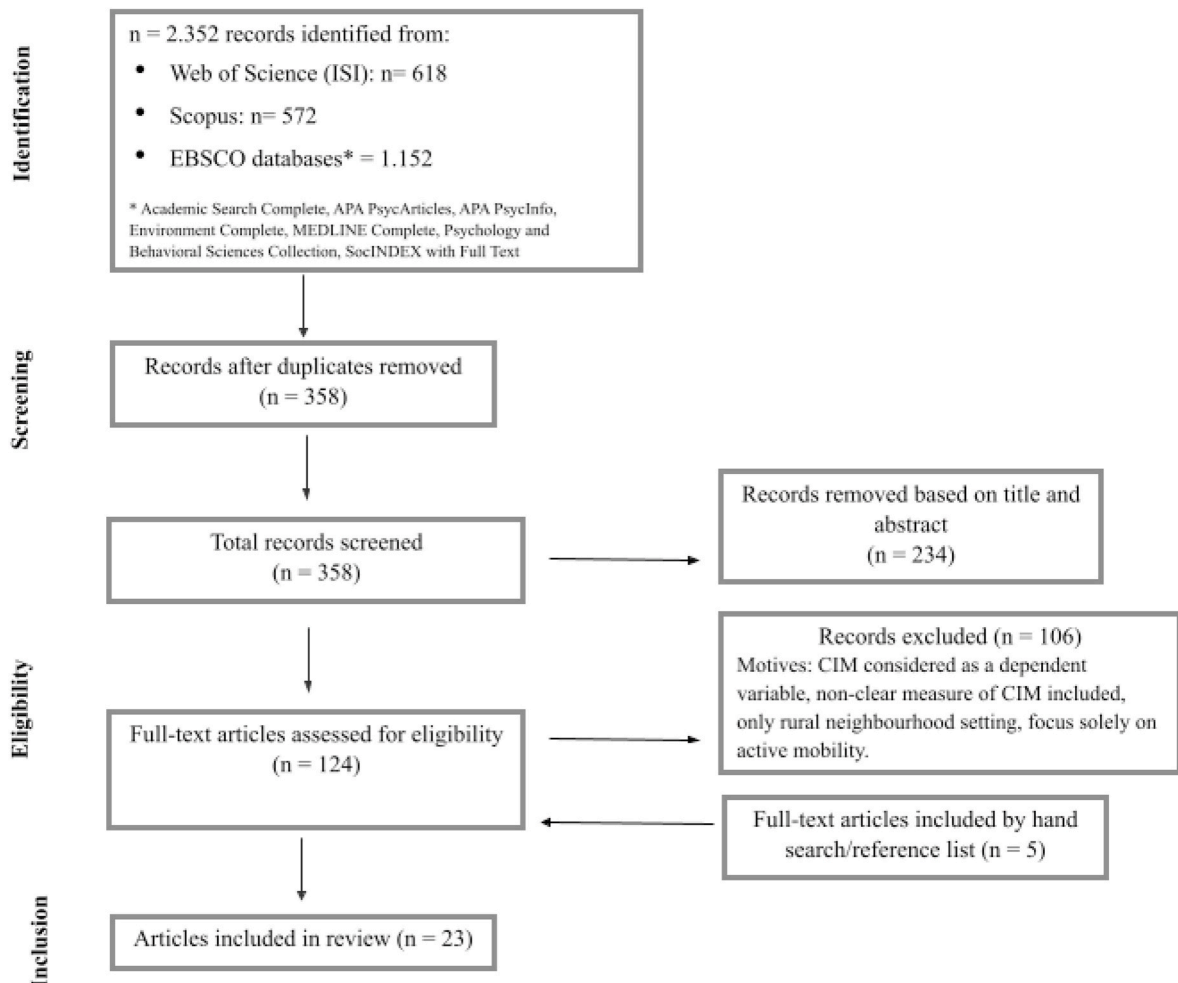


Fig. 1. Results of search strategy based on the PRISMA Statement (Page et al., 2021).

Table 1
Reviewed studies.

