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CONTENTS

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Paper I and III. Pille-Riin Meerits had primary responsibility for leading the design of the studies, enrolment of the participants, coordinating, and implementing data collection, performing statistical analyses, and drafting the manuscripts.

Paper II. Pille-Riin Meerits was involved in the design of the study, review and editing of the manuscript.

1. INTRODUCTION

Physical activity (PA) is widely recognized as a cornerstone of physical and mental well-being for individuals of all ages (Warburton, 2006). For children and adolescents, regular PA provides numerous benefits, including improved cardiovascular fitness, better academic performance, and reduced anxiety and depression (Marques et al., 2018; Pozuelo-Carrascosa et al., 2018; Stanczykiewicz et al., 2019). Despite these well-documented advantages, global trends indicate that most adolescents fail to meet the World Health Organization's (WHO) recommendation of at least an average of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day (Bull et al., 2020). Insufficient PA in childhood and adolescence increases the risk of non-communicable diseases, such as cardiovascular disease and obesity, later in life (McPhee et al., 2020; Reilly et al., 2019). To address this issue, interventions targeting the key determinants of PA behavior are essential to encourage lifelong engagement in PA.

One of the most prominent frameworks for understanding and promoting motivation towards PA is self-determination theory (SDT) (Deci & Ryan, 2000). SDT posits that the satisfaction of three basic psychological needs – autonomy, competence, and relatedness – is essential for fostering intrinsic motivation and sustained engagement in health-promoting behaviors, including PA. Autonomy refers to the feeling of being in control of one's actions, competence involves the perception of effectiveness in achieving goals, and relatedness pertains to meaningful connections with others (Ryan & Deci, 2000b). When these needs are supported within a social environment, individuals are more likely to develop autonomous motivation, which has been shown to predict higher levels of PA (Ryan & Deci, 2000b).

In educational settings, physical education (PE) classes play a pivotal role in shaping students' attitudes and behaviors toward PA. PE teachers are vital in promoting PA among adolescents by providing structured opportunities for students to engage in various physical activities and develop motor skills (Yli-Piipari, 2014). Research has shown that autonomy-supportive teaching practices in PE, such as providing meaningful choices, enhance students' intrinsic motivation and engagement in both PE and leisure-time physical activity (LTPA) (Hagger et al., 2003). The trans-contextual model of motivation (TCM) extends the principles of SDT by explaining how motivation in one context, such as PE, can transfer to other contexts, such as LTPA (Hagger et al., 2003). This motivational transfer is mediated by social cognition constructs, including attitude, subjective norms, and perceived behavioral control (PBC), which collectively influence intentions and behaviors related to PA (Barkoukis et al., 2020; Hagger & Chatzisarantis, 2016).

In addition to the role of PE teachers, parental involvement is crucial in shaping children's attitude towards PA, as well as enhancing their overall PA levels through factors such as autonomous motivation, attitude, subjective norms, PBC, and intentions (González-Cutre, Ferriz, et al., 2014; Tilga, Kalajas-Tilga, Hein, Raudsepp, et al., 2021b). Parents often serve as role models and provide

the necessary support and encouragement for their children to engage in PA (Messing et al., 2019). However, many parents lack the knowledge and skills to effectively support their children's PA (Goh et al., 2009).

Digital interventions, such as web-based training programs, offer a scalable and flexible approach to equipping parents and teachers with the tools to foster need-supportive environments (Reeve & Cheon, 2021). Recent studies have demonstrated the effectiveness of such interventions in promoting autonomy-supportive behaviors, enhancing students' psychological need satisfaction, and improving PA-related outcomes (Tilga et al., 2019; Tilga, Kalajas-Tilga, et al., 2020a). While interventions based on SDT have proven effective in fostering intrinsic motivation for PA (Tilga, Kalajas-Tilga, Hein, & Koka, 2021), previous studies have primarily addressed support for autonomy and have not examined the simultaneous fulfillment of all three basic psychological needs: autonomy, competence, and relatedness. By leveraging digital platforms, these interventions can reach a broad audience while allowing participants to engage with the content at their own pace (Reeve & Cheon, 2021).

Building on these theoretical and empirical foundations, this thesis aims to explore the distinctive and combined effects of web-based need-supportive interventions for PE teachers and parents on adolescents' motivation towards and engagement in PA. By integrating insights from SDT and the TCM, the study seeks to contribute to the development of evidence-based strategies for promoting PA among adolescents in both school and home environments.

2. LITERATURE REVIEW

2.1. Physical activity in adolescents

The significance of regular PA for adolescents is well-documented in research, which underscores its numerous physical, mental, and cognitive benefits. Regular participation in PA has been associated with enhanced cardiorespiratory fitness (Pozuelo-Carrascosa et al., 2018), reduced levels of anxiety (Stanczykiewicz et al., 2019), and improved academic performance (Marques et al., 2018). Despite these benefits, the majority of adolescents fail to meet the WHO recommendation of at least an average of 60 minutes of MVPA per day (Guthold et al., 2020). In Estonia, the context of this research, recent data indicate that 57% of children and adolescents are not sufficiently physically active (Mäestu et al., 2023).

PA levels decline significantly during adolescence (Farooq et al., 2018), accompanied by an increase in sedentary behavior at the expense of PA (Rubín et al., 2022). However, PA habits formed during adolescence are crucial for determining long-term health outcomes and activity levels. Longitudinal research indicates that adolescents who regularly engage in PA are far more likely to maintain an active lifestyle into adulthood (Telama et al., 2005). The transition to adulthood is characterized by considerable variability in PA patterns, with the majority of adolescents belonging to the low PA level group. These patterns are influenced by a variety of factors, including psychological and social determinants, such as enjoyment, role modelling and emotional support in PA. (Mathisen, Kristensen, et al., 2023; Mathisen, Torsheim, et al., 2023) Adolescents are more likely to find enjoyment in engaging in PA when they perceive themselves as physically competent, receive adequate support, and are actively involved in the decision-making process (Chen, 2014). Additionally, when PE teachers adopt autonomy-supportive and structured teaching styles, they can better support students' psychological needs, fostering autonomous motivation for PA in both PE and leisure time (Tilga et al., 2023).

The advantages of PA for adolescents are indisputable; however, the widespread prevalence of insufficient PA and the notable decrease in activity levels during adolescence underscore a public health concern. Sustaining adequate PA levels is essential for promoting long-term health outcomes.

2.2. Theoretical frameworks for understanding physical activity motivation

2.2.1. Self-Determination Theory

SDT offers a comprehensive framework for understanding human motivation by distinguishing between various types of motivation, ranging from intrinsic to extrinsic (Deci & Ryan, 2000). Intrinsic motivation is characterized by engaging in activities for inherent enjoyment and personal satisfaction rather than due to

external rewards or pressures. This is the most autonomous form of motivation and also the most persistent (Ryan & Deci, 2000a). Identified regulation involves activities that are personally meaningful and chosen voluntarily, aiming to achieve outcomes aligned with one's values. In contrast, introjected regulation is driven by internal pressures, such as feelings of guilt, obligation, or the desire for social approval. At the other end of the spectrum, external regulation refers to actions performed to avoid punishment or gain rewards (Deci & Ryan, 2000).

A central tenet of SDT is that the development of more autonomous forms of motivation toward an activity requires the fulfillment of three basic psychological needs within that activity. Autonomy reflects the need to experience a sense of volition and self-direction in one's actions. Competence signifies the need to feel effective and capable in navigating one's environment. Relatedness refers to the need to establish meaningful connections and feel valued within social contexts (Deci & Ryan, 2000). These needs – autonomy, competence, and relatedness – are regarded as universal and vital for cultivating intrinsic motivation. An individual's social environment, including interactions with parents, teachers, and peers, should foster and support these inherent psychological needs (Ryan & Deci, 2000a, 2000b).

SDT is frequently applied as a theoretical framework in the design of health-related interventions, and evidence has shown that such interventions are effective in promoting positive changes in health behaviors (Ntoumanis et al., 2021). Teixeira and colleagues (2020) have classified 21 motivation and behavior change techniques that can be employed to support the basic psychological needs outlined by SDT in health-focused interventions. Each psychological need is supported by seven specific techniques. For instance, autonomy can be enhanced by providing a variety of exercise options or allowing adolescents to choose the type of PA they prefer. Competence can be fostered through clear feedback, setting achievable challenges, and offering opportunities for skill development. Relatedness can be fulfilled through group activities, team sports, or engaging in PA with friends or family (Teixeira et al., 2020). Designing interventions and environments that prioritize meeting basic psychological needs is essential for encouraging lifelong participation in PA.

2.2.2. Trans-Contextual Model of Motivation

The application of TCM has significantly enhanced our understanding of the factors influencing PA among adolescents. TCM offers a theoretical framework to explain how motivation developed in one context, such as PE, can be transferred to other contexts, such as LTPA (Hagger & Chatzisarantis, 2012). The model combines key principles from SDT, the theory of planned behavior, and the hierarchical model of intrinsic and extrinsic motivation to elucidate the mechanisms driving this transfer (Hagger et al., 2003). SDT distinguishes between autonomous and controlled forms of motivation toward specific behaviors (e.g., PA), while the theory of planned behavior posits that intention, supported by autonomous motivation, serves as the most immediate predictor of PA behavior. The

hierarchical model further explains how autonomous motivation in one context can influence motivation in another. The integration of these theoretical perspectives is grounded in their complementarity, with SDT and the theory of planned behavior addressing the underlying reasons for motivated behavior and the hierarchical model serving as the link between different contexts (Hagger & Chatzisarantis, 2012).

Empirical evidence supports this framework, showing that adolescents who experience greater autonomy support in PE are more likely to participate in PA outside of school. This relationship is mediated by enhanced autonomous motivation, social cognition beliefs (e.g., attitudes, subjective norms, and PBC), and intentions to engage in PA. (Hagger & Chatzisarantis, 2012, 2016) Numerous intervention studies within the school setting have explored this dynamic, with PE teachers employing need-supportive strategies to foster autonomous motivation (Vasconcellos et al., 2020). Research further indicates a positive correlation between need satisfaction in PE classes and the amount of out-of-school MVPA, with reductions in need satisfaction being linked to declines in PA levels (Gråstén et al., 2023). Moreover, TCM has been expanded to incorporate autonomy support from additional social agents, such as peers and parents, and to address basic psychological needs (González-Cutre, Sicilia, et al., 2014). By emphasizing the dynamic relationship between motivation and social-cognitive constructs, TCM highlights the critical role of cultivating autonomy-supportive environments in PE to effectively promote the transfer of motivation for PA to out-of-school settings.

