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Preschool children's sedentary behavior: The role of individual characteristics,
home and preschool settings, and socioeconomic status

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“We should take wandering outdoor walks, so that the mind might be nourished and refreshed by the open air and deep breathing” – Seneca

ABSTRACT

The sedentary lifestyle is rooted in our lives across many settings in contemporary society. The phenomenon has raised public health concerns due to increasing knowledge of the negative health consequences of extensive sedentary behavior (SB). SB is defined as any waking behavior characterized by a low energy expenditure while in a sitting, reclining or lying posture. Already, preschool-aged children are sedentary for over half their daily waking hours. The prevalence of their SB encourages understanding of the factors associated with it. The two key settings for the development of preschool children's SB habits are home and preschool. As postulated by the socioecological model of SB, each setting, with its social and physical environment, shapes the individual's possibilities for SB differently. Each setting may also differ in socioeconomic status (SES). Beside settings, individual characteristics (e.g. temperament) shape behavior. These theoretical assumptions create the potential to study the interplay between individual characteristics, SES, home and preschool settings, and children's SB.

The main research focus of this dissertation was to examine how SES, individual factors, and home and preschool settings combine to shape preschool children's SB. The specific questions targeted in this study were: 1) Which individual, home, and preschool factors were associated with the preschool children's overall SB and to what extent did these factors explain variance in children's overall SB? 2) Which factors in the preschool setting were associated with preschool children's SB during preschool hours and did these factors in preschool setting act as moderators in the associations between parental SES and SB? 3) Did co-participation in physical activity (PA) as a parenting practice act as a mediator in the associations between parental SES and SB? and 4) Did the frequent visits to places where PA is encouraged and weekly common practices in the preschool group associate with preschool children's SB during preschool hours?

This research was based on the DAGIS (Increased Health and Wellbeing in Preschool) cross-sectional study, which was conducted in 66 preschools in Western and Southern Finland in the years 2015 and 2016. A total of 864 children, aged three to six years, participated in this study. This multimethod study included objective measurement of SB, observations, and multiple questionnaires covering the children's characteristics, the preschool setting and the home setting. The preschool setting was defined as consisting of social, physical and organizational environments whereas the home setting comprised parenting behaviors and practices, family knowledge and social norms, and family SES. The indicators of SES were parental educational background and preschool neighborhood SES. All the main analyses in the

sub-studies applied multilevel linear regression models, but additionally cross-level interactions were tested in study II and indirect effects in study III.

The main results of this research were: 1) Being a boy and having higher levels of surgency temperament were associated with lower SB. Individual characteristics explained the variance in children's SB more than the settings. 2) Parental perceived barriers related to children's outdoor PA was associated with children's higher SB, whereas more frequent parental co-participation in PA, especially in their own yard and in nature, was associated with children's lower SB. 3) Parental SES differences existed regarding co-participation in PA practices. Compared to parents with high SES backgrounds, parents with low SES reported visiting more frequently their own yards, and this was associated with their children's lower SB. Parents with high SES reported more frequent visits to indoor sports facilities than parents with middle or low SES backgrounds, but this frequency did not have a statistically significant association with children's SB. 4) Preschool practices were associated with children's lower SB during preschool hours. Namely, more minutes spent on physical education lessons, higher numbers of PA theme weeks, more frequently conducted nature trips and early educators' practices to break children's SB were related to children's lower SB. 5) Higher parental SES was associated with children's higher SB in preschools either a higher number of organized SB theme weeks, a lower number of PA theme weeks or a lower number of PE lessons.

This dissertation brings novel and practical knowledge about the important role of parental and preschool practices in relation to preschool children's SB. The practical implications based on the results of this dissertation encourage the development of public health programs and intervention strategies related to parental and preschool practices enhancing preschool children's healthy SB habits. More specifically, strategies inspiring families' frequent co-participation in PA, specifically in nature and their own yards, can be beneficial. In addition, all the preschools should assure frequent nature trips, PE lessons and PA theme weeks for their children, as these practices have the potential to diminish children's SB. However, the children's individual characteristics also need to be reflected on better. More research is needed on the mechanisms of SES in children's SB.

TIIVISTELMÄ

Fyysisesti passiivinen elämäntyyli ja paikallaanolo ovat juurtuneet osaksi päivittäistä elämää nyky-yhteiskunnan eri konteksteissa. Ilmiö on herättänyt kansanterveydellistä huolta, kun tietämys paikallaanolon kielteisistä terveysvaikutuksista on lisääntynyt. Paikallaanolo tarkoittaa vähän energiaa kuluttavaa, istuen, maaten tai loikoillen tapahtuvaa käyttäytymistä valveillaoloaikana. Jo päiväkotikäiset lapset viettävät puolet ajastaan paikallaan. Tämä yleisyys kannustaakin tutkimaan paikallaanoloon yhteydessä olevia tekijöitä. Päiväkotijä ja koti ovat kaksi keskeisintä päiväkotikäisten lasten kasvuympäristöä. Sosioekologisen paikallaanoloa kuvaavan mallin mukaisesti jokainen konteksti sosiaalisine ja fyysisine tekijöineen muokkaa yksilön mahdollisuuksia paikallaanoloon eri tavoin. Jokainen konteksti voi myös olla erilainen sosioekonomisen aseman suhteen. Kasvuympäristöjen lisäksi yksilölliset piirteet (esim. temperamentti) muokkaavat käyttäytymistä. Nämä teoreettiset oletukset luovat mahdollisuuden tutkia vuorovaikutuksia sosioekonomisen aseman, yksilöllisten piirteiden, kodin, päiväkodin ja lasten paikallaanolon välillä.

