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Assessing travel time-based accessibility to outdoor ice skating fields for children in Helsinki during the COVID-19 pandemic

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Informal sport is central to Finnish children's leisure and physical activity time. This paper aims to build a better understanding of the travel time-based accessibility to informal sports facilities, specifically to ice skating fields, for children and adolescents (aged 7–19) in the city of Helsinki. We focused on the winter of 2020–2021 because COVID-19 restrictions on indoor activities resulted in ice skating fields being among the few public facilities that could remain open. Additionally, the weather was favourable for maintaining outdoor ice skating fields. We analysed if there would be a difference in children's independent travel times by public transport or walking to ice skating fields due to the COVID-19 pandemic related recommendations by Helsinki Region Transport to avoid public transport. Children in Finland usually travel to and from school independently. Hence we focused on the transition from public transport to walking and omitted car usage, which would require an adult. We also looked at the potential differences in travel time to ice skating fields by analysing different types of fields separately. This difference would be of significance if climate change resulted in warmer winters in Finland. Helsinki has two types of ice skating fields: naturally frozen and mechanically frozen, of which only the mechanically frozen fields would be used during a warmer winter that is above zero degrees Celsius. We took a geographic information systems (GIS) analysis approach using travel time and population catchments. The study's main findings show that during a milder winter and by walking, the accessibility for children is greatly reduced to 55.2%; that is, children face an increased travel time when naturally frozen ice skating fields are not in use. However, almost 100% of the child population can access both types of fields within a travel time of 30 minutes by public transport.

Keywords: COVID-19, spatial accessibility, geographic information systems (GIS), grid cell data, ice skating, informal sports

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Introduction

The COVID-19 pandemic forced people to undertake most of their everyday activities outdoors, because restrictions and closures hindered indoor sports training or participating in other leisure time activities. In Finland, outdoor public ice skating fields are abundant, being the third most prevalent sporting facility (approximately 2,100), after ball fields (4,900) and gymnastics centres (3,100) (University of Jyväskylä 2021). Ice skating fields and ski tracks were among the few public sporting facilities that were allowed to remain open to the public during the winter of 2020–2021 due to the COVID-19 pandemic. Due to the reason that many public sporting facilities were closed, the COVID-19 pandemic is therefore likely to result in an increase in sedentary lifestyles (Yamada *et al*. 2020), especially for children (Rundle *et al*. 2020; Burkart *et al*. 2022).

This paper focuses on travel time-based accessibility differences for children and adolescents between using public transport and walking as a form of independent travel to get to two types of ice skating fields (naturally frozen and mechanically frozen). The population group is aged between 7 and 19 (hereafter referred to as children) and the case study area is the city of Helsinki. We emphasise the safe and independent year-round walkability and usability of public transport for Finnish school-aged children (Kallio *et al*. 2016). For Finnish children, walking is already conducted both during the school commute and leisure time as an important mode of independent travel (Kyttä *et al*. 2018); however, cycling during winter is less common for children (Kallio *et al*. 2016) so we omit this travel mode. The City of Helsinki aims to increase the percentage of users who travel by walking, public transport, and cycling between 2021–2025, therefore this is a timely study to divert the attention away from car usage (City of Helsinki 2021a). During the COVID-19 pandemic, Helsinki Region Transport recommended avoiding public transport (City of Helsinki 2020). For children, this recommendation resulted in walking or cycling, which facilitated social distancing and active travel (Christidis *et al*. 2021). Thus, this study places importance on the transfer from using public transport to walking in relation to the informal physical activity of ice skating during the COVID-19 pandemic.

If weather conditions are favourable, in Helsinki there are up to 147 public ice skating fields that are maintained by the City of Helsinki (hereafter, the City) (University of Jyväskylä 2021). In this paper we considered two types of fields: naturally frozen ice skating fields (137) and mechanically frozen ice skating fields (10). The two types of ice skating fields are formed differently. Naturally frozen ice skating fields are created by flooding public sports fields with a water hose and leaving them to freeze naturally, whereas mechanically frozen ice skating fields have a plastic floor and require an inbuilt cooling system. Mechanically frozen ice skating fields have higher quality ice and can provide ice skating opportunities during milder winters, when naturally frozen ice skating fields cannot be used. This issue will be elaborated upon later in this paper.

The COVID-19 pandemic has shown the exceptional popularity of informal sports in Helsinki. Informal sports facilities do not include a formal structure such as paid membership, or opening

hours, and can include running, cycling, outdoor gyms, and outdoor ice skating. Changes in web traffic of the Outdoor Exercise Map between 2019 and 2021 indicate that the COVID-19 pandemic increased the demand for winter sports in Helsinki. This Outdoor Exercise Map shows the opening times and condition of ice skating fields, skiing tracks, and swimming places (City of Helsinki 2021b). For example, web search results show an increase of 364% in web traffic from 1 January 2021 to 31 July 2021, compared to the same period in 2020; web traffic increased by 130% when comparing 2021 to pre-pandemic 2019 (Jalava 2021). This 2021 increase indicates that the ice skating fields have been exceptionally popular and important places for people during the times of heavy restrictions on the use of indoor sports facilities and public spaces due to the COVID-19 pandemic. Also, the favourable winter weather conditions in Helsinki in 2020–2021 affected the increased interest in ice skating and other winter sports.

For example, in December 2020, the Brahe Sports Field (a mechanically frozen ice skating field) had 20,000 ice skaters, which is twice the number of ice skaters in an average month (Helsinki Times 2021). The Brahe Sports Field was the only mechanically frozen ice skating field to rent out ice skates during the COVID-19 period. Resources (such as staff) from indoor sports facilities were transferred to the mechanically frozen fields due to the unexpected increase in demand of this informal sport (Jerrman 2020).

Informal sport is central to Finnish children's leisure and physical activity (Kokko & Martin 2019); ice skating is a particularly easy and financially accessible activity (City of Helsinki 2018). The high number of ice skating options in Helsinki is not unique; many ice skating fields also exist in the next largest Finnish cities: Espoo (108), Tampere (145), Vantaa (73), and Oulu (95) (University of Jyväskylä 2021).

Typically, the City maintains the ice skating fields from the middle of November until the first week in March, depending on the weather conditions in Helsinki. Establishing and maintaining naturally frozen ice skating fields requires temperatures mainly staying below zero degrees Celsius. The increasing unpredictability of the Finnish winter affects residents' usage of ice skating fields.