2.3. Role of PE teachers and parents in promoting physical activity

Social environment, including interpersonal style of parents and PE teachers, must facilitate the fulfillment of the basic psychological needs for autonomy, competence and relatedness (Ryan & Deci, 2000a, 2000b; Slemp et al., 2024). Supportive influences from these social agents have been shown to be positively linked to adolescents' intentions to engage in LTPA (Su et al., 2023).

2.3.1. The role of PE teachers

PE programs play a vital role in promoting physical, cognitive, and psychosocial development by providing children and adolescents with regular PA, essential skills, and the motivation needed to maintain a health-conscious lifestyle (Yli-Piipari, 2014). In Estonia, the new PE curriculum focuses on developing the skills, knowledge, and intrinsic motivation needed for a healthy and active life, emphasizing student-centered learning, individual movement habits, self-analysis, and the principle that all students can acquire essential movement skills for life (*National curriculum for basic schools,* 2023). Positive early experiences in PE classes are particularly significant, as they help cultivate a supportive

attitude toward PA, serving as a foundation for sustained future engagement (Fitton Davies et al., 2021; White et al., 2021). Furthermore, PE classes provide an ideal platform for implementing PA interventions, as they offer a unique opportunity to reach nearly all children within the school system (Powell et al., 2016). School-based interventions for PE teachers appear to positively influence adolescents' PA levels and PA-related outcomes (Christodoulakis et al., 2024).

In alignment with SDT, satisfying the basic psychological needs for autonomy, competence, and relatedness in PE classes establishes a strong foundation for fostering intrinsic motivation toward PA (Ryan & Deci, 2000b; Standage et al., 2005; Yun et al., 2024). Furthermore, when children and adolescents are intrinsically motivated in PE, they are more likely to participate in PA beyond school hours (Hagger et al., 2003).

PE teachers play a crucial role in addressing students' basic psychological needs within the classroom environment (Llorca-Cano et al., 2025; White et al., 2021). A supportive learning environment, defined by autonomy, choice, recognition, and clear communication about the value of physical exercise, significantly contributes to the satisfaction of basic psychological needs. In contrast, controlling teacher behaviors undermine these needs, leading to student dissatisfaction and diminished motivation. (White et al., 2021) Research indicates that controlling teacher behaviors are negatively correlated with intrinsic motivation and identified regulation, while being positively associated with external regulation, introjected regulation, and amotivation (Burgueño et al., 2021; De Meyer et al., 2016). Reducing external control has been demonstrated to enhance intrinsic motivation, along with improving well-being, performance, and self-esteem (Deci & Ryan, 2000). Need satisfaction in PE classes is strongly linked to the amount of LTPA students engage in (Gråstén et al., 2023), with psychological need satisfaction and intrinsic motivation in PE mediating the effect of perceived autonomy support on PA (Kalajas-Tilga et al., 2020). Therefore, it is crucial to identify and implement strategies that support their basic psychological needs to prevent a decline in PA levels (Gråstén et al., 2023).

A growing body of research highlights the significant benefits of training teachers in autonomy-supportive behaviors. By fostering autonomy in PE classes, teachers can not only improve classroom dynamics but also enhance student performance and engagement in PE (Cheon et al., 2022). A school-based intervention empowered adolescents to engage in PA both during and beyond school hours by emphasizing need-supportive teaching principles, leading to notable improvements in sociocultural determinants and motivational outcomes related to both PE and LTPA (Sevil-Serrano et al., 2020). Similarly, another intervention demonstrated the positive impact of autonomy support on students' PA-related outcomes, with benefits observed both in PE classes and outside of school (Barkoukis et al., 2020). Furthermore, research has shown that both teachers and students can experience lasting benefits from autonomy-supportive training programs, with teachers becoming more autonomy-supportive over time and students reporting greater motivation and positive outcomes (Cheon & Reeve, 2013). These findings

underscore the critical role PE teachers play in fostering students' engagement in LTPA.

To maximize the effectiveness of PE teachers in promoting PA, it is essential to provide professional development opportunities, including training in need-supportive teaching practices. Such programs have proven effective in cultivating positive teaching behaviors. For instance, Tilga and colleagues (2021a) demonstrated that a web-based autonomy-supportive intervention significantly enhanced PE teachers' self-reported autonomy-supportive behaviors and teaching efficacy, which, in turn, improved students' psychological need satisfaction and intrinsic motivation.

2.3.2. The role of parents

Parents play a pivotal role in promoting PA among children and adolescents by creating supportive environments and modeling active behaviors (Mathisen, Kristensen, et al., 2023; Messing et al., 2019). Parental support is strongly associated with children's PA levels (Gustafson & Rhodes, 2006; Xu et al., 2015). Notably, interventions designed to increase preschoolers' PA levels have been most effective when they target parents and involve childcare centers (Reilly et al., 2019). However, sustained parental support for PA remains crucial during adolescence (van Sluijs et al., 2021), with parental influence often surpassing that of PE teachers (Olivares et al., 2015). Research has further demonstrated that perceived autonomy support from parents and peers positively predicts the fulfillment of basic psychological needs in LTPA, which in turn fosters autonomous motivation toward such activities (González-Cutre, Sicilia, et al., 2014). Additionally, it has been shown that parental support and basic psychological need satisfaction are significantly associated with actual participation in PA, with autonomous motivation playing a crucial mediating role (De Oliveira Barbosa et al., 2024). These findings emphasize the critical role of parents and peers in shaping adolescents' motivation and engagement in LTPA. However, despite recognizing their vital role in shaping their children's health habits, many parents report lacking the knowledge and skills necessary to effectively fulfill this responsibility (Goh et al., 2009).

Interventions involving parents in the home setting are less common compared to those implemented in the school context (Messing et al., 2019). A notable example of a combined school- and home-based health intervention is the study by Robbins and colleagues (2020), which recruited student-parent pairs to improve adolescents' PA levels and eating habits. As part of the intervention, parents were provided with a dedicated Facebook group to support their efforts in encouraging children to exercise and adopt healthy eating habits. Post-intervention, students whose parents participated in the intervention group demonstrated higher autonomous motivation for PA and greater self-efficacy for healthy eating. Additionally, parents who took part in post-intervention focus groups reported benefiting from the shared information, practical strategies, and the opportunity to exchange experiences with other parents (Robbins et al., 2020). In another

school- and home-based intervention, parents participated in three meetings and an outdoor excursion, engaging in PA together as a family, which positively influenced their attitudes toward promoting PA in their children. Both parents and adolescents emphasized the importance of family involvement in creating an environment where PA could occur regularly (González-Cutre et al., 2018).

Despite their vital role, parents often encounter challenges in promoting PA, including time constraints and a lack of knowledge or skills. To address these barriers, interventions should prioritize educating parents on the significance of need-supportive practices while being designed to be flexible and self-paced, allowing them to seamlessly integrate into daily routines.

2.4. Digital interventions for promoting physical activity

Digital interventions are highly scalable, offering a unique advantage in their ability to reach large, diverse populations across geographic locations. These programs provide a self-paced and personalized approach, allowing participants to engage with the content at their convenience (Reeve & Cheon, 2021). Compared to traditional face-to-face interventions, web-based programs demonstrate greater cost-effectiveness by eliminating expenses associated with travel, venue rentals, printed materials and extensive personnel involvement (Gentili et al., 2022).

Despite the advantages, digital interventions face challenges that can limit their effectiveness. For example, technical difficulties can make participation problematic (Nikolopoulou, 2022). Engagement is another critical challenge, as participants may lose interest or motivation to complete the program over time. Without face-to-face interaction, it can be difficult to maintain accountability and provide personalized encouragement (Yardley et al., 2016).

SDT emphasizes the importance of satisfying individuals' basic psychological needs for autonomy, competence, and relatedness to foster intrinsic motivation and well-being (Ryan & Deci, 2000b). Digital interventions can be tailored to incorporate these principles effectively. For autonomy, platforms can provide participants with meaningful choices, such as selecting topics of interest or determining the pace of their progress through the program. To support competence, digital interventions may include interactive activities, quizzes, and leaderboards to encourage friendly competition. Regarding relatedness, teamwork and online forums can encourage peer-to-peer interactions, fostering a sense of community among participants. (David & Weinstein, 2024)

Several studies have demonstrated the effectiveness of web-based interventions. For example, Tilga and colleagues (2019) found that a fully web-based intervention program designed for PE teachers significantly improved students' perceptions of autonomy-supportive teaching practices and their satisfaction of basic psychological needs. Furthermore, the study's effects were sustained at a 15-month follow-up, with the effects on students' intrinsic motivation initially not significant, but pronounced at follow-up (Tilga, Kalajas-Tilga, et al., 2020a).

2.5. Summary of the background

Several gaps exist in the research on promoting PA among adolescents. First, while interventions based on SDT have proven effective in fostering intrinsic motivation for PA, previous studies have addressed support for autonomy, and not comprehensively the simultaneous fulfillment of all three basic psychological needs: autonomy, competence, and relatedness. Second, although both parents and PE teachers significantly influence adolescents' PA levels, there is a lack of integrated interventions that combine the efforts of these key social agents to maximize their effect. Finally, while digital interventions offer scalable, cost-effective, and flexible solutions for promoting PA, their potential remains underutilized, particularly in incorporating SDT principles to enhance engagement and motivation. Addressing these gaps requires the development of interventions that are based on SDT principles, leverage digital platforms, and actively involve both parents and educators to create a comprehensive and sustainable strategy for promoting PA among adolescents.

3. OBJECTIVES OF THE STUDY

In this study, two web-based need-supportive intervention programs were developed, grounded in the classification system of motivational behaviors proposed by Teixeira et al. (2020), designed specifically for parents and PE teachers. These programs aimed to teach need-supportive behaviors, enabling parents and PE teachers to interact with adolescents in ways that foster their basic psychological needs – autonomy, competence, and relatedness. By doing so, the interventions sought to enhance adolescents' autonomous motivation towards LTPA and their effort to engage in LTPA.

The primary objective of the study was to evaluate the effectiveness of each web-based need-supportive intervention independently, as well as their combined effect, on changes in adolescents' PA-related outcomes, using a randomized controlled trial design.

The specific objectives of this study were as follows:

1. To assess the effects of a web-based need-supportive intervention program designed for parents.
2. To examine the effects of a web-based need-supportive intervention program designed for PE teachers.
3. To investigate both the distinctive and combined effects of web-based need-supportive intervention programs targeting parents and PE teachers.

