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Children’s independent mobility and activity spaces during COVID-19 in Finland

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ABSTRACT
Children’s Independent Mobility (CIM) is usually higher in Nordic countries, although like in many other countries it is declining over time. COVID-19 has created new large-scale restrictions into the patterns of children’s mobility. We explore children’s and parents’ perceptions of CIM during the pandemic. To better understand how to promote CIM, we use COVID-19 restrictions as a model to investigate how acute changes in play and sports are associated with the level of CIM and activity space. In this mixed-methods study, a total of 22 children (10–12-years-old) and their parents were interviewed, and a public-participatory GIS (PPGIS) questionnaire was completed by 427 children and 177 parents in two small cities in Southern Finland. CIM was measured as the independently traveled distance to and from all places visited during the previous week and as CIM licenses. Activity space was obtained by using a home range model. Based on the interviews, the most typically mentioned rules related to CIM were informing parents of destination and company, and curfews. COVID-19 mainly affected organized sports participation requiring a ride from parent but had little influence on CIM. According to questionnaire data, COVID-19 decreased organized sports in 23% of children but increased outdoor games and play in 17% of children. Increased play was associated with a greater CIM, while decreased sports was associated with a smaller activity space. The findings suggest that in comparison to organized sports, outdoor games and play should be promoted to support CIM.

Introduction
Children’s Independent Mobility (CIM) refers to children’s freedom to move around and play in public places without adults’ supervision or company (Hillman, Adams, and Whitelegg 1990). As Marzi and Reimers (2018) noted, CIM is often defined in various ways: as independent travel to a range of destinations, walking to/from school, independent travel as walking, cycling, and taking public transport without adult supervision, and sometimes as independent play outside.

CIM is considered to support children’s development and their level of physical activity, and in terms of their rights, providing opportunities to access public space for play, recreation, and citizenship (Crawford et al. 2017; Mikkelsen and Christensen 2009; Nansen et al. 2015; UNICEF 1989).
However, in many countries, CIM has been decreasing in recent decades (e.g. Johansson et al. 2011; Shaw et al. 2015). In Finland, Kyttä et al. (2015) demonstrated the significant decline in 8–10-year-olds independent mobility from the beginning of the 1990s up to 2011, even more noticeably in small towns and rural villages than in inner cities. Further, much of the independent active travel of primary school children has been replaced by private cars (Fyhri et al. 2011; Kyttä et al. 2015) and the proportion of children driven to school by their parents has increased (Fyhri et al. 2011; Mehtäläinen, Jokinen, and Väljiärvi 2013; Turpeinen et al. 2013). A similar trend has resulted in an increased number of children participating in organized sports and other hobbies (Laakso et al. 2008). Nevertheless, Finnish children enjoy a high degree of independent mobility compared to children from other countries (Shaw et al. 2015).

The ongoing decline in CIM has produced a substantial body of research on the physical and social environmental factors promoting or constraining CIM (for further reading see Wales, Märtensson, and Jansson 2020). In previous studies, the factors affecting CIM have included both individual and family characteristics, environmental factors, as well as elements relating to social trust and risks (e.g. Kyttä et al. 2015). The review of Marzi and Reimers (2018) showed that in previous studies, CIM has correlated with several socio-demographic, social, and physical environmental factors.

Marzi and Reimers (2018) noted that although parents are important gatekeepers for children’s independence and active mobility (granting children freedom to travel around independently and parental perception of the neighborhood environment), studies often focus only on parental perceptions, while studies on children’s views are limited. This relates to the critique of the concept of CIM. Mikkelsen and Christiansen (2009) highlighted that the concept stems from a tradition of developmental psychology in which children are considered as essentially dependent. Thus, the idea of CIM ‘reflects a cultural and adult-centered focus on individual agency seeing independent mobility as a natural step in children’ (Mikkelsen and Christiansen 2009, 41–42). In addition, as Nansen et al. (2015, 469) described with the concept of children’s interdependent mobility, practices of children’s everyday mobility are not simply determined by social, physical, and policy environments, but include many kinds of relations, agency, mobility companions, technologies, and the mediated or peripheral presence of adults.

While CIM considers independently traveled distance, children’s total mobility can be investigated with other spatial outcomes that also include e.g. trips to hobbies by car. Activity spaces, by definition, are the local areas within which people move or travel during their daily activities (Golledge and Stimson 1997; Rai et al. 2007). As an individual measure of spatial behavior (Sherman et al. 2005), an activity space is typically around the home or movement near the home, daily activity locations and movements around those locations, and movement and travel between daily activity locations (Golledge and Stimson 1997). The structure of activity spaces relates ‘to the location of activities, but also to the types and frequencies of these activities within a specific time-period’ (e.g. Perchoux et al. 2013). In recent years, children’s journeys to organized activities have lengthened while these activities have specialized (Fyhri et al. 2011), whereas unstructured activities, outdoor games, and play, are typically participated in the local neighborhood. Therefore, activity space can supplement the concept of CIM by providing information on the extent of children’s spatial mobility.