Our main objective was to analyse the travel time patterns to ice skating fields in optimal conditions, meaning continued average temperatures below zero degrees Celsius so that both types of ice skating fields could remain in use. Such conditions were realised during winter 2020–2021 due to a 'good' winter and the continued promotion of outdoor activities throughout the COVID-19 pandemic. Secondly, we compared how the travel time pattern changes during milder ('bad') winters, when only the mechanically frozen ice skating fields can be used. Furthermore, we aimed to understand the changes in travel time to the two types of ice skating fields depending on the travel mode (public transport or walking) within a 30-minute travel time, based on Lima and colleagues (2013), Huotari and others (2020) and Kotavaara and colleagues (2021). This 30-minute travel time is suitable for our study population of children who already walk on average a maximum of 36–45 minutes during their school commute (Kallio *et al*. 2016). Finally, we discuss possible explanatory factors regarding disparities in travel time to the closest ice skating field.

Understanding travel time-based accessibility of informal sports

This paper focuses on the concepts of travel time-based accessibility and informal sports. Jeanes and colleagues (2019) state that informal sport is often excluded in policy making for health and social policy agendas. We took this exclusion in policy making as an opportunity to bring to the forefront the importance of equality of sports accessibility in Finland. As a result, we strived to discover if there were any travel time differences to ice skating fields for children in Helsinki. Bergsgard and others (2019) report that in Finland, sport policy includes the Sports Act (1978, latest update 2015), which targets the promotion of physical activity, competitive level sport, and community participation, as well as the health and well-being of children. According to this Act, municipalities are then responsible for organising physical activity services and facilities. Consequently, Finland is well acquainted with the promotion of informal sports and is suitable for this study. Investigating the opportunities for physical activities during the pandemic is important because even short-term changes in physical activity rates can have a lasting impact on children such as an increased risk of obesity, diabetes, and cardiovascular disease (Dunton *et al*. 2020). Moore and colleagues (2020) illustrate how the pandemic

decreased the physical activity rates of children, which highlights the importance of ice skating fields as a winter leisure physical activity environment during the pandemic. Lima and others (2013) and Davison and Lawson (2006) demonstrated positive associations between proximity to sporting facilities and children's participation in physical activity. Thus, a longer travel time to sporting facilities negatively affects the opportunities and likelihood of children being physically active (Hasanen 2017).

Travel time-based accessibility

In this paper, the travel time-based accessibility is calculated in minutes between the origin (a person's permanent home address) and the destination (the nearest naturally frozen or mechanically frozen ice skating field). Typically, travel time to a destination is reduced by using public transport. However, this study focuses on the result of public transport being unavailable, in this case, due to the COVID-19 pandemic. Research on people's opportunities to well-being and health regarding geographical (or spatial) accessibility has focused on several themes in Finland, for example, spatial accessibility to maternity hospitals (Huotari *et al*. 2020). Kotavaara and colleagues (2021) recently researched geographical accessibility (synonymous with travel time) of primary health care, using the country of Finland as the case study.

In terms of travel time research in other countries there is recently a trend in 'x-minute cities' (Logan *et al*. 2022). Slater's (2021) and Calafiore and others' (2022) focus on the interpretation of transport deprivation is important, in which they look at a '20-minute city' and whether essential amenities such as supermarkets, health facilities, schools, or green space access are reachable within a 20-minute roundtrip walk. Tudor-Locke and colleagues (2011) state that many health benefits can be achieved by 30 minutes of daily walking, which is classed as a moderate vigorous physical activity. Lima and others (2013) revealed that the use of sports facilities by adolescents decreased significantly when the perceived travel time distance was over 30 minutes. Additionally, Huotari and colleagues (2020) report that in Finland, a 30-minute travel time was described as 'excellent', whereas longer than 2 hours was described as 'poor'. Kotavaara and others (2021) also used a 30-minute cut-off time. Therefore, previous research seems to have consistently applied a 30-minute travel time.

Ice skating as an informal sport

This study concerns informal sport, particularly children's travel time to ice skating fields. In Helsinki, several multi-purpose sports fields exist that can be put to different uses throughout the year. The focus on ice skating as the chosen informal sport relates to the general push to the promotion of informal sport by the City (City of Helsinki 2018). This promotion aims to increase participation in sport among people who might otherwise choose not to participate in a formally organised competitive sport (Jeanes *et al*. 2019). Although ice skating is technically an individual activity, it is typically conducted as a group, because people usually go to a skating field with family or friends as a social activity. These informal sporting facilities are seen as places for relaxation and social interaction outside the home (Gilchrist & Wheaton 2017), which we consider important, especially during the pandemic.

Deelen, Ettema and Kamphuis (2018) define the term 'facilities' as including informal settings; they distinguish between 'soft' (informal and flexible) and 'heavy' (timetabled club based) sports. Finland, and Helsinki in particular, has a variety of free and public informal sport settings such as disc golf parks, ping pong tables, skate parks, BMX tracks, and man-made workout steps hills (My Helsinki 2021a). Additional settings in wintertime include ice skating fields, cross-country skiing tracks, and ice swimming in holes made in sea ice, so the population is well acquainted with spending leisure time outdoors.

As part of the departure from the traditional club sports culture, Rafoss and Troelsen (2010) emphasise ice rinks in Denmark and refer to the increased focus on 'self-organised physical activity' since the 1990s. Ibsen (2003) further emphasises this by reporting that in 2003, half of the children in Copenhagen used the artificial ice rinks in the winter months. Benefits of ice skating mentioned include its suitability to people who have little spare time in their daily lives, the resulting increases in both physical activity and health, and the cost-free nature of ice fields rinks that eliminates any

economic barrier. Unlike downhill skiing, recreational ice skating is not associated with being an informal sport just for the elite, and so this allows a larger population to take part (Horgan *et al*. 2020).

Due the COVID-19 pandemic, in winter 2020–2021, the mechanically frozen ice skating fields in Helsinki were made free of charge for the first time, which normally costs €2 (My Helsinki 2021b). This removed most financial barriers to ice skating, other than needing to own or rent ice skates. The active recycling and second-hand culture in Finland (Harrabin 2018) further decreased financial barriers, as skates were available at a low price. Ice skating during the winter season is also practised in schools as part of physical education lessons (Stewen 2019). Consequently, most children own their own skates, which possibly facilitated the increased participation in informal skating.

We draw attention to the potential loss of ice skating as a form of outdoor recreation due to climate change. Climate change affects many popular outdoor sporting activities in Finland, including ice skating and cross-country skiing, and this has been recognised as a threat to the sports culture (Simula & Oja 2019). Therefore, Finland is a suitable country for this study due to the decreasing likelihood over time of having a snowy and cold winter (Lépy *et al*. 2016). Similarly, Visser and Petersen (2009) found that the likelihood of holding the annual Eleven Cities Tour (Elfstedentocht) Ice Skating Marathon in the Netherlands, in the province of Friesland, has decreased. This is conducted on a circuit of frozen canals, rivers, and lakes, and the chance of hosting it has decreased from one in four in 1956, to one in ten in 1999. Although this type of likelihood indicator does not exist in Finland, it illustrates how the effect of climate change on weather-dependent leisure activities can be reported to the public in a comprehensible and practical way.

