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# One should really be more worried about too little physical activity than injuries while walking or cycling to school. Parents' perception of risk concerning active school transportation.

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## ABSTRACT

**Introduction:** Active school transportation (AST) can be a powerful strategy to promote physical activity and improve children's health. Parents' perceptions of traffic risks are an important factor in their decision concerning their child's transport mode to school and addressing discordances between the perceived risks and actual incidents might contribute to promote children's AST. This study adopted a game originally designed for the context of information security to resonate with the context of Swedish AST and the aim of the study was to describe parent's experience of playing the game.

**Methods:** A qualitative approach was chosen and data was collected using focus groups with 16 parents for totally 29 children aged 7–12. The collected data were analyzed using qualitative content analysis.

**Results:** The results formed one main theme "Playing promotes parents' awareness and consideration of active school transportation" and three subthemes; "Fast, fun, and functional; Experiences from playing the game" showing that the parents perceived the game to be fun, easy, and time efficient to play. "Then and now. Own childhood experience vs being a parent" showing that parents' perception of risk can sometimes be barriers to their children's opportunity to use AST. "Personal perceptions vs statistical risk" showing that playing the game addressed the discordance between the parents' perceived risks and actual incidents, as well as promoted parents' awareness and consideration of AST.

**Conclusions:** Including an intervention component such as a game for parents and using schools as the arena for implementing projects promoting AST to improve children's physical activity levels, might be a fruitful avenue.

## 1. Introduction

The World Health Organization (WHO) recommends that children should be physically active for at least 60 min per day to achieve several health benefits. The severe consequences of physical inactivity emphasize the urgency to prioritize health promotion efforts ([World Health Organization, 2020](https://www.who.int/news-room/fact-sheets/detail/physical-inactivity)). Active school transportation (AST) has been suggested as a promising strategy to meet these

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recommendations since children who use AST participate in more physical activity than those who do not follow this principle (Faulkner et al., 2009; Larouche et al., 2020; Masoumi et al., 2020). Hence, AST can be a powerful strategy to promote physical activity and improve children's health (Campos-Sanchez et al., 2020; Larouche et al., 2020; Lubans et al., 2009). In addition to promoting physical activity, previous research have identified other reasons to encourage AST, for example, improvement of emotional, psychological and social well-being and personal development (Campos-Sanchez et al., 2020; Frömel et al., 2020). Active commuting is associated with a lower risk of cardiovascular disease and cancer independent of measured confounding factors (Celis-Morales et al., 2017) and high walkability index is associated with high active travel mode, which indirectly correlates with reduced obesity and finally links to an increased likelihood of better health (Li et al., 2021). Although active transport involves risks, the effects of the increased physical activity strongly outweigh detrimental consequences originating from traffic incidents and air pollution exposure on health (Mueller et al., 2015). Hence, active transport can provide substantial net health benefits irrespective of geographical context (Mueller et al., 2015). Mizdrak et al. (2019) concluded that substantial health gains and healthcare cost savings could be achieved by walking or cycling instead of taking short car trips and that promoting active transportation is likely to be a cost-effective way for improving population health that will also reduce greenhouse gas emissions.

Unfortunately, a decline in active travel to school among children and adolescents has occurred (González et al., 2020; Rothman, L., Macpherson, Ross and Buliung, 2017). For example, among Swedish children aged 6–15, only 48% and 57% use AST in the winter and summer months, respectively (Swedish Transport Administration, 2018). The problem is not unique for Sweden. A comparison concerning AST in 49 countries shows that the global average grade was a “C”, indicating that countries are succeeding with about half of children and youth (47%–53%) where the scale ranges from “A+” indicating 94–100% to “F” indicating below 20%. (González et al., 2020). Health promotion interventions should be initiated as early as possible since physical activity behavior, including active transport, tends to form in childhood and track into adulthood (Telama et al., 2014; Yang et al., 2014).

Parents' perceptions of traffic risks are an important factor in their decision concerning their child's transport mode to school (Aranda-Balboa et al., 2020), especially in terms of allowing children to travel independently (Ahern et al., 2017). Previous studies have demonstrated that higher perceived risk among parents are associated with lower levels of AST (Mammen et al., 2014; Meh-dizadeh et al., 2017). These studies found that security concerns were more profound among parents who did not let their children walk to school. Unfortunately, most of the literature on risk perception and transportation focuses on drivers, and limited exploration of the situation for other road users, such as children, has been published (Cloutier et al., 2011). Moreover, a study involving parents indicates that their perception of risk is not always in accordance with the actual measures of traffic safety (Rothman et al., 2015). In this regard, Thomsen (2005) is talking about a “safety paradox” for which parents' anxiety about injuries to their children while in traffic is increasing, while the actual traffic incidents involving children are decreasing. Rothman et al. (2015) also concludes that it might be helpful to address this discrepancy between the perceived risks and actual incidents when aiming to promote AST so that parents can make informed decisions based on statistical evidence rather than fear.

In previous studies, the involvement of the end-users (children and their parents) throughout the whole process has been a cornerstone (Rutberg and Lindqvist, 2018a; Savolainen et al., 2020) in addition to the use of gamification and games (Kostenius et al., 2018; Laine et al., 2022; Lindqvist et al., 2018; Oyelere et al., 2022). As previously stated, the role of parents as “gate-keepers” and the need to address parental concerns have been described in previous research and also in several of our intervention studies (Forsberg et al., 2020, 2021; Rutberg and Lindqvist, 2018). One intervention part attempting to address parents' perception of risk, has been information during parental meeting regarding the positive outcomes of AST and concerns about its perceived risks (Lindqvist and Rutberg, 2018). To promote children's motivation in participating in interventions, gamification can be used to increase the enthusiasm of children to overcome parental hesitation with AST (Lindqvist et al., 2019; Rutberg and Lindqvist, 2018). However, further efforts are needed to address parental concerns and ultimately promote children's AST.