As Nansen et al. (2015) noted, there are studies about external and regulatory factors limiting children’s everyday mobility, for example, changes in built environment and transportation, in parental perceptions and rules, and in changing cultural norms, values, and lifestyles. Typical parental concerns relating to CIM, with a potential influence on activity space, are associated with traffic safety, unsafe neighborhood(s), and stranger danger (e.g. Bennetts et al. 2018; Crawford et al. 2017; Francis et al. 2017). However, COVID-19 has created a new external threat which can be in familiar places, such as public spaces, friends’ homes, and organized activities. Understanding the COVID-19 pandemic as an external factor has some similarities with Kyttä’s (2002) study on children’s affordances and independent mobility in Finland and in Belarus, especially in the
radioactively contaminated urban-areas of the latter. From an external environment viewpoint, they both can be seen as invisible toxicity. In both cases, children are protected from an external threat through the restriction of their mobility. In spring 2020, the Finnish government applied recommendations and restrictions to secure the health of the population and slow the spread of COVID-19. Among other measures, people were urged to avoid non-essential travel, maintain a safe distance from other people, avoid crowds, work remotely, and avoid using public transport. On 17 March 2020, the Finnish government enacted emergency powers legislation and closed public places, such as libraries, swimming halls, and other sport facilities. Public gatherings were limited to 10 persons, and as a result, most of the sports clubs were shut down. Apart from early childhood education, schools moved to distance teaching. The easing of restrictive measures started in stages from 14 May 2020 (Kantomaa 2020). Unsurprisingly, during spring 2020, children and young people’s physical activity decreased significantly in Finland. Compared to two years prior, the decline in the number of steps was significant. This change has been explained by reduced physical activity at school and related travel. (Vasankari et al. 2020) Thus, the pandemic has also affected the mobility of children in Finland similarly to other countries (e.g. Dunton, Do, and Wang 2020; Moore et al. 2020; Medrano et al. 2021; Yomoda and Kurita 2021). Some studies (Pelletier, Cornish, and Sanders 2021; Riazi et al. 2021) have also found an increase in children’s informal or unstructured play and a decrease in structured activities during COVID-19. However, it is unknown how these possible changes are associated with CIM or activity space.

The purpose of this study is to examine both children’s and their parents’ perceptions of CIM as well as the effect of COVID-19 on mobility and activity space using qualitative and quantitative data from interviews and questionnaires of children and their parents. We answer the question: How do parents and their 10–12-year-old children perceive CIM during COVID-19? To better understand how to promote CIM, we use COVID-19 restrictions as a model to investigate: How have changes in sports and play due to COVID-19 affected CIM and activity space?

Material and methods

This cross-sectional study was a part of the project FREERIDE, which compares the physical activity and CIM levels of 10–12-year-old children living in Mikkeli, a city with free public transport, to children living in Kouvola, a reference city without free public transport (Pesola et al. 2020). We selected this age group based on the assumptions that although this group already enjoy a relatively high level of CIM (Kytta et al. 2015), they are still dependent on their parents on longer journeys (a moped license is granted from age 15 in Finland). The main results regarding physical activity and public transport use will be published elsewhere. Mikkeli (54,000 residents) and Kouvola (83,000 residents) are small cities located in South-Eastern Finland with a similar climate, geographical structure, and possibilities for active transport, including an active bus network.

The children in this study were recruited through 21 primary schools located in neighborhoods that were paired between the two cities, the pairing was conducted based on objectively analyzed public transport accessibility (Pesola et al. 2020). The permission to contact schools was received from the head of local education and culture department of both cities, school principals, and teachers. The teachers delivered an information letter and an informed consent form to the children’s guardians. The children’s participation in the data collection was voluntary and they were required to return the consent form signed by their parents before taking part in the study. The project was approved by the ethics committee of Aalto University (decision number 2019_17_FREERIDE).

During the data collection of this study in autumn term 2020, the primary schools had contact teaching despite some local quarantines of individual schools. In Mikkeli, there was also a two-week period of distance education in the inner-city schools of grades 4–9 (10–16-year-olds) in September 2020. The local restrictions relate to, for example, sports club activities or other hobbies. There were places and venues where activities were conducted normally, but rapid changes were made if there were local COVID-19 cases. In the last months of 2020, COVID-19 cases increased nationally and
this affected many locally organized activities for children. In both cities, sports venues were closed from 2 to 21 December 2020. In Mikkeli, the sports groups for under 12 years (and professional athletes) made an exception—their training was permitted, but only in groups under 20 persons. In Kouvola, the organized leisure activities for under 15-year-olds could continue, but they were recommended to be held outdoors. Sports club training for groups of under 15-year-olds was allowed outdoors as well. However, at the same time the group teaching of local music schools shifted to distance education or in the case of Kouvola, they took a break. (City of Mikkeli; City of Kouvola.)