The city of Helsinki as a research setting

The study area is the city of Helsinki; Figure 1 illustrates its boundary. Helsinki is the capital city of Finland and is located in the south of the country. The city of Helsinki has a total population of approximately 640,000, while the population of the Greater Helsinki Region is approximately 1.2 million (Statistics Finland 2020a). This paper focuses on children and adolescents aged between 7 and 19, that is, all school-age children in Finland. This age group matches the age groups reported by Statistics Finland, which confirms that this decision is data driven (Statistics Finland 2020a). We understand that it is increasingly unusual for school-aged children to walk independently, as has been noticed by Gill (2021) in the United Kingdom (UK), but children in Finland typically travel to school independently by both walking and using public transport already at that age (7 years old) (Kyttä *et al*. 2015). Living in the city of Helsinki are approximately 75,000 children, which is 11.7% of the total population. Figure 2 demonstrates the percentage distribution of children in Helsinki. The chosen age group is a suitable target group, as according to the City 80% of children in Helsinki do not reach the recommended three hours of daily physical activity (City of Helsinki 2018). Globally recommended as beneficial to children's health is at least one hour of daily physical activity (World Health Organization 2010). Horgan and colleagues (2020) found that in Canada the most frequently occurring population during observations at fields were children under 12 with accompanying adults and groups of teenagers, which boosts the suitability of focusing on children.

This paper claims that an optimal winter has an air temperature that is consistently below zero degrees Celsius, which facilitates ice skating fields remaining frozen. In Finland, cold air temperatures do not limit children from conducting exercise outdoors (Kallio *et al*. 2016). In optimal weather conditions, up to 137 maintained outdoor naturally frozen ice skating fields exist in Helsinki, which are always free to the public. The naturally frozen ice skating fields are artificially created on sports fields, most of which are built on AstroTurf pitches or multi-use sports parks. These parks and pitches are used for playing football, basketball, Finnish baseball, tennis, or have an athletics track, when there is no snow or ice. A water hose is used to flood the surface and is allowed to freeze over several layers. The City maintains the fields by removing the snow, which allows a new layer of ice to be formed regularly. During less optimal weather conditions, these fields may melt, leaving only the mechanically frozen ice skating fields in use. The City provides ice hockey goals and benches to sit on whilst changing shoes. Due to the large number of ice skating fields, in this analysis we propose that children use their nearest field as there are no big differences in the size or quality of the ice to attract children to a further away field.

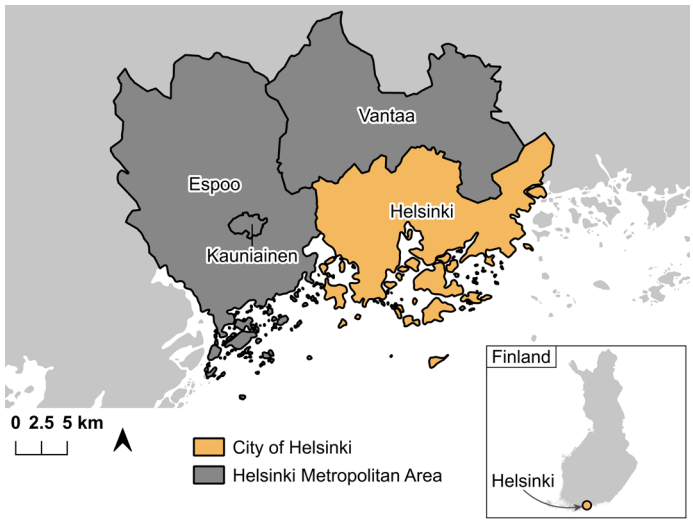


Fig. 1. City of Helsinki location in relation to Finland.

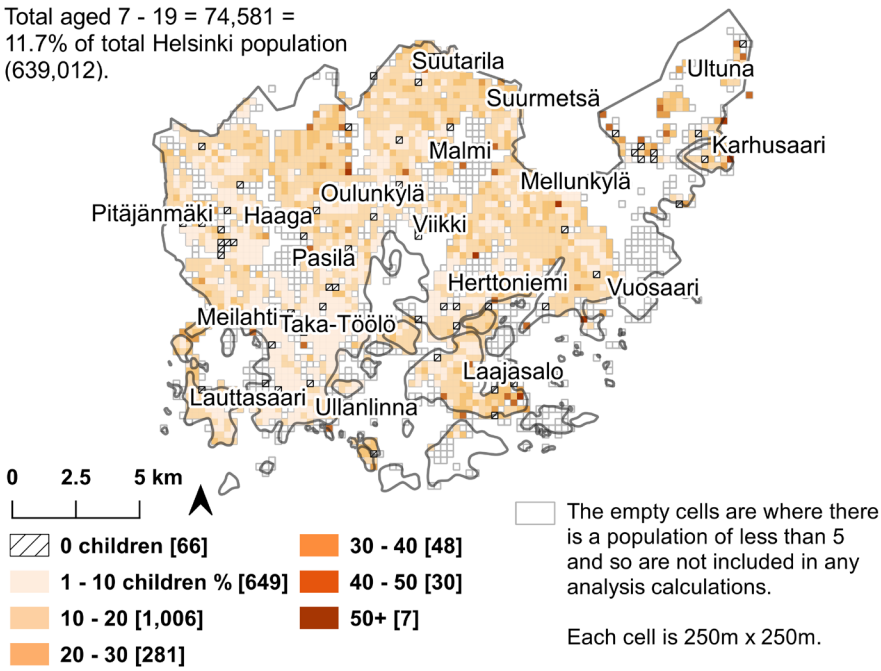


Fig. 2. Percentage of children and adolescents in Helsinki.

In addition to the naturally frozen ice skating fields, Helsinki has ten mechanically frozen ice skating fields. However, only nine of these were opened for the 2020–2021 season; Rautatientori ('Ice Park') was not in use during the pandemic as it is mainly a tourist attraction, and the pandemic prevented people from travelling. The mechanically frozen ice skating field locations are less informal, due to in-built cooling systems that keep the ice permanently cold, specific opening hours for public skating times, and ice resurfacing vehicles and flood lights used in the evenings (City of Helsinki 2021b). Some of the mechanically frozen ice fields are also used for training and games by local ice hockey and bandy clubs. The mechanically frozen ice skating fields in this study provide additional facilities for users that

the naturally frozen ice skating fields do not have such as, toilets and changing rooms, equipment renting, car parks, and cafés. Consequently, the mechanically frozen ice skating fields require more maintenance, which the City manages. During the pandemic, changing rooms and service buildings remained closed, apart from toilet facilities. This study excluded ice skating on frozen open water.