4. METHODS

4.1. Participants and research design

The study employed a cluster-randomized controlled design. In Studies I and II, the intervention components targeting parents and PE teachers, respectively, were piloted. In Study III, both interventions were combined, resulting in four study groups: (1) a PE teacher training group, (2) a parent training group, (3) a combined PE teacher and parent training group, and (4) a control group. Depending on their assigned group, PE teachers and parents either participated in a web-based need-supportive training program or continued their usual teaching and parenting practices. The duration of the intervention was adjusted from 6 weeks (Study I) to 4 weeks (Studies II and III) to improve feasibility and accommodate participants' time constraints while maintaining the program's core content and objectives. Students were blinded to group allocation.

There are altogether 452 lower secondary schools in Estonia where the language of tuition is Estonian (*Educational Institutions*, 2025). Participants were cluster-randomized into study groups at the school level, using a random number generator. Lower secondary schools from Tartumaa County were randomly selected for inclusion in either the intervention or control groups in Study I. For the subsequent studies, schools from all counties in Estonia were included in the selection. Students who had no restrictions on their participation in PE classes were included, along with their parents and/or PE teachers, as determined by the specific intervention.

In Study I, the final sample consisted of 68 students (M_{age} = 12.50; SD = 0.72; range = 11–15; 58.8% girls) and one parent per child. The participating students were enlisted from 5 schools. The students completed pen-and-paper questionnaires at three time points (i.e., baseline, post-intervention, and 1-month follow-up).

In Study II, the final sample included 1283 students (M_{age} = 13.93; SD = 0.88; range = 13–17; 56.6% girls) and 85 PE teachers from 32 schools. The participating students completed electronic questionnaires on two measuring occasions (i.e., baseline and 9-week follow-up).

In Study III, the final sample comprised of 115 students (M_{age} = 12.47; SD = 0.68; range = 11–15; 52.2% girls), one parent for each child (M_{age} = 42.45; SD = 5.95; range = 30–57) and 64 PE teachers. The participating students were enlisted from 37 schools. The students completed electronic questionnaires at four time points (i.e., baseline, post-intervention, 1-month and 6-month follow-ups).

4.2. Research procedure

In all studies, permission to conduct the research was obtained from the school administration. In Study I, informed consent forms and study information were distributed in person by members of the research team, who also addressed any

questions on-site. In Studies II and III, informed consent forms and study information were electronically sent to the principal or head of studies at each participating school, who then forwarded them to students and their legal guardians via eKool or Stuudium – web-based school management platforms in Estonia that facilitate communication between students, teachers, and parents. The participants had the opportunity to contact the researchers with any questions.

The informed consent forms provided details about the study's purpose, procedures, duration, potential benefits, and risks. They emphasized that participants' anonymity would be maintained, and that participation was entirely voluntary, with the option to withdraw at any time without any negative consequences. Students and parents who agreed to participate completed an electronic consent form (a pen-and-paper version in Study I). Subsequent questionnaires were distributed electronically in all studies except Study I, where pen-and-paper questionnaires were used throughout. To match questionnaire responses from the same participant across time points, a unique personal code was created for each student. While the specific details of the code varied slightly between studies, it consistently included the school's name abbreviation, grade number, the participant's initials or the first three letters of their name, and their gender.

The study did not harm the participants either mentally or physically, and invasive research methods were not used. The study was conducted in accordance with the Declaration of Helsinki and approval was granted by the Tartu University Ethics Committee (code: 327/T-1, 19.10.2020). The study was registered in ISRCTN registry as ISRCTN78373974 (15.12.2022).

4.3. Web-based need-supportive intervention programs

The purpose of the web-based intervention programs was to introduce motivational techniques to both PE teachers and parents to support children's basic psychological needs and motivation for engaging in LTPA. Customized sites were created on the Moodle learning platform, tailored separately for PE teachers and parents. These sites followed a similar structure, and participants were given access to the content for a duration of 4 weeks (6 weeks in Study I). Invitation links to join the program were sent to PE teachers and parents who had been assigned to their respective study groups.

The programs began by outlining the objectives and procedures for the courses. Following this, SDT was introduced, with a particular focus on the significance of fulfilling the basic psychological needs for autonomy, competence, and relatedness in fostering autonomous motivation. The core educational material for the programs was based on the motivational and behavior change techniques (MBCT) framework outlined by Teixeira and colleagues (2020). These techniques were categorized according to the three basic psychological needs, with seven techniques aimed at supporting each need. Examples of MBCTs include providing meaningful choices to support autonomy, offering clear and constructive feedback to enhance competence, and practicing empathetic listening to

nurture relatedness (Teixeira et al., 2020). These general MBCT strategies were adapted to suit the specific contexts of school PE lessons and parent-child interactions within the LTPA context.

The intervention programs featured short, self-paced educational videos, each lasting up to five minutes. The language used in these educational videos was Estonian. Participants were encouraged to watch five to six videos per week, but they had the flexibility to choose when to view them. All materials from previous weeks remained accessible throughout the program. Each video focused on a particular behavioral technique designed to support one of the basic psychological needs. The videos began by explaining the relevant psychological need targeted by the technique. This was followed by an introduction to the technique itself and an explanation of the expected benefits of its use. Finally, a sample video clip demonstrated how the technique could be applied in interactions with children, either by PE teachers or parents. The educational videos were filmed by and featured the employees of the Institute of Sport Sciences and Physiotherapy, and they are available upon request.

After watching each week's educational videos, participants were asked to take a brief multiple-choice quiz to confirm their understanding of the techniques. Additionally, a weekly forum discussion was initiated, allowing participants to share their experiences of applying the techniques in daily interactions with children.

4.4. Measures

All measures were self-reported. Responses were collected on 7-point Likert scales with endpoints meaning *strongly disagree* (1) and *strongly agree* (7), unless stated otherwise.

4.4.1. Perceived need support

Students' views on the need-supportive behaviors of their parents and PE teachers in relation to PA were assessed using the perceived autonomy support scale (Hagger et al., 2007) and the need support scale (Standage et al., 2005) to measure perceptions of competence and relatedness support. In Studies I and III, perceived need-support from parents was assessed and the scales were adapted to reflect the home environment. The final version of the scale measuring perceived need support from parents included 13 items, with four items assessing autonomy support and competence support, and five items evaluating relatedness support. In Studies II and III, perceived need-support from PE teachers was assessed using 16 items, with seven items measuring autonomy support, four items assessing competence support, and five items focusing on relatedness support. Sample statements from the scales include: "I feel that my PE teacher/parent provides me with choices and opportunities about whether to do active sports and/or vigorous exercise (in my free time)" (autonomy support); "I feel that my PE teacher/parent

helps me to improve (in LTPA)" (competence support); and "I feel that my PE teacher/parent is interested in my experiences" (relatedness support). Previous studies have confirmed the reliability and validity of the perceived autonomy support scale for evaluating autonomy support from both PE teachers and parents (Hagger et al., 2009), and it has been utilized with Estonian students (Hagger et al., 2009; Kalajas-Tilga et al., 2022). The need support scale has been shown to reliably and validly measure perceived competence and relatedness support from parents and PE teachers, and it has also been previously applied in Estonia (Viira & Koka, 2012).

4.4.2. Perceived controlling behavior

In Study II, the multidimensional controlling coach behaviors scale (Bartholomew et al., 2010), adapted for PE and translated into Estonian (Hein et al., 2015), was used to evaluate students' perceptions of controlling behaviors exhibited by their PE teachers. This subscale included five items designed to capture controlling teaching practices. An example item from the subscale is: "My teacher uses the threat of punishment to keep me in line during lesson." The scale has been validated in previous research and has demonstrated reliability when used with adolescent populations (Tilga, Hein, et al., 2020). Higher scores on the subscale reflect a greater perception of controlling behavior by the teacher, suggesting a more authoritarian teaching style.

4.4.3. Psychological need satisfaction and frustration

Students' perceptions of their satisfaction and frustration with autonomy, competence, and relatedness in the context of LTPA were assessed using the Basic Psychological Need Satisfaction and Need Frustration Scale (BPNSNF) (Chen et al., 2015). Two versions of the BPNSNF scale were utilized in this study: the version adapted to the PE setting by Haerens and colleagues (Haerens et al., 2015), which was used in Studies II and III, and a further modified version specifically addressing LTPA, which was used in Studies I and III. The scale comprised 24 items, with four items each measuring the satisfaction of autonomy, competence, and relatedness, as well as four items for the frustration of each of these psychological needs. Each item was introduced with the phrase: "In PE classes / When I engage in PA during my free time…". Examples of items include: "…I feel a sense of choice and freedom in the things I undertake" (autonomy satisfaction); "…most of the things I do feel like "I have to"" (autonomy frustration); "…I feel that the people I care about also care about me" (relatedness satisfaction); "…I feel excluded from the group I want to belong to" (relatedness frustration); "…I feel confident that I can do things well" (competence satisfaction); and "…I have serious doubts about whether I can do things well" (competence frustration). The BPNSNF scale has been shown to be both reliable and valid and has previously been applied in studies conducted in Estonia in both

PE (Diloy-Peña et al., 2024; Tilga, Hein, et al., 2020) and LTPA contexts (Meerits et al., 2023).

4.4.4. Motivation towards physical activity

Students' autonomous and controlled motivation for participating in PE classes and LTPA was assessed using a modified version of the perceived locus of causality questionnaire (Ryan & Connell, 1989). The questionnaire referred to school settings in Studies II and III, and to out-of-school settings in Studies I, II, and III. These scales both comprised four subscales with two statements in each. Every item began with the stem "I participate in PE classes / I am physically active in my free time…" and was followed by statements measuring different types of motivation: intrinsic motivation ("…because I enjoy it"), identified regulation ("…because it is important to me"), introjected regulation ("…I will feel bad about myself if I don't"), and external regulation ("…I feel pressure to do it"). This instrument has been validated and found to be reliable in previous research (Kalajas-Tilga et al., 2022; Polet et al., 2020) and has been successfully applied in studies conducted in Estonia (Kalajas-Tilga et al., 2022).

4.4.5. Theory of planned behavior constructs

In Studies I and III, attitude, subjective norms, PBC, and intention toward LTPA were assessed using scales designed in line with the recommended guidelines (Ajzen, 2003). Attitude was evaluated through three items, each beginning with the same stem: "For me, participating in active sports and/or vigorous physical activities during my free time in the next 5 weeks…". Responses were recorded on 7-point scales with contrasting adjectives at either end (e.g., unenjoyable/enjoyable, bad/good, useless/useful). Subjective norms were assessed using two items, such as "Most people close to me expect me to do active sports and/or vigorous physical activities during my free time in the next 5 weeks." PBC was measured with two items, including one example: "How much control do you have over doing active sports and/or vigorous physical activities during your free time in the next 5 weeks?" Responses for PBC were also collected on 7-point scales, ranging from very little control (1) to full control (7). Intention was captured through two items, such as "I intend to do active sports and/or vigorous physical activities during my free time in the next 5 weeks." These measures have been shown to be both reliable and valid in previous research (Hagger et al., 2003, 2009) and have been successfully applied in Estonia (Kalajas-Tilga et al., 2022).

