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Adolescents' Perspectives on Smartphone Applications for Physical Activity Promotion: Insights from Focus Group Discussions

Adolescents' Views on Physical Activity Apps: Insights from Focus Group

Perspectivas de los adolescentes sobre las aplicaciones de teléfonos inteligentes para la promoción de la actividad física: Perspectivas de los grupos de discusión

La opinión de los adolescentes sobre las aplicaciones de actividad física: conclusiones de un grupo de discusión

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Abstract. Purpose: This study explores how children and adolescents perceive physical activity (PA) and PA apps. We aim to understand their perceptions, past experiences, and expectations of PA and PA apps. Methods: Participants (N=39) aged 11-15 from five European countries: Netherlands (NL), Poland (PL), Portugal (PT), Spain (ES), and Sweden (SWE) participated in the study. They provided insight regarding Behaviour Chance Techniques (BCTs) that enhance app engagement. Results: The results offer valuable insights for creating fun and engaging adolescent PA apps that meet diverse user preferences. They also provide invaluable guidance for designing PA apps that boost adolescents' enjoyment, fun, and engagement while considering a broad spectrum of user preferences. Key BCTs identified as significantly impacting app engagement included self-monitoring, rewards, feedback, social support, action planning, and reminders - preferences and suggestions varied by gender, age, and PA levels. Conclusions: Findings in the present study inform the MOVE4FUN project that contributes to understanding how BCTs promote sustained PA in adolescents. It underscores the pivotal role of personalised app design and a supportive climate in fulfilling individual needs and intrinsic goals. These insights contribute significantly to developing educational tools that encourage regular PA and nurture the holistic development of physically educated citizens.
Keywords: Children and adolescents, Physical Activity; PA Apps; Behaviour Chance Techniques.

Resumen. Propósito: Este estudio explora cómo los niños y adolescentes perciben la actividad física (AF) y las aplicaciones de AF. Nuestro objetivo es comprender sus percepciones, experiencias pasadas y expectativas de AF y aplicaciones relacionadas. Métodos: Participaron en el estudio 39 participantes de 11 a 15 años de cinco países europeos: Países Bajos (NL), Polonia (PL), Portugal (PT), España (ES) y Suecia (SWE). Proporcionaron información sobre las Técnicas de Cambio de Comportamiento (TCC) que mejoran la participación en las aplicaciones. Resultados: Los resultados ofrecen información valiosa para la creación de aplicaciones de AF divertidas y atractivas para adolescentes, que satisfacen diversas preferencias de usuario. También brindan orientación invaluable para diseñar aplicaciones de AF que aumenten el disfrute, la diversión y la participación de los adolescentes, teniendo en cuenta un amplio espectro de preferencias de usuario. Las TCC identificadas como impactantes en la participación en las aplicaciones incluyeron el autocontrol, las recompensas, la retroalimentación, el apoyo social, la planificación de acciones y los recordatorios; las preferencias y sugerencias variaron según el género, la edad y los niveles de AF. Conclusiones: Los hallazgos en este estudio informan al proyecto MOVE4FUN, que contribuye a comprender cómo las TCC promueven la AF sostenida en adolescentes. Destaca el papel crucial del diseño personalizado de aplicaciones y un clima de apoyo para satisfacer las necesidades individuales y metas intrínsecas. Estos conocimientos contribuyen significativamente al desarrollo de herramientas educativas que fomentan la AF regular y fomentan el desarrollo integral de ciudadanos físicamente educados.
Palabras clave: Niños y adolescentes, Actividad Física; Aplicaciones de AF; Técnicas de Cambio de Comportamiento.