Tämän väitöskirjan päätutkimuskysymys oli tutkia miten sosioekonominen asema, yksilölliset tekijät, koti ja päiväkotij yhdessä muokkaavat päiväkotikäisen lasten objektiivisesti mitattua paikallaanoloa. Alatutkimuskysymykset olivat 1) mitkä yksilölliset, koti- ja päiväkotitekiäjät olivat yhteydessä päiväkotikäisten lasten paikallaanoloon ja missä määrin kyseiset tekijät selittivät eroavaisuuksia lasten paikallaanolossa? 2) mitkä päiväkotiympäristön tekijät olivat yhteydessä lasten paikallaanoloon ja muoivasivatko nämä tekijät vanhempien sosioekonomisen aseman ja paikallaanolon välistä yhteyttä? 3) toimiko yhdessä liikkuminen mediaattorina vanhempien sosioekonomisen aseman ja lasten paikallaanolon välissä? ja 4) olivatko säännölliset vierailut liikkumista kannustaviin paikkoihin ja viikoittaiset päiväkotiryhmien käytännöt yhteydessä lasten paikallaanoloon päiväkotiaikana?

Tämä tutkimus perustui DAGIS-poikkileikkaustutkimukseen, mikä toteutettiin 66 päiväkodissa Länsi- ja Etelä-Suomessa vuosina 2015 ja 2016. Yhteensä 864 lasta, iältään 3–5-vuotiaita, osallistuivat tutkimukseen. Tämä monimenetelmällinen tutkimus sisälsi paikallaanolon objektiivisen mittaamisen, havainnoinnin sekä lukuisia kyselylomakkeita lasten piirteisiin, päiväkotiympäristöön ja kotiympäristöön liittyen. Päiväkotiympäristö määritettiin koostuvan sosiaalisesta, fyysisestä ja organisaattorisista tekijöistä, kun puolestaan kotiympäristö koostui vanhemmuuskäytännöistä, vanhempien käyttäytymisestä, perheen tiedoista ja sosiaalisista normeista sekä perheen sosioekonomisesta asemasta. Sosioekonomisen aseman indikaattorit olivat vanhempien koulutustausta ja päiväkodin naapuruston sosioekonominen asema. Kaikissa pääanalyseissa käytettiin menetelmänä

monitasoista lineaarisista regressioanalyysia. Lisäksi tutkimuksessa II huomioitiin tasojen väliset interaktiovaikutukset ja tutkimuksessa III puolestaan epäsuora vaikutus.

Tutkimuksen päätulokset olivat: 1) pojat ja ulospäinsuuntautuneen temperamenttipiirteiden omaavat lapset olivat vähemmän paikallaan. Lapsen yksilölliset piirteet selittivät enemmän eroavaisuuksia lasten paikallaanoloissa kuin kasvuympäristöt. 2) Vanhempien kokemat esteet lasten ulkoilua kohtaan olivat yhteydessä lasten runsaampaan paikallaanoloon. Puolestaan useammin tapahtuva perheen yhdessä liikkuminen, erityisesti omalla pihalla tai luonnossa, oli yhteydessä lasten vähäisempään paikallaanoloon. 3) Yhdessä liikkumiskäytännöissä esiintyi eroja vanhempien sosioekonomisen aseman mukaan. Verrattuna korkean sosioekonomisen aseman omaaviin vanhempiin, matalan sosioekonomisen aseman omaavat vanhemmat liikkuvat yhdessä lasten kanssa omalla pihalla useammin, ja näin heidän lapsilla oli vähemmän paikallaanoloa. Korkean sosioekonomisen aseman omaavat vanhemmat kävivät useammin sisäliikuntapaikoissa yhdessä lapsen kanssa kuin matalan tai keskitason sosioekonomisen aseman omaavat vanhemmat, mutta tämä vierailutiheys ei ollut tilastollisesti merkitsevästi yhteydessä lasten paikallaanoloon. 4) Päiväkodin käytännöt olivat yhteydessä lasten vähäisempään paikallaanoloon päiväkotiaikana. Enemmän liikuntatunteja ja liikunnan teemaviikkoja sekä useammin toteutetut luontoretket sekä varhaiskasvattajien tiheämpi käytäntö tauottaa lasten paikallaanoloa olivat yhteydessä lasten vähäisempään paikallaanoloon. 5) Vanhempien korkea sosioekonominen asema oli yhteydessä lasten runsaampaan paikallaanoloon päiväkodeissa, joissa oli joko enemmän paikallaanolon teemaviikkoja, vähemmän liikuntatunteja tai harvemmin liikunnan teemaviikkoja.