4.4.6. Perceived effort

In Studies I and III, students reported their effort toward LTPA using a scale created by Hagger and Hamilton (2019). Effort was measured through two items, such as "During the last 5 weeks, how hard did you try to be physically active in

your free time?" Responses were recorded on a 7-point Likert scale, with (1) indicating "did not try at all" and (7) representing "tried extremely hard." This scale has been shown to be both reliable and valid (Hagger & Hamilton, 2019; Tilga, Kalajas-Tilga, et al., 2020b) and has previously been applied in Estonia (Tilga, Kalajas-Tilga, et al., 2020b).

4.4.7. Physical activity

The behavioral outcome was measured by assessing children's participation in MVPA outside of school hours (Studies I and II). MVPA was chosen as the behavioral indicator due to its numerous health benefits for adolescents, including improved mental health, enhanced cardiorespiratory fitness, and reduced fat accumulation (Grgic et al., 2018).

In Study I, students reported their PA behavior using the short version of the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003), which was adapted to specifically address LTPA. The IPAQ responses were converted into Metabolic Equivalent Task (MET) minutes per week following the IPAQ scoring guidelines (2005). To calculate MET scores for different activity levels, total minutes of vigorous activity, moderate-intensity activity, and walking over the past seven days were multiplied by 8.0, 4.0, and 3.3, respectively. This method has been validated and found to be reliable in previous studies (Craig et al., 2003) and has also been applied in Estonia (Koka et al., 2020).

In Study II, students' PA levels were evaluated using the Leisure Time Exercise Questionnaire (Godin & Shephard, 1985) which included two items. The questions were: "How often did you participate in sports and/or vigorous physical activity during your leisure time for at least 20 minutes continuously over the past 5 weeks?" and "What was the frequency of your participation in sports and/or vigorous physical activities during your leisure time for at least 20 minutes continuously over the past 5 weeks?" Responses were recorded on a 6-point scale, ranging from 1 ("Never") to 6 ("Every day"). This scale has been demonstrated to be both valid and reliable in prior studies and has been utilized with Estonian adolescents (Pihu et al., 2008).

4.5. Statistical analysis

In Study I, data were gathered using pen-and-paper questionnaires and later transferred into electronic form. In Studies II and III, data collection and management were conducted electronically, using Google Forms in Study II and REDCap (Research Electronic Data Capture) electronic data capture tool in Study III (Harris et al., 2009, 2019) hosted at the local university. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export

procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

Skewness values ranging from –2 to +2 and kurtosis values between –7 and +7 were deemed to indicate that the data followed a normal distribution (Byrne, 2010). Mean values (M) and standard deviations (SD) were computed for all variables included in the study. A chi-square test was conducted to assess differences in participants' gender and grade level across the study groups. Cronbach's alpha coefficient was used to evaluate the internal consistency of the subscales (Cohen et al., 2007).

In Studies I and II, the data analysis was conducted using JASP (Version 0.17.1; University of Amsterdam, Amsterdam, the Netherlands). The independent samples *t*-test was used to examine baseline differences between study groups (randomization check) and to evaluate differences between participants who completed the study and those who were lost to follow-up (attrition check). In Studies II, the paired samples *t*-test was applied to analyze within-group changes in study variables before and after the intervention.

In Study I, the main analysis involved performing a series of repeated-measures ANOVAs to examine the effectiveness of the web-based need-supportive parenting program on the dependent variables. The intervention condition (intervention vs. control) was treated as the between-subjects factor, while time (baseline, post-intervention, and one-month follow-up) was included as the within-subjects factor in each analysis. In Study II, analysis of covariance (ANCOVA) was conducted to evaluate the effectiveness of the web-based need-supportive program designed for PE teachers on the dependent variables. Pre-intervention scores were included as covariates in each analysis to account for baseline differences.

In Study III, data were analyzed using SPSS AMOS Version 29 (IBM Corp., Armonk, NY, USA). Composite scores were calculated for perceived need support from both PE teachers and parents by averaging the items from the autonomy, competence, and relatedness support scales in each context. Similarly, composite scores for autonomous motivation in PE and towards LTPA were derived by averaging the items from the intrinsic motivation and identified regulation scales, while controlled motivation in PE and towards LTPA was calculated by averaging the items from the introjected and external regulation scales in both contexts. A series of ANOVA tests were performed to check for baseline differences between study groups (randomization check). Attrition was assessed using independent samples *t*-tests, and chi-square tests were applied to identify any potential gender differences.

In the main analysis, path analysis was used to examine the effects of the interventions on the study variables. Residual change scores were derived by subtracting predicted values from the observed scores, with the predicted values obtained through regression of baseline measurements on follow-up scores. In this way, a residual score represents the follow-up score with the influence of the baseline score removed. These scores emphasize the actual changes occurring over time while adjusting for baseline levels, thereby providing more accurate

and interpretable results in longitudinal studies (Miller et al., 2002). For example, residual change scores have been suggested as the optimal approach for evaluating intention stability in PA (Rowan et al., 2017).

The impact of the interventions was assessed by predicting changes in the study variables using dichotomous intervention variables, coded as 1 = no intervention and 2 = intervention. Path analysis was conducted using the maximum likelihood method with 5000 bootstrap resamples (Byrne, 2010). Four distinct path models were tested: combined intervention, teacher intervention only, parental intervention only, and no intervention. Model fit was assessed using several goodness-of-fit indices, including the comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA) (Hu & Bentler, 1995). A CFI value above 0.90 and SRMR and RMSEA values below 0.08 were considered indicative of a well-fitting model.

5. RESULTS

5.1. The effects of a web-based need-supportive intervention for parents on students' physical activity related outcomes

Firstly, the preliminary analyses revealed that the data adhered to a normal distribution, with skewness and kurtosis values ranging from –1.81 to 1.27 and –0.99 to 5.71 respectively (Byrne, 2010). Cronbach's alpha values exceeded the acceptable level of 0.7, with the exception of external motivation and subjective norms at baseline, as well as subjective norms at the 1-month follow-up (Nunnally, 1978). Descriptive statistics and comparison of baseline characteristics between the study groups are summarized in Table 1 (refer to Paper I). The results of the independent samples *t*-test indicated no significant differences in the study variables between the intervention and control groups at baseline. However, the chi-square test identified a significant difference in the proportion of male and female students between the two groups. Table 2 (refer to Paper I) presents the characteristics of participants who remained in the study compared to those lost to follow-up. The independent samples *t*-test showed no significant baseline differences in the study variables, except for perceived competence support from parents, which was significantly higher among students who remained in the study, and autonomy frustration and total LTPA at baseline, both of which were significantly lower among the remaining students.

For the main analysis, the results of the repeated measures ANOVAs are summarized in Table 3 (refer to Paper I). Due to the randomization check identifying a significant difference in the proportion of male and female students between the intervention and control groups, participant gender was included as a covariate in all ANOVA analyses and treated as an additional between-subject variable.

The repeated measures ANOVAs revealed a significant, though borderline, time-by-study group interaction effect for intrinsic motivation ($F(2, 84) = 3.095$, $p = 0.050$) and introjected regulation ($F(2, 88) = 3.107$, $p = 0.050$). However, subsequent post hoc pairwise comparisons found no significant differences between the intervention and control groups at any follow-up time point. For intrinsic motivation, the post-intervention mean value was higher in the control group. In contrast, introjected regulation showed a decline in mean values in the intervention group. Statistically significant time-by-study group interaction effects were observed for intention ($F(2, 84) = 4.838$, $p = 0.010$) and effort ($F(2, 80) = 3.473$, $p = 0.036$) towards LTPA. Regarding intention, post hoc tests revealed no significant differences between the intervention and control groups at any follow-up time points. The mean values for intention towards LTPA indicate a decline within the intervention group. For effort, time had a statistically significant effect on the outcome when comparing baseline and post-intervention measurements ($t = 3.026$, $p = 0.010$), based on post hoc comparisons averaged

over group and gender. Additionally, in post hoc pairwise comparisons of time-by-study group interaction effects (averaged over gender), significant differences were found between baseline and post-intervention ($t = 3.109$, $p = 0.039$) as well as between baseline and follow-up ($t = 3.123$, $p = 0.037$) for the intervention group. The mean values for effort towards LTPA in the intervention group were higher at baseline compared to post-intervention and one-month follow-up, indicating a significant decrease over time.

For PA, repeated measures ANOVAs did not identify any statistically significant main effects for time or study group, nor a statistically significant time-by-study group interaction effect. Nevertheless, students in the intervention group demonstrated an increase in the mean vigorous and mean total PA per week at both post-intervention and one-month follow-up.

5.2. The effects of a web-based need-supportive intervention for physical education teachers on students' physical activity related outcomes

In the preliminary analyses, skewness and kurtosis values, ranging from –0.89 to 0.53 and –0.77 to 0.51 respectively, suggested that the data adhered to a normal distribution (Byrne, 2010). Cronbach's alpha values ranging from 0.75 to 0.94 indicated reliability of the subscales (Nunnally, 1978). A comparison of baseline characteristics between the study groups indicated that, prior to the intervention, autonomous motivation towards LTPA ($t = 3.41$, $p = 0.001$) and self-reported PA ($t = 2.16$, $p = 0.031$) were significantly higher in the intervention group compared to the control group. No other statistically significant differences were found between the groups at baseline. Additionally, a comparison of characteristics between participants who remained in the study and those who dropped out revealed no statistically significant differences in the mean values of any variables examined.

Intragroup changes in study variables before and after the intervention are detailed in Table 1 (refer to Paper II). After the intervention, the control group reported significantly decreased levels of perceived autonomy ($t = 3.31$, $p = 0.001$), competence ($t = 4.48$, $p < 0.001$), and relatedness support ($t = 2.59$, $p = 0.010$) in PE class compared to the pre-intervention measurement.

For the main analysis, differences in psychological variables between the intervention and control groups at post-test are summarized in Table 2 (see Paper II). ANCOVA analysis revealed that students in the intervention group reported significantly higher levels of autonomy support ($F(1,444) = 4.09$, $p = 0.044$), competence support ($F(1,444) = 7.27$, $p = 0.007$), and relatedness support ($F(1,444) = 4.10$, $p = 0.044$) from their PE teachers following the intervention, compared to students in the control group.