In terms of ice skating opportunities, Table 1 shows that Helsinki had so-called good winters in 2020–2021 and 2018–2019, having monthly average temperatures below or close to zero degrees Celsius and many snowy days. These circumstances support ice skating and other winter activities, such as cross-country skiing. Winter 2019–2020 was mild in Helsinki, with no monthly average minus temperatures and little snow, which demonstrates that a so-called good winter in Helsinki is not always guaranteed. During winter 2019–2020 some outdoor facilities such as mechanically frozen ice skating fields had user-number restrictions due to the pandemic. Table 2 shows the allowed maximum number of skaters on a field at one time, which is between 30 and 300 skaters depending on the field size. The naturally frozen ice skating fields had no skater number limitations because they tend not to be as widely used by larger groups as mechanically frozen fields.

Table 1. Average air temperature and total snowy days in Helsinki for the winters of 2018–2021.

Winter	Average Air Temperature (°C)	Snowy Days
December 2018	-0.8	14
January 2019	-4.6	25
February 2019	0.4	28
March 2019	0.4	19
December 2019	2.6	5
January 2020	3.0	0
February 2020	1.4	0
March 2020	2.4	0
December 2020	1.9	0
January 2021	-3.6	29
February 2021	-6.6	28
March 2021	0.0	28

Data source: Finnish Meteorological Institute
Kaisaniemi observations taken at 00:00

Table 2. Maximum number of skaters at each mechanically frozen ice skating field.

Mechanically Frozen Field	Maximum Skater Numbers	Field Size (m^2)	Per Skater (m^2)
Oulunkylä Sports Park	300	13,320	44.4
Brahe Sports Field	150	7,604	50.7
Jätkäsaari Sports Park	150	6,400	42.7
Käpylä Sports Park	120	5,300	44.2
Kontula Sports Park	120	6,825	56.9
Lauttasaari Sports Park	40	2,160	54
Laajasalo Sports Park	30	2,268	75.6
Lassila Sports Park	30	1,624	42.1
Pukinmäki Sports Park	30	2,592	86.4

(e.g. size: football field =7,140m^2 / tennis court = 194.7m^2)

Data source: MyHelsinki.fi / City of Helsinki

Calculating travel time using grid cells

The main datasets derive from 1. LIPAS ice skating fields (University of Jyväskylä 2021), 2. Statistics Finland population data (Statistics Finland 2020b), and 3. Mapple Analytics Oy Insights application programming interface travel time data (hereafter referred to as Mapple API) (Mapple 2020). LIPAS is the national database of sporting facilities in Finland (University of Jyväskylä 2021). The two field types were retrieved from the LIPAS system during spring 2020 based on the classification type codes 1510 (mechanically frozen open-air ice rink) and 1520 (naturally frozen ice skating field).

The population data are stored in 250 m x 250 m grid cell format from Statistics Finland (Statistics Finland 2020a). Travel time analysis is suitable for grid cells, due to their previous successful research outcomes in Finland (Kauppila & Rusanen 2009; Jäppinen *et al*. 2013; Tenkanen *et al*. 2016; Kotavaara *et al*. 2021). We summed the age groups 7–12, 13–15, 16–17, and 18–19 from the population grid data. Grid cells with a population of fewer than five were omitted from further analysis. No permanent inhabitants live in the remaining empty spaces between the grid cells and the Helsinki boundary.

Mapple API is a by-product of the Helsinki Region Travel Time Matrix (Tenkanen & Toivonen 2020), which uses a similar methodology, but covers the entire country of Finland instead of only the Helsinki Region (see Lehtonen 2021). This study used the Mapple API to calculate travel times to ice skating fields by public transport or walking. The travel time data were retrieved via command prompt and processed in Jupyter Lab Version 3.0.7 (Kluyver *et al*. 2016) with Python Version 3.8.0 (Python Software Program 2019). Travel times were calculated from each ice skating field to all populated 250 m x 250 m grid cells (more than four inhabitants) that fall within a 60-minute travel period. The outputs were combined by identifying the lowest value for each populated grid cell, which indicates the travel time to the nearest (timewise) ice skating field. These steps were carried out separately for naturally frozen and mechanically frozen ice skating fields, and for both public transport and walking.

The walking speed in the travel time calculation was 4.4km/h and the routing followed the Open Street Map road and path network. The public transport time calculations use a door-to-door method, including the time taken to walk to the transit stop, possible transfer times, and the journey to the destination from the last transit stop (Tenkanen & Toivonen 2020). The travel times for public transport were taken during rush hour. However, the source code of the Mapple API is not openly available and consequently, some details regarding the calculations remain unknown, such as the source of public transport data and the exact date or time of the day used in the calculations.

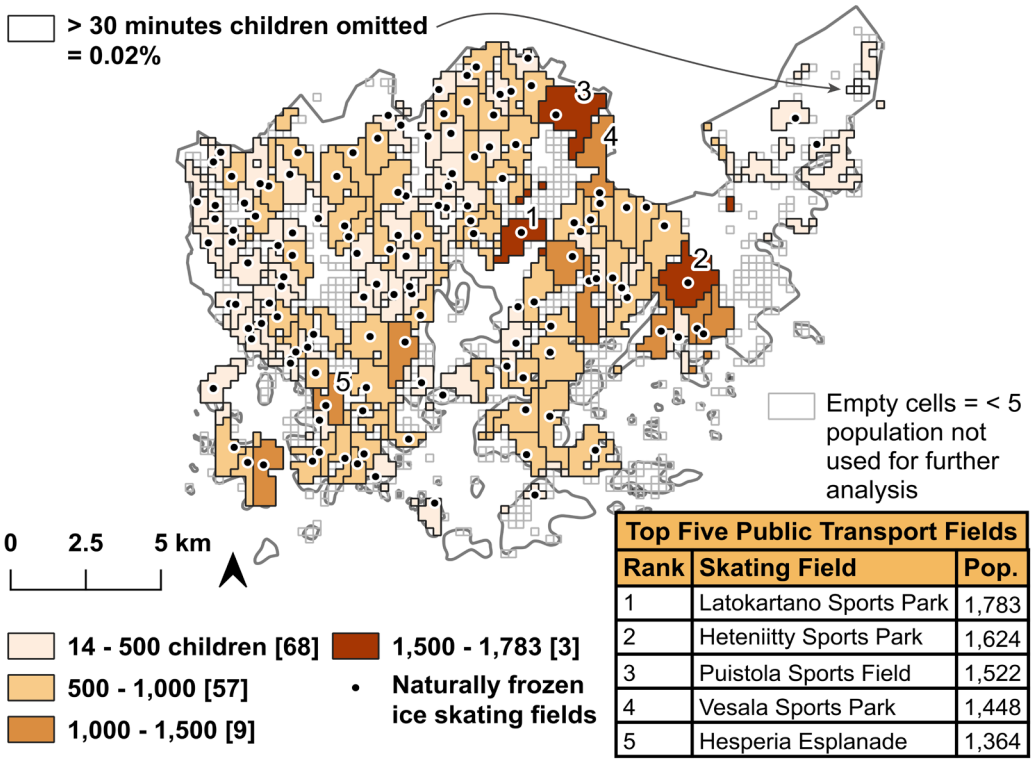
The travel time data and ice skating points were used to conduct a nearest populated cell catchment area analysis. This analysis was calculated with the Nearest Neighbour Join ('NNJoin') Plugin tool in QGIS Version 3.16.2 (QGIS Development Team 2021). The grid cells were filtered for less than or equal to 30 minutes as a cut-off travel time, based on previous research (Lima *et al*. 2013; Huotari *et al*. 2020; Kotavaara *et al*. 2021). We acknowledge that children might not be willing or able to travel the full 30 minutes independently, but that they might need to depending on the spatial distribution of the ice skating fields. The final catchment areas were dissolved to show only the outline boundary. We further calculated the cumulative child population who can reach their closest field up to a 60-minute travel time to the two types of ice skating fields and by the two travel modes.