Resumo. Objetivo: Este estudo explora como crianças e adolescentes percecionam a atividade física (AF) e aplicações de AF. O objetivo é compreender as suas perceções, experiências passadas e expetativas em relação à AF e às aplicações de AF. Métodos: Participaram no estudo 39 participantes com idades entre 11 e 15 anos, provenientes de cinco países europeus: Países Baixos (NL), Polónia (PL), Portugal (PT), Espanha (ES) e Suécia (SWE). Foram fornecidos insights sobre Técnicas de Mudança de Comportamento (TCCs) que melhoram a interação nas aplicações. Resultados: Os resultados oferecem perceções valiosas para a criação de aplicações de AF divertidas e envolventes para adolescentes, atendendo a diversas preferências dos utilizadores. Além disso, fornecem orientações inestimáveis para o design de aplicações de AF que aumentam o prazer, a diversão e a participação dos adolescentes, considerando um amplo espectro de preferências dos utilizadores. As TCCs identificadas como impactantes na participação nas aplicações incluíram autocontrolo, recompensas, feedback, apoio social, planeamento de ações e lembretes; as preferências e sugestões variaram consoante o sexo, idade e níveis de AF. Conclusões: Os achados deste estudo informam o projeto MOVE4FUN, contribuindo para entender como as TCCs promovem a AF sustentada em adolescentes. Destaca-se o papel crucial do design personalizado de aplicações e de um clima de apoio para satisfazer as necessidades individuais e metas intrínsecas. Estes insights contribuem significativamente para o desenvolvimento de ferramentas educacionais que incentivam a prática regular de AF e promovem o desenvolvimento holístico de cidadãos fisicamente educados.
Palavras-chave: Crianças e adolescentes, Atividade Física; Aplicações de AF; Técnicas de Mudança de Comportamento.

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Introduction

Physical inactivity is a significant global public health issue and has been linked to many adverse health outcomes, including obesity, cardiovascular disease, diabetes, and some cancers (Guthold, Stevens, Riley, & Bull, 2020; Park, Moon, Kim, Kong, & Oh, 2020; USDHHS, 2018). Despite the well-established benefits of regular PA (Warburton & Bredin, 2017; WHO, 2018), recent reports have highlighted that only a small percentage of European adolescents aged between 11 and 15 achieve the recommended levels of PA (Guthold et al., 2020; OECD & WHO, 2023). This emerging trend is a cause for concern, as inadequate levels of PA during childhood and adolescence have been linked to the development of sedentary behaviours in adulthood (Telama et al., 2005). Consequently, implementing effective interventions to promote PA and counteracting age-related declines is paramount (Marques et al., 2020).

The development of interventions that promote and support the practice of PA in children and adolescents between the ages of 11 and 15 is a priority since it is in this age group that the decline in participation begins, particularly in girls (OECD & WHO, 2023; van Sluijs et al., 2007). Smartphones have emerged as a promising tool in health-related interventions, including promoting PA (Domin et al., 2021; He et al., 2021; Petersen et al., 2020). Smartphones are the primary mode of Internet access for many children and adolescents, providing continuous connectivity without the constraints of time and place. Approximately 70% of European children and youth own smartphones and use them to access the internet, making smartphones an integral part of their daily lives. Typical activities include watching videos, listening to music, communicating with friends and family, visiting social networking sites, and playing online games (Salway et al., 2023; Takano, 2015). These figures highlight smartphones' pervasive presence among adolescents and their integration into daily routines. Smartphone applications (apps) have gained popularity as cost-effective interventions that can reach a large population (Aznar Díaz, Cáceres Reche, Trujillo Torres, & Romero Rodríguez, 2019; Schoeppe et al., 2016). These apps can engage users and provide personalised support, encouraging individuals to adopt and maintain active lifestyles (Aznar Díaz et al., 2019).

By incorporating evidence-based techniques, such as goal-setting, self-monitoring, feedback, social support, and behaviour-change strategies, these apps can enhance their effectiveness in motivating individuals to engage in regular PA (Nibbeling et al., 2021).

Using persuasive strategies in exercise apps allows for a more tailored and user-centered approach. For instance, personalised goal-setting features can help individuals set specific targets based on their fitness levels and preferences. Including self-monitoring tools enables users to track their progress, providing a sense of accomplishment and accountability (Sporrel et al., 2020). Feedback mechanisms, such as performance summaries or rewards, can reinforce positive behaviours and encourage continued participation (Fanning et al., 2012; Xiao et al., 2022). Moreover, social support features within these apps can facilitate peer interaction and virtual communities, fostering users' sense of belonging and motivation (Petersen et al., 2020).

The wide availability of various smartphone apps to promote active and healthy lifestyles offers options for adolescents. However, their effectiveness remains to be determined (Gowin et al., 2015; Nibbeling et al., 2021). Therefore, it is crucial to consider children and adolescents' interests and factors that promote their involvement in PA based on behavioural change techniques BCTs (Domin et al., 2021; He et al., 2021) and adhering to PA recommendations (Bull et al., 2020).