5.3. The effects of a combined web-based intervention program for physical education teachers and parents on students' physical activity related outcomes

Firstly, the preliminary analyses revealed that the data adhered to a normal distribution with skewness and kurtosis values ranging from –1.94 to 0.57 and –0.81 to 4.13 respectively (Byrne, 2010). Cronbach's alpha values exceeded the acceptable level of 0.7, except for controlled motivation in PE and subjective norms (Nunnally, 1978) (refer to Table 1 in Paper III). Comparisons of the baseline characteristics between the study groups were conducted using a series of ANOVA tests. The results indicated no significant differences in any of the study variables between the groups at baseline. Additionally, there were no significant differences in the proportion of boys and girls or in the age of the participating students between the study groups. The results of the *t*-tests indicated no significant differences in any study variables at baseline between students who completed the study and those who dropped out, except for PBC regarding LTPA. For this variable, students who dropped out had significantly higher baseline scores compared to those who remained in the study ($t = –2.38$, $p = 0.02$). Additionally, there were no significant differences in the proportion of boys and girls or in the age of the participating students at baseline between those who remained in the study and those lost during follow-ups. All study variables were calculated as residual change scores, and their intercorrelations are presented in Table 1 (refer to Paper III).

In the main analysis, the tested path models showed a good fit with the data (combined intervention: $\chi^2 = 37.03$, df = 35, $p = 0.376$, CFI = 0.99, SRMR = 0.062, RMSEA = 0.032; teacher intervention alone: $\chi^2 = 36.38$, df = 35, $p = 0.404$, CFI = 0.99, SRMR = 0.068, RMSEA = 0.026; parental intervention alone: $\chi^2 = 42.09$, df = 35, $p = 0.191$, CFI = 0.96, SRMR = 0.080, RMSEA = 0.060; no intervention: $\chi^2 = 40.88$, df = 35, $p = 0.228$, CFI = 0.97, SRMR = 0.087, RMSEA = 0.054). The results of the path analysis for the combined intervention, using standardized parameter estimates, are presented in Figure 1.

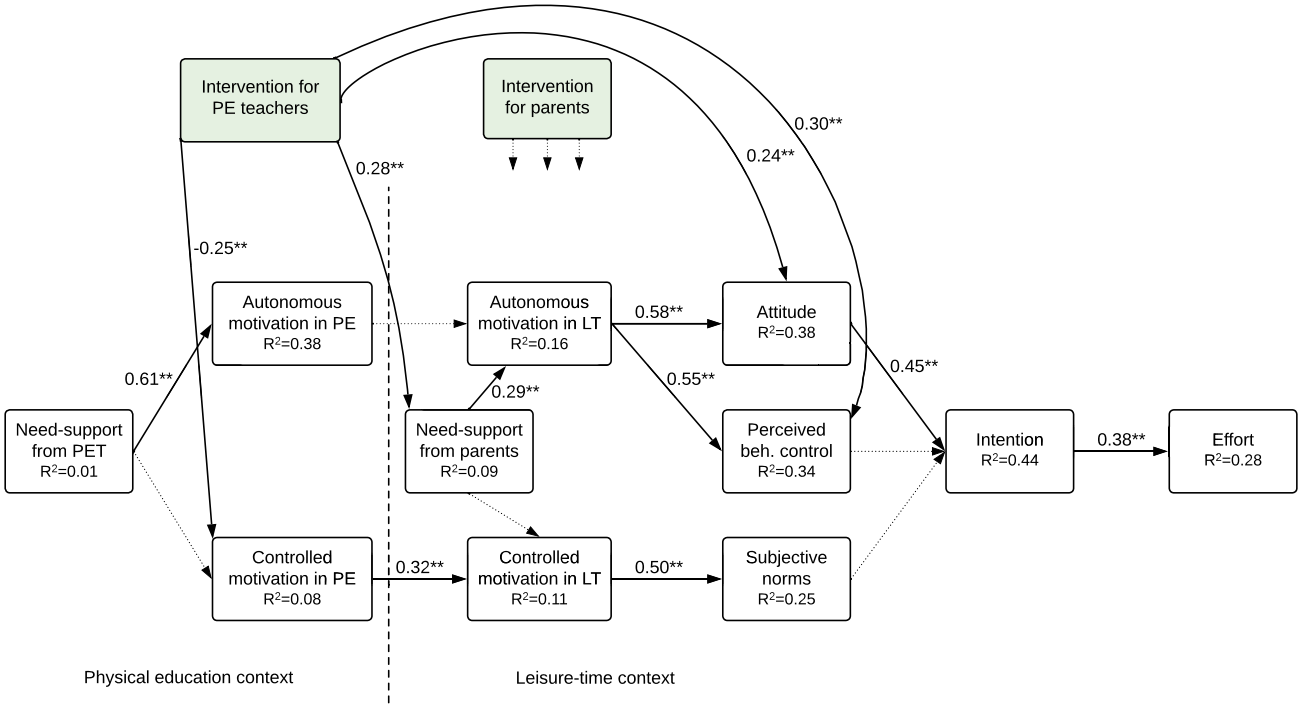

Figure 1. Results of the path analysis testing the effects of combined need-supportive intervention programs for PE teachers and parents. *Note*. All psychometric variables were residual change scores. The following covariances were added: need-support from PE teachers and need-support from parents; autonomous and controlled motivation in PE; autonomous and controlled motivation towards LTPA; attitude and PBC; attitude and subjective norms; PBC and subjective norms; autonomous motivation towards LTPA and effort towards LTPA. For clarity, the non-significant paths are presented in gray. PE = physical education; LT = leisure-time context; Perceived beh. control = perceived behavioral control. *$p < 0.05$, **$p < 0.01$

The results indicated that the need-supportive intervention for PE teachers had a significant direct effect on changes in perceived need-support from parents ($\beta = 0.28$, $p = 0.027$), controlled motivation in PE ($\beta = –0.25$, $p = 0.042$), attitude towards LTPA ($\beta = 0.24$, $p = 0.016$), and PBC regarding LTPA ($\beta = 0.30$, $p = 0.006$). Additionally, change in perceived need-support from PE teachers had a significant direct effect on change in autonomous motivation in PE ($\beta = 0.61$, $p = 0.001$). Change in perceived need-support from parents significantly influenced change in autonomous motivation towards LTPA ($\beta = 0.29$, $p = 0.041$). Change in controlled motivation in PE had a significant direct effect on change in controlled motivation towards LTPA ($\beta = 0.32$, $p = 0.031$). Furthermore, change in autonomous motivation towards LTPA had a significant direct effect on changes in attitude towards LTPA ($\beta = 0.58$, $p = 0.001$) and PBC regarding LTPA ($\beta = 0.55$, $p < 0.001$). Change in controlled motivation towards LTPA significantly influenced change in subjective norm ($\beta = 0.50$, $p = 0.002$). Finally, change in attitude towards LTPA had a significant direct effect on change in intention to engage in LTPA ($\beta = 0.45$, $p = 0.005$), and change in intention to engage in LTPA had a significant direct effect on change in effort to engage in LTPA ($\beta = 0.38$, $p = 0.002$).

Significant indirect effects were also observed in the case of the path model with combined intervention. Changes in perceived need-support from parents had significant indirect effects on changes in PBC ($\beta = 0.16$, $p = 0.039$) and attitude ($\beta = 0.17$, $p = 0.035$) mediated by autonomous motivation in leisure time. Additionally, significant indirect effects were found for changes in perceived need-support from parents on intention to engage in LTPA ($\beta = 0.12$, $p = 0.032$) and effort to engage in LTPA ($\beta = 0.05$, $p = 0.023$). For changes in intention, the sequence involving perceived need-support from parents, autonomous motivation towards LTPA, attitude, and intention was significant ($B = 0.06$, $p = 0.025$). However, the sequence mediated by PBC instead of attitude was non-significant. For changes in effort, both sequences – perceived need-support from parents, autonomous motivation towards LTPA, attitude, intention, effort ($B = 0.04$, $p = 0.024$) and perceived need-support from parents, autonomous motivation towards LTPA, PBC, intention, effort ($B = 0.02$, $p = 0.048$) – were significant. However, the sequence mediated by attitude was stronger. Furthermore, changes in controlled motivation in PE demonstrated a significant indirect effect on changes in subjective norm ($\beta = 0.16$, $p = 0.017$) that was mediated by controlled motivation in leisure time. For autonomous motivation towards LTPA, significant indirect effects were identified for changes in intention to engage in LTPA ($\beta = 0.39$, $p < 0.001$) and effort to engage in LTPA ($\beta = 0.15$, $p = 0.001$). Lastly, a significant indirect effect of changes in attitude towards LTPA on changes in effort to engage in LTPA was also observed ($\beta = 0.17$, $p = 0.006$) that was mediated by intention to engage in LTPA.

6. DISCUSSION

6.1 The effects of a web-based need-supportive intervention for parents on students' physical activity related outcomes

In Study I, we examined the effects of a web-based need-supportive intervention for parents on students' PA-related outcomes. The main findings were:

- In the intervention group there were significantly more boys than girls compared to the control group.
- Students in the intervention group reported marginally higher perceptions of intrinsic motivation and lower perceptions of introjected regulation and autonomy frustration at follow-up when compared to the control group.
- No significant changes were found in perceptions of need-supportive behavior from parents, attitude and PBC.
- Students in the intervention group reported declined perceptions of intention and effort towards LTPA at follow-up.
- No statistically significant intervention effect was found on students' LTPA at follow-up.

There were significantly more boys in the intervention group compared to the control group. To account for this imbalance, the gender of participants was included as a covariate in each of the ANOVA analyses and was treated as another between-subject variable. However, this discrepancy still limits the generalizability of the findings and suggests that future studies should ensure balanced randomization to account for potential gender-specific effects.

Students in the intervention group reported marginally higher perceptions of intrinsic motivation and lower perceptions of introjected regulation and autonomy frustration at follow-up. These findings are consistent with the principles of SDT, which emphasizes the importance of satisfying basic psychological needs – autonomy, competence, and relatedness – to foster intrinsic motivation and reduce controlled forms of motivation (Ryan & Deci, 2000a). Intrinsic motivation, characterized by engaging in an activity for its inherent enjoyment or interest, is considered the most self-determined form of motivation and has been linked to more sustainable outcomes in various domains, including PA. The intervention's focus on teaching parents autonomy-supportive techniques likely contributed to these observed changes. Autonomy-supportive parenting practices, such as offering meaningful choices, acknowledging children's perspectives, and using non-controlling, empathetic language, are designed to create an environment where children feel a sense of ownership over their actions. By promoting these practices, the intervention may have helped students perceive PA as a choice rather than an obligation, thereby enhancing their intrinsic motivation. Additionally, the reduction in perceptions of introjected regulation – where individuals

feel pressured to engage in activities out of guilt, shame, or obligation – suggests that the intervention successfully shifted students away from controlled forms of motivation. Furthermore, the reported decrease in autonomy frustration indicates that students in the intervention group felt less constrained or controlled in their decision-making processes related to PA. Thus, the parents who participated in the intervention may have created a more supportive environment that aligned with students' psychological needs, thereby fostering more positive motivational experiences. However, it is important to note that these changes were marginal. Longer follow-up periods may be necessary to allow the effects of the intervention to fully manifest and be captured.

