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Review

Digital components and interaction types in counseling interventions for childhood and adolescent obesity: A systematic review

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ABSTRACT

Objectives: Childhood and adolescent obesity are an increasing global health concern. This study aimed to evaluate the effectiveness of digital components and interaction types in counseling interventions for prevention and treatment.

Methods: All studies were searched in online databases and grey literature, including PubMed (Medline), Web of Science, CINAHL, Scopus, IEEE Xplore Digital Library, Journal of Medical Internet Research (JMIR), MedNar, EBSCO Open Dissertations. The search period is from inception to June 2023, and the languages are Finnish, English and Swedish. The research quality was evaluated using the web-based data management system Covidence for prevalence studies. The study protocol was registered with PROSPERO (registration number: CRD42021247595).

Results: In this review, 4,407 studies were screened, and 22 were included. These involved 3,433 participants and 264 child-parent pairs. The digital approaches included multicomponent elements like internet platforms, text messaging, video conferencing, online communities, wearable technology, and mobile apps, allowing one-way, two-way, and face-to-face interactions. Two studies showed statistically significant effects of treatment on BMI and waist-to-hip ratio. Most interventions reported positive outcomes, with no significant differences between groups, and none showed null effects during follow-up.

Conclusions: Digital multicomponents like mobile apps and wearables can help obese children and adolescents adopt healthier lifestyles. While these interventions show promise for obesity management, further research is needed to assess their effectiveness, particularly regarding nurses' perspectives.

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What is know?

- Childhood and adolescent obesity represent a significant global health concern that is increasingly escalating.
- Excessive weight adversely affects the quality of life, self-esteem, and body image, contributing to social stigma. Furthermore, it increases the risk of cardiovascular diseases, neurodegenerative disorders, type 2 diabetes, and metabolic syndrome as individuals age.
- Innovative solutions are imperative for tackling the persistent public health challenge of childhood and adolescent obesity. The implementation of preventive measures is crucial for mitigating economic burdens, emphasising the urgency for prompt action.

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What is new?

- Interactive technologies have the potential to advance the development of more effective and sustainable counseling methods aimed at safeguarding the health of children and adolescents from the adverse effects of overweight and obesity.
- Technology-based interventions, such as mHealth apps, telehealth, and internet-based curricula, reduce the logistical barriers, making them suitable for underserved populations.
- High engagement, satisfaction, and feasibility can lead to meaningful improvements in weight management (BMI values) and lifestyle behaviors as nutrition. Still, their comparative effectiveness and long-term impact require further investigation.
- Nurses can significantly contribute by using digital multicomponents to aid children and adolescents through programs that improve adherence and compliance.

1. Introduction

Childhood and adolescent obesity are a major global health problem that is on the rise. The WHO has identified obesity as one of the major health challenges facing young people in the 21st century [1]. According to the international Health Behavior in School-aged Children study [2], about 21% of 15-year-old adolescents worldwide are overweight or obese, with higher rates among boys (25%) than girls (16%). Nearly a quarter of adolescents are overweight in the United States (US) [3]. In Asia, the prevalence of obesity is 5.8% in children aged 5–11 years and 8.6% in adolescents aged 12–19 years [4]. In the European Union, more than a quarter of boys (28.7%) and girls (26.5%) are overweight or obese [5].

Being overweight or obese can negatively impact quality of life [6], self-esteem [7] and body image [8]. It can also lead to stigmatisation by others [9]. In addition, being overweight or obese is associated with an increased risk of heart disease, neurodegenerative diseases, type 2 diabetes, metabolic syndrome and other health problems later in life [10,11]. Adolescence is a crucial period when health behaviors are formed and consolidated. It is essential for adolescents to adopt healthy lifestyles to ensure proper growth and development [2]. In addition, obesity rates are increasing worldwide, leading to higher healthcare costs and premature deaths. Preventive measures are essential to reduce the economic impact of this problem, so it is important to act [12].

Encouraging people to adopt healthy lifestyles is a complex process influenced by various physical, psychological, social and environmental factors [13]. Despite public health efforts, promoting healthy lifestyle behaviors remains a challenge that requires innovative solutions now and beyond [14]. Given the increasing incidence of obesity, there is an urgent need for effective interventions, such as youth-friendly lifestyle guidance and counseling. Information and communication technologies, including personal digital assistants, computers and mobile devices, can be used to deliver effective health interventions. This can help improve body fat, promote adherence to healthier dietary patterns, and increase physical activity and exercise intensity [15].