The study aims to explore children's and adolescents' perceptions, past experiences, and expectations regarding physical activity (PA) and PA apps, focusing on understanding their enjoyment and engagement with PA and PA apps. Additionally, the study seeks to investigate adolescents' perspectives on including Behavior Change Techniques (BCTs) in PA apps and identify their expectations for developing an ideal PA app. Furthermore, the study aims to involve potential end-users in the design process of an app for the MOVE4FUN Erasmus+ Sport project, which aims to promote active lifestyles among children and adolescents aged 11-15 years across five European countries: Netherlands (NL), Poland (PL), Portugal (PT), Spain (ES), and Sweden (SWE). The findings of this study are expected to provide valuable insights for developing effective and engaging PA apps that promote sustained PA among adolescents.

Method

Participants

Children and adolescents between 11 and 15 years old (M_{age} =12.9 years, SD 1.2 years) were informed through a convenience sample recruited from schools, sports clubs, and friends. However, in certain instances, the recruitment approach varied by country. For example, the study was promoted in Poland through the Institute of Sport's media channels like Facebook and Instagram. In MOVE4FUN-involved countries, individuals interested in participating were required to complete an informed consent form, and the same procedure applied to their parents or legal guardians. The following criteria had to be met for inclusion: owning a smartphone, ensuring the representativeness of the focus groups' age, sex, and PA-levels profile self-reported (e.g., active or inactive), meeting the World Health Organization (WHO) recommendations for PA (Bull et al., 2020).

This is a sample of 39 participants from all consortium countries, 16 males and 23 females (NL, N=7, five females; PL, N=10, five females; PT, N=7, four females; ES, N=6, three females; SWE, N=9, six females). The sample was diverse regarding PA levels, with 25 participants meeting the World Health Organization (WHO) recommendations for PA (Bull et al., 2020), while 14 were considered

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inactive[1]. This allowed for diverse perspectives on PA apps and their potential impact on PA levels to be explored. Additionally, the study had a mix of participants from both urban and rural areas, with 28 living in urban zones and 11 living in rural areas.

MOVE4FUN Project

This study is part of the larger MOVE4FUN Erasmus+ project nº 101050871 to promote active lifestyles among children and adolescents aged 11-15 years in five countries and their organisations: NL, Cui Cui Studios; PL, Institute of Sport – National Research Institute, coordinator of the project, PT, CIDEFES, Universidade Lusófona; ES, EUNIK; SWE, UMEÅ University, which was initiated in May of 2022, and will end on April of 2025. The MOVE4FUN project aims to address insufficient PA participation among European adolescents through a mobile application that offers innovative and evidence-based content. The project aligns with new WHO guidance, emphasising that every step counts. By combining evidence-based content with fun, game-based programs in a mobile app, MOVE4FUN aims to engage adolescents in PA. The project also prioritises social inclusion, enabling access for populations with limited infrastructure or facing unusual epidemic restrictions.

The study focuses on involving end users, specifically children and adolescents, in the design of the PA app. The research utilised the focus group method to gather valuable insights and input from the target audience—the analysis of the focus group discussions aimed to address three Research Objectives (ROs).

RO1: The first objective aimed to describe adolescents' experiences and expectations towards PA and PA apps. This involved exploring their past experiences using PA promotion apps and understanding their expectations towards an ideal app.

RO2: The second objective focused on capturing adolescents' experiences associated with PA and app usage. The goal was to describe the extent to which children and adolescents found PA engaging and enjoyable and to assess their experiences and perceptions of using apps concerning fun and enjoyment.

RO3: The third objective aimed to explore adolescents' views on including BCTs in the apps. Specifically, it sought their opinions on incorporating BCTs such as goal setting and action planning, feedback, self-monitoring, social support, rewards, and reminders.

Study Design and Procedure

Multiple focus groups (i.e., 5) were conducted to gain insight into the underlying assumptions, stimulate participant interaction, and gather additional insight on the topic of interest. The focus groups were conducted in November 2022 in each respective country and consisted of six to ten participants. The discussions followed a semi-structured interview script guided by the recommendations for appropriate focus group discussions (Krueger & Casey, 2015).

The script was initially written in English and then translated into the native languages of each country. Research teams from each country reviewed and validated the translated script to ensure clarity and understanding. The discussions were audio-recorded and transcribed verbatim for analysis, with all data anonymised to ensure confidentiality.