One recent effort to address structured dialogues about risk assessments and perceptions of risks, the consequences, and probabilities has resulted in a game called Riskify (Lugnet et al., 2020). Riskify is a team exercise in both a digital and physical format (CYNIC, 2019). The background for the exercise originates from theories of risk management, which has been gamified in the Riskify format. The goal of the exercise is for the team to gain insights into how different risks, probabilities and consequences are interpreted by different persons. Riskify has been tested with many actors from both the information security area and with employees in different companies in which the humans in the loop have apparently are the weakest link (Pinto et al., 2013). Consequently, no matter if an individual believes in his/her own competence and/or skills, they might expose themselves to risks that he/she has misjudged or lacks the knowledge about how to make informed decisions. The game was developed to be a support method or used as Dialogue cards in groups to enhance awareness about how our individual perceptions of risks differ. Riskify proposes a number of risk statements, initially nine statements were proposed. Those statements should be arranged in order of likelihood that they occur, not the consequences of the risk, from lowest to highest risk. The basic principle from Riskify has been adopted into additional contexts since the “game mechanism” and the concept with structured dialogues based on a number of risk statements could be of benefit in different contexts (Albrechtsen and Hovden, 2010).

As described in the following section, the original game's statements have been adapted in cooperation with experts within health science and transport research and the intended end-users aiming to promote children's AST by addressing parental concerns and perceptions. In this paper, the game is referred to as Promoting Education by Playing (‘PEP for parents’) as the name could also be seen as a reference to a ‘pep-talk’ by talking positive and promoting a change in behavior. The aim of this study was to describe end-users' experiences of playing The PEP for parents.

## 2. Methods

### 2.1. Context

The research project, Sustainable Innovation for Children Transporting Actively (SICTA), is a school-based intervention that was developed to promote AST. Several studies have been published during the process of developing SICTA, and some of them has been discussed in the introduction.

### 2.2. Using the game in the AST context

The adaptation of Riskify from the context of information security were done in several consecutive steps, to better resonate with the target audience and context of Swedish AST. The first step involved researchers (see [Table 1](#)) who developed a new set of statements. During this step, the concept of risk was discussed. The wording and ways to interpret risk had a great impact on formulation of the statements but also on the instructions to participants and the one facilitating a session. Risk was therefore replaced with ‘the probability of an event occurring’. An instruction was used to introduce the exercise to the participants:

This is a game intending to combine benefit with fun. The purpose is to facilitate awareness about how you as a parent actually reason about probability and risk that different situations might cause. The game has nine cards, each of which describes a situation, and the task is to rank them. Place the cards by ‘drag and drop’ so what is considered most likely to happen ends up at the top, and so on. When you are satisfied, press the button to flip the cards, thus revealing the observed risk. Play together, interact, and discuss, this is more valuable than striving for 100% right answers.

Feedback session 1: Thirty-two researchers (20 females) who attended an international conference agreed to contribute to the study. The experts had experience in AST-studies and were mainly from a Scandinavian context, but Spain and the United States were also represented with four researchers from each country. Feedback session 2: Fifteen teachers (10 females) teaching grades 4–6 at a school that was going to implement school-based interventions the following year agreed to contribute in the second feedback session.

The results from feedback sessions 1 and 2 were then used to further adapt the game so that the game played in feedback session 2 was the revised version after considering feedback session 1. Finally, the game played in the data collection with the parents was the revised version after considering feedback session 2. Thus, the game changed during the process; however, the overarching goal was to create a game that could easily facilitate discussion about AST without being demoralizing. Since a cornerstone for the SICTA project is promotion rather than prevention, it was important that the tonality of the cards was ‘promotion of the good’ not ‘prevention of the bad’ even though this intervention component addresses risk perception. Most cards had a clear connection to children’s physical activity and transportation. The ‘Mobile phone’ and ‘Kiss’ cards were created to keep the game easy and fun but also to include more general statements to which parents can relate. While some statements that refer to AST can be interpreted differently depending on the traffic situation/environment in which their children will have to ‘perform’ AST. The ‘Lightning strike’ card was chosen to add perspective to how uncommon the occurrence of traffic injuries during AST actually are. The probability for traffic injury was calculated using statistics from the Swedish Transport Administration ([Swedish Transport Administration, 2018](#)), and the Swedish Traffic Accident Data Acquisition (STRADA). In STRADA, those injured in traffic are registered by both the police and hospitals. Injured cyclists and pedestrians, 6–15 years old, registered in STRADA between 2015 and 2019 were included in the analysis. Some examples of discussions during the development process: The experts in feedback session 1 described the need for specifying sources for the cards. In conclusion, they agreed that it would be a disadvantage since it might direct the conversation from reasoning and sharing experiences towards a discussion towards right and wrong and fact checking. The original cards started with the statement “The risk that ...” However, feedback session 1 indicated that the participants got stuck on the word ‘risk’, which prompted a change to ‘probability’ in the second revision. The teachers in the second feedback session requested the possibility to play an analogue version of the game at parent-teacher meetings. After the second feedback session with the teachers, the researchers incorporated the suggestions that clarified and improved the understanding of the game, and this process was done in step 3 (see [Table 1](#)). The final version of the game can be played in both an online version and physically with printed cards. See appendix 1 for the final statements. The game was later implemented and tested using focus groups explained below.

### 2.3. Design of data collection with end-users

A qualitative approach was chosen to describe end-users experience of taking part in the intervention component ‘PEP for parents’.