Despite the intervention's emphasis on teaching parents need-supportive behaviors, no significant changes were observed in students' perceptions of their parents' behavior, students' attitude, or PBC towards PA. This lack of change may reflect the limited duration of the intervention, or the challenges parents faced in consistently applying the techniques in everyday interactions. Unlike structured environments such as PE classes, where teacher behaviors are more readily observable, the home setting may require more time for children to recognize and internalize changes in parental behavior. Additionally, the high baseline levels of perceived need-supportive behavior and attitude reported by students may have left little room for improvement (Schneider et al., 2020). Both Schneider and colleagues' study, as well as ours, suggest that altering students' perceptions of need-supportive behavior from social agents requires time. Moreover, the greater effect may stem from minimizing controlling behavior, as demonstrated in our case by the reduced autonomy frustration within the intervention group.

Contrary to expectations, students in the intervention group reported a decline in perceptions of intention and effort towards LTPA at follow-up. One possible explanation could be related to the very high baseline levels of intention and effort towards LTPA, especially in the intervention group, leaving little room for improvement as discussed in a study by Schneider and colleagues (2020). This "ceiling effect" could explain why their perceptions declined over time, as maintaining high levels of motivation can be challenging without consistent reinforcement or additional stimuli. Another possibility is that the intervention focused on reducing controlled forms of motivation (e.g., introjected regulation) and promoting intrinsic motivation. However, as this shift might have reduced external pressures or obligations (e.g., guilt or parental expectations) that previously drove effort and intention towards LTPA, the students may have felt less compelled to engage in LTPA, leading to a decline in effort and intention. Furthermore, the timing of the follow-up measurement one month after the intervention may not have been sufficient to capture the long-term effects of the intervention. Motivation and effort towards LTPA might fluctuate over time, and the observed decline could be a temporary dip rather than a permanent trend. Yet another explanation could be related to seasonal factors, as the study was conducted during the autumn and winter months in Estonia, when outdoor PA may be less appealing due to adverse weather conditions. The winter months are associated with lower levels of PA, particularly for girls (Gracia-Marco et al., 2013). Shorter daylight

hours and colder temperatures during autumn and winter may not only reduce opportunities for outdoor activities but also decrease students' overall energy levels.

The study found no statistically significant intervention effect on students' LTPA at follow-up, which is consistent with findings from other family-based interventions, such as the "Active 1 + FUN" (Ha et al., 2021) and FRESH studies (Guagliano et al., 2020). Several factors may explain this outcome. First, the relatively small sample size and high variability in self-reported PA measures likely reduced the statistical power to detect significant changes. Second, the self-paced online format of the intervention may have limited engagement and implementation fidelity among parents, as indicated by the moderate participation rates in online activities. Finally, it is possible that the intervention's focus on psychological constructs, such as motivation and need satisfaction, was not sufficient to translate into measurable behavioral changes in PA without addressing external factors, such as access to resources or opportunities for LTPA.

6.2 The effects of a web-based need-supportive intervention for physical education teachers on students' physical activity related outcomes

In Study II, we examined the effects of a web-based need-supportive intervention for PE teachers on students' PA-related outcomes. The main findings were:

- At baseline, autonomous motivation towards LTPA and self-reported PA were significantly higher in the intervention group compared to the control group.
- The within-group analysis revealed that while the control group experienced a significant decline in perceived autonomy support, competence support, and relatedness support after the intervention, the experimental group maintained baseline levels.
- The between-group comparison showed that post-intervention, the experimental group reported significantly higher levels of autonomy support, competence support, and relatedness support compared to the control group.
- No statistically significant intervention effect was found on students' LTPA after the intervention.

At baseline, students in the intervention group reported significantly higher levels of autonomous motivation towards LTPA and self-reported PA compared to the control group. This difference in baseline characteristics suggests that students in the intervention group may have started with a greater predisposition towards PA and autonomous forms of motivation such as intrinsic motivation and identified regulation, which could have influenced their perceptions of teacher behaviors and their responses to the intervention. Previous research has demonstrated that students with higher baseline motivation are more likely to perceive teacher

behaviors as supportive (Beutel, 2010; Koka, 2013; Pelletier et al., 2002), which may have contributed to the observed outcomes.

The within-group analysis revealed notable differences in how the intervention impacted the two groups. While students in the control group experienced a significant decline in perceived autonomy support, competence support, and relatedness support from their PE teachers post-intervention, the experimental group maintained their baseline levels of these variables. This finding highlights the potential protective effect of the intervention in preserving students' perceptions of need-supportive teaching behaviors. The decline observed in the control group could reflect natural variations in teaching practices or external factors unrelated to the intervention, underscoring the importance of implementing strategies to maintain supportive teacher behaviors.

The between-group comparison further supported the effectiveness of the intervention. Post-intervention, students in the experimental group reported significantly higher levels of perceived autonomy support, competence support, and relatedness support compared to their counterparts in the control group. These results align with previous studies emphasizing the importance of need-supportive teaching in fostering positive psychological experiences for students (Carriedo et al., 2023; Tilga et al., 2019; Tilga, Kalajas-Tilga, Hein, & Koka, 2021). By equipping teachers with practical strategies to support students' basic psychological needs, the intervention successfully maintained students' perceptions of their PE teachers' supportive behaviors. With higher levels of support for their basic psychological needs, students are much more likely to enjoy participating in PE classes. This positive experience not only contributes to increased PA levels during PE classes (Chen, 2014) but also extends beyond the school environment, encouraging higher levels of LTPA (Hagger et al., 2003; Hagger & Chatzisarantis, 2016).

Despite these promising findings, no statistically significant intervention effect was observed on students' LTPA levels after the intervention. This result suggests that while the intervention effectively maintained experimental group students' perceptions of need-supportive teaching during the school year when compared to students in the control group, these changes did not transfer into increased PA outside of school during the study period. Several factors may explain this outcome. Firstly, the duration of the intervention may have been insufficient to produce measurable changes in students' LTPA behaviors. Behavioral changes often require sustained exposure to supportive environments and may take longer to manifest. Schneider and colleagues (2020) conducted an autonomy-supportive intervention program for PE teachers with a 4-week implementation period and similarly found no significant changes in PA behavior. In contrast, Springer and colleagues (2020) implemented a year-long intervention program aimed at preventing cigarette smoking and promoting PA among high school students, which resulted in significant improvements in PA levels within the experimental group. Secondly, seasonal variations and weather conditions during the study period may have influenced students' opportunities for engaging in LTPA (Gracia-Marco et al., 2013).

Overall, the findings of this study highlight the importance of need-supportive teaching practices in creating a positive learning environment for students in PE. The intervention demonstrated its effectiveness in maintaining students' perceptions of autonomy, competence, and relatedness support, which are critical components of self-determination theory. However, the lack of significant effects on LTPA underscores the need for future research to explore strategies for bridging the gap between improved psychological experiences in PE and increased PA outside of school.

6.3 The effects of a combined web-based intervention program for physical education teachers and parents on students' physical activity related outcomes

In Study III, we examined the effects of separate web-based need-supportive interventions for PE teachers and parents, respectively, on students' PA-related outcomes. The main findings were:

- The students who dropped out of the study demonstrated significantly higher baseline scores for PBC regarding LTPA compared to students who completed the study.
- The intervention for PE teachers had a significant direct positive effect on adolescents' perceived need-support from parents, controlled motivation in PE, attitude towards, and PBC regarding LTPA.
- The intervention for parents showed no direct effect on any of the study variables.
- Changes in perceived need support from PE teachers enhanced students' autonomous motivation in PE, while need support from parents increased autonomous motivation towards LTPA.
- Changes in perceived need-support from parents additionally had significant positive specific indirect effects on changes in adolescents' intention and effort towards LTPA, mediated by changes in autonomous motivation and attitude.

The study revealed that students who dropped out demonstrated significantly higher baseline scores for PBC regarding LTPA compared to those who completed the study. This finding suggests that students with higher PBC may feel more confident in their ability to engage in LTPA independently, potentially perceiving less need for external support provided by the interventions. These students may have been less motivated to continue participating in the study, as they might not have seen additional value in the intervention. Future research should explore strategies to retain such participants, such as emphasizing the broader benefits of the program, including social and emotional support.

The intervention for PE teachers demonstrated significant direct positive effects on adolescents' perceived need-support from parents, controlled motivation in PE, attitude toward LTPA, and PBC regarding LTPA. These findings highlight the influential role of PE teachers in shaping students' motivation and attitudes toward PA. Notably, the intervention also had a spillover effect, improving adolescents' perceptions of need-support from their parents. This aligns with previous research showing that autonomy-supportive teaching practices can influence other relationships in adolescents' social environments, such as parental interactions (Cheon et al., 2024). This teacher-to-parent spillover effect emphasizes the interconnectedness of adolescents' social contexts and underscores the importance of equipping PE teachers with need-supportive strategies to foster motivation both directly and indirectly.

In contrast to the PE teacher intervention, the parental intervention did not yield any direct effects on the study variables. This finding is consistent with challenges observed in our first study involving the parental intervention alone, where low engagement and competing responsibilities possibly hindered participation (Study I). Only 42% of parents in this study completed the weekly quizzes, which suggests limited engagement with the intervention content. Additionally, the self-paced nature of the program may have reduced accountability. Future interventions targeting parents should consider incorporating tailored content, interactive features, and personalized reminders to enhance engagement (Aldridge et al., 2024). Offering incentives or simplifying program delivery could also address barriers to participation.

Changes in perceived need-support from PE teachers were significantly associated with enhanced autonomous motivation in PE, while perceived need-support from parents increased autonomous motivation toward LTPA. These findings align with SDT, which emphasizes the importance of satisfying basic psychological needs – autonomy, competence, and relatedness – to foster autonomous motivation (Ryan & Deci, 2000a). The results also support the trans-contextual model of motivation, demonstrating that motivation developed in one context (e.g., PE) can transfer to another (e.g., LTPA) (Hagger & Chatzisarantis, 2012). By fostering need-supportive environments, both PE teachers and parents can play crucial roles in promoting adolescents' motivation across contexts.