N	Author(s)/Year	Research design	Definition of CIM	Relevant Findings	Target population (p), Age range (a), Sample (n), Country/ies (c)	Group (1)
1	Joshi et al. (1999)	Mixed methods	Independent travel to school and non-school journeys (CIM destination)	(+) Spatial knowledge	p = children; parents a = 7–12 y.o. n = 93 c = UK	1
2	Prezza, et al. (2001)	Quantitative (Cross-sectional, retrospective)	Travel or play around independently from adults (CIM destination)	(+) Play with peers (outdoors and indoors)	p = children; mothers a = 7–12 y.o. n = 251 c = Italy	2
3	Rissotto & Tonucci (2002)	Quantitative (Cross-sectional, retrospective)	Independent travel to school (CIM license CIM destination)	(+) Spatial knowledge	p = children a = 8–11 y.o. n = 46 c = Italy	1
4	Kyttä (2004)	Quantitative (Cross-sectional, retrospective)	Independent travel license and behaviour (CIM license CIM destination)	(+) Actualised affordances	p = children; parents a = 8–9 y.o. n = 227 c = Finland, Belarus	1
5	Ahmadi & Taniguchi (2007)	Mixed methods (Case study)	Independent travel to/from school (CIM destination)	(+) Spatial knowledge	p = children a = 9, 11 and 13 y.o. n = 75 c = Iran	1
6	Prezza & Pacilli (2007)	Quantitative (Cross-sectional)	Independent travel and play in public and semi-public places in childhood (CIM license CIM destination)	(–) Fear of crime in adolescence (+) Sense of community in adolescence (–) Loneliness (trough sense of community and fear of crime)	p = adolescents a = M _{Age} 16.6 (3rd year of high school) n = 789 c = Italy	2
7	Johansson, et al. (2009)	Quantitative (Cross-sectional)	Freedom to independently travel around and be outdoors in the neighbourhood (CIM license)	(–) Fear of crime (for boys)	p = children a = 12–14 y.o. n = 1,009 c = Sweden	2
8	Cops, D. (2013)	Quantitative (Cross-sectional)	Frequency of autonomous participation in leisure activity in public spaces (CIM destination)	(–) Fear of crime (+) Victimization risk	p = adolescents a = 14–19 y.o. n = 1,287 c = Belgium	2
9	Pacilli, et al. (2013)	Quantitative (Cross-sectional)	Independent travel and play in childhood (CIM destination)	(+) Sense of community, sense of safety and peer frequentation (–) Loneliness, indirectly	p = children a = 10–15 y.o. n = 589 c = Italy	2
10	Horton, et al. (2014)	Qualitative (Case study)	Independent walking or play in residential area, without adults (CIM destination)	(+) Sociability (interaction with peers and friendship development) (+) Spatial knowledge	p = children a = 9–16 y.o. n = 175 c = England	1; 2
11	Ramanathan, et al. (2014)	Quantitative (Cross-sectional)	Active travel to school without adults (CIM destination)	(+) Well-being (for parents of active travellers) (+) Child emotional, community, and environmental well-being (for children of parents who did not accompany to school)	p = children; parents a = 3–15 y.o. n = 5,423 c = Canada	2
12	Cook, et al. (2015)	Mixed methods (Observational)	Independent travel or play around the neighbourhood or city, without adults (CIM license CIM destination)	(+) Active citizenship (+) Ability to articulate local environmental preferences	p = children a = 8–12 y.o. n = 392 c = Australia	1; 2
13	Waygood & Friman (2015)	Mixed methods	Independent travel without adults (CIM destination)	(+) Sociability (seeing a known person while travelling)	p = children a = 10–11 y.o. n = 411 c = Japan	2
14	Witten, et al. (2015)	Qualitative	Autonomous presence (play and travel) in public spaces (CIM destination)	(+) Spatial (city) knowledge (+) Sociability (interaction with peers and increased responsibility)	p = children a = 9–12 y.o.	1; 2

(continued on next page)

Table 1 (continued)