**Table 1**

Overview of adaptation timeline during December 2020–April 2021.

Timeline	Development Dec	Feedback session 1 January	Revision 1 February	Feedback session 2 March	Revision 2 April
Participants	Authors	32 researchers from health science and transport research participated in six focus groups with 4–6 participants each.	Authors	15 teachers teaching grade 4–6 participated in two focus groups with 7–8 participants each.	Authors

Intervention research is defined as the process of creating and refining elements of an intervention in a series of studies; throughout the process, qualitative analyses play an important role (Skivington et al., 2021).

#### 2.4. Participants and data collection

Data were collected using focus groups with 16 parents (eight mothers) for a total of 29 children (15 girls) aged 7–12. The parents were chosen using snowball sampling. All participants were informed about the project by the authors and gave their informed consent to participate in the study. The study was approved by the Ethics Review Authority, Sweden (No. 2021–00283).

The data collection sessions started by the previously described instructions for playing the game. The participants then played the digital online version of the game, a procedure that took 10–15 min. The focus group discussions that followed the game lasted between 20 and 30 min. A semi-structured interview guide had been constructed to cover all experiences of playing the game. The first question was “Could you please tell me about your experience of playing the game?”. To deepen the answers, follow-up questions were asked, such as “Could you tell me more?” and “How did you experience that?” (Kvale and Brinkmann, 2009). Both discussions that occurred when the game was played, and the following focus group discussions were sound-recorded and manually transcribed.

#### 2.5. Data analysis

The collected data were analyzed using a qualitative content analysis inspired by Graneheim and Lundman (2004) using the following procedure:

- (1) The written material was first read several times to obtain a sense of the overall data.
- (2) The text was divided into meaning units.
- (3) In the abstraction process, the meaning units were manually coded, and the codes were compared, contrasted, and sorted into preliminary categories, where the authors strove to be close to the text throughout this step.
- (4) The preliminary categories were sorted and contrasted in a back and forward process, which finally resulted in three subthemes and one main theme.

### 3. Results

The results of the qualitative analysis formed one main theme and three subthemes (see Table 2). The quotes were labeled with the number of the focus group, M for male, F for female, and a participant number.

#### 3.1. Fast, fun, and functional; experiences from playing the game

The overarching goal while developing this intervention component was to create a game that could easily facilitate discussions about AST without being moralizing. The instructions for the game were reported to be clear and precise by the parents. The parents also thought that the group size for playing the game was suitable. Furthermore, the overall experience of playing the game was very positive. The parents perceived the game to be fun, easy, and time efficient to play.

Focus group 1

M3: Do you have more cards?

F1: Yes, can we play more? It was fun and thought-provoking.

F2: I think it has been good that it was easy, a not so complicated task that took a long time to solve. It's a little fun and takes about a quarter of an hour, I thought that was good.

The parents believed that the game could be possible to play both digitally at a teacher–parent meeting online and with printed cards at a regular meeting at school. Another idea that arose was the use of Mentimeter (online interactive presentation tool that help you to engage with audience using real-time voting) to play the game individually. However, most parents emphasized that the most rewarding part of the session was the discussion of that the ranking in which the cards resulted. In all the focus groups. The game was played while having lively discussions and providing opportunities to reflect while having a dialogue with other parents.

Focus group 2

**Table 2**

Overview of the results.

Main theme	Playing promotes parents' awareness and consideration of active school transportation		
Subthemes	Fast, fun, and functional; Experiences from playing the game	Then and now. Own childhood experience versus being a parent	Personal perceptions versus statistical risk

M1: I thought it was good, the questions created reflection and if you do it with other parents, you also get a good dialogue and think about what you think and get to check your own behavior and values against others.

M3: Yes, it will be more interactive than just getting information, which is good.

One of the starting points when developing the game was 'promotion of the good' not 'prevention of the bad' and the aim was to avoid any provocation of shame and guilt. The results show that this intention was fulfilled since none of the parents mentioned anything in this direction but rather described the opposite experience.

Focus group 2

F1: I think you do not feel ashamed either because you do something bad. It is a good way to provide information, you choose yourself. It does not get embarrassing and gives people a bad conscience.

The results also show that the parents appreciated that 'fun facts', such as the 'kissing card' were included since it helped maintain a playful mindset and prevent players from becoming overly serious.

### 3.2. Then and now; own childhood experience versus being a parent

One of the main topics that playing the game instigated was parents' reflections on their own physical activity levels as children compared to their children's present day activity levels. The parents agreed that children nowadays have a lower physical activity level, which included both overall physical activity and the usage of active transportation. The result also show that the parents were allowed a larger amount of independent mobility when they were young compared to the freedom that they permit their own children to have at present. The parents reflected upon the reasons for this whether it was due to the circumstances, awareness, or the attitudes that have changed.

Focus group 1

F2: Why are we all worried when our children cycle? We have all cycled behind our children and had our hearts in our throats fearing that something bad will happen. But I can still remember when I cycled when I was 8–9 years old, and I was never worried about being hit by a car and I could watch out for myself.

M2: Society looks different now from when we were little. My parents had more freedom than I got, and our son can do less than we got. Then the question is whether we spoil children nowadays or are more aware of the risks.

The parents discussed that order in a group of siblings had an influence. They had stricter rules for their first-born children and allowed a greater amount of freedom for younger siblings. This difference was partly due to the fact that older brother and sisters could accompany younger one but also dependent on the fact that the first-born children had managed to use active transportation without incidents and because of that process gave the parents a sense of security.

Focus group 3

M3: I reflect on my childhood, and I cycled all I could. Letting our son cycle around the neighborhood did not feel right when we moved here. Now he can ride a bike and then his little sister can come along. If we compare it, we have been much stricter than when we grew up.