In the first part of the study, 427 children (10–12-year-old) responded to a Public-Participatory GIS (PPGIS) questionnaire during school time from 8th September to 16th November 2020, assisted by a researcher. PPGIS is also referred to as SoftGIS, an online method developed to integrate behavior to actual physical settings and to the datasets of the GIS system (Brown and Kyttä 2014). The children mapped their school, hobbies, and other everyday destinations, the number of visited places and visitation frequency at organized sports activities and outdoor games and play, travel mode, and company to different destinations. In addition to spatial elements, the questionnaire included questions on CIM, self-assessed PA, subjective accessibility of (free) public transport, usage of (free) public transport, and perceived health. Lastly, we asked if COVID-19 had affected the respondents' modes of transport, participation in organized activities, or in outdoor games and play. The PPGIS questionnaire data were used to analyze CIM licenses, as well as CIM. The parents received their own PPGIS questionnaire by e-mail. Altogether 177 parents responded. Parent's PPGIS questionnaire data contributed to the CIM licenses (see Questionnaire measures for additional information).

After conducting the PPGIS questionnaire, the interviewees (n = 11) were recruited by the first author from among the families who had taken part in the questionnaire and given written consent (n = 102). In the selection of participants, the purpose was to interview the same number of girls and boys from both cities and different schools and neighborhoods. Altogether 22 people took part in the interviews in October–December 2020. 11 were children (6 girls, 5 boys), and 11 were parents (8 mothers, 3 fathers). Typically, children were interviewed with one parent. Six of the families were from Mikkeli, and five from Kouvola. According to the national geospatial dataset (YKR, Urban Zones in English) that divides urban regions into zones according to their distance from the city center and multiple travel-relevant variables (see Pesola et al. 2020), the children's schools were in four cases in a car zone, three outside of urban zones, namely in rural areas, two in an intensive public transit zone, and two in a walking zone. In five interviews, the homes of the families were in a suburban area, in three cases in rural area, and in three interviews in urban core area of Mikkeli or Kouvola. Due to COVID-19, interviews were conducted by remote video connections—Whatsapp, Teams, or Skype. The thematic, audio-recorded interviews conducted in Finnish lasted between 28 min and 1 h 16 min (mean = 44 min).

At the beginning of the interviews, the participants were asked about their biographical information; age, school class/grade, family members, hobbies, level of education, parent(s)' occupation and income level, and the arrangements at school due to COVID-19. Before the interview, the children also had an opportunity to take photos or videos about their ordinary journeys to school, hobbies, or friends. They were instructed that while taking photos they could think about: 'This is how I travel to my school/hobbies'; 'These kinds of places make me mobile alone/with my friends'; 'I go to these places with my parent(s)'; and 'In this place I don't want to be mobile because...'. They were told that mobility means the ways in which they move from one place to another, not just physical activities. Altogether 5 children took 25 photos, no videos. Of the photos, 13 were journeys to/from school, 7 sports hobbies, and 5 outdoor activities. If the children had these, the photos comprised the first interview theme. The following themes were school journeys, hobbies, and friends (the length of the trips, the travel modes, travel companion, if the journey was easy/nice/difficult and how the children wanted to travel, and the role of the parents in these trips). The next questions were about places
in the children’s domicile (places they would like to go), rules with parents, whether their mobility had changed during the years, and differences between the mobility of children and adults. The last theme was public transport. In both cities, the children and their parents were asked whether they used public transport and which factors enabled and prevented its usage. In Mikkeli, where the bus was free of charge to the interviewees, the questions also related to the effects of this on their mobility. In each theme, it was asked whether or how COVID-19 affected hobbies, modes of transport, places to go, people to meet, and so on.

**Questionnaire measures**

**CIM licenses:** Children were asked whether they were allowed to (1) cross main roads alone, (2) cycle on roads alone, and (3) take the bus alone. Parents were queried whether children were allowed to (4) come home from school on their own, (5) go alone to places within walking distance other than school, or (6) go out alone after dark. These CIM license questions were answered using a dichotomous scale (0 = no, 1 = yes), but not question 5. For question 5, it was possible to answer: ‘it depends’. A mobility license score (value range 0–6) was computed by summing these six items, three from the parents’ questionnaire and three from the children’s (n = 162) using a procedure applied in the original study by Hillman, Adams, and Whitelegg (1990). Item 5 however, was first coded dichotomous 0 = no or varies, 1 = yes.