N	Author(s)/Year	Research design	Definition of CIM	Relevant Findings	Target population (p), Age range (a), Sample (n), Country/ies (c)	Group ⁽¹⁾
15	Appleyard (2017)	Qualitative	Independent travel from/to school (CIM destination)	(+) Spatial knowledge	n = 253 c = New Zealand p = children a = 9–10 y.o. n = 36 c = USA	1
16	Leung & Loo (2017)	Quantitative	Independent travel to/from school (CIM destination)	(+) Happiness with PE lessons and outdoor play with friends (+) Psychological wellbeing through confidence in self-care ability, perceived road safety	p = children; parents a = 5–12 y.o. n = 393 c = China	2
17	Waygood et al. (2017a)	Mixed methods	Independent travel without adults (CIM destination)	(+) Seeing a known person	p = children a = 10–11 y.o. n = 499 c = Sweden, Japan, Canada	2
18	Jamme, et al. (2018)	Mixed methods	Independent travel to school without adults (CIM destination)	(+) Environmental knowledge (+) Attitude towards neighbourhood community, related to social network and sense of community	p = children a = 10–11 y.o. n = 135 c = USA	1; 2
19	Lopes, et al. (2018)	Quantitative (Cross-sectional)	Permission to move in neighbourhood and between school-home without adults (CIM license)	(+) Number of meaningful places (+) Social affordances in neighbourhood	p = children a = 11–17 y.o. n = 145 c = Portugal	1; 2
20	Waygood, et al. (2019)	Quantitative	Independent travel without adults and range of independent mobility (CIM license CIM range)	(+) Travel satisfaction (+) Life satisfaction, through travel satisfaction	p = children a = 9–12 y.o. n = 425 c = Sweden, Japan, Canada	2
21	Waygood, et al. (2020)	Mixed methods	Independent travel without adults and range of independent mobility (CIM license CIM range)	(+) Diversity of places to meet friends. (+) Frequency of face-to-face interactions	p = children a = 10–12 y.o. n = 456 c = Sweden, Japan, Canada	2
22	Porter et al. (2020)	Qualitative	Independent travel without adults and range of independent mobility (CIM license CIM range)	(+) Happiness (+) Strong spatial literacies	p = children a = 11–12 y.o. n = 18 c = Australia	2
23	Wales et al. (2020)	Qualitative	Freedom of independent travel or play in local areas without adults (CIM license).	(+) Spatial knowledge and actualised affordances (preferred places) (+) Sense of place through increased relation with peers	p = children a = 10–11 y.o. n = 16 c = Sweden	1; 2

Note.

⁽¹⁾ Articles suggesting an effect of CIM on children's cognitive [Group 1] or socioemotional [Group 2] development.

resulted in the selection of a final set of 23 eligible articles subject for thematic analysis. A summary of the literature review process is presented in Fig. 1.

All studies were thoroughly analysed, and information categorised regarding different elements directly related to the defined selection criteria (ex. target population, study setting, CIM assessed as a predictor or mediator/moderator) and to more general study characteristics (ex. aim and objectives, sample characteristics, definition, and measure(s) of CIM, theoretical framework applied, outcomes and correlates of CIM explored).

The methodological quality of the selected quantitative and mixed method studies was evaluated in accordance with previous systematic reviews (Riazi et al., 2022) using a 17-point grading system for reporting on observational studies that was modified from Schoeppe et al. (2013). Both the parameters of the study's quality and the reporting quality were captured by the updated checklist. Two reviewers (IAF and MG) independently evaluated the studies' quality, and any discrepancies were settled by discussion with a third reviewer (FF). On a scale of 0–1, each criterion was evaluated for its degree of fulfilment (0 = no/unclear; 0.5 = partial; 1 = yes). The maximum score that a study could receive was 17, and to calculate the total percentage of study quality, the score for each study was divided by the maximum score and multiplied by 100. After that, the quantitative studies were categorised as having high (>66.7%), fair (50%–66.6%), or low (<50%) study quality, in line with Riazi et al. (2022) (see Appendix C).

Furthermore, in order to guarantee the quality assessment of all studies in this review, the selected qualitative studies were

appraised with the use of the Critical Appraisal Skills Programme (CASP, 2018) Qualitative Research Checklist. This tool allows the systematic assessment of qualitative research based on ten criteria, namely 1) clarity of research aims, the quality of 2) methodology, 3) research design, 4) recruitment strategies, 5) data collection, 6) relationship between participants and researcher, 7) data analysis, 8) the ethical considerations, 9) the research findings and 10) the value of the research. This assessment was conducted by two independent reviewers (IAF and FF) and discrepancies settled in discussion with a third reviewer (MG). All qualitative studies considered (i.e., 5) were categorised as having high quality (i.e., 7 to 10 of the criteria were evidenced; see Appendix C).

4. Results

4.1. Articles included in the review

All the 23 articles analysed in the present review were published in peer-reviewed international scientific journals. These dated from 1999 to 2020 and are primarily from the research fields of psychology, transportation, and public health.