The results also show that the parents believed it to be more difficult to solve the puzzle of everyday life today than it used to be, but managing to do so by accompanying the child to school and then letting him/her go home from school independently could be a starting point for more active transportation. One of the arguments for this set-up was that the amount of traffic in circulation around the time school ends is less than in the morning and therefore, a calmer learning environment. Once this situation was managed, the child could go independently to school and also to other destinations.

Focus group 2

F2: He can cycle home himself when school is over. It was a milestone in his development and at some point you have to let go.

### 3.3. Personal perceptions versus statistical risk

The results show that parental perception of risk differs from objective measures of traffic safety and that playing the game can instigate discussions concerning this discordance. The parents discussed the risk of traffic injury in relation to seldom hearing about it through media and came to the conclusion that it could not be that common. However, all of the focus groups ended up in placing the 'lightning strike card' at the bottom indicating that they believed that traffic injury was more unlikely to occur than the situation described in the 'traffic injury card'. When faced with this fact, a lively discussion started in all groups.

Focus group 1

M3: Interesting thing about the traffic injury, it means that you are overprotective.

**M2:** We are not rational. We start thinking here and there and come to the conclusion that it is risky to cycle. We mix parental feelings and responsibility. If we go on the theory of probability, there is absolutely no danger.

**F1:** It is like a mental barrier. If you see these numbers, you might dare to set them free and allow them to walk or bike.

The result thus indicates that it is possible that playing the game could support parents when they are attempting to make informed decisions based on evidence rather than fear. However, the discussions concerning traffic injury also included the fact that although it is very rare, the consequences might be devastating. On the other hand, the results also show that the child can grow with a sense of responsibility in relation to independent active transportation.

#### Focus group 3

**M2:** I think they take more responsibility when they are alone. When you are involved, they do not take as much control.

Another matter that was lively discussed in all of the focus groups was the 'physical activity card'. The parents discussed their intentions to do what is best for their children both in a short and a long-term perspective. The discussions among the parents concluded that promoting physical activity and active transportation should be prioritized to a higher level and that the schools could have an important role in that process.

#### Focus group 1

**F3:** It can be stated that the statistics say that our children move far too little and that there are very few traffic incidents so they can actively travel to and from school in any case.

**F2:** One should really be more worried about too little physical activity than injuries while walking or cycling to school.

## 4. Discussion

### 4.1. Discussion of results

The focus of this study was to describe end-users experience of playing the game, which is referred to as 'PEP for parents' in this paper. The game was initially developed as a team exercise to gamify and increase the insights into how different risks, probabilities, and consequences are interpreted; in this study, the game was used to address parental concerns and ultimately promote children's AST. Our findings show that playing the game promoted parental awareness and consideration of active school transportation.

Our overarching research project SICTA has theoretical underpinnings in health promotion (Bandura, 2004) and 'promotion of the good rather than 'prevention of the bad' and has been our intention throughout the project. Approaches aimed at enabling one's behavior or deterring another is commonly used concerning behavior change. When using the 'carrots and sticks' metaphor regarding travel behavior it might be profitable to leverage both enablers and deterrents to yield the greatest progress toward increasing active travel (Piatkowski et al., 2019). However, the starting point when developing the game was 'promotion of the good' and therefore the game intentionally avoided any provocation of shame and guilt formulations. The results show that this intention was fulfilled since none of the parents mentioned anything in this direction but rather described the opposite experience. Our findings show that playing the game provided an opportunity to start a dialogue with other parents concerning AST and societal expectations, something that in previous studies has emerged as one important factor influencing parental behavior although more research in this direction is needed (Kim et al., 2019; Riazi et al., 2021). Adult learners prefer actions rather than explanations and the possibility to apply more than one learning style (Mettler and Pinto, 2015); therefore, the game can be used to train cognitive skills, such as context awareness and attitudes. Also, traditional formats of training (the formal activities that strive to build relevant skills and competence) have been criticized to make people believe that they already knew the answer (South, 2007). This thinking occurs when people are exposed to questions and happened to find the one expected correct answer. In these situations, 'we' tend to believe that we already knew how to answer to the question, which relates to hindsight bias, and foresight bias (South, 2007). Instead, it is suggested that realistic and more complex problems should be used, namely, not providing one single-solution (Lugnet et al., 2020; Wilson and Hash, 2003). Therefore, the rationale for incorporating the game in terms of a group exercise refers to the concept of awareness and training in which the efforts of informing individuals about, for instance, risks in each context is not enough to promote change, and the 'learners' in this study are the parents who also need to take a more active role (Lugnet et al., 2020; Wilson and Hash, 2003).

Our study shows that playing the game led to discussions between the parents concerning their own high use of active transportation as a child compared to their children's lower activity. The result also show that the parents reflected upon generational differences between the presences of independent mobility in which parents were allowed a higher degree of independency when they were young compared to the freedom that they permit their own children to have. Children's independent mobility is defined as the freedom to move around their neighborhood without adult supervision (Tranter and Whitelegg, 1994). Our findings concerning this idea is consistent with the findings of Riazi et al. (2021) in which parents consistently referred to their childhood independent mobility freedoms and painted a stark picture of the differences between their childhood periods and those of children today.