Previous research indicates that internet-based interventions are notably effective in facilitating knowledge acquisition, enhancing health behaviors, and sustaining overall well-being among adults [15,16]. Digital tools, including web-based programs, SMS notifications, and smartphone reminders, present significant opportunities to engage a vast audience, particularly benefiting obese children, adolescents, and their parents. Such instruments can improve follow-up rates and adherence, thereby providing scalable options for behavior modification [17,18]. Furthermore, techniques such as 'ask the expert' features and discussion forums have demonstrated moderate success in fostering engagement and promoting enduring health behaviors [19]. The review conducted by Porri et al. [20] highlights the significance of digital tools, encompassing mobile applications, telemedicine, and interactive platforms, in obesity counseling for children and adolescents. Utilising behavior tracking tools, goal-setting, and personalised feedback, these interventions can successfully tackle barriers to care, boost engagement, and enhance health outcomes. They also help decrease unnecessary hospital visits and readmissions, while facilitating the early identification of potential health concerns and promoting preventive care strategies. Furthermore, digital interventions produce significant patient data that can guide evidence-based practices and policy-making [21]. Interactive approaches, such as expert consultations, discussion forums, and group support, further bolster these programs, ensuring they remain accessible and effective for diverse populations [20]. Moreover, digital tools empower healthcare professionals to utilise scalable and customisable applications for managing dietary habits, physical activity, sleep, and screen time while fostering direct communication between families and healthcare providers [22]. The findings underscore the urgent necessity to integrate digital solutions into obesity counseling to ensure scalable, personalised, and equitable care delivery.

Healthcare professionals, particularly nurses, play a crucial role in addressing childhood and adolescent obesity globally. Frequently the first point of contact in healthcare settings, nurses are critical in implementing community initiatives and advocating for policy changes to improve overall health. They emphasise early detection, prevention, and management of obesity by providing education, counseling, and support to promote healthy lifestyle choices. Furthermore, nurses participate in community interventions and champion policies that create healthier environments [23].

Addressing childhood and adolescent overweight is vital for national economic health, and digital interventions further advantage by alleviating geographical and temporal barriers, thus providing equitable access [24]. They also help lessen the risk of severe health issues, such as diabetes and heart disease, while enhancing children's and adolescents' self-esteem and mental well-being [25]. However, a comprehensive systematic review of obesity in children and adolescents are still lacking. This review aimed to evaluate the effectiveness of digital components and interaction types in counseling interventions for childhood and adolescent obesity. The specific research question for this review was what are the digital components and interaction types used in counseling interventions in obese children and adolescents?

2. Methods

2.1. Review design

This review was conducted according to the guidelines of the Joanna Briggs Institute [26] and the Preferred Reporting Items for Systematic Reviews (PRISMA) statement. The selection process for the included articles was reported according to the PRISMA guidelines [27]. The review protocol was registered in PROSPERO (CRD42021247595).

2.2. Literature search

Data searches were conducted on eight electronic databases: PubMed (Medline), Web of Science, CINAHL, Scopus, IEEE Xplore Digital Library, Journal of Medical Internet Research (JMIR), MedNar, and EBSCO Open Dissertations. An information scientist assisted in performing the searches during March 2021, and the

search was repeated in June 2023. The search included all items up to June 7th, 2023, and was restricted to Finnish, English, and Swedish languages. The key Medical Subject Headings (MeSH) terms and CINAHL headings were used to identify all relevant studies wherever possible. The key search terms "child," "adolescent," "obesity," "technology" and "counseling" were used with each database. Keywords were combined using AND and OR operators. We searched for relevant grey literature by searching the MedNar (A free medically medically-focused deep web search engine) database and EBSCO Open Dissertations using similar keywords. The more detailed search terms are shown in Appendix A. Before the final review, we conducted a scoping search to verify the effectiveness of identifying relevant studies and exclusion criteria [28].