The majority of the studies are based on research conducted in Europe ($n = 11$). Other studies are based on data collected in North America ($n = 3$), Asia ($n = 3$), and Oceania ($n = 3$). Three studies (Waygood et al., 2017a, 2019, 2020) included empirical data from Sweden (Europe), Japan (Asia) and Canada (North America) altogether (see Table 1; see Appendix C). Regarding the target population, most study samples consisted of children and adolescents (except for four studies that also included children's parents or primary caregivers: (Joshi et al., 1999; Kytä, 2004; Prezza et al., 2001; Ramanathan et al., 2014). Studies' sample size ranged from 16 to 5.423, with only three studies reporting data from a large sample ($n > 1.000$; Cops, 2013; Johansson et al., 2009; Ramanathan et al., 2014). As for the age of children and/or adolescents, adopting Erikson stages perspective (Erikson and Erikson, 1998), namely preschool age (3–5 years old), school age (6–12 years old), and adolescence (13–18 years old), most studies analysed focused on the second age group ($n = 15$; 4 quantitative and 4 qualitative respectively, and 7 mixed methods), with less considering the third age group ($n = 2$; quantitative), both the second and the third ($n = 5$; 3 quantitative, 1 mixed methods, 1 qualitative), or all groups ($n = 1$, quantitative). As for the study design, most were based on quantitative ($n = 11$) and mixed method data ($n = 7$), and few on a qualitative approach ($n = 5$) (see Table 1; see Appendix C). Although most quantitative and mixed method studies reviewed reported statistically significant associations between CIM and other variables under study, some of them (6/18) did not report data on the effect size of such relationships, and most of those that did, reported a small effect size (7/18), followed by small to medium (2/18), medium (2/16), and only one reporting medium to large effect size (effect size characterization based on Cohen's (1988) guidelines, as suggested by Nieminen (2022) and Sullivan and Feinn (2012); see Appendix C). Regarding the quality assessment of the studies, most of the quantitative and mixed method studies were categorised as having high (>66.7%), fair (50%–66.6%), or poor (<50%) quality (Riazi et al., 2022). Descriptive and inferential statistical methods were always used, and some studies showed multivariate techniques of regression analysis or structural equation models, with innovative methods such as the partial least squares structural equation modelling (PLS-SEM; Hillman et al., 1990). Study design, population and variables were always well reported, while participants selection, recruitment and missing data were occasionally incompletely reported. Inclusion and exclusion criteria were often omitted, as well as a theoretical model. As for the quality of the qualitative studies, all ($n = 5$) were appraised as having high quality. Nevertheless, consideration of the researcher-participant relationship was often omitted or incomplete. Regarding the definition of CIM presented in the reviewed studies, most measures used to assess it were mainly related to CIM destination ($n = 13$), followed by combined measures of CIM license and destination ($n = 4$) and less of CIM license solely ($n = 3$) or combined with CIM range ($n = 3$). Four studies did not provide clear information of the measures or items used to assess CIM.

Two major groups of articles can be identified. The first group comprises articles that include an analysis of CIM in association to children's cognitive development ($n = 11$). The second group includes articles with a focus on CIM in relation to children's socio-emotional development ($n = 18$). Moreover, six of the selected articles fitted in both clusters, as their findings suggest CIM's contribute to both children's cognitive and socio-emotional well-being (see Table 1; see Appendix C).

4.2. Children's independent mobility (CIM) and psychological responses

4.2.1. Group 1: studies focusing on CIM's effect on cognitive development

The studies included in Group 1 address CIM in terms of children's unsupervised and independent use of their outdoor living environment, particularly in terms of a travel mode to go to specific destinations such as school and/or other meaningful places. CIM was assessed in terms of freedom of movement for travel and outdoor play in very few cases (Jamme et al., 2018). Moreover, measures used in these studies to assess CIM were mainly related to CIM destination ($n = 6$). Many studies in this group used cognitive mapping techniques, such as sketch and blank maps (Ahmadi and Taniguchi, 2007; Cook et al., 2015; Lopes et al., 2018), whereas others (also) used individual interviews and/or questionnaires, focus groups and/or walk-along interviews (Horton et al., 2014; Jamme et al., 2018; Kytä, 2004; Wales et al., 2020; Witten et al., 2015). Regarding the age of the children or adolescents, most studies in this group focused on school age children ($n = 8$; 2 quantitative, 3 qualitative, and 3 mixed studies), and few focused on adolescents ($n = 2$; 1 qualitative and 1 mixed studies) (see Table 1; see Appendix C).