Although the parental intervention did not show direct effects, changes in perceived need-support from parents had significant positive specific indirect effects on adolescents' intention and effort toward LTPA. These effects were mediated by changes in autonomous motivation and attitude. This finding underscores the importance of parental support in shaping adolescents' motivational processes and behavioral intentions. Previous research has shown that parental encouragement and autonomy-supportive practices are positively associated with adolescents' PA levels and motivational constructs (Gustafson & Rhodes, 2006; Xu et al., 2015). The indirect effects observed in this study highlight the potential for parental interventions to influence adolescents' PA-related outcomes, even if the direct effects are not immediately apparent.

6.4 Insights from the web-based interventions for parents and PE teachers

The findings from Studies I, II, and III collectively emphasize the importance of creating cohesive, need-supportive environments across school and home contexts to promote adolescents' engagement in LTPA. Across all three studies, the interventions demonstrated varying degrees of success in influencing students' motivation-related constructs, underscoring the importance of need-supportive environments in promoting self-determined forms of motivation. Despite the positive effect on motivational constructs, none of the interventions demonstrated statistically significant effects on students' LTPA levels at follow-up. This pattern highlights the complexity of translating psychological improvements into measurable behavioral changes. Behavioral changes often require sustained exposure to supportive environments, and the relatively short duration of the interventions may not have been sufficient to produce measurable changes in LTPA. Seasonal factors, such as adverse weather conditions during the winter months in Estonia, may have further limited opportunities for outdoor PA.

A recurring theme in Studies I and III was the limited engagement of parents in web-based interventions. Future interventions targeting parents should incorporate strategies to enhance engagement, such as providing personalized, context-specific guidance that aligns with parents' unique needs and circumstances (Aldridge et al., 2024). The findings also highlight the challenges of implementing behavioral interventions in unstructured environments like the home, where consistent application of need-supportive practices may require more time and effort compared to structured settings like PE classes.

One of the most notable insights from the combined interventions (Study III) was the spillover effect of need-supportive teaching by PE teachers on adolescents' perceptions of parental need-support. This finding underscores the interconnectedness of adolescents' social environments and suggests that fostering need-supportive practices in one context (e.g., school) can positively influence relationships in another (e.g., home). This teacher-to-parent spillover effect aligns with previous research showing that autonomy-supportive teaching can improve interpersonal relationships beyond the classroom (Cheon et al., 2024). It also highlights the potential for interventions targeting educators to indirectly influence parental behaviors and, by extension, students' motivation and attitudes toward LTPA.

6.5 Strengths, limitations and future directions

The present study has notable strengths. First, its design integrates support for all three basic psychological needs – autonomy, competence, and relatedness. Second, the study is grounded in a specific classification system that serves as the foundation for the content of the web-based interventions (Teixeira et al., 2020). Third, the study incorporates need-support from both PE teachers at school and parents

in the home setting, thus covering both contexts expected to affect students' PA related outcomes. Fourth, the study leverages an online approach, enabling the inclusion of a larger number of participants compared to a purely in-person design. This web-based format not only enhances scalability for wider implementation but also proves to be cost-effective, facilitating sustainable interventions with minimal material expenses while reaching a significant number of participants.

Although the study provides valuable insights into developing strategies to promote PA among adolescents in both school and home environments, several limitations should be considered when interpreting the results. First, the study relied solely on self-reported measures to assess PA and related psychological constructs. While these measures are widely used, they are prone to biases such as overestimation or social desirability effects. Future studies could benefit from incorporating objective measures, such as accelerometers, to provide more accurate assessments of PA levels. Additionally, focus group interviews with parents and teachers, as well as classroom observations, could offer richer qualitative insights into the intervention's impact and implementation. Second, the sample sizes in Studies I and III limited the statistical power to detect significant effects and reduced the generalizability of the findings. Recruitment challenges were a significant barrier, particularly in engaging parents. It is likely that the parents who agreed to participate were already more interested in their children's activity levels and knowledgeable about the importance of sufficient PA, which may have introduced selection bias.

Third, low engagement was observed among parents participating in the intervention in Studies I and III. Competing demands, such as work and household responsibilities, likely hindered their involvement. Parents play a vital role in encouraging adolescents' PA by demonstrating supportive behaviors and implementing motivational strategies at home. However, low participation in the intervention may have limited their capacity to fully embrace these behaviors, potentially reducing the intended effects on adolescents' motivation and PA. This underscores the importance of developing tailored strategies to enhance parental engagement, including the integration of features like goal setting, personalized action plans, and adaptive modules that dynamically adjust based on initial assessments or ongoing progress. Additionally, systematic, theory-driven frameworks like Intervention Mapping (Kok et al., 2016), Logic Modeling (Page et al., 2009), and the Behavior Change Wheel (Michie et al., 2011) could enhance intervention effectiveness, particularly for engaging parents. These tools identify key behavioral determinants, such as knowledge and self-efficacy, and design targeted strategies to address them, potentially strengthening intervention outcomes. By focusing on specific needs, these frameworks ensure tailored approaches that address barriers like parental motivation or engagement. However, their implementation can be challenging for teams with limited resources, as they demand substantial time, expertise, and funding. While these frameworks hold promise for improving parental involvement and intervention success, their application must carefully balance potential benefits with practical resource limitations.

Fourth, a high attrition rate was observed in Studies II and III, which could have affected the reliability of the results. The lack of direct contact between researchers and participants during the intervention might have contributed to dropout, highlighting the need for more interactive or blended approaches in future interventions to maintain participant engagement. Fifth, there was a significant gender imbalance between study groups in Study I, which may have influenced the results and limited their applicability to diverse populations. However, the gender of participants was incorporated as a covariate in each ANOVA analysis and considered as an additional between-subject variable. Future studies should aim to ensure balanced representation of genders across study groups to provide more comprehensive insights. Sixth, a limitation of the study was the inability to establish a direct connection between individual parental participation in the training and their child's outcomes. Although students and parents were matched at a group level, ethical considerations and the necessity to preserve anonymity restricted the analysis of individual-level effects. This limitation hindered the ability to gain more detailed insights into the specific influence of parental involvement on student outcomes. Seventh, in the present study, both interventions were exclusively web-based. However, previous research has demonstrated that a combination of web-based and face-to-face interventions is more effective than either web-based or face-to-face interventions alone (Tilga, Kalajas-Tilga, Hein, & Koka, 2021). Therefore, future efforts could focus on developing a face-to-face intervention program to complement the current web-based approach.

Lastly, the intervention programs in this study were based on a motivational classification system focused solely on techniques supporting basic psychological needs (Teixeira et al., 2020). However, prior research indicates that supporting and thwarting basic psychological needs influence adolescents' experiences through distinct pathways: need satisfaction and need frustration, respectively (Haerens et al., 2015; Tilga, Hein, et al., 2020). Thus, training in supporting basic psychological needs does not automatically reduce behaviors that undermine them. Ahmadi and colleagues (2023) recently proposed a classification system that identifies both techniques for supporting basic psychological needs and need-thwarting behaviors, offering a framework that can enhance future intervention programs by teaching both supportive practices and the avoidance of harmful behaviors. Furthermore, the system by Ahmadi and colleagues, designed for educational contexts, may be more suitable for teacher-focused programs compared to the health-oriented framework by Teixeira and colleagues. Addressing these limitations in future research will enhance the robustness of findings and provide a clearer understanding of the effectiveness of interventions aimed at promoting PA among adolescents.

7. PRACTICAL IMPLICATIONS

The three studies collectively emphasize the importance of fostering need-supportive environments to promote adolescents' autonomous motivation, attitude, subjective norms, PBC, and intention towards PA, with specific implications for parents and educational facilities.

Parents play a pivotal role in shaping adolescents' attitudes and behaviors toward PA. Interventions should focus on equipping parents with practical tools and strategies to create a need-supportive environment at home. This includes offering meaningful choices for PA, fostering autonomy through non-controlling language, and providing constructive feedback. Digital platforms, such as web-based training programs, can provide accessible, self-paced resources for parents, ensuring scalability and convenience. However, these tools should be tailored to the needs and parents' current level of knowledge and complemented by ongoing support to sustain parental engagement.

Schools are uniquely positioned to influence adolescents' PA levels through structured programs and supportive environments. Training PE teachers in need-supportive strategies is an effective way to enhance students' motivation and engagement in PA by prioritizing teaching practices that encourage students to make choices, set personal goals, and participate in activities aligned with their interests. Training programs for PE teachers, particularly those delivered in web-based formats, should be integrated into professional development frameworks to ensure widespread adoption.

Across all three studies, the findings underscore the utility of SDT as a framework for designing interventions that address adolescents' basic psychological needs – autonomy, competence, and relatedness. The studies collectively suggest that digital tools can effectively train both parents and teachers, offering scalable and cost-effective solutions. By fostering collaboration between parents and schools, future interventions can create a cohesive, supportive environment that promotes sustainable PA habits in adolescents. These efforts will not only enhance adolescents' physical health but also contribute to their overall well-being and long-term quality of life.

8. CONCLUSIONS

1. The web-based intervention for parents resulted in lower perceptions of introjected regulation and autonomy frustration, alongside increased perceptions of intrinsic motivation in the experimental group adolescents compared to the control group, reflecting the development of more autonomous forms of motivation.
2. The web-based intervention for PE teachers was successful in maintaining students' perceptions of need-supportive teaching behaviors in the experimental group compared to the control group, demonstrating its potential for scalability and integration into teacher training programs.
3. The web-based intervention for PE teachers effectively improved students' perceptions of need-supportive parenting, attitude towards LTPA, and PBC, while also reducing controlled motivation in PE. However, the parental intervention did not produce the anticipated direct effects, suggesting that parental interventions may require more tailored strategies to achieve the desired outcomes.

The collective findings from these studies emphasize the vital importance of need-supportive behaviors in nurturing intrinsic motivation for PA among adolescents. Meeting the psychological needs of adolescents in both home and school environments is crucial for designing effective strategies to encourage and sustain LTPA.

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SUMMARY IN ESTONIAN

Kooliõpilaste kehalise aktiivsuse suurendamine psühholoogiliste põhivajaduste toetamise kaudu: kehalise kasvatuse õpetajatele ja lapsevanematele suunatud veebipõhiste sekkumisprogrammide roll

Kehaline aktiivsus on oluline igas vanuses inimestele nii füüsilise kui ka vaimse heaolu toetamiseks (Warburton, 2006). Samas ei täida enamik lapsi ja noori Maailma Terviseorganisatsiooni (WHO) soovitust olla vähemalt 60 minutit keskmiselt iga päeva kohta mõõdukalt kuni tugevalt kehaliselt aktiivne (Bull et al., 2020). Seetõttu tuleb leida tõhusaid viise, kuidas noori selleks motiveerida ja toetada.