Tämä väitöskirja tuo uutta ja käytännönläheistä tietoa päiväkodin ja kodin käytäntöjen merkityksestä lasten paikallaanoloissa. Käytännön suosituksena tutkimuksen tulosten perusteella kannustetaan kehittämään terveydenedistämishjelmia ja interventioiden menetelmiä, joilla edistetään kodin ja päiväkodin terveellisiä lasten paikallaanoloa vähentäviä käytäntöjä. Erityisesti menetelmät, joilla innostetaan perheitä yhdessäliikkumiseen varsinkin omalla pihalla tai luonnossa, ovat hyödyllisiä. Lisäksi kaikissa päiväkodeissa tulisi taata lapsille säännöllisesti liikuntatunteja, luontoretkeä sekä liikunnan teemaviikkoja, koska näillä käytännöillä on mahdollisuus vähentää lasten paikallaanoloa. Kuitenkin lasten yksilölliset piirteet tulee huomioida paremmin. Lisätutkimusta tarvitaan sosioekonomisen aseman mekanismeista lasten paikallaanoloissa.

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LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following publications:

- I Määttä, S., Konttinen, H., de Oliveira Figueiredo, R., Haukkala, A., Sajaniemi, N., Erkkola, M., Roos, E. Individual-, home-, and preschool-level correlates of preschool children's sedentary time. *BMC Pediatrics*. 2020, 20, 58; doi.org/10.1186/s12887-020-1948-y
- II Määttä, S., Konttinen, H., Lehto, R., Haukkala, A., Erkkola, M., Roos, E. Preschool environmental factors, parental socioeconomic status and children's sedentary time: an examination of cross-level interactions. *International Journal of Environmental Research and Public Health*. 2018, 16, 1; doi:10.3390/ijerph16010046
- III Määttä, S., Ray, C., Vepsäläinen, H., Lehto, E., Kaukonen, R., Ylönen, A., Roos, E. Parental education and preschool children's objectively measured sedentary time: the role of co-participation in physical activity. *International Journal of Environmental Research and Public Health*. 2018, 15, 366; doi:10.3390/ijerph15020366
- IV Määttä, S., Lehto, R., Konttinen, H., Ray, C., Sajaniemi, N., Erkkola, M., Roos, E. Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland. *BMJ open*. 2019;9:e032210. doi: 10.1136/bmjopen-2019-032210

The publications are referred to in the text by their roman numerals.

ABBREVIATIONS

ANGELO	Analysis Grid for Environments Linked to Obesity framework
BMI	body mass index
EBRBs	energy balance-related behaviors
FEM	the Family Ecological Model
HAPA	the health action process approach
MET	metabolic equivalents
MVPA	moderate-to-vigorous physical activity
PA	physical activity
PE	physical education
SB	sedentary behavior
SES	socioeconomic status
WHO	World Health Organization

1 INTRODUCTION

Humans are meant to move and take steps. Preschool-aged children, roughly three to five years, are considered to be the most active segment of society. However, there are concerns that elements of our modern society are causing children to become less active, more sedentary, overweight and less healthy. The World Health Organization (WHO) has estimated that globally over 41 million children under age five were overweight in the year 2016 (WHO, 2016). Although being overweight is a complex issue with a variety of shaping factors that can influence its creation directly or indirectly (Rutter, 2011), a sedentary lifestyle is one of the key aspects of current society that increases the risk of being overweight (WHO, 2016). Lifestyle changes over the past 50 years have created the current modern environment with labor-saving devices, continuously developing screen technologies and dependence on cars. The modern urban lifestyle has brought passive commuting, smaller houses and leisure time that is increasingly spent indoors. These societal and industrial changes that provide possibilities for taking fewer steps have brought a sedentary lifestyle into most aspects of daily living. (De Craemer et al., 2018; Lanningham-Foster, Nysse, & Levine, 2003; Ng & Popkin, 2012; Salmon, Tremblay, Marshall, & Hume, 2011; W. Zhu & Owen, 2017.) A recent meta-analysis based on 50 studies conducted among preschool-aged children assessing sedentary behavior (SB) with objective measurements (e.g. accelerometers) conclude that children spend over half of their waking time in SBs (Pereira, Cliff, Sousa-Sa, Zhang, & Santos, 2018). It is no wonder that WHO has stated a sedentary lifestyle is a global problem even at preschool age, and recommends that preschool-aged children shall not be restrained for more than one hour at a time or be sedentary for extended periods of time, breaking SB often as possible (WHO, 2019). As a sedentary lifestyle is forecasted to increase in the future with an estimated health and economic burden for societies (Ding et al., 2016; Ng & Popkin, 2012), it is relevant to understand SB by taking into consideration the settings in which it occurs for each age group.

Preschool age is a sensitive period of rapid growth and physical, social, emotional and cognitive development that lays the foundation for lifelong health and wellbeing (Knudsen, 2004