The selection criteria were defined according to the inclusion criteria, which followed Joanna Briggs Institute Manual and PICO-model, where P stands for population, I for intervention, C for comparator, and O for outcomes [28]. In this review inclusion criteria were: (P) population included participants who were children or adolescents aged 2–18 years who were either overweight or obese, or their parents; (I) interventions focus were interactive digital counseling for weight management, including electronic, mobile or ubiquitous devices (such as virtual reality [VR], augmented reality [AR], 360VR, mixed reality [MR], tags, codes, sensors or wearables). Interactive digital interventions participants had an opportunity to discuss and receive synchronous/asynchronous feedback online/offline from healthcare staff; (C) interventions compared with either conventional counseling as face-to-face counseling or exergaming studies (video gaming involving physical activity) without interactive counseling or feedback; (O) studies which described outcomes for overweight or obesity such as changes in weight, BMI or body fat, diet, physical activity, psychosocial variables such as self-esteem, peer victimisation, anxiety, stigma, depressive symptoms, and changes in knowledge, motivation or satisfaction. This review includes randomised controlled trials (RCT) or quasi-experimental study design. Studies excluded if they focused on either conventional counseling or were not interactive such as automated text message-based counseling.

Two authors (M. Virtanen and H. Kerimaa) assessed all relevant titles, abstracts, and full texts against a set of selection criteria. Disagreements between reviewers were resolved through discussion. The selection of studies was carried out using the Covidence systematic review software [29].

2.3. Quality appraisal

The quality appraisal was carried out independently by three researchers (M. Virtanen, H. Kerimaa, and P. Kaakinen), following the guidelines of the Joanna Briggs Institute. They used the web-based data management system Covidence [29] to assess the quality of the studies. The quality assessment included 13 domains for RCTs and nine domains for quasi-experimental studies. Methodological quality scoring disagreements were solved by consulting a third reviewer (P. Kaakinen). Quality was quantified by assigning scores of 0–1 point per criterion. Domain was rated as high (H) if it received one point and low (L) if it received zero point or defined as unclear (U). The total quality score ranged in this review from 7 to 11 out of 13, any studies not excluded based on quality appraisal. High risk indicates that the methodology used could have significantly influenced the outcomes measured. Low risk indicates that the methods used met quality requirements, meaning the risk of bias was low. Unclear indicates that there was not enough information to judge the study. Not applicable (NA) was used when this risk assessment was irrelevant to the study. After the quality assessment, any differences between the researchers' assessments were discussed until discrepancies were resolved and agreement was reached.

2.4. Data analysis

Data were extracted from the included studies: name of author, year of publication, country, study design and sample, obesity criteria, aim of study, intervention components, and key findings and quality assessment points. One author (M. Virtanen) entered the data into an extraction sheet, while another (H. Kerimaa) validated the entries. The results of the search and selection process were reported using the PRISMA flowchart [27]. Given the disparities in follow-up duration and outcome measures, a meta-analysis could not be conducted; hence, narrative synthesis was used to summarise the findings.

3. Results

3.1. Description of selected studies

Initially, 6,638 studies were identified using electronic databases. After removing duplicates, 4,407 studies were systematically screened and finally 22 studies were selected for inclusion using the selection criteria (Fig. 1). A summary of the main characteristics of the 22 studies is shown in Appendix B. Seventeen of the included studies were RCT, and the remaining five were quasi-experimental and studies were published between 2011 and 2023. Post-intervention follow-up assessments varied from two weeks [30] to 24 months [31]. One study lacked detailed information on the intervention and follow-up duration [32].

For RCT studies, the average quality score was 11, while for quasi-experimental studies, it was 8. Of all studies, one RCT study [33] scored 3, and one quasi-experimental study [34] scored 3, indicating a high risk of bias. The main reasons for low-quality scores and high risk of bias were that participants were not blinded to the assessment, treatment groups were not treated or reported identically, outcomes were not measured or reported consistently, and the study design did not appear adequate.

The sample size of the studies ranged from 20 to 721, and the ages of the participants, who were children and adolescents without carers or parents present, ranged from 2 to 18 years. The average age of the participants was 12.2 years, based on the mean values provided. Of the total interventions, eight strongly focused

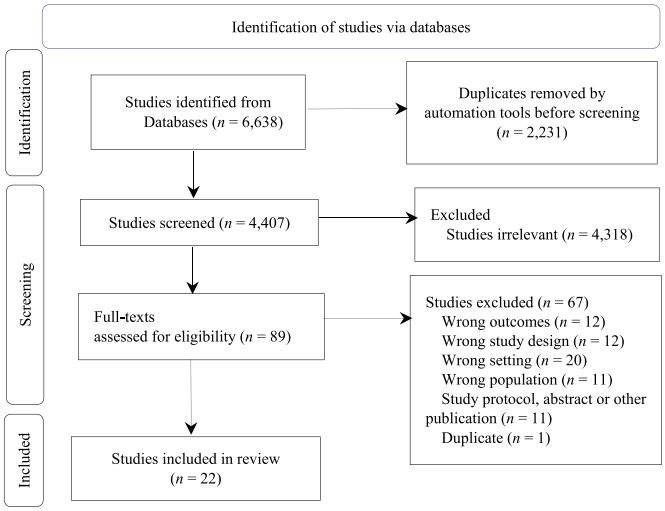

Fig. 1. Flow chart of selection process.

on children with a mean age below 12 years, while the remaining fourteen studies targeted young people aged 11–18 years.