Interpreting travel time to ice skating fields in Helsinki

Naturally Frozen Ice skating Fields

The child population catchment area for each of the 137 ice skating fields was based on travel time. Figure 3 demonstrates the possibility of reaching the closest ice skating field via public transport within 30 minutes. Based on our calculations, almost all of the children in Helsinki can access their closest naturally frozen ice skating field within 30 minutes travel time. We discovered only one child populated cluster from which the travel time to the closest skating field exceeded 30 minutes. This cluster accounts for 16 children (0.02%) and is located in Ultuna, in the northeast of the boundary. Most of the naturally frozen ice skating fields capture 14 to 500 children, accounting for 68 fields.

In addition, 57 fields capture 500–1,000 children, nine capture 1,000–1,500 children, and three capture 1,500–1,783 children. The top five fields with the highest number of children in their catchment areas are Latokartano Sports Park (capturing 1,783 children), Heteniitty Sports Field (1,624), Puistola Sports Park (1,522), Vesala Sports Park (1,448), and Hesperia Esplanade (1,364). In terms of child population catchment reachability, a higher number indicates a higher number of potential child users; however, these fields would be the most crowded if each child went to their closest field at the same time.

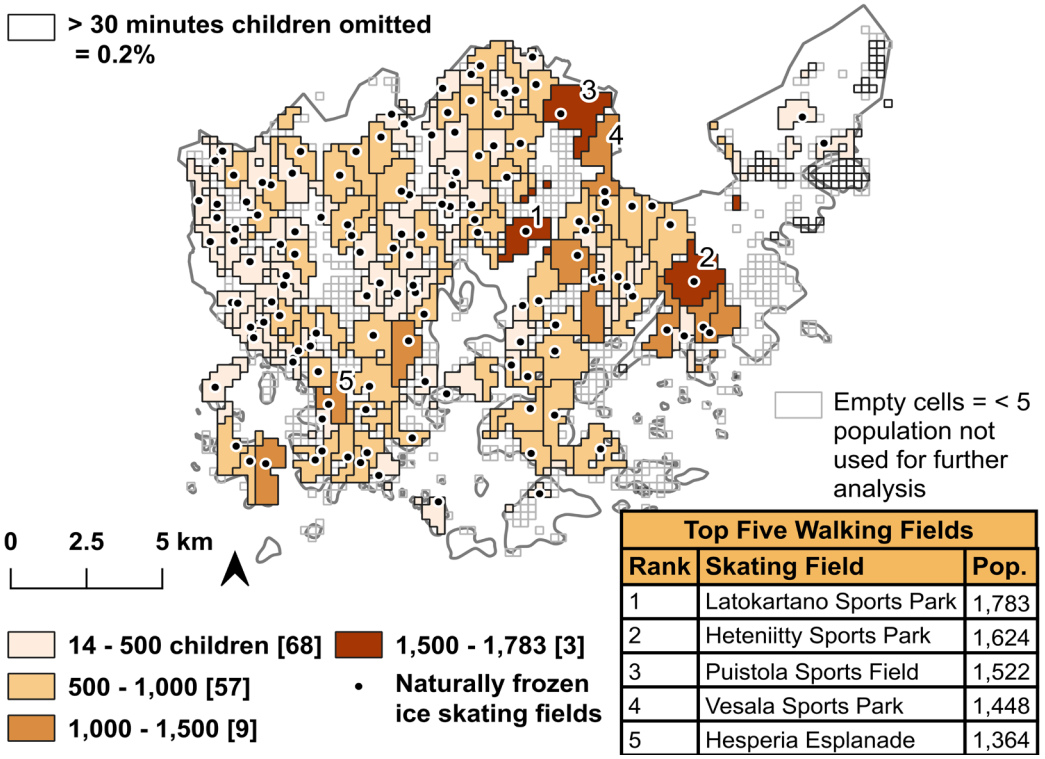


Top Five Public Transport Fields		
Rank	Skating Field	Pop.
1	Latokartano Sports Park	1,783
2	Heteniitty Sports Park	1,624
3	Puistola Sports Field	1,522
4	Vesala Sports Park	1,448
5	Hesperia Esplanade	1,364

Fig. 3. Population catchment areas for children and adolescents of naturally frozen ice skating fields based on travel time by public transport.

Figure 4 shows the child population catchment area for each ice skating field, based on travel time by walking. At first glance, the results are very similar, especially as the five most reachable naturally frozen ice skating fields are of the same order and the same children capture sums. The travel times to these fields are longer as walking is slower than using public transport. A noticeable difference is that the eastern areas stand out by having a much larger cluster of areas with longer than a 30-minutes travel time to the closest naturally frozen ice skating field.

Figure 5 shows that when comparing the cumulative child population to naturally frozen ice skating fields in Helsinki, over 99% of children can access their closest field within 15 minutes by public transport and within 23 minutes by walking. All children can access their closest field within 38 minutes by public transport. We additionally calculated travel times for up to 60 minutes for walking, at which point 0.02% of children (accounting for 17 children) could still not reach the closest naturally frozen ice skating field.



Top Five Walking Fields		
Rank	Skating Field	Pop.
1	Latokartano Sports Park	1,783
2	Heteniitty Sports Park	1,624
3	Puistola Sports Field	1,522
4	Vesala Sports Park	1,448
5	Hesperia Esplanade	1,364

Fig. 4. Population catchment areas for children and adolescents of naturally frozen ice skating fields based on travel time by foot.