All studies included in this group found an association between CIM and aspects of children's cognitive development. More specifically, a first set of studies ($n = 8$) suggest a relationship between CIM and children's spatial or environmental knowledge, while a second set of studies ($n = 3$) suggest CIM's association with the actualization of children's perceived place affordances.

Regarding the first set, eight studies show evidence of a positive association between children moving around independently from adults (i.e., alone and/or with peers) and the development of their environmental knowledge (Ahmadi and Taniguchi, 2007; Horton

et al., 2014; Jamme et al., 2018; Joshi et al., 1999; Lopes et al., 2018; Wales et al., 2020; Witten et al., 2015). These found higher independent mobility to be associated with an improvement in children's spatial knowledge regarding their living environment, witnessed by more elaborate descriptions and/or mental representations of the area. Identification of a higher number of relevant spatial elements (i.e., landmarks) and expression of a more accurate structuration and/or orientation of the route, when assessing how to get to specific destinations (e.g., school) also emerged (Ahmadi and Taniguchi, 2007; Cook et al., 2015; Joshi et al., 1999; Lopes et al., 2018). Some findings (Horton et al., 2014; Witten et al., 2015) suggest that children with higher independent mobility are given greater opportunity to become street-smart (i.e., familiar with a place, knowing how to get to destinations and which areas to go to and to avoid, by being observant and alert to potential dangers). They may better learn the environment, with increased awareness of useful pedestrian short cuts, alternative routes, and features and secret places often unknown to adults, at least within the licensed independent mobility range area of their residential environment. In addition, most of these studies suggest that children who walk alone show better spatial knowledge than those travelling alone by other means (Ahmadi and Taniguchi, 2007; Cook et al., 2015; Horton et al., 2014; Leung and Loo, 2017). For instance, Rissotto and Tonucci (2002) found children going to school on their own (walking or in public transport) performing better than those being driven there, namely in terms of their overall representation of and orientation on the route, as well as the number of landmarks identified in the itinerary. Similarly, Appleyard (2017) found that more autonomous children were able to draw more comprehensive maps of their neighbourhood than those who did not explore their living area independently. However, contrary to Rissotto and Tonucci (2002), this author found children who walked to school with their parents to perform even better than those walking alone or with their peers. Additionally, some studies found some environmental features influencing this relationship, namely traffic exposure and/or urban density in the place. In particular, children exposed to less traffic volume and speed (Appleyard, 2017) and living in more densely urbanised areas (Kyttä, 2004) were found showing richer descriptions and representations of their environment and reporting more preferred (or meaningful) areas in their residential place.

As for the second set of studies, three suggested an association between children's freedom of movement in their residential environment and the development and actualization of cognitive affordances of the place (Cook et al., 2015; Kyttä, 2004; Lopes et al., 2018). Kyttä (2004) found independent mobility license as a mediator of the relationship between the degree of urbanisation and the actualization of affordances in Finland, but not in Belarus. In fact, in Finnish neighbourhoods, higher degree of license for children's mobility predicted a higher number of neighbourhood actualised affordances, whereas in Belarusian neighbourhoods this relation was not significant. Belarussian neighbourhoods were mainly identified by children as less conducive of CIM and consequently allowing for less actualised affordances (Cell-type environment), whereas Finnish neighbourhoods were more conducive of CIM and allowed for more actualised affordances which, in return, induced more CIM among children. Lopes et al. (2018) found that children living in a neighbourhood in central Lisbon (Portugal) assessed it as mainly youth-friendly, and particularly as a place promoting social interactions. Such perceived social affordances were associated with children's identification of more meaningful places and to the increased opportunity for active and independent travel. Finally, Cook et al. (2015) found that children prefer mainly spatial elements in their residential area, whereas social affordances (e.g., liked people and animals) were particularly relevant for those living in suburban neighbourhoods. Moreover, such affordances provided children with greater opportunities for moving around independently in their area. These findings suggest that a lack of affordances may induce children's self-limiting exploration of their environment and, consequently, decrease both their place attachment and the number of preferred areas within the place.