The studies were conducted in different countries, including the USA ($n = 11$), Canada ($n = 1$), Spain ($n = 2$), Portugal ($n = 1$), Sweden ($n = 1$), Switzerland ($n = 1$), Israel ($n = 1$), China ($n = 1$), Ireland ($n = 1$), Australia ($n = 1$) and Malaysia ($n = 1$). Of these, eight studies focused mainly on data from children and/or adolescents, while others also collected feedback from caregiver(s)/parent(s).

3.2. Digital components

Digital components were categorised as web-based, mobile-based, or multi-component interventions. Those were used online contact with healthcare staff, online social support, behavioral prompts (such as reminders and booster messages), and wearables or smart devices. Most interventions ($n = 14$) were conducted through web-based platforms and used for educational purposes. Also, there were customised smartphone applications, making them mobile-based [30,35–38]. A web-based platform included a home-based support system with multimedia elements such as videos and skill-based video games [39–41]. Fewer studies used wearables such as smartwatches or pedometers [30,36,42], while there were studies that used fitness applications integrated into an online treatment programme [30,35–38].

Behavioral prompts such as text messages, reminders or emails were used [33,37,41–47], while five studies used online contact with a healthcare staff through video or telephone calls [33,37,42,47,48]. Wright et al. [49] used automated voice programme technology to encourage healthy eating habits in parents and children. In addition, five studies used supportive online social communities [32,33,35,38,50] as part of their interventions.

3.3. Outcomes of interventions

There were positive effects on weight-related factors such as BMI, BMIz-score and body fat [31,32,38,43,44,48,49]. Of these, studies showed significant differences in anthropometric measures between the intervention and control groups [42,49,51]. Chen et al. [51] study has a significant decrease in waist-to-hip ratio (0.08 ± 0.04 vs 0.89 ± 0.04, $P = 0.02$; effect size -0.01), Chen et al. [42]. reported a significant decrease in BMI**z**-score ($Z = -4.72$, $P = 0.001$) and BMI ($Z = -4.89$, $P < 0.001$), effect size was 0.06, and Wright et al. [49]study participants has a decrease in weight (61.2 ± 10.9 vs 52.1 ± 9, $P = 0.14$), BMI (26 ± 2.6 vs 25.5 ± 2.4, $P = 0.47$) and BMIz-score (1.9 ± 0.28 vs 1.9 ± 0.3, $P = 0.48$) when using an automated interactive voice response (IVR) system that compared high users with low users.

There were positive effects on sedentary behavior ($P = 0.006$), fruit and vegetable consumption ($P = 0.024$) [41], parental empowerment (0.22, 95%*CI* 0.15 to 0.28, $P =$ ns vs 0.29, 95%*CI* 0.22 to 0.35, $P =$ ns) [46], but treatment visits had a lower attrition rate (3.3 visits vs 2.1 visits, $P < 0.001$) in the control group [45]. Baños et al. [39] study anthropometric variables improved in both groups (Cognitive Behavioral Therapy [CBT] and Enhanced Cognitive Behavioral Therapy [CBT-E**]**), but in the CBT-E intervention showed higher efficacy in physical activity and lower fat mass. Jones et al. [32] reported that BMI percentile (mean change -0.50 SD 1.49, $P = 0.001$) and BMIz-score (mean change -0.03 SD 0.11, $P = 0.005$) decreased significantly while physical activity increased. They also found that television time and soda consumption decreased while fruit and vegetable consumption increased.

3.4. Interaction types

Digital components were classified as multicomponent because they used three or more different interaction types [30,33,41,42,46]. The type of multicomponent interaction was categorised as one-way if it involved the exchange of educational materials and two-way if it involved personalised counseling or messaging between healthcare providers and children or adolescents. Face-to-face counseling visits were also considered part of multifunctional interventions. In total, nineteen studies [30–37,39–42,44–47,50,51] provided one-way interaction, twelve studies [30,32–35,38,41,42,44,46,48,50] provided two-way interaction, and twelve studies [36–41,43–45,47,48,50] included additional on-site face-to-face counseling visits.