CIM was measured as the total distance per week (km/week) children traveled alone, with a similarly aged or younger child (following the example by Broberg, Kyttä, and Fagerholm 2013) to the places they marked on the PPGIS questionnaire (school, play, hobbies, organized sport, errands, friends). First, a geospatially derived total travel distance was measured based on the mapped places and their visitation frequency from the PPGIS questionnaire. The distance between respondents’ home and each marked point was analyzed using a Network Analysis extension tool by Esri ArcGIS Pro©. This calculated the shortest way to get from home to all destination points. We assumed that all trips originated and ended at home and calculated the total trip distance to each point by multiplying the total network distance by two to each point visited.

**Activity Space:** To measure the children’s everyday activity space, we used a home range model by Hasanzadeh, Broberg, and Kyttä (2017). The home range model is an individual-specific boundary method to delineate individual activity spaces. Using the points marked by the children and following the criteria and analysis steps suggested by Hasanzadeh, Broberg, and Kyttä (2017), we created an individual activity space for each child and used its geographical area (km²) as a unit of analysis for each child’s activity space.

**Effects of COVID-19 on CIM and Activity Space:** We used six items from the children’s questionnaire to measure the effects of COVID-19 on CIM. The children were asked if COVID-19 influenced their commuting to school in an active way; traveling to school by bus; traveling to school in parents’ car; participation in organized sports at leisure; participation in outdoor games and play, and/or their use of bus at leisure.

Furthermore, we generated additional categories based on children’s responses to the effects of COVID-19 on sports and play participation, and the actual visited sports and play places. The categories are explained below and presented in a contingency table in the results section (Table 2).

**Sports decreased.** This category consists of children reporting a decrease in sports participation following COVID-19.

**No effect, sports.** Children reporting at least one visitation to a sports place and reporting that COVID-19 had no effect on their sports participation.

**No effect, no sports.** Children reporting no visits to sports places, and that COVID-19 had no effects on their sports participation.

**Sports increased.** Children reporting at least one visitation to a sports place, and that COVID-19 had increased their sports participation (omitted from final analysis).
Play decreased. Children reporting a decrease in play following COVID-19 (omitted from final analysis).

No effect, play. Children reporting at least one visitation to a play place and that COVID-19 had no effect on play.

No effect, no play. Children reporting no visitations to play places and that COVID-19 had no effects on their play.

Play increased. Children reporting at least one visitation to a play place and that COVID-19 had increased their play.

Data analysis

The statistical analyses were performed in RStudio Version 1.3.1093 (RStudio, PBC). Statistical significance was set at \( p < 0.05 \) (two-tailed). Normal distribution was tested with Shapiro–Wilk tests and by visual inspection of QQ- and density plots, and homogeneity of variance with Levene’s test. Background variables are presented as frequencies and percentages (categorical outcomes: Chi-square test), as averages and standard deviations (normally distributed outcomes: \( t \)-test), and as medians and interquartile ranges (ordinal or non-normally distributed outcomes: Wilcoxon test).

Linear mixed models were used to compare CIM and Activity Space between the COVID-19 change categories (fixed effect) using lmer4 package. As the effect of COVID-19 on sports and play can vary based on where children live, pre-determined region pairs were nested within cities and used as random effects in the models, with random slopes and intercepts allowed. First, separate models for COVID-19 play change categories, and COVID-19 sport change categories were fitted. Next, models with and without interaction between COVID-19 play change and COVID-19 sport change were compared with Akaike and Bayesian information criteria. A model with an interaction term was chosen for reporting based on a better fit. CIM was square root transformed, and Activity Space log-transformed to reach normally distributed residual variance based on visual inspection of Q-Q plots. Outliers were detected with a boxplot method and removed from the final analysis to reach model residual normal distribution. Moreover, some factor levels were omitted due to a small sample size and a resulting deviation from linearity as well as model residual non-normality (Table 2).

We used thematic analysis on the transcribed interviews as it is a flexible approach to conceptualize shared meaning (Braun and Clarke 2006; 2019; 2021). First, by reading the data thoroughly, we located all mentions about CIM, activity space, and COVID-19. Coding was conducted by operationalizing CIM and activity space using children and their parents’ answers relating to the length of the journeys to school, friends’ homes and hobbies, the mode of travel, the travel companion, the role of the parents in these journeys, and the mobility rules with the parents. The COVID-19 effects were operationalized from the answers about the arrangements in schools during COVID-19 and how COVID-19 had affected children’s hobbies, their modes of transport, places they go and people they meet. After that, the codes of CIM and activity space were moved to a large Excel table and examined in relation to the codes of COVID-19. The reflections were discussed and reviewed among all research team members, coming from different disciplines (sports physiology, social psychology and youth studies, health studies, and built environment) in order to provide a rich interpretation.