4.2.2. Group 2: studies focusing on CIM's effect on socio-emotional development

All studies in this group focus on CIM in terms of children's unsupervised independent use of their living outdoor environment, for moving around and/or for play. In this group, most studies assessed CIM using items mainly focusing on CIM destination ($n = 10$). Only in this group were found studies assessing CIM through combined measures of CIM license and range ($n = 4$). Furthermore, the majority of the studies used individual interviews and/or questionnaires (Cook et al., 2015; Cops, 2013; Johansson et al., 2009; Leung and Loo, 2017; Lopes et al., 2018; Pacilli et al., 2013; Prezza et al., 2001; Prezza and Pacilli, 2007; Porter et al., 2020; Ramanathan et al., 2014; Waygood et al., 2019, 2020), and few of them also walk-along interviews (Horton et al., 2014; Wales et al., 2020) or travel diaries (Jamme et al., 2018; Waygood and Friman, 2015). Besides, most studies in this group addressed school-aged children ($n = 11$; 3 quantitative, 3 qualitative, and 5 mixed studies), and few focused on adolescents only ($n = 3$; quantitative), on both school-aged children and adolescents ($n = 3$; 1 of each study type), and one study focused on pre-schoolers up to adolescents (quantitative) (Ramanathan et al., 2014). (see Table 1; see Appendix C).

The studies included in this group provide evidence of an association between CIM and children's socio-emotional responses, namely sociability, affective experience of the place (i.e., meaningful, or preferred, areas), fear of crime, sense of community, place attachment, momentary (i.e., travel) and overall (i.e., life) satisfaction.

Six studies (see Table 1; see Appendix C) suggest a positive relation between CIM and children's sociability, in terms of increased frequency and/or quality of social interactions with other people, in general, and peers in particular (Horton et al., 2014; Pacilli et al., 2013; Prezza et al., 2001; Wales et al., 2020; Waygood et al., 2017a; Waygood and Friman, 2015). For instance, some found that children who were more autonomous users of their living environment tended to meet their peers more frequently (Pacilli et al., 2013; Prezza et al., 2001; Waygood et al., 2019). Additionally, others found that more peer frequentation resulting from higher CIM may also contribute to an increased reliance and surveillance between children, expressed by their efforts to keep each other safe while moving around their neighbourhood (Horton et al., 2014; Wales et al., 2020).

Furthermore, a few studies in this group show an impact of CIM on children's affective experience and/or emotional connection to their neighbourhood (Cook et al., 2015; Jamme et al., 2018; Wales et al., 2020). In this regard, four studies found children with higher independent mobility identifying a greater number of preferred or meaningful places in their living area (Cook et al., 2015; Jamme et al., 2018; Lopes et al., 2018; Waygood et al., 2020), namely for its social affordances, enabling greater opportunity for meeting with

friends or other people in general, for its increased sense of surveillance and protection. Additionally, two of these studies found a positive effect of CIM on the development of children's place attachment (Cook et al., 2015; Jamme et al., 2018). This was expressed, for instance, by the fact that children who autonomously explored their neighbourhoods described it in more social and affective terms, identifying important places for them those representing positive memories and/or social bonds (ex. relative or friend's place; Jamme et al., 2018).

Other four studies (see Table 1; see Appendix C) found more CIM to be related to children and adolescents' decreased feelings of insecurity and/or fear of crime (Cops, 2013; Johansson et al., 2009; Pacilli et al., 2013; Prezza and Pacilli, 2007).

Moreover, findings in two studies suggest CIM to be positively associated with a stronger sense of community in adolescents (see Table 1; see Appendix C). Prezza and Pacilli (2007) found independent mobility in childhood contributing to a stronger sense of community and reduced fear of crime in adolescence. Similarly, Pacilli et al. (2013) found more independent mobility among adolescents directly related to an increase in their sense of community, sense of safety, and peer frequentation and, indirectly, lower feelings of loneliness.

Finally, four studies suggested CIM to positively affect children's momentary or overall well-being, in terms of, respectively, travel satisfaction (while autonomously travelling to school or to other meaningful places) and/or overall satisfaction (namely with school or life in general) (Leung and Loo, 2017; Porter et al., 2020; Ramanathan et al., 2014; Waygood et al., 2019).

5. Discussion

The present review aimed to contribute to the understanding of the association between children and adolescents' independent mobility in (sub)urban residential areas, and their psychological well-being.