Informed Consent

This study prioritised ethical considerations to ensure the protection and welfare of children and adolescents. All participants were required to sign a consent form before participating in the focus group discussion, while parents also provided authorisation through a separate consent form. This ensured that participants were fully informed about the purpose of the study, the nature of their involvement, and their rights to leave the study at any time. The confidentiality of the discussion was also emphasised to ensure that participants felt safe and comfortable sharing their thoughts and opinions.

Conducting the Focus Groups

The focus groups were held in a comfortable private room where participants could discuss without external distractions. Each focus group lasted 60 to 90 minutes and was moderated by one or two researchers. The moderators introduced themselves and explained the study's purpose, the participation rules, and the session's audio recording.

The discussion began with an icebreaker question to create a relaxed and comfortable environment for the participants. The moderators then introduced the first question from the script, allowing participants to share their experiences, perceptions, and attitudes (e.g., What kind of PA apps do you know?). The moderators ensured that the discussion stayed on topic and that all participants had an equal opportunity to share their opinions. The focus group discussion began with a sequence of questions aimed at gathering information about participants' frequency of smartphone use, the purposes for which they use their smartphones, and which apps they use the most for PA (Which one do you like more and why?). This initial step gave the moderators a basic understanding of the participants' experiences with smartphone apps for PA. In the next phase, participants were asked to answer questions about their experience with smartphone apps for PA. To further discussion, the moderator presented trigger materials and provided visual examples of the commonly found elements in commercial and research-oriented applications designed to encourage PA. These components included goal setting and planning, coaching and training programs, feedback, social support and comparison (in-app social profile and challenges), sharing workout results via social networks, location tracking, automatic activity recognition, digital avatar and coach, rewards (virtual), and reminders (e.g., What

[1] Meeting the recommendations - active (A); inactive or not active (NA)

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kind of PA goals would you like to set? Do you like the possibility of choosing preselected activities? Or including your activities?). This step was intended to prompt participants to discuss their experiences and preferences regarding the various app components. The focus group discussion was audio-recorded and transcribed for later analysis.

Data Analysis

The transcripts were analysed using a thematic approach to identify themes, patterns, and discussion insights. The data analysis was guided by a final codebook developed based on the coding categories identified through a collaborative process involving all team members. After the focus groups were completed, the recorded interviews were transcribed verbatim. The data were then analysed using inductive content analysis involving six stages (Braun & Clarke, 2006). Three investigators were responsible for the first content analysis process in Portugal. The researchers employed the inductive approach in this study. The inductive version created the codebook by directly examining the data. This approach is particularly suitable for exploratory or discovery-oriented projects, allowing themes and patterns to emerge organically from the data (Morgan & Hoffman, 2018). First, they familiarised themselves with the data by reading the transcripts multiple times. Second, they generated initial codes through open coding and extracted verbatim quotes. Third, they searched for themes based on the discussion topic and emerging ones from the extracts. Fourth, they reviewed the initial codes and identified latent themes, which they combined into preliminary themes. Fifth, they refined and developed the themes in subsequent iterations. Finally, they consolidated the identified themes under fewer themes. This process allowed for comprehensive data analysis, ensuring all relevant themes were identified and refined to reflect the interviewee's perspectives accurately. The research team reviewed the transcripts and identified the discussions' themes, patterns, and insights. The final codebook was achieved through an interactive process, ensuring that all team members coded the data consistently and accurately (Reyes et al., 2021). The NVIVO 1.7.1 software (Lumivero, US) was used to manage data during the analysis process.

Results

In this study, we delve into the insights gained from children and adolescents regarding PA and PA apps, as well as their preferences and expectations for such applications. To ensure clarity, we've organised the findings according to the distinct research objectives of the study. In the first objective, we focused on understanding children and adolescents' past experiences with PA promotion apps and their expectations for ideal PA apps. The key themes identified include Exercise Ideas, Social Comparison, Beyond PA, Wearables, Lack of Time, Nudges Separation, and Instructions. Children and adolescents desired more precise guidance within apps to facilitate behaviour change, such as tailored instructions, height and weight calculations, and habit-improvement suggestions.

Additionally, we found that children and adolescents express keen interest in certain thematic elements within PA apps. These include themes related to popularity, sports-oriented approaches, and practical tips. These thematic elements resonate with their preferences and expectations for engaging with PA apps. They frequently turn to these apps to discover new exercise ideas and draw inspiration from various platforms, including social media platforms like TikTok. Furthermore, they highly value apps that facilitate weight tracking and gamified experiences, such as Pokémon Go, as these elements enhance their engagement with physical activity.