Results

Descriptive statistics for both cities are presented in Table 1. The average age of the total of 427 children who responded to the PPGIS questionnaire was \( 11.0 \pm 0.76 \) years. Most children were living in the Suburban zone. The distribution of school classes varied between the cities, a higher proportion of Kouvolans children were in the 5th grade. The median distance of the children’s one-way
trip to organized sport places was 3.43 kilometers and to play places 0.47 kilometers (Table 1). However, the children visited play places more often than sports places (3.38 vs. 1.56). There were no differences in spatial variables between the cities.
CIIM licenses data in Table 1 show that children in both cities enjoyed a high degree of CIIM licenses (median 5 out of 6), despite the COVID-19 pandemic. Furthermore, school travel modes as well as sports and play remained the same during the pandemic compared to the situation before. For example, active school travel and bus school travel remained the same in 80.1% and 57.4% of children, and sports and play remained the same in 56.7% and 59.0% of children, respectively (Table 1).

**Parents’ and their 10–12-year-old children’s perceptions on CIIM during COVID-19**

CIIM is at the core of family relations: it is the arena of intertwining restrictions, fears, attitudes, and recommendations (e.g. Visser 2020). Thus, as Riazi (2020) stated, children are often seen as ‘vulnerable’ and in need of protection. Parents wanting to promote their child’s independent mobility ‘need to navigate the fine line between allowing their children freedom to explore and practicing “good” parenting by protecting their children from potential danger’ (Riazi 2020, 112).

The most typically mentioned rules or licenses in the interviews relating to CIIM, were that the children were expected to inform their parents where they were and where they were planning to go, and with whom: ‘I’m not allowed to stay outside late and have to usually tell mom where I am’. (Interview 5 with a 11-year-old boy and his mother, rural area, Mikkeli).

Almost everyone mentioned curfews (between 6.30 and 8 pm). In five interviews, either the child or the parent mentioned that the child is not allowed to be outside alone late or when it is dark.

Mother: There are no, for example, streetlights because we live in the countryside. So, X must come home before it gets dark or then we pick her up with a car. Usually, we pick her up by car because X’s friends live so far away. If she would take a bike, it would take a whole day for her to ride these journeys. (Interview 1 with 12-year-old girl and her mother, rural area, Kouvolan)

As above, in three other interviews, either a parent or a child referred to parental rules relating to traffic safety – children should use a cycling helmet, walk their bike over zebra crossings, or generally be careful in traffic. Three children had agreed with their parents on taking the dog out after school and/or in the weekends and evenings. In general, the parents considered that there had not yet been a need to set many rules or restrict the places where children can go. Previous studies show that children’s independent travel is more common once a child turns 13 or 14 years (Kyytä et al. 2015; Larsen, Buljung, and Faulkner 2015). As one of the interviewed fathers pointed out, even if there had not yet been a need to discuss curfews, the parents had reflected on safety of their child:

[...] One might hear that their friends are doing this and that, but maybe we [parents] have thought about their safety first. We considered Z more as a small [child] than allowing her to go anywhere at any time.
For us as parents this has worked well so far. Of course, Z, who soon is a teenager, might have a little bit of a different opinion, but we have managed well with our family's style, at least so far. (Interview 2 with 12-year-old girl with her father, Kouvolan center area)

There were only few mentions about the places where children were not allowed to go. In two interviews, these related to hanging out in the mall or outside a market. In one interview, a parent mentioned 'different kinds of suburbs'. Other individual mentions made by the children were strange or unknown places. As such, the expressions of stranger danger (e.g. Crawford et al. 2017; Visser 2020), were not very common in the interviews. This is perhaps because the areas in both cities were considered safe by parents. In addition, while the interviews were conducted together with the parents, the children perhaps could not speak freely about forbidden places they might go to without their parent's knowledge. For example, in the only interview conducted without the presence of the parents, a 10-year-old girl talked vividly about her visit to an untidy/junky place in the forest in her nearby neighborhood, a place that many of the younger and older children of the neighborhood knew, but their parents did not and as such could not prohibit them to go (although she did not want to go again). While parents might wish to show 'good' parenting (Berg and Peltola 2015; Riazi 2020, 122), children might wish to appear 'good' children in the eyes of their parents.

At the time of this study, all the interviewed children traveled to school independently, alone and/or with their younger siblings and friends (see also Kullman 2010; Nansen et al. 2015). The school journeys varied from 200 meters to 10 kilometers (mean 2.6 km), most typically no more than 1.5 kilometers. Two children traveled to school by bus, others walked or cycled.

Girl: Usually I'm alone on my journey to school but my mom and dog escort me sometimes [...]