The perception of risk is defined as an individual's subjective interpretation of a potentially dangerous situation based on the information that a person has (Cloutier et al., 2011). Boholm and Corvellec (2011) emphasize the importance of considering the social and cultural context in which these risks are perceived and managed, but also the aspect of communication in shaping people's perceptions of risk. People's perceptions of risk are also shaped by their cognitive and emotional responses (Slovic, 1987) to the risk

and any perceived benefits of the activity that poses the risk (Kahneman et al., 1982). For example, people may be more likely to perceive a risk as being high if it evokes strong emotional reactions, such as fear or disgust. Similarly, people may be more likely to perceive a risk as low if it is associated with positive emotions, such as pleasure or excitement. Two important dimensions in our study are personal vs statistical risks and controllability. First, people tend to perceive risks as higher when they can relate to the individuals affected by the risk, as opposed to when the risk is presented in statistical terms. Secondly, people tend to perceive risks as higher when they feel they have little control over the activity that poses the risk (Slovic, 1987). One such example could be that adults accept and perceive the level of risk for themselves differently than they would for their children. According to Legorburu et al. (2022), families are the main source of construction of security or risk, and family conversations have a great influence on the perceptions that children have of their environment. Moreover, the authors conclude that it is essential for families to provide confidence so that children feel able and confident to use AST. From a systematic review, Lorenc et al. (2008) also concluded that a need to change the norms and perceived risk among parents regarding children's independent mobility exists. Our findings show that parents' perceptions of risk are not in accordance with the actual measures of traffic safety and that playing 'PEP for parents' might be helpful to deal with this discrepancy. This concept is consistent with a report from the Swedish Transport Agency (Trafikanalys, 2019), which concludes that a gap between people's perceptions of risk and the actual known traffic risks exists as measured by responsible authorities; moreover, it is essential to reduce the perception of risk for road users since the number of actual traffic incidents are few. They also state that it is the subjective experience that is central rather than the statistically measured risk (Trafikanalys, 2019), something that the game might be capable of addressing. This study included only parents; however, findings from an Australian study showed that children perceive a wider range of safety concerns than their parents, including harm from strangers or traffic, bullying, and/or getting lost (Crawford et al., 2017). At the same time, the children expressed great delight in being independent when transporting themselves to school and often seek to actively influence parents' decision making (Crawford et al., 2017). Furthermore, our findings indicate that children can grow with the transportation responsibility in relation to independent AST. This result is consistent with the findings of Legorburu et al. (2022) showing that children who could go to school alone feel that their parents trust them more. Furthermore, being able to use AST unaccompanied by parents, alone or with friends, can foster children's autonomy and improve both parents' and children's perceptions of safety (Herrador-Colmenero et al., 2017). According to the parents participating in our study, promoting active transportation should be prioritized to a higher level, and schools could have an important role in that process. This finding is consistent with Legorburu et al. (2022) who concluded that schools should implement projects that aim to promote AST in order to improve children's physical condition and their psychological and personal development. This concept is highly relevant for policy-makers and practitioners within municipalities in many countries.

#### 4.2. Methodological considerations

According to Öhman (2005), credibility can be increased by triangulation; by using this approach, the research problem can be viewed from various angles by a research team with different professional backgrounds as seen in the case with the authors of this article. We also used peer debriefing, which entails discussing the preliminary results with colleagues who have experiences working with qualitative methods (Öhman, 2005). Quotes are used to strengthen the credibility of the study and to illustrate the conclusions drawn (Graneheim and Lundman, 2004). Both males and females participated and included individuals with different experiences (such children of various age and varying experiences with AST). This type of group provided diversity and ensured that a good possibility that light would be shed on different aspects of the topic under investigation existed (Graneheim and Lundman, 2004). An interview guide comprised of a few main questions with follow-up questions was constructed and which according to Graneheim and Lundman (2004) strengthens the dependability of the study. To facilitate transferability, the context, the research process, the participants, and the results have been described in detail, however, the transferability of the results to other contexts must be judged by the reader (Graneheim and Lundman, 2004).

#### 4.3. Conclusions and future research

The findings of our study indicate that parents' perception of risk can sometimes be barriers to their children's opportunity to use AST. Performing this facilitated group exercise by playing the game during parental meetings could address the discordance between the parents' perceived risks and actual incidents, which potentially could promote the use of AST. Including an intervention component, such as a game for parents and using schools as the arena for implementing projects promoting AST might therefore be a fruitful avenue for increasing children's physical activity. This study also concludes that the game mechanisms used in this exercise could be adapted and used in different context and still benefit from similar rewarding dialogues and informative discussions. However, more research is needed, and our next step will be to evaluate if interventions like this have an impact on parental norms and behavior in order to ultimately positively influence children's use of AST. Another interesting research question could be to evaluate if parent's perception differs depending on the children's age.

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## Author contributions

Conceptualization; A-KL, SR, JL, AN.  
 Data curation; SR.  
 Analysis; A-KL, SR.  
 Funding acquisition; A-KL, SR, AN.  
 Investigation; SR.  
 Methodology; A-KL.  
 Project administration; A-KL.  
 Resources; JL, AN.  
 Validation; A-KL, SR.  
 Writing - original draft; A-KL.  
 Writing - review & editing; A-KL, SR, JL, AN.  
 All authors have read and agreed to the published version of the manuscript.

## Declaration of competing interest

None.

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## APPENDIX 1

The nine cards of the final version of the game had the following text on the 'question' side:

<b>Physical activity</b> The probability that a 15-year-old girl does less than 60 min of physical activity in one day.	<b>Car child seat</b> The probability that a four-year-old child is seated facing the wrong way in the car	<b>Mobile phone</b> The probability that a parent uses their phone when they are at a restaurant with their child
<b>Bicycle helmet</b> The probability that an adult ride a bicycle without a helmet	<b>School transport</b> The probability that a child aged 6–15 travels by car or bus between home and school during spring and autumn	<b>Kiss</b> The probability that a woman has open eyes during a kiss
<b>Football</b> The probability that a boy is injured during a football match so that he has to give up sports for a few weeks.	<b>Lightning strike</b> The probability of being struck by lightning during your lifetime	<b>Traffic injury</b> The probability that a child is seriously injured or killed when walking or cycling between home and school.