In our review, 23 studies were identified suggesting that CIM and child psychological well-being (broadly defined, including also cognitive and socio-emotional domains) are interconnected. The small number of studies included suggests that empirical research on this topic is scarce, despite the extensive literature on CIM, with published works from scholars of different disciplinary fields throughout the last few decades.

The reviewed studies used diverse methods and measures to assess CIM, which lowers the comparability of the findings (Bates and Stone, 2015). However, most of them applied quantitative or mixed methods ($n = 11$ | $n = 7$, respectively) and defined CIM with similar terms (e.g., freedom/permission of movement; autonomous presence in public space; independent travel). Most assessed it as children and adolescents' autonomous mobility to specific destinations (CIM destination) independently ($n = 11$) or combined with parental allowance for autonomous mobility (CIM license; $n = 8$), whereas three studies also considered the territorial range where children were allowed to explore unsupervised (CIM range; Hillman et al., 1990). No studies were found assessing specifically CIM time. Moreover, while most considered CIM solely as independent travel (to specific destinations or to move around; $n = 12$), eleven studies (i.e., 48% of the studies) considered CIM more broadly, as both autonomous travel and outdoor play.

Regarding the target age group, not surprisingly we found a majority of studies assessing CIM in relation to cognitive and/or socio-emotional well-being mainly in school-aged children (6–12 years old), and fewer showing such association only (or also) in adolescents (13–18 years old). This may suggest that independent mobility is particularly relevant for children's psychological growth during that period, or merely that more focus on CIM has been given to this group considering that children tend to start being given more freedom of autonomous movement (CIM) at that stage (Schoeppel et al., 2013; Shaw et al., 2015).

Regarding well-being an overall positive relationship between CIM and children and adolescents' cognitive development was found in nearly 46% of the reviewed studies. More specifically, CIM was consistently found positively associated with spatial knowledge acquisition (Waygood et al., 2017b). This finding suggests that the free exploration of the nearby outdoor environment allows children and adolescents to get more familiar with the area where they live and to better identify important landmarks and routes in the place, which may promote their spatial orientation and wayfinding skills (Jansen-Osmann and Wiedenbauer, 2004). Besides, in a few studies, the autonomous exploration of their environment was also found positively associated with the actualization of place affordances, which in turn invites children to use more their residential living area.

Nevertheless, contrary to findings from AT (active travel/transportation) research (Westman et al., 2017), an association between CIM and children and adolescents' cognitive or academic performance was not explored in these studies. This may be due to the fact that, overall, less research exists on CIM compared to AT. Moreover, it may be that the mere active interaction with the local environment, through an activity like AT, even if not alone but accompanied by adults, may stimulate children and adolescents' brain functioning and contribute to their higher concentration and improved performance in cognitive tasks.

Moreover, to a higher extent, a positive relationship between CIM and children and adolescents' socio-emotional development was found in 77% of the analysed studies. In particular, CIM was suggested to be associated with the promotion of children's sociability, in enhancing the opportunity for social interactions and peer frequentation in place (Mackett et al., 2007; Westman et al., 2020). In fact, as previous research suggests, children may want to be more independently mobile in order for more social exploration, social interaction, and inclusion, as well as the desire to be considered mature and capable, particularly by their parents (Cook et al., 2015; Westman et al., 2020). As Clark and Uzzell (2002) suggest, the social affordances allowing both socialisation and restoration may be the most relevant and actualised neighbourhood affordances, particularly for adolescents. Also, some of the reviewed studies showed that CIM may enable children to actualise place social affordances (Lopes et al., 2018) and associate positive social experiences to places involving affective memories and thus contributing to the development of emotional bonds to the place (Jamme et al., 2018). Indeed, as previous research has shown, the neighbourhood is a proximal environment that children interact with daily, a primordial place for establishing friendships and affective connections (Lewicka, 2011; Rogers, 2012). In there, children may thus be more exposed to social interactions, allowing them to expand their social networks and friendships, and consequently boost their satisfaction

and sense of place (Mackett et al., 2007; Westman et al., 2017). Although the association between neighbourhood attachment and walking in adults has been previously suggested (Ferreira et al., 2016), less evidence exists on the effect of children's free exploration of the neighbourhood on their affective connection to it (Johansson et al., 2020; Wales et al., 2020). Children seem to cultivate a sense of place through their environmental understanding of the place, their environmental competence (i.e. knowing how to navigate and engage with the place), and the establishment of diverse and strong affective relationships with it (Westman et al., 2017).