The second objective assessed children and adolescents' engagement and enjoyment levels concerning PA and app usage. The prominent themes highlighted by participants included Competition, App Tailoring, Challenges, and Customized apps. Adolescents also expressed interest in themes such as Popularity, Social Media, Friends and Family, Fun, Health, Safety, and the connection between PA and sports.

The third objective aimed to explore children and adolescents' views on incorporating Behavior Change Techniques (BCTs) in PA apps. The most frequently mentioned BCTs were Self-Monitoring, Rewards, Feedback, Social Support, Action Planning, and Nudges/Reminders. These findings offer valuable insights for developing effective PA apps to promote sustained PA engagement among adolescents.

Next, we will present a table (1) with themes, examples, and quotations.

Table 1.
Themes explanation, categories, and quotations of the consortium, Focus Group.

RO	Categories	Quotations
RO1: Adolescents' Experiences and Expectations Regarding PA and PA App	- Seeking exercise ideas and tips	"The one from the monster jump I liked because there were exercises I had never seen or done." PT Female 3[2], NA[3].
	- Gaining inspiration from TikTok	"Yes, but that is what you can find inspiration from others if you see how they do it on social media. Type TikTok. Then you can get motivation from them. If, for example, they post what sports they do or something. Then you might not have this motivation to go, but they can make you still be motivated…" SE Female 1, A.
	- Utilizing apps for weight tracking	"I have some app that counts steps, and you get points. Then, when you get points, you can step up. Then you can get something." SE Female 1, A "Pokémon GO, (something like) playing a game." PL Female 6, NA.

[2] Participant identification.

[3] Active (A) inactive or non-active (NA).

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	- Engaging in gamified experiences like Pokémon Go	
	- Enjoying challenges and achievements	
RO2: Enjoyment and Engagement of PA and App Usage for Adolescents	- Customizing app features	"I have some app that counts steps, and you get points. Then, when you get points, you can step up, and then you can get something." - SE Female 1, A "It would be good to have an 'adult theme' and a 'child theme' so everybody can feel good with the app." - ES Male 3, NA
	- Engaging in competition	"You can play with your group against other groups in the world. The groups will be ranked. You also have a personal ranking." - NL Female 3, A "The most interesting would be the number of people installing the App because that is many people you can compare yourself to." - NL Male 1, NA
	- Social interaction	"Yes, how to click around on it and color." - SE Female 2, NA
	- Customizable app themes	
RO3: Adolescents' Opinions on Including BCTs in the App	- Emphasizing the importance of action planning - Valuing self-monitoring for tracking progress - Expressing the desire for rewards and incentives	"To have a (type of) planning visible only for us. For example, planning your training, to know what and when." - PT Female 3, A "I prefer the A because it has the maps; I find fascinating GPS information…" - PT Female 3, A
	- Seeking social support and interaction	"You should have sort of a trophy cabinet. With some colors. If you click on a trophy, you can see what you have done to receive it." - NL Female 2, NA "There could be two categories, one you go into as an individual and the other that group." - PL Male 6, NA
	- Recognizing the motivational aspects of competition	"Because you can see the level of others to play, and you can challenge other people." - SP Male 1, A
	- Appreciating feedback for progress - Setting personalized goals	"I like it because you can see where you went." - NL Male 1, NA "It would be interesting when we enter the application and create the account, create our goals." - PT Female 3, A
	- Preferring customizable nudges and reminders	"I would have appreciated it if I had received a notification that there are now 10 minutes left until your training session for the day…" - SE Male 4, A

Discussion

Our study provided deep insights into the perceptions, experiences, and expectations of children and adolescents regarding PA apps, revealing a nuanced understanding of their interactions with these tools. One significant finding was the substantial impact of PA apps in broadening the exercise horizons of children and adolescents, echoing previous research emphasising the motivational power of offering diverse exercise options (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). This diversification was notably influenced by the pervasive influence of social media platforms, particularly TikTok, which played a significant role in motivating PA through social comparison (Direito et al., 2014). However, challenges arose with wearables, such as discomfort and accuracy issues, underscoring the need for improvements to enhance user experiences and foster long-term engagement (Middelweerd et al., 2015).