3.5. Role of healthcare professionals

According to Abraham et al. [44] and Jones et al. [32], nurses played a crucial role in supporting adolescents and implementing programmes that enhanced their adherence and compliance, emphasising the importance of nurses in promoting adolescent health and weight management. Other studies involved physicians, pediatricians, clinicians, or medical doctors [33,35,38,43–46,48,50]. Physiotherapists, dietitians, and health coaches contributed to eight studies [35–37,41,43,44,48,50], and social workers were involved in one [37]. Research assistants and facilitators were utilised in two studies [47,51]. Five studies did not specify professional roles [31,32,34,39,40].

4. Discussion

Our study highlights the benefit of digital components in treating obesity among children and adolescents. Those were focused on weight management, physical activity, and nutrition. Digital components were classified as web-based, mobile-based, and multicomponent systems, which included online contact with healthcare staff, online social support, behavioral prompts, and wearables or smart devices. These components facilitate the monitoring and promotion of healthy lifestyle choices.

Digital components should be specifically tailored to children, adolescents, and their families. These groups require support and feedback from healthcare staff, particularly nurses. Despite the crucial role nurses play in counseling children and adolescent towards healthier lifestyles. Our study found that only two of the reviewed studies included nurses as participants. In the future, it will be essential to involve children and adolescents in the development process to ensure their needs are met and enhance usability [52,53]. Our research underscores that combating obesity in children and adolescents through digital counseling requires a multicomponent approach rather than a singular tool. Heerman et al. [54] indicates that combining automated calls, text messages, and personalised feedback enhances engagement and health outcomes for children and adolescents. However, previous study lack essential interaction, which is vital for motivation [55]. To effectively implement these interventions, healthcare staff require training and strategies that foster individualised care, ensuring sustained behavior change and improved health outcomes [56].

Our research shows that digital multicomponent interventions can effectively treat obesity in children and adolescents. This effectiveness is particularly evident when using anthropometric measures such as BMI, BMI z-score, and body fat percentage. These outcomes align with earlier researches [20,24,57], which demonstrated significant improvements in these measurements through digital approaches. This is significant because digital approach for child and adolescent obesity meets the WHO's objectives for using digital tools to promote public health and enhance health services and increase the economic and social value of health [21].

Our results indicate that video or telephone consultations and

internet-based programs [31,38,48] and automated and interactive platforms [49], can be just as effective for weight loss as traditional approaches. However, these methods should prioritize behavioral changes over mere health education to help children and adolescents achieve and sustain a healthy weight [43a,b]. Digital interventions must be implemented repeatedly over time to engage children and adolescents and ensure enduring results. This finding aligns with earlier research pointing out that digital approaches alone are insufficient; successful interventions must also feature the active involvement of healthcare professionals, ongoing support, and consistent follow-ups [58,59]. Furthermore, as noted by Madigan et al. [59], effective weight management programs that incorporate healthcare professionals' active engagement, regular follow-ups, and multiple interactions lead to substantial reductions in both weight and waist circumference. Long-term, interactive digital interventions provide a superior opportunity for lasting improvements in obesity management among children and adolescents.

A review shows that treating overweight and obesity in children and adolescents usually happens in outpatient settings, like hospitals and schools, with the family playing a key role in treatment success. Preventive communication for parents, children, and adolescents is vital in identifying risk factors and managing diet and portion sizes [60]. From a nursing perspective, the limited inclusion of nurses in the reviewed studies highlights a gap in research that directly addresses their role in healthcare interventions and outcomes. While physicians, pediatricians, and other medical professionals were prominently featured, nurses were only involved in two studies [48,49], despite their critical role in patient care and interdisciplinary collaboration. This underrepresentation may obscure valuable insights into the unique contributions of nurse practitioners as promoters in healthcare transformation, particularly their role in improving patient outcomes and health service delivery [61]. Furthermore, the involvement of other healthcare professionals, such as physiotherapists, dietitians, and social workers underscores the importance of a multidisciplinary approach. Yet, the minimal focus on nursing suggests a need for future research to integrate better and explore the perspectives and impact of nurses in diverse healthcare settings. Addressing this gap could provide a more comprehensive understanding of healthcare dynamics and improve patient outcomes.