Father: [...] the last few years she has been quite independent on her trips to school. (Interview 2 with 12-year-old girl and her father, Kouvolan center area)

The children also walked and cycled independently to visit their friends who lived within a 2–3 kilometers' radius from their homes. The parents sometimes needed to drive the children to their friends who lived further away. The visits to friends were seldom made by bus. In their leisure time, the children spent time with their friends in their neighborhood, in parks, yards and friends' homes.

Nine of the interviewed children had hobbies. The children mostly traveled to their hobbies driven in their parents' car, only three went by bike or on foot. Usually, the hobbies were located geographically furthest in their activity space. The length of the trip varied from less than a kilometer to 30 kilometers (mean 10.6 km). In four cases, a hobby was located to 0–4 kilometers from their homes, in five cases from 5–15 kilometers, and in two cases over 15 kilometers from their homes. In the interview data, the children seemed to be least independently mobile on their way to their hobbies.

How has COVID-19 affected CIM? Interview results

All the interviewed children had distance education at school during 18 March to 14 May 2020. During autumn 2020, when the interviews were conducted, all children had contact teaching at school. Only two of the interviewees had two weeks of distance education earlier in autumn 2020. COVID-19 had no effect on the journeys to school – eight of the children walked or cycled, as they would have done anyway. Only two children went to school by bus, and they also did so at the time of the interview. One of the interviewees (Interview 7, 11-year-old boy with his mother, Kouvolan center area) mentioned that the current COVID-19 situation does not encourage him to use the bus, but he did not use the bus anyway. In the open-ended answers in the PPGIS questionnaire relating to the reasons not to use busses, only 12 children from 295 answered that they do not use the bus because of COVID-19.
Regarding meeting friends and things they do with their friends, six of the interviewed children mentioned that COVID-19 affected their practices more in the previous spring. At that time, they had not met their friends very much or met them more outside. Only two children mentioned that they were still more often outside than previously, and one had not met with one of her friends who lived further away. One of the children also mentioned that during spring 2020, many places they used to go with friends were closed. In another interview, it came up that COVID-19 still had an effect on things that children could do and places they could go with their friends:

Boy: well, there's a badminton hall near, although almost all badminton venues are closed due to coronavirus. In a normal situation, we might play (badminton) on Sunday, maybe on Saturday and Thursday too.

Mother: Yes, and it is about 1.5 kilometers, or 2 kilometers to the badminton hall from our home. And then there's also another place about 3 kilometers away.

Interviewer: So, could one say that COVID-19 has had some consequences on what you can do with your friends? For example, you can't go to badminton or swimming hall now?

Mother: Yeah, it [COVID-19] has affected these physical activities a little bit. (Interview 9, 11-year-old boy and his mother, Kouvola suburban area)

In the example above, the child used to play badminton or go to the swimming hall with his friend in his leisure time. In addition, COVID-19 seemed to effect organized sports and other activities of the children. During spring 2020, many of their hobbies were closed due to COVID-19. During autumn 2020, some of them did these hobbies at a distance (such as playing some musical instrument). At the time of the interview, four of the children had a break from their organized sports hobbies due to COVID-19.

Mother: COVID-19 has had influence on physical activities: parkour ended, and R has not had the possibility to go to swimming hall or [name of the sport venue] with his friend. COVID-19 has affected to his physical activities a lot. But R has gone cycling, so that has been something instead, but there's many physical activities that have been cut. (Interview 8, 12-year-old boy and his mother, Mikkeli suburban area)

As parents mainly drove children to their hobbies and only a few went by bike or on foot, no one mentioned that COVID-19 affected the ways in which they travel to their hobbies. However, the places where the interviewed children were either not allowed to go or to which the journeys had decreased due to COVID-19 were in four cases shopping trips to the town/center either with family or friends. In three cases, the places were related to sport facilities, for example a swimming hall. Individual mentions about avoiding places were staying inside or sleepovers with friends, public places, visits to relatives, or to the capital city. Only in two interviews, was it stated that COVID-19 has had no effect on the places they visit.

**How changes in sports and play due to COVID-19 were associated with CIM and activity space? Questionnaire results**

Table 2 shows the cross-tabulation for play and sports categories. For example, a total of 89 children continued having both sports and play, and 21 continued not having both sports and play (Table 2). Of those children whose sports decreased following COVID-19 (Sports decreased, N = 99), 45 continued their play and 18 increased their play. Of those children who reported not having sports consistently (No effect, no sports, N = 83), 35 continued their play while 15 increased their play.

Next, we used linear mixed effects models to investigate how changes in children’s sport and play were associated with CIM and activity space during the pandemic. The reference categories were children whose play increased or whose sports decreased.