The nine cards of the final version of the game had the following text on the 'answer' side:

<b>Physical activity</b> 91% More than 9 out of 10 do not achieve the recommended amount of 60 min of daily physical activity	<b>Car child seat</b> 80% On average, 4 out of 5 children sit facing forward, even though children travel more safely backwards in a car until they are at least four years old.	<b>Mobile phone</b> 73% About 3 out of 4 parents use their phone during a restaurant visit with their child.
<b>Bicycle helmet</b> 69% About 7 out of 10 adult cyclists do not wear a bicycle helmet.	<b>School transport</b> 43% About half of the children travel by bus or car and half walk or cycle during spring and autumn.	<b>Kiss</b> 4% 4 out of 100 women have open eyes during a kiss. The corresponding figure for men is 6 out of 10.
<b>Football</b> 0.02% About 1 in 5000 get injured during a football match	<b>Lightning strike</b> 0.0001% The risk of being struck by lightning is about 1 in 1,000,000	<b>Traffic injury</b> 0.00003% It is very uncommon for children to be seriously injured or killed while walking or cycling between home and school.

## References

- Ahern, S.M., Arnott, B., Chatterton, T., de Nazelle, A., Kellar, I., McEachan, R.R.C., 2017. Understanding parents' school travel choices: a qualitative study using the theoretical domains framework. *J. Transport Health* 4 (Suppl. C), 278–293. <https://doi.org/10.1016/j.jth.2016.11.001>.
- Albrechtsen, E., Hovden, J., 2010. Improving information security awareness and behaviour through dialogue, participation and collective reflection. an intervention study. *Comput. Secur.* 29 (4), 432–445. <https://doi.org/10.1016/j.cose.2009.12.005>.
- Aranda-Balboa, M., Huertas-Delgado, F., Herrador-Colmenero, M., Cardon, G., Chillón, P., 2020. Parental barriers to active transport to school: a systematic review. *Int. J. Publ. Health* 65 (1), 87–98. <https://doi.org/10.1007/s00038-019-01313-1>.
- Bandura, A., 2004. Health promotion by social cognitive means. *Health Educ. Behav.* 31 (2), 143–164. <https://doi.org/10.1177/1090198104263660>.
- Boholm, Å., Corvellec, H., 2011. A relational theory of risk. *J. Risk Res.* 14 (2), 175–190. <https://doi.org/10.1080/13669877.2010.515313>.
- Campos-Sanchez, S.F., Javier Abarca-Alvarez, F., Molina-Garcia, J., Chillon, P., 2020. A GIS-based method for analysing the association between school-built environment and home-school route measures with active commuting to school in urban children and adolescents. *Int. J. Environ. Res. Publ. Health* 17 (7). <https://doi.org/10.3390/ijerph17072295>.
- Celis-Morales, C., Lyall, D.M., Welsh, P., Anderson, J., Steell, L., Guo, Y., et al., 2017. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. *BMJ (Clinical Research Ed)*. <https://doi.org/10.1136/bmj.j1456>.
- Cloutier, M., Bergeron, J., Apparcio, P., 2011. Predictors of parental risk perceptions: the case of child pedestrian injuries in school context. *Risk Anal.* 31 (2), 312–323. <https://doi.org/10.1111/j.1539-6924.2010.01501.x>.
- Crawford, S.B., Bennetts, S.K., Hackworth, N.J., Green, J., Graesser, H., Cooklin, A.R., Nicholson, J.M., 2017. Worries, 'weirdos', neighborhoods and knowing people: a qualitative study with children and parents regarding children's independent mobility. *Health Place* 45, 131–139. <https://doi.org/10.1016/j.healthplace.2017.03.005>.
- CYNIC, 2019. Riskify. Retrieved from. <https://www.cynic.se/training/riskify/>.
- Faulkner, G.E.J., Buliung, R.N., Flora, P.K., Fusco, C., 2009. Active school transport, physical activity levels and body weight of children and youth: a systematic review. *Prev. Med.* 48 (1), 3–8. <https://doi.org/10.1016/j.ypmed.2008.10.017>.
- Forsberg, H., Lindqvist, A., Forward, S., Nyberg, L., Rutberg, S., 2021. Development and initial validation of the PILCAST questionnaire: Understanding parents' intentions to let their child cycle or walk to school. *International Journal of Environmental Research and Public Health* 18 (21). <https://doi.org/10.3390/ijerph182111651>.
- Forsberg, H., Rutberg, S., Mikaelsson, K., Lindqvist, A., 2020. It's about being the good parent: Exploring attitudes and beliefs towards active school transportation. *International Journal of Circumpolar Health* 79 (1). <https://doi.org/10.1080/22423982.2020.1798113>.
- Frömel, K., Mitás, J., Dygrýn, J., Šafář, M., Groffik, D., Valach, P., 2020. Active travel of Czech and polish adolescents in relation to their well-being: support for physical activity and health. *Int. J. Environ. Res. Publ. Health* 17 (6). <https://doi.org/10.3390/ijerph17062001>.
- González, S.A., Aubert, S., Barnes, J.D., Larouche, R., Tremblay, M.S., 2020. Profiles of active transportation among children and adolescents in the global matrix 3.0 initiative: a 49-country comparison. *Int. J. Environ. Res. Publ. Health* 17 (16), 1–29. <https://doi.org/10.3390/ijerph17165997>.
- Graneheim, U.H., Lundman, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ. Today* 24 (2), 105–112. <https://doi.org/10.1016/j.nedt.2003.10.001>.
- Herrador-Colmenero, M., Villa-González, E., Chillón, P., 2017. Children who commute to school unaccompanied have greater autonomy and perceptions of safety. *Acta Paediatr. Int. J. Paediatr.* 106 (12), 2042–2047. <https://doi.org/10.1111/apa.14047>.