Another noteworthy aspect was the emergence of time constraints as a significant challenge, prompting the call for more efficient app interfaces to accommodate the busy schedules of children and adolescents (Ruseski, Humphreys, Hallmann, & Breuer, 2011). Personalised nudges, including tailored reminders and notifications, were deemed essential for initiating and sustaining regular PA participation, with a caution against overwhelming users to prevent disengagement (Forberger, Wichmann, & Comito, 2022).

In terms of expectations, precision and actionable guidance were highly valued by adolescents, who sought specific instructions to enhance their PA habits. They also preferred novelty in PA apps, indicating that new and engaging elements effectively ignited motivation and encouraged participation.

Furthermore, adolescents desired tailored recommendations for improving their PA routines, emphasising the importance of app popularity and a sports-specific approach in promoting PA among this demographic (Soliman et al., 2022). Curiosity about uncovering tips and insights related to PA also surfaced, presenting opportunities to enhance engagement.

In conclusion, our comprehensive exploration underscores the importance of offering diverse exercise options, facilitating beneficial social comparisons, integrating multifaceted app features, addressing wearable challenges, and implementing efficient interfaces and tailored nudges to craft engaging and effective PA apps for adolescents. Meeting their expectations for specific instructions, novelty, and personalised suggestions can further invigorate their regular PA engagement. Moreover, considering the app's popularity, a sports-centric approach and the availability of valuable tips are crucial to cater to adolescents' unique preferences and motivations.

In our second objective, we aimed to delve into children's and adolescents' perceptions, experiences, and expectations regarding PA apps. Our findings revealed a multifaceted understanding of their interactions with these platforms, with significant insights uncovered. PA apps substantially impacted expanding exercise horizons, aligning with prior research emphasising the motivational power of offering diverse exercise options (Torres et al., 2021). This diversification was notably influenced by the pervasive influence of social media platforms, particularly TikTok, which played a significant role in motivating PA through social comparison (Gu, Gao, & Li, 2022). Challenges arose with wearables, such as discomfort and accuracy issues,

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underscoring the need for improvements to enhance user experiences and foster long-term engagement (Middelweerd et al., 2015).

Moreover, adolescents stressed the importance of precision and actionable guidance in PA apps, seeking specific instructions to enhance their PA habits. They also expressed a preference for novelty, indicating that new and engaging elements were effective in igniting motivation and encouraging participation. Tailored recommendations for improving PA routines were desired, emphasising the importance of app popularity and a sports-specific approach in promoting PA among this demographic (Soliman et al., 2022). Personalised nudges, including tailored reminders and notifications, were deemed essential for initiating and sustaining regular PA participation, with a caution against overwhelming users to prevent disengagement (Forberger et al., 2022). Time constraints emerged as a significant challenge, prompting the call for more efficient app interfaces to accommodate the busy schedules of children and adolescents (Ruseski et al., 2011). In conclusion, our comprehensive exploration underscores the importance of offering diverse exercise options, facilitating beneficial social comparisons, integrating multifaceted app features, addressing wearable challenges, and implementing efficient interfaces and tailored nudges to craft engaging and effective PA apps for adolescents. Meeting their expectations for specific instructions, novelty, and personalised suggestions can further invigorate their regular PA engagement (Lakicevic et al., 2020).

Our third objective explored the perspectives of children and adolescents regarding BCTs in PA apps. By analysing the data, we can gain valuable insights into which BCTs are essential for enhancing engagement and effectiveness in PA apps for this demographic. The results revealed that the participants repeatedly mentioned several key BCTs, underscoring their importance in PA apps (Domin, Spruijt-Metz, Theisen, Ouzzahra, & Vögele, 2021; Yau et al., 2022). These key BCTs included Self-Monitoring, Rewards, Feedback, Social Support, Action Planning, and Nudges/Reminders (Bunn et al., 2018; Direito et al., 2014). Children and adolescents consistently emphasised the significance of self-monitoring within PA apps (Thornton et al., 2021). This BCT allows users to track their PA levels and progress, enhancing self-awareness and motivation (Domin, Ouzzahra, & Vögele, 2022). By incorporating self-monitoring features, PA apps can empower adolescents to take more control over their fitness journeys.