Children reporting having no play consistently (No effect, no play; 21.30 km/wk; 95% CI 15.44–28.09 km/wk) had a lower CIM compared to those children reporting increased play (31.38 [25.08–38.38] km/wk, p < 0.05, Model 1 in Table 3 and Figure 1(a)). There were no differences between sports categories (Model 2 in Table 3, Figure 1(b)). Therefore, increasing play was associated
Table 3. Linear mixed effects model examining the differences in CIM and Activity space between COVID-19 sports and play change categories. The reference categories are those whose play increased, or sports decreased, following COVID-19 (Play increased; Sports decreased).

<table>
<thead>
<tr>
<th></th>
<th>sqrt(CIM (km/week))</th>
<th>log(Activity space (km²))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>No effect, no play</td>
<td>−0.99 (−1.83, −0.15)</td>
<td>−1.52 (−3.49, 0.45)</td>
</tr>
<tr>
<td>No effect, play</td>
<td>0.13 (−0.50, 0.77)</td>
<td>−0.75 (−1.95, 0.45)</td>
</tr>
<tr>
<td>No effect, no sports</td>
<td>−0.13 (−0.78, 0.53)</td>
<td>−0.73 (−2.24, 0.79)</td>
</tr>
<tr>
<td>No effect, sports</td>
<td>0.45 (−0.11, 1.02)</td>
<td>−0.13 (−1.48, 1.23)</td>
</tr>
<tr>
<td>No effect, no play × No</td>
<td>0.02 (−2.46, 2.50)</td>
<td>−0.75 (−1.95, 0.45)</td>
</tr>
<tr>
<td>No effect, play × No</td>
<td>1.12 (−0.70, 2.93)</td>
<td>−0.73 (−2.24, 0.79)</td>
</tr>
<tr>
<td>No effect, no play × No</td>
<td>0.81 (−1.50, 3.12)</td>
<td>−0.73 (−2.24, 0.79)</td>
</tr>
<tr>
<td>No effect, play × No</td>
<td>0.72 (−0.86, 2.29)</td>
<td>−0.73 (−2.24, 0.79)</td>
</tr>
<tr>
<td>Constant</td>
<td>5.60 (5.01, 6.20)</td>
<td>5.15 (4.68, 5.63)</td>
</tr>
<tr>
<td>Observations</td>
<td>314</td>
<td>314</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>−650.27</td>
<td>−653.34</td>
</tr>
<tr>
<td>Akaike Inf. Crit.</td>
<td>1314.54</td>
<td>1320.69</td>
</tr>
<tr>
<td>Bayesian Inf. Crit.</td>
<td>1340.27</td>
<td>1346.64</td>
</tr>
</tbody>
</table>

Note: *p < 0.05; **p < 0.01; ***p < 0.001.

Figure 1. Estimated marginal means of CIM and Activity space between COVID-19 sports and play change categories.
with a greater CIM, but decreasing sports was not associated with a lower CIM. This suggests that play is more important for CIM (or vice versa) than sports. There were no significant interactions in the models considering both play and sports categories (Model 3 in Table 3, Figure 1(c)).

Next, we investigated how activity space differs between play and sports categories. There were no differences between play categories (Model 4 in Table 3, Figure 1(b)). Those children reporting no sports consistently (No effect, no sports; 3.38 [2.44–4.70] km²) had a smaller activity space when compared to children reporting decreased sports (6.00 [4.39–8.19] km², p < 0.01, Model 5 in Table 3, Figure 1(e)). However, those reporting sports consistently (No effect, sports; 9.25 [6.99–12.24] km²) had a larger activity space, compared to those reporting decreased sports (p < 0.01, Model 5 in Table 3). This suggests that those whose sports decreased had a smaller activity space, compared to those who were able to maintain sports, but still a larger activity space when compared to those who did not have sports at all. There were no differences between groups in Model 6 considering the interactions between play and sports (Model 6 in Table 3, Figure 1(f)).

Discussion

CIM is a highly culturally and geographically shaped phenomenon. Children in Nordic countries enjoy a high degree of CIM compared to, for example, some Asian countries, but the level of CIM has decreased during the past few decades (Johansson et al. 2011; Kyttä et al. 2015; Shaw et al. 2015) due to a gradual sparsening of service networks (such as school closures) and the resulting need to drive children to school and hobbies (e.g. Fyhri et al. 2011; Laakso et al. 2008; Mehtäläinen, Jokinen, and Välijärvi 2013; Turpeinen et al. 2013). However, less is known about how different constituents of CIM outside of school, like outdoor games and play and organized sports, contribute to the level of CIM. COVID-19 has created a quick, large-scale intervention in children’s everyday mobility patterns.