Üks olulisemaid raamistikke, mis aitab mõista ja edendada motivatsiooni kehalise aktiivsuse suhtes, on enesemääratlusteooria (Deci & Ryan, 2000). Enesemääratlusteooria järgi on kolm psühholoogilist põhivajadust – autonoomsus, kompetentsus ja seotus – võtmetähtsusega, et kujundada sisemist motivatsiooni kehalise aktiivsuse suhtes ja toetada tervislikke eluviise (Ryan & Deci, 2000b).

Koolikeskkonnas on kehalise kasvatuse tundidel oluline roll noorte suhtumise ja käitumise kujundamisel kehalise aktiivsuse suhtes. Kehalise kasvatuse õpetajad saavad noori toetada, pakkudes mitmekesiseid liikumisvõimalusi ja aidates arendada motoorseid oskusi (Yli-Piipari, 2014). Uuringud on näidanud, et autonoomsust toetavad õpetamisvõtted suurendavad õpilaste sisemist motivatsiooni nii kehalise kasvatuse tundides kui ka vabal ajal (Hagger et al., 2003). Transkontekstiline motivatsioonimudel selgitab, kuidas motivatsioon, mis kujuneb välja ühes kontekstis, võib kanduda üle teise konteksti, näiteks kehalise kasvatuse tundidest vaba aja tegevustesse (Hagger et al., 2003).

Lisaks õpetajatele mängivad kehalise aktiivsuse edendamisel olulist rolli lapsevanemad, kes mõjutavad laste hoiakuid ja käitumist, olles eeskujuks ning pakkudes tuge ja julgustust (Messing et al., 2019). Vanemate poolne laste autonoomsust toetav käitumine võib aidata lastel näha kehalist aktiivsust pigem nauditava valikuna kui kohustusena (González-Cutre, Sicilia, et al., 2014; Tilga, Kalajas-Tilga, Hein, Raudsepp, et al., 2021b). Samas tunnistavad paljud vanemad, et neil puuduvad teadmised ja oskused, kuidas oma laste kehalist aktiivsust tõhusalt toetada (Goh et al., 2009).

Veebipõhised koolitusprogrammid pakuvad paindlikku ja kulutõhusat võimalust õpetajate ja lapsevanemate toetamiseks. Need võimaldavad sekkumistel jõuda laiema avalikkuseni ja osalejatel õppida omas tempos (Reeve & Cheon, 2021). Uuringud on näidanud, et veebipõhised sekkumised võivad suurendada autonoomsust toetavat käitumist, parandada õpilaste psühholoogiliste vajaduste rahuldamist ja tõsta kehalise aktiivsuse taset (Tilga et al., 2019; Tilga, Kalajas-Tilga, et al., 2020a).

Varasemad uuringud on keskendunud peamiselt autonoomsuse toetamisele ega ole põhjalikult uurinud kõigi kolme psühholoogilise põhivajaduse – autonoomsuse, kompetentsuse ja seotuse – samaaegset toetamist. Käesoleva töö ees-

märk on uurida, kuidas kehalise kasvatuse õpetajatele ja lapsevanematele suunatud veebipõhised kõiki kolme põhivajadust toetavad sekkumised mõjutavad teismeliste sisemist motivatsiooni kehalise aktiivsuse suhtes.

Käesolev töö koosneb kolmest uuringust. Esimeses uuringus osales 68 õpilast vanuses 11–15 aastat. Uuringus keskenduti veebipõhise psühholoogilisi põhivajadusi toetava vanemluskoolituse mõjule laste kehalise aktiivsusega seotud näitajatele ning rakendamise periood pärast koolitust oli üks kuu. Sekkumine vähendas noorte tajutud kontrollitud motivatsiooni ja autonoomsusvajaduse frustratsiooni ning suurendas sisemist motivatsiooni kehalise aktiivsuse suhtes. Positiivsed muutused motivatsioonis ei kandunud rakendusperioodi jooksul üle teismeliste tegelikule koolivälisele kehalisele aktiivsusele.

Teises uuringus osales 1283 õpilast vanuses 13–17 aastat. Uuring keskendus kehalise kasvatuse õpetajatele suunatud veebipõhise psühholoogilisi põhivajadusi toetava programmi mõjule õpilaste kehalise aktiivsusega seotud näitajatele ning rakendamise periood pärast koolitust oli 9 nädalat. Sekkumine aitas säilitada õpilaste tajutud autonoomsuse, kompetentsuse ja seotuse toetust õpetajatelt, samas kui kontrollgrupis need näitajad vähenesid. Õpilaste koolivälisele kehalisele aktiivsusele olulist mõju rakendusperioodi jooksul ei täheldatud.

Kolmas uuring oli kombineeritud sekkumine, mis hõlmas nii kehalise kasvatuse õpetajaid kui ka lapsevanemaid. Uuringus osales 115 õpilast vanuses 11–15 aastat. Mõõtmised viidi läbi ühe ja kuue kuu möödumisel sekkumisest ning nende abil selgitati sekkumiseprogrammide mõju muutustele uuringutunnustes. Kehalise kasvatuse õpetajatele suunatud sekkumine parandas sekkumisrühma laste tajutud lapsevanemate vajadusi toetavat käitumist, hoiakuid ja tajutud käitumuslikku kontrolli kehalise aktiivsuse osas ning vähendas kontrollitud motivatsiooni kehalise kasvatuse tundides võrreldes kontrollgrupiga. Lapsevanematele suunatud sekkumine ei avaldanud otsest mõju laste kehalise aktiivsusega seotud näitajatele.

Käesoleva töö tulemused näitasid, et psühholoogilisi põhivajadusi toetava keskkonna loomine on oluline laste ja noorte sisemise motivatsiooni edendamiseks kehalise aktiivsuse suhtes. Vanemate roll laste kehalise aktiivsuse toetamisel on keskne, kuna nende käitumine ja suhtumine mõjutavad oluliselt noorte hoiakuid. Seetõttu on oluline pakkuda vanematele praktilisi juhiseid, kuidas luua kodus psühholoogilisi põhivajadusi toetav keskkond. Samuti on koolidel suurepärane võimalus mõjutada teismeliste kehalise aktiivsuse taset, pakkudes struktureeritud programme ja toetavat keskkonda – kehalise kasvatuse õpetajate koolitamine vajadusi toetavate strateegiate osas aitab suurendada õpilaste motivatsiooni ja kaasatust. Nii vanemate kui õpetajate toetamiseks on võimalik kasutada veebipõhised koolitusprogramme, mis on osalejatele mugavad ja aega säästvad ning mida saab kohandada vastavalt olemasolevatele teadmistele. Kehalise kasvatuse õpetajate ja lapsevanemate koostöö ning psühholoogilisi põhivajadusi toetavad käitumispraktikad võivad oluliselt parandada teismeliste motivatsiooni ja suhtumist kehalisse aktiivsusesse, luues aluse tervislikule eluviisile tulevikus.

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PUBLICATIONS

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Interventions to increase adolescents' out-of-school physical activity.

Publications

Meerits, P.-R.; Tilga, H.; Koka, A. (2025) Web-based intervention program to foster need-supportive behaviors in physical education teachers and parents: a cluster-randomized controlled study to increase students' intention and effort to engage in physical activity. *BMC Public Health* 25, 2142. DOI: 10.1186/s12889-025-22590-x

Paap, H., Koka, A., Meerits, PR., Tilga, H. (2025). The effects of a web-based need-supportive intervention for physical education teachers on students' physical activity and related outcomes: A randomized controlled trial. *Children*, 12 (1), 56. DOI: 10.3390/children12010056.

Tilga, H., Aljasmäe, L.M., Paap, H., Meerits, P.R. & Koka, A. (2024). Effects of a web-based need-supportive intervention programme on physical education teacher outcomes. *Kinesiology*, 56 (2), 291–303. DOI: 10.26582/k.56.2.12.

Meerits, PR., Tilga, H. & Koka, A. (2023). Web-based need-supportive parenting program to promote physical activity in secondary school students: a randomized controlled pilot trial. *BMC Public Health*, 23 (1), 1627. DOI: 10.1186/s12889-023-16528-4.

Meerits, P.-R.; Tilga, H.; Koka, A. (2022). Fostering Need-Supportive Behaviors in Physical Education Teachers and Parents: A Cluster Randomized Controlled Trial Study Protocol of a Web-Based Intervention on Secondary School Students' Physical Activity. *Methods and Protocols*, 5 (5), 83. DOI: 10.3390/mps5050083.

Conference presentations

Meerits, P.-R.; Tilga, H.; Koka, A. (2024). Web-based need-supportive interventions for physical education teachers and parents to support children's physical activity related cognitive outcomes. 17th Conference of Baltic Society of Sport Sciences, Tartu, Estonia, April 24–26. University of Tartu.

Tilga, H., Aljasmäe, LM., Paap, H., Meerits, P-R. & Koka, A. (2024). The effectiveness of a web-based intervention program in enhancing physical education teachers' need-supportive behaviors: a study of teachers' experiences. 17th Conference of Baltic Society of Sport Sciences, Tartu, Estonia, April 24–26. University of Tartu.

Paap, H., Koka, A., Meerits, P-R. & Tilga, H. (2024). Examining the efficacy of a web-based need-supportive intervention program for physical education teachers: the changes in cognitive and behavioral outcomes among students in relation to physical activity. 17th Conference of Baltic Society of Sport Sciences, Tartu, Estonia, April 24–26. University of Tartu.

Meerits, P.-R., Raudsepp, L., Tilga, H., Koka, A. (2021). Theory-based interventions combining physical education teachers' and parents' autonomy-supportive training to increase out-of-school physical activity among secondary school students – a randomized controlled trial protocol. 14th Conference of Baltic Society of Sport Sciences, Riga, Latvia, April 29–30. Latvijas Sporta Pedagogijas Akademija.

Meerits, P.-R., Raudsepp, L., Tilga, H., Hein, V., Koka, A. (2021). Development of the theory- and web-based parental autonomy-supportive intervention to increase out-of-school physical activity among secondary school students. 26th Annual ECSS Virtual Congress, September 8–10. European College of Sport Science, 221–222.

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Sekkumisuuringud kooliõpilaste kehalise aktiivsuse suurendamiseks

Publikatsioonid

Meerits, P.-R.; Tilga, H.; Koka, A. (2025) Web-based intervention program to foster need-supportive behaviors in physical education teachers and parents: a cluster-randomized controlled study to increase students' intention and effort to engage in physical activity. *BMC Public Health* 25, 2142. DOI: 10.1186/s12889-025-22590-x

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Meerits, P.-R.; Tilga, H.; Koka, A. (2024). Web-based need-supportive interventions for physical education teachers and parents to support children's physical activity related cognitive outcomes. 17th Conference of Baltic Society of Sport Sciences, Tartu, Estonia, April 24–26. Tartu Ülikool.

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