- Kahneman, D., Slovic, S.P., Tversky, A., 1982. *Judgment under Uncertainty: Heuristics and Biases*. Cambridge university press.
- Kim, J., Dunn, E., Rellinger, K., Robertson-Wilson, J., Eys, M., 2019. Social norms and physical activity in american and canadian contexts: a scoping review. *Int. Rev. Sport Exerc. Psychol.* 12 (1), 26–48. <https://doi.org/10.1080/1750984X.2017.1354229>.
- Kostenius, C., Hallberg, J., Lindqvist, A.-K., 2018. Gamification of health education : Schoolchildren's participation in the development of a serious game to promote health and learning. *Health Education* 118 (4), 354–368. <https://doi.org/10.1108/HE-10-2017-0055>.
- Kvale, S., Brinkmann, S., 2009. *Den Kvalitativa Forskningsintervjun, second ed.* Studentlitteratur, Lund.
- Laine, T.H., Duong, N., Lindvall, H., Oyelere, S.S., Rutberg, S., Lindqvist, A., 2022. A reusable multiplayer game for promoting active school transport: Development study. *JMIR Serious Games* 10 (1), e31638. <https://doi.org/10.2196/31638>.
- Larouche, R., Barnes, J.D., Blanchette, S., Faulkner, G., Riazzi, N.A., Trudeau, F., Tremblay, M.S., 2020. Relationships among children's independent mobility, active transportation, and physical activity: a multisite cross-sectional study. *Pediatr. Exerc. Sci.* 32 (4), 189–196.
- Legorburu, I., Idoiaga Mondragon, N., Alonso, I., Berasategi, N., 2022. Why are you allowed to go to school on your own? exploring children's voices on independent mobility. *Child. Soc.* 1 <https://doi.org/10.1111/chso.12559>.
- Li, X., Hu, Q., Liu, J., Nambisan, S., Khattak, A., Lidbe, A., Lee, H., 2021. Pathway analysis of relationships among community development, active travel behavior, body mass index, and self-rated health. *Int. J. Sustain. Transport.* 16 (4), 340–356. <https://doi.org/10.1080/15568318.2021.1872123>.
- Lindqvist, A., Castelli, D., Hallberg, J., Rutberg, S., 2018. The praise and price of pokemon GO: A qualitative study of children's and parents' experiences. *Jmirc Serious Games* 6 (1). <https://doi.org/10.2196/games.8979>.
- Lindqvist, A., Löf, M., Ek, A., Rutberg, S., 2019. Active school transportation in winter conditions: Biking together is warmer. *Int. J. Environ. Res. Publ. Health* (2), 234. <https://doi.org/10.3390/ijerph16020234>.
- Lindqvist, A., Rutberg, S., 2018. One step forward: Development of a program promoting active school transportation. *JMIR Res Protoc* 7 (5). <https://doi.org/10.2196/resprot.9505>.
- Lorenc, T., Brunton, G., Oliver, S., Oliver, K., Oakley, A., 2008. Attitudes to walking and cycling among children, young people and parents: a systematic review. *J. Epidemiol. Commun. Health* (1979-) 62 (10), 852–857.
- Lubans, D.R., Morgan, P.J., Tudor-Locke, C., 2009. A systematic review of studies using pedometers to promote physical activity among youth. *Prev. Med.* 48 (4), 307–315. <https://doi.org/10.1016/j.ypmed.2009.02.014>.
- Lugnet, J., Ericson, Å., Lundgren, M., Wenngren, J., 2020. On the design of playful training material for information security awareness. *CYNIC Proceedings of the Sixth International Conference on Design Creativity* , 239–246. <https://doi.org/10.35199/ICDC.2020.30>.
- Mammen, G., Stone, M.R., Buliung, R., Faulkner, G., 2014. School travel planning in Canada: identifying child, family, and school-level characteristics associated with travel mode shift from driving to active school travel. *J. Transport Health* 1 (4), 288–294. <https://doi.org/10.1016/j.jth.2014.09.004>.
- Masoumi, H., Martin, v.R., Grzegorz, Sierpiński, 2020. Children's independent mobility to school in seven european countries: a multinomial logit model. *Int. J. Environ. Res. Publ. Health* 17 (9149), 9149. <https://doi.org/10.3390/ijerph17239149>.
- Mehdizadeh, M., Nordfjaern, T., Mamdoohi, A.R., Shariat Mohaymany, A., 2017. The role of parental risk judgements, transport safety attitudes, transport priorities and accident experiences on pupils' walking to school. *Accid. Anal. Prev.* 102, 60–71. <https://doi.org/10.1016/j.aap.2017.02.020>.
- Mettler, T., Pinto, R., 2015. Serious games as a means for scientific knowledge transfer - a case from engineering management education. *IEEE Trans. Eng. Manag.* 62 (2), 256–265. <https://doi.org/10.1109/TEM.2015.2413494>.
- Mizdrak, A., Blakely, T., Cleghorn, C.L., Cobiac, L.J., 2019. Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: a modelling study. *PLoS One* 14 (7), 1–17. <https://doi.org/10.1371/journal.pone.0219316>.
- Mueller, N., Rojas-Rueda, D., Cole-Hunter, T., de Nazelle, A., Dons, E., Gerike, R., Nieuwenhuijsen, M., 2015. Health impact assessment of active transportation: a systematic review. *Prev. Med.* 76, 103–114. <https://doi.org/10.1016/j.ypmed.2015.04.010>.
- Öhman, A., 2005. Qualitative methodology for rehabilitation research. *J. Rehabil. Med.* 37 (5), 273–280. <https://doi.org/10.1080/16501970510040056>.
- Oyelere, S.S., Berghem, S.M., Brännström, R., Rutberg, S., Laine, T.H., Lindqvist, A., 2022. Initial design and testing of multiplayer cooperative game to support physical activity in schools. *Educ. Sci.* 12 (2) <https://doi.org/10.3390/educsci12020100>.
- Piatkowski, D.P., Marshall, W.E., Krizek, K.J., 2019. Carrots versus sticks: assessing intervention effectiveness and implementation challenges for active transport. *J. Plann. Educ. Res.* 39 (1), 50–64. <https://doi.org/10.1177/0739456X17715306>.