In this study, we used this situation as an opportunity to investigate how changes in play and organized sports places were associated with the level of CIM. The main findings were that children generally enjoyed a high degree of independency in their mobility patterns regardless of COVID-19. However, there were changes in outdoor games and play (mostly increased), and organized sports (mostly decreased) in many children. Only increased play was associated with a greater CIM, while only decreased sports was associated with a smaller activity space, suggesting that outdoor games and play can potentially increase CIM. Previous studies have shown that during the pandemic, declines in physical activity of children under the age of 18 appear greater among those who participate in organized team sports and those with limited space and opportunity for habitual PA at home or in their neighborhood (Yomoda and Kurita 2021). Moreover, parallel with our findings, recent studies (Pelletier, Cornish, and Sanders 2021; Riazi et al. 2021) in Canada have found an increase in children’s informal or unstructured play and a decrease in structured activities during COVID-19.

The typical CIM licenses in our interview data related to informing the parents about child’s location and company, curfews, and not staying outside alone in the dark. Generally, at the age of 10–12, in the space between childhood and youth, the parents saw no need to restrict the CIM other than for safety reasons. As noted in previous studies, children’s independent travel is more common once a child turns 13 or 14 (Larsen, Buliung, and Faulkner 2015). For younger children, the influence of parents is greater, but for example cell phones are ways to afford children more independent mobility earlier (Kullman 2010; Nansen et al. 2015; Riazi 2020). In their normal everyday mobility, children traveled independently to school and to see friends. However, as the distances to organized activities were usually the longest in the activity space, with these journeys children were dependent on their parents, who typically transported them by car.

Likely due to longer distance to places of interest, and increasing distance due to centralizing city structures, CIM has decreased more in small Finnish towns and rural regions, than in the inner-city regions (Kyttä et al. 2015). The present results give further insights on CIM in children living in
small towns and rural regions and support the previous findings that despite any changes in city structures (Kyttä et al. 2015) or COVID-19, 10–12-year-old children enjoy a high degree of CIM. While the small sample size prevented stratified analyses by city region, the interview data collected from children and their parents living in city, suburban, and rural regions showed only a few restrictions on CIM. As mentioned earlier, these restrictions were mainly related to the long distances to organized sports or other destinations. Public transport can be one option for longer independent trips (Pesola et al. 2020), but based on interviews, was a less common travel mode as compared to private car. This is consistent with national travel surveys (National Travel Survey 2016). Moreover, bus and car travel to school increased both by approximately 25% of children, suggesting that changes in bus travel (e.g. due to restrictions) would have forced children to rely more on parents’ chauffeuring. Therefore, it appears that restrictions on activities (such as canceled hobbies/sporting activities) were the main reason for the small change in mobility, rather than the long distance or travel mode. Based on this we also speculate that city region has only a small effect on these results.

The COVID-19 pandemic is an invisible toxicity that has created some limits to children’s mobility and their activity space. In the interview data, it seemed that COVID-19 diminished the size of the activity space of the 10–12-year-old children. Additionally, it seemed to restrain the journeys to the organized activities and public spaces (such as shops, etc.), because these were usually reached by parents’ car. This may have not had so much of an effect on CIM. However, while the threats relating to CIM have usually been related to traffic safety, and strange places and people, spatially the COVID-19 situation seems to locate the threats within more familiar places: public places, friends’ homes, and organized activities which are, at least in the Nordic countries, usually considered familiar and safe for children. If the safe places during the COVID-19 pandemic are in a nearby neighborhood, home, and yard, this indirectly restricts the activity space. The results of the questionnaires suggest that increasing play following COVID-19 was associated with a greater CIM, but not with a larger activity space. However, decreasing sports was not associated with differences in CIM, but was associated with a smaller activity space. Assuming causality, play should be promoted to increase CIM.

The strength of this study is data produced with mixed methods that supplement each other. However, we do not have longitudinal data about CIM and activity spaces of the same children before COVID-19. The data gathering were completed during minor COVID-19 restrictions and any changes in play and sports were asked retrospectively. CIM was measured at one point during the pandemic. The results do not enable conclusions about the specific effects of COVID-19, since also other factors, like season, may have an effect on play, sports, and CIM. The design does not allow any causal inferences, and while play and sports are important sources of mobility in children, it is unclear if play and sports affect CIM, or if any changes in CIM may affect these activities. The analyses were exploratory. We also needed to abolish some of the factor levels due to the low number of participants. Therefore, these results should be interpreted with caution and tested in longitudinal studies.

In conclusion, we show that children enjoy a very high degree of CIM licenses despite the COVID-19 pandemic. Most children were able to continue their daily traveling habits, sports, and play normally, and were not restricted by their parents. The results of this study may have some implications for interventions that aim to increase CIM in 10–12-year-old children. Promoting increased sports may increase activity space, but is dependent on parents. Yet, increasing play can increase CIM. Therefore, children should be provided with destinations for play, which can be reached independently. Future studies should test how promoting outdoor games and play (vs. sports) would impact the level of CIM as well as the total physical activity level of children.

Disclosure statement

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