About the association between CIM and children's positive emotional experiences while moving around in the place, very few studies found this pattern. This interconnection has been particularly emphasized in studies of AT showing that those walking or cycling to school reported more positive emotions (e.g., happiness, excitement, or relaxation) than those using passive or motorized transport, particularly while travelling with adults, for the increased opportunity to interact with them (Ramanathan et al., 2014; Westman et al., 2017). Nevertheless, some of the reviewed studies found CIM specifically related to a decrease in fear of crime (Cops, 2013) which suggests that the independent use of their outdoor spaces may allow children to experience fewer negative sensations in place and further incentivize them to continue exploring their neighbourhood on their own.

Although this review may represent an important appraisal of the current state of the art on this topic, it also has some limitations that shall be considered. Firstly, the defined inclusion criteria may have limited the literature search. In particular, relevant published articles may have been excluded from limiting the literature search to English-written papers only, as well as from not considering active mobility more than independent mobility only. However, CIM was considered a more appropriate construct to understand their direct interaction with their area as active citizens, not depending on adults. Besides, a previous review on this topic exists (Waygood et al., 2017b), but not including research on active outdoor play beyond active travel, which further explains our decision. Secondly, the poor-quality design of some of the reviewed studies may suggest caution in generalising the findings, especially in non-(sub)urban neighbourhood contexts. In particular, some of the studies did not include explicit information on the measures used to assess CIM (e.g., some are exclusively qualitative), which limits the comparability of study findings. However, the overall information presented in some mixed studies, combining qualitative techniques such as mapping or thematic analysis with rigorous statistical techniques such as logistic regression or logit analysis, gives hope for future improvement. Also, most reviewed studies did not follow or explicitly mentioned a theoretical approach or model used (14/23), thus reducing the possibility of conducting a better interpretation and comparison of the results found. Furthermore, some one-off relationships were found, i.e., findings of a study that were not corroborated by another study, suggesting that many aspects of well-being have not been much studied in relation to CIM yet, particularly when it comes to psychological outcomes for children and adolescents. Also, most of the quantitative and mixed method studies reviewed reported associations between CIM and relevant child variables with a fairly small effect size (7/18), which further justifies the need for future studies on this topic to explore the relationship of CIM and child outcomes in a more thorough way. Lastly, although many reviewed studies refer to European contexts (11 out of 23), this does not allow to generalise these findings to the European context and, even less, to other non-European contexts.

Nevertheless, this review sheds light to the importance that the autonomous use children and adolescents make of their own residential areas has on the way they adapt to and psychologically develop in it. Furthermore, it highlights the importance that mobility (and in this case autonomous mobility), may have for children's well-being, reinforcing the importance of promoting CIM to meet the 3rd sustainable development goal.

6. Conclusions

This review provides a relevant contribution to the literature in CIM by summing up evidence on the relationship between CIM and psychological well-being among children and adolescents. Beyond its benefit for physical activity (Schoeppe et al., 2013), this review highlights its crucial role for children and adolescents' cognitive and socio-emotional well-being. In particular, it may support children and adolescents with increased opportunity to develop accurate mental place representations and better orient themselves in a place, thus maturing crucial cognitive skills. Additionally, it may promote children and adolescents' social interaction with others and thus support the evolution of their social skills and expansion of their social networks, allowing an effective adaptation and emotional connection within the neighbourhood. Nonetheless, few studies were found on the association between CIM and child and adolescent affective experiences (e.g., fear of crime, happiness) and bond (e.g., place attachment), suggesting that literature may gain from future studies focusing on these topics. Besides, research about CIM and cognitive or academic performance seem to lack, contrary to AT (Westman et al., 2017), and thus this may be a relevant focus of interest for upcoming research.

Over and above all, the development of cognitive and socio-emotional skills through CIM seem to contribute to children and adolescents' further adaptation to the (physical and social) neighbourhood they live in, a place with which they daily interact with and that may support them in becoming more competent and active agents in our society.

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CRedit authorship contribution statement

Inês A. Ferreira: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ferdinando Fornara:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

Vanessa Pinna: Writing – review & editing, Data curation. **Andrea Manca:** Writing – review & editing, Data curation. **Marco Guicciardi:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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