Rewards emerged as another crucial BCT that motivated adolescents to engage in PA. The prospect of receiving tangible or intangible rewards effectively maintained their enthusiasm and commitment. Reward systems have positively impacted adolescent motivation and behaviour change (Bunn, Navalta, Fountaine, & Reece, 2018). Feedback was recognised as a pivotal BCT that helped adolescents understand their progress and areas for improvement. Adolescents valued feedback mechanisms that provided insights into their achievements and how they could better their PA performance (Domin et al., 2022). This BCT fosters self-regulation and encourages regular PA participation (Tong et al., 2022). Social Support was another essential BCT (Hosseinpour & Terlutter, 2019; Laird et al., 2016).

The ability to connect with friends and family through PA apps and engage in shared activities was seen as a motivating factor. Social interaction through the app was an important form of encouragement and motivation for adolescents, particularly in setting and achieving PA goals. Children and adolescents valued the importance of action planning and nudges/reminders as they allowed for adequate scheduling and organisation of PA activities (Domin et al., 2022). However, balancing these nudges from becoming intrusive and annoying was essential, too, potentially leading to app avoidance (Fröberg, 2017). While some considered social comparison beneficial, it was important to maintain a balance. Excessive social comparison could negatively affect children and adolescents' motivation, especially when comparing themselves to highly active peers (Hosseinpour & Terlutter, 2019; Santos Labrador, 2023). Children and adolescents' preferences and suggestions for PA apps varied based on sex, age, and PA levels (Jee et al., 2021). Girls prioritised social aspects and customisation options, while boys focused more on gamification and competitive elements. Younger adolescents favoured fun and interactive features, while older adolescents were more inclined toward data tracking and feedback (Soliman et al., 2022). These variations emphasised the importance of tailoring PA apps to meet different adolescent groups' diverse needs and preferences (Domin et al., 2021).

This study is not without limitations

The focus group discussions included 6-10 participants from each of the five countries, totaling 39 participants. The generalizability of the findings to other cultural and geographical contexts may be limited due to the specific characteristics of the participant sample. Nonetheless, the **study's major Strengths** relate to the in-depth qualitative analysis by delving deeply into the perspectives and experiences of the participants with PA apps. This method facilitated a thorough analysis, capturing nuanced data and providing rich insights that quantitative methods might overlook. Another key strength of the study lies in its active engagement with the target population. Participants were given a platform through focus group discussions to express their views and contribute to the research findings. This participant-centered approach underscores the importance of including the voices of those directly affected by the research topic. Furthermore, the multi-country sample is also a significant strength, as it included participants from five European countries, resulting in a diverse and varied sample. This diverse representation allows for a more comprehensive understanding of the experiences and perspectives of adolescents across different cultural and geographical contexts.

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Conclusion

Following the first objective, we delved into adolescents' perceptions of PA apps, and the results highlight that they value diversity, app personalisation, and multifaceted features. They seek inspiration from social media and prefer apps beyond traditional PA measures. Wearables, while appreciated, need improvements in terms of comfort and compatibility. Results emphasise the significance of providing efficient app interfaces and personalised nudges to accommodate adolescents' busy schedules while avoiding annoyance for children and adolescents.

We also explored the enjoyable aspects of PA apps for adolescents (second goal). They find engagement and fun in customisation, the balance of social interaction and privacy, and the introduction of novelty and challenge in-app features. However, potential negative impacts, such as excessive competition and comparison, must be carefully managed through gamification techniques to avoid adverse psychological effects.

Results from the third goal of the study highlight and emphasize key BCTs for enhancing app engagement. Self-monitoring, rewards, feedback, social support, action planning, and nudges/reminders emerged as pivotal BCTs for the participants in these focus groups. Preferences and suggestions varied based on sex, age, and PA levels, emphasising the need for tailored app design.

The paramount significance of this research is its pursuit of providing a comprehensive understanding of the factors that shape children and adolescents' interactions with PA apps. These insights are a valuable foundation for designing evidence-based, pedagogically sound tools. These tools aim to encourage regular PA and nurture the development of well-rounded, physically educated citizens.

Declarations

Ethics approval and consent to participate: Ethical approval was granted by the Institute of Sport – National Research Institute (KEBN-22-74-MS).

Consent for publication

Not available

Availability of data and materials

There are some legal restrictions on sharing data that contain potentially identifying or

sensitive personal information on children and adolescents in Portugal and Sweden.

The data is held officially by each consortium and is available upon request.

Competing interests

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