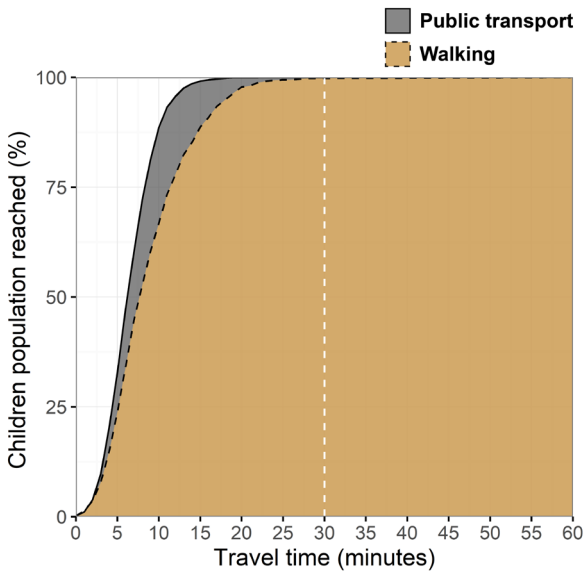
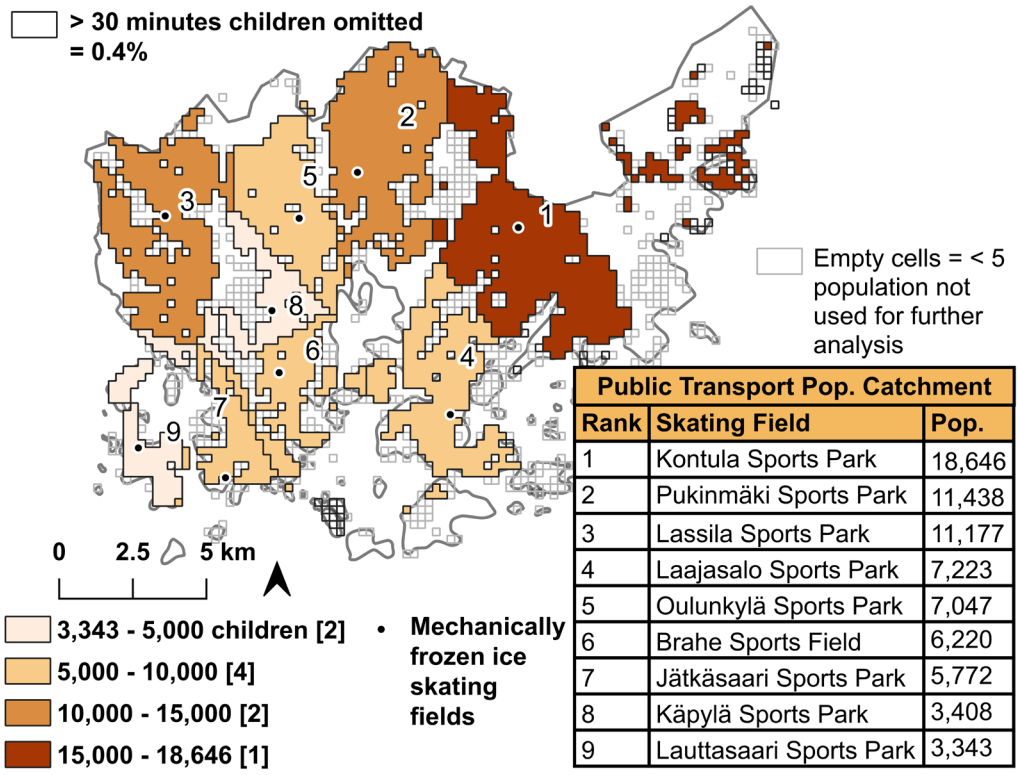


Fig. 5. Travel time accessibility to the closest naturally frozen ice skating fields for children and adolescents in Helsinki. The threshold of 30 minutes is shown with a white dashed line.

Mechanically frozen ice skating fields

The nine mechanically frozen ice skating fields have larger population catchment areas (Fig. 6 & Fig. 7) than naturally frozen ice skating fields. Figure 6 shows that most children can access mechanically frozen ice skating fields within 30 minutes by public transport. Exceptions exist in the eastern areas, which are mainly unreachable by public transport in 30 minutes. The mechanically frozen ice skating field that has the largest child population catchment is Kontula Sports Park (ice skating field 1), which captures 25% of the total child population. This percentage is large, considering the total number of fields is nine. In contrast, the smallest population catchment areas are Käpylä Sports Park and Lauttasaari Sports Park which capture 4.6% and 4.5% of the total child population respectively. The areas with longer than 30 minutes travel time equate to 0.4% of the total population of children.

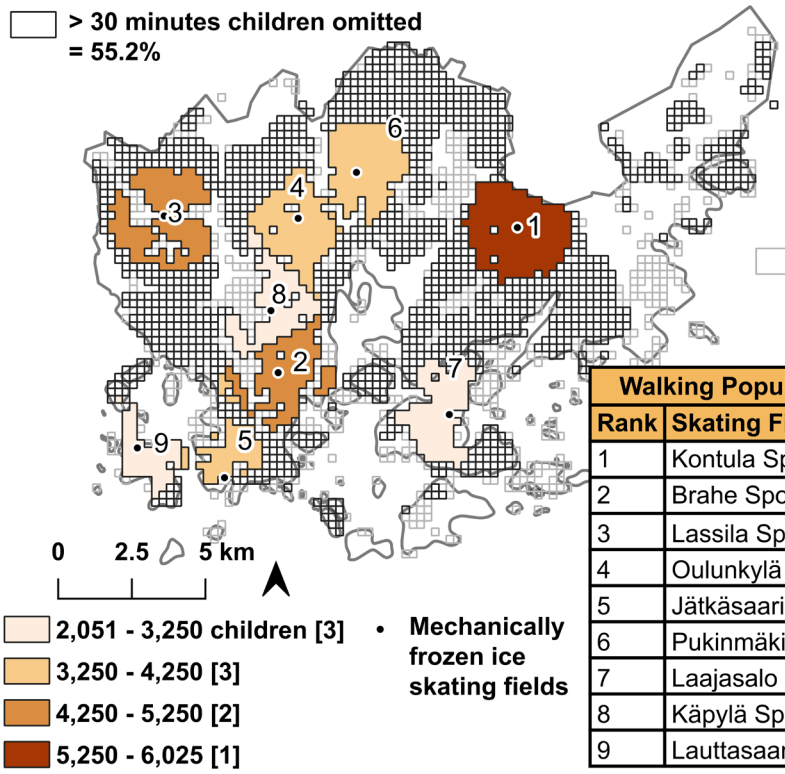


Public Transport Pop. Catchment		
Rank	Skating Field	Pop.
1	Kontula Sports Park	18,646
2	Pukinmäki Sports Park	11,438
3	Lassila Sports Park	11,177
4	Laajasalo Sports Park	7,223
5	Oulunkylä Sports Park	7,047
6	Brahe Sports Field	6,220
7	Jätkäsaari Sports Park	5,772
8	Käpylä Sports Park	3,408
9	Lauttasaari Sports Park	3,343

Fig. 6. Population catchment areas for children and adolescents of mechanically frozen ice skating fields based on travel time by public transport.

In contrast, Figure 7 illustrates the large percentage of children (55.2%) who cannot reach the nearest mechanically frozen ice skating field by walking within 30 minutes. The ranking of child catchment totals differs when compared to Figure 6. The location of the highest proportion of children is Kontula Sports Park (8.1%), and the smallest are Käpylä Sports Park (3.2%) and Lauttasaari Sports Park (2.7%).

Finally, Figure 8 summarises the cumulative child population at different travel times by public transport and walking to mechanically frozen ice skating fields. In typical conditions, children living in any location in Helsinki can access these fields within 53 minutes by public transport, and 99% of children access the fields within 27 minutes. In contrast, 92.5% can reach the nearest field by walking in less than 60 minutes. When using the 30 minutes cut-off, only 44.8% of children can reach a field by walking, and 99.6% by public transport.



Walking Population Catchment		
Rank	Skating Field	Pop.
1	Kontula Sports Park	6,025
2	Brahe Sports Field	4,577
3	Lassila Sports Park	4,524
4	Oulunkylä Sports Park	3,654
5	Jätkäsaari Sports Park	3,636
6	Pukinmäki Sports Park	3,631
7	Laajasalo Sports Park	2,907
8	Käpylä Sports Park	2,424
9	Lauttasaari Sports Park	2,051

Fig. 7. Population catchment areas for children and adolescents of mechanically frozen ice skating fields based on travel time on foot.

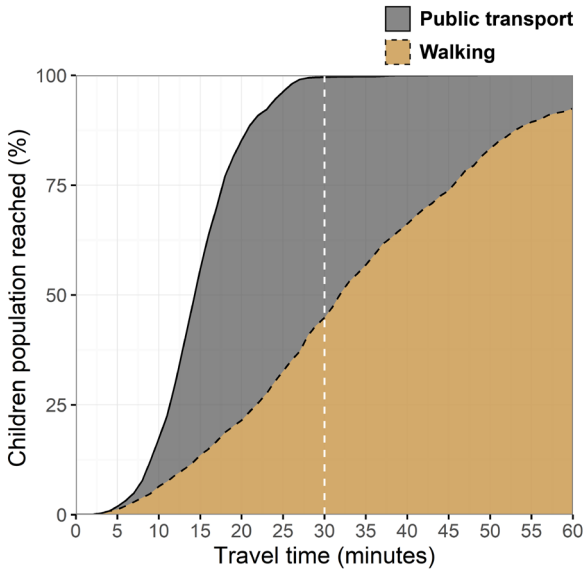


Fig. 8. Travel time accessibility to mechanically frozen ice skating fields for children and adolescents in Helsinki. The threshold of 30 minutes is shown with a white dashed line.

How walking and using public transport affects travel time for the child population

The main purpose of this paper was to find out if there is a difference in travel time and nearest child catchment area in an optimal winter when both types of ice skating fields are in use. We compared this to a bad winter when only the mechanically frozen fields can be kept frozen. The results demonstrate that the travel time-based accessibility for children in Helsinki to naturally frozen ice skating fields is very good by public transport or by walking. However, mechanically frozen ice skating fields are fewer; consequently, the related travel times are generally longer. In addition, we demonstrated the necessity of considering the spatial distribution of the child population who potentially use this type of informal sport facility, due to the uneven population spread within the Helsinki boundary.

The overall result is that the travel time-based accessibility within Helsinki is very good when using public transport to travel to both types of ice skating field. Most of the child population could access at least one naturally frozen ice skating field, not only within 30 minutes but even within 20 minutes, either by public transport (99.1%) or walking (97.8%). Tudor-Locke and others (2011) designated a threshold value of 30 minutes for walkable or easy access travel for children. The abundance of naturally frozen ice skating fields in Helsinki results in few fields being unreachable within 30 minutes by either public transport or walking. Furthermore, the ideal of a 20-minute round trip (Calafiore *et al*. 2022) travel time to the nearest ice skating field applies to 66.7% of children by walking and 88.6% by public transport. The short travel times to the nearest naturally frozen ice skating field results in little difference in travel time between walking or taking public transport. However, the active mode of walking to a hobby increases the total time used for physical activity. This increased activity time would benefit the 80% of children in Helsinki who are not sufficiently physically active (City of Helsinki 2018). These shorter distances can have a positive impact on younger children. Kallio and colleagues (2016) found that the majority of children aged between 11–14 years old travelled to school less than 3km which is equivalent to a maximum of 36–45 minutes at a speed of 4–5km/h. The travel time distances to naturally frozen ice skating fields are therefore shorter than the average childrens' walking commute to school and this suggests that even younger children are capable of walking to their nearest field with a travel time of 20-minutes.

The mechanically frozen ice skating fields are accessible within 30 minutes by public transport, despite the fewer fields. The omission of only 0.02% of the total child population means that the spatial placement of mechanically frozen ice skating fields is already suitable in Helsinki, when isolating public transport travel times and the child population. Travelling to mechanically frozen ice skating fields by walking is the only situation in which most of the child population cannot access their nearest field within 30 minutes. This inaccessibility varies spatially. The southern and central parts of Helsinki have shorter travel times and therefore better accessibility than the western or eastern parts. The southern and central parts have the smallest amounts of children in their catchment areas compared to the higher potential number of child users in the eastern parts regarding potential child users. However, other age groups such as 20–30 years or 30–40 years also use the ice skating facilities, which can cause more usage pressure in the fields that are in the most densely populated areas, such as those in the southern and central parts of the city. We have also acknowledged that children might not be willing or able to travel the full 30 minutes on top of carrying their ice skating equipment. This can consist of at least the ice skates and if they are playing ice hockey then also a helmet and stick. Subsequently, it further shows that when the City recommended to stay away from public transport that this has repercussions for the population.

From the regional equality perspective, it is concerning that Kontula Sports Park is the only mechanically frozen ice skating field in the eastern part of Helsinki, although having the highest number of children in its population catchment area. This finding, alongside the child population without access to any mechanically frozen ice skating field within a reasonable travel time (30 minutes) in eastern parts, indicates a catchment gap in this area. Some eastern parts of Helsinki have neighbourhoods with lower socio-economic status levels. From the perspective of enhancing the equality of access to sporting facilities especially for disadvantaged people, addressing the

above-mentioned catchment gap is necessary regarding the optimal location-allocation placement of any additional future fields.

Travel time is affected by both the extent of the service network and the existing road network and public transport system. For example, parts of eastern Helsinki are poorly accessible by public transport (Albacete *et al*. 2017), which is partly due to the history of the area. Having previously belonged to the municipality of Sipoo, Östersundom (see Fig. 3 & Fig. 6, the areas of Ultuna & Karhusaari) was incorporated into the city of Helsinki in 2009. Since then, public criticism has slowed the planning process regarding area development (Supreme Administrative Court of Finland 2021). Consequently, the inter-connectivity between Östersundom and the rest of the Helsinki City Region has not yet been realised (City of Helsinki 2017). Therefore, the population of children in our case study area is not given sufficient public transport opportunities to reach different parts of the city. The finding of a catchment gap due to insufficient public transport indicates the importance of providing equal transportation opportunities for inhabitants living in different suburbs and areas in cities. Disconnection in cities is not new; Rae and others (2016) focused on unequal economic growth at the neighbourhood level in the UK.

The results and calculations in this paper concerning naturally frozen ice skating fields are only valid for a so-called good winter that supports the maintenance of naturally frozen ice skating fields. For example, during an unusually warm New Year's Eve 2021 in the UK, even the mechanically frozen ice rinks were forced to close as they had melted in the 15 degrees Celsius daytime temperature, which is above the usual December average temperature (Komarova 2022). Particularly in the east of Helsinki, the City should focus on improving the travel time-based accessibility of mechanically frozen ice skating fields, which are less reliant on weather conditions although in a climate friendly way. Mechanically frozen ice skating fields are associated with a high water and electricity cost. In the Netherlands, Hop (2021) devised a more climate friendly experimental method for mechanically frozen ice skating fields to create and maintain the ice floor during less severe winters. The method tested an insulating layer below the asphalt on which the field is built and more precise spray carts were utilised to both save on energy costs and keep the ice frozen.

People do not always use the nearest ice skating fields, as they may prefer another ice skating field further away. For example, Edwards and Kulczycki (2018) found that only 27% of adolescents (352 out of 1,304 participants) used their closest park. Naturally frozen ice skating fields have no facilities; however, so an assumption can be made that independently travelling children might use their nearest field. The popularity of mechanically frozen ice skating fields can vary, especially as some have facilities such as cafes, toilets, music, or car parks. Nevertheless, if the travel time distance to the closest mechanically frozen ice skating field is very long – as mentioned regarding eastern parts of our case study area – the likelihood of traveling to these mechanically frozen fields is lower than using a more local naturally frozen ice skating field. This issue is important, especially for younger children who cannot travel far by themselves and typically ice-skate for a shorter time. Figures 5 and 8 have shown the cumulative population and their respective travel time. Figure 5 showed that over 99% of children can access their closest field within 15 minutes by public transport or within 23 minutes by walking. This result is suitable for all ages (7–19). However, Figure 8 showed that the travel time to the mechanically frozen ice skating fields is generally longer and this perhaps exceeds the time that younger children are willing or permitted to travel independently so the overall realised accessibility could in fact be lower. In examining or considering the popularity of ice skating fields, we could measure more detailed visitor numbers (with counters that the City already use), or utilise user generated data, such as from Twitter (Koivisto 2021), alongside further web search data from the Outdoor Exercise Map.

During the Covid-19 pandemic, there has been less active school travel-related physical activity among children due to school closures and remote learning. Some physical education classes continued remotely, albeit with a lower priority and quality than other subjects (Ng *et al*. 2021), although Finnish students rated physical education as the easiest subject to do remotely (Lavonen & Salmela-Aro 2021). Thus, leisure time sports and active travel to informal leisure time places during exceptional times can be expected to play an increasingly dominant role in adopting and maintaining healthy lifestyles.

Conclusions and suggestions for future research

The main aim of this paper was to build a better understanding of the travel time to ice skating fields for the child population in Helsinki. We took two perspectives on the topic. Firstly, we analysed the possible effect of climate change on the accessibility of ice skating fields. The particular focus on the travel time to mechanically frozen ice skating fields over naturally frozen ice skating fields related to the prospect of Finland facing milder winters in the future. Secondly, we analysed the travel time to these fields for children by walking, as a form of active travel compared to using public transport. This modal comparison between walking and using public transport is topical due to the recommendations to avoid public transport during the COVID-19 pandemic; additionally, walking is a healthy and environmentally friendly way of travelling.

Analysis through travel time calculations and nearest-neighbour catchment area analysis facilitates comparing how the change in travel mode affects the size of service areas and the number of people who have adequate access to services. Making the analyses separately for the two types of ice skating fields allows making interpretations on how the travel time to ice skating fields increases during bad winters. Using this case study of Helsinki, with a 30-minute cut-off travel time, we conclude that changing the travel mode from public transport to walking only marginally affects the travel time to naturally frozen ice skating fields, but majorly affects the travel time to mechanically frozen ice skating fields. The accessibility of ice skating fields during bad winters is therefore greatly reduced, especially by walking as the travel mode. However, the cumulative child population sum charts reveals the actual differences in travel times between the two travel modes.

Furthermore, travel time analysis may reveal gaps in the service network and disparities between the number of potential users and availability of fields. We investigated how both the extent of service network (number of facilities and their spatial distribution) and road and transport networks affect the differences and disparities in the accessibility of services. Regarding participation in ice skating and other winter sports, the weather and climate are central to both children's accessibility and their leisure physical activity time.

More mechanically frozen fields are likely required in the future; therefore, future research could focus on location-allocation particularly linked to the spatial location of schools. School children in Finland use ice skating fields during their physical education classes; consequently, including a school location dataset and their respective student population catchment could be important. However, adding more mechanically frozen ice skating fields further negatively impacts the climate. Climate change should therefore be a central factor of future research such as creating a new indicator of likelihood as per Visser and Petersen (2009).

Future policy recommendations should follow Hop's (2021) engineering study regarding more climate friendly management of mechanically frozen ice skating facilities. Hop's (2021) new method would improve the chances of mechanically frozen ice skating fields to remain in use during milder winters and thus allows children to continue ice skating even when the naturally frozen ice skating fields would not remain frozen. Such management is currently relevant as even the mechanically frozen fields melted during warmer winter daytime temperatures (Komarova 2022). We conclude that cities should focus on both the population pattern and the maintenance of energy efficient outdoor sports facilities. Simultaneously taking a climate friendly approach will improve the possibility of engaging in winter leisure physical activity even in milder winter conditions.

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