- Pinto, R., Mettler, T., Taisch, M., 2013. Managing supplier delivery reliability risk under limited information: foundations for a human-in-the-loop DSS. *Decis. Support Syst.* 54 (2), 1076–1084. <https://doi.org/10.1016/j.dss.2012.10.033>.
- Riazi, N.A., Brussoni, M., Vertinsky, P., Faulkner, G., 2021. "Well, you feel more responsible when you're unsupervised": exploring family perspectives on children's independent mobility. *Children-Basel* 8 (3). <https://doi.org/10.3390/children8030225>.
- Rothman, L., Buliung, R., To, T., Macarthur, C., Macpherson, A., Howard, A., 2015. Associations between parents' perception of traffic danger, the built environment and walking to school. *J. Transport Health* 2 (3), 327–335. <https://doi.org/10.1016/j.jth.2015.05.004>.
- Rothman, L., Macpherson, A.K., Ross, T., Buliung, R.N., 2017. The decline in active school transportation (AST): a systematic review of the factors related to AST and changes in school transport over time in north America. *Prev. Med.* <https://doi.org/10.1016/j.ypmed.2017.11.018>.
- Rutberg, S., Lindqvist, A., 2018a. Active school transportation is an investment in school health. *Health Behav. Policy Rev.* 5 (2), 88–97. <https://doi.org/10.14485/HBPR.5.2.9>.
- Rutberg, S., Lindqvist, A., 2018. Children's motivation overcame parental hesitation. active school transportation in sweden. *Health Promot. Int.* <https://doi.org/10.1093/heapro/day083>.
- Savolainen, E., Rutberg, S., Backman, Y., Lindqvist, A., 2020. Long-term perspectives of a school-based intervention to promote active school transportation. *Int. J. Environ. Res. Publ. Health* 17 (14). <https://doi.org/10.3390/ijerph17145006>.
- Skivington, K., Matthews, L., Simpson, S.A., Craig, P., Baird, J., Blazeby, J.M., et al., 2021. A new framework for developing and evaluating complex interventions: update of medical research council guidance. *BMJ Br. Med. J. (Clin. Res. Ed.)* 374. <https://doi.org/10.1136/bmj.n2061>.
- Slovic, P., 1987. Perception of risk. *Science* 236 (4799), 280–285. <https://doi.org/10.1126/science.3563507>.
- South, B., 2007. Combining mandala and the johari window: an exercise in self-awareness. *Teach. Learn. Nurs.* 2 (1), 8–11. <https://doi.org/10.1016/j.teln.2006.10.001>.
- Swedish Transport Administration, 2018. Attityundersökning barns skolvägar (children's routes to school). Retrieved from. <https://www.trafikverket.se/contentassets/799dec75057b45069c9621f395ac39ee/rapport-barns-skolvagar-2018.pdf>.
- Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., et al., 2014. Tracking of physical activity from early childhood through youth into adulthood. *Med. Sci. Sports Exerc.* 46 (5), 955–962. <https://doi.org/10.1249/MSS.0000000000000181>.
- Thomsen, T.U., 2005. Parents' construction of traffic safety: children's independent mobility at risk? In: Thomsen, U.T., Nielssen, L.D., Gudmundsson, H. (Eds.), *Social Perspective on Mobility*. Ashgate, Cornwall, pp. 12–28.
- Trafikanalys, 2019. Mer hälsa för pengarna? slutrapport i fördjupningen av de transportpolitiska målen - hälsa och livsmiljö. rapport. (More health for the money? final report in-depth study of the transport policy goals - health and living environment). Retrieved from. [https://www.trafa.se/globalassets/rapporter/2019/rapport-2019\\_15-mer-halsa-for-pengarna-slutrapport-i-fordjupning-av-de-transportpolitiska-malen-halsa-och-livsmiljo.pdf](https://www.trafa.se/globalassets/rapporter/2019/rapport-2019_15-mer-halsa-for-pengarna-slutrapport-i-fordjupning-av-de-transportpolitiska-malen-halsa-och-livsmiljo.pdf).
- Tranter, P., Whitelegg, J., 1994. Children's travel behaviours in canberra: car-dependent lifestyles in a low-density city. *J. Transport Geogr.* 2 (4), 265–273. [https://doi.org/10.1016/0966-6923\(94\)90050-7](https://doi.org/10.1016/0966-6923(94)90050-7).
- Wilson, M., Hash, J., 2003. Building an information technology security awareness and training program. *NIST Spec. Publ.* 800–850. Retrieved from. <https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-50.pdf>.
- World Health Organization, 2020. WHO guidelines on physical activity and sedentary behaviour. Retrieved from. <https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf>.
- Yang, X., Telama, R., Hirvensalo, M., Tammelin, T., Viikari, J.S.A., Raitakari, O.T., 2014. Active commuting from youth to adulthood and as a predictor of physical activity in early midlife: the young finns study. *Prev. Med.* 59, 5–11. <https://doi.org/10.1016/j.ypmed.2013.10.019>.