Jebeile et al. [62] emphasise that treatment should focus on the child or adolescent's age, family socioeconomic status, and health and lifestyle. Digital interventions should be designed based on different learning theories, such as cognitive, behavioral, and social theories, which were also used in the studies in this review. Key to these theories are advice, counseling, tasks, activities, reminders, monitoring, support, and reward systems [63]. Fedele et al. [64] state that digital methods offer advantages such as real-time data collection and immediate encouragement and response. Digitalisation has indeed enhanced interventions aimed at fostering healthier lifestyles [15]. Compared to traditional treatments, digital interventions present considerable advantages, particularly in terms of cost-effectiveness and accessibility [65]. Moreover, technology-based interventions, often grounded in behavioral principles, avoid the adverse side effects commonly associated with pharmacological treatments [66].

It is important to highlight that none of the studies address the competence of healthcare professionals, which is likely critical for technology-enhanced interventions. Jarva et al. [67] states that digital health competence encompasses care provision, technology usage, and digital interaction. The study revealed a divided perception among professionals, with evident gaps in competence in certain areas. Notably, few studies thus far comparing the costs of interventions or evaluating their economic implications. Previous research suggests, however, that new interventions may improve adherence and maintain their effects at a low cost and on a broader scale [68,69]. The study suggests that digital multicomponent interventions offer significant advantages over traditional treatments, particularly in terms of accessibility.

5. Strengths and limitations

The review has notable strengths, particularly its transparent systematic protocol, detailed methodology, and use of multiple databases, which enhance validity. The inclusion of grey literature and experienced researchers further supports the study. A key strength lies in distinguishing between one-way and two-way interactions in digital methods, an often-overlooked aspect in previous research. It's essential to assess whether patients receive one-way information or engage in two-way communication, although this is complicated by interventions that include face-to-face elements. To ensure thorough review and avoid publication bias, we included all studies that demonstrated good methodological quality, regardless of reporting deficiencies. Using the revised JBI critical appraisal tool [70], we recognised that excluding studies with a high risk of bias could limit meaningful evidence synthesis and understanding. Our study's methodological quality was rated high compared to other systematic reviews [47], further supporting our findings.

The review analyzed two quasi-experimental and three non-randomised studies, finding that treatment effectiveness is more dependent on study quality than on randomisation. Variations in methodologies complicate the interpretation of results, emphasising the need for consistency. Discrepancies in the studies may stem from factors such as inadequate sample sizes, poor recruitment strategies, short intervention durations, high dropout rates, and a lack of long-term follow-up. Therefore, the findings should be interpreted with caution.

6. Conclusion

This systematic review examines the digital multicomponents and types of interaction used in counseling interventions to tackle childhood and adolescent obesity. Although the differences noted between intervention and control groups were modest, digital interventions demonstrate significant potential in enhancing healthcare operations and optimising resource utilisation. Effective two-way interactions that combine both digital and face-to-face approaches have been shown to improve children and adolescent engagement. Moreover, digital intervention provides cost-effective solutions; however, it is essential to ensure that the competencies of healthcare professionals, especially nurses, are suitably aligned with the implementation of these tools. Future research efforts should concentrate on optimising these interventions to enhance health outcomes for children and adolescents.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Mari Virtanen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Project administration. **Heli Kerimaa:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft,

Writing - review & editing, Project administration. **Niko Männikkö:** Conceptualization, Methodology, Data curation, Writing - review & editing. **Merja Männistö:** Conceptualization, Methodology, Writing - review & editing. **Karoliina Paalimäki-Paakki:** Conceptualization, Methodology, Writing - review & editing. **Minna Lahtinen:** Conceptualization, Methodology, Writing - review & editing. **Miia Jansson:** Conceptualization, Methodology, Writing - review & editing. **Kirsi Kivelä:** Conceptualization, Methodology, Writing - review & editing. **Anne Oikarinen:** Conceptualization, Methodology, Writing - review & editing. **Mira Rajala:** Conceptualization, Methodology, Writing - review & editing. **Minna Vanhanen:** Conceptualization, Methodology, Writing - review & editing. **Maria Kääriäinen:** Conceptualization, Methodology, Writing - review & editing. **Pirjo Kaakinen:** Conceptualization, Methodology, Writing - review & editing, Supervision.

Declaration of generative AI

While preparing the manuscript the authors used generative AI to enhance language and reporting in English. Following the use of OpenAI tool, the authors carefully reviewed and revised the content as necessary. The manuscript was subsequently checked by an academic proofreading service.

Declaration of competing interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. We confirm that we do not have any financial or personal relationships with other people or organizations that could inappropriately influence (bias) our work presented in this manuscript.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2025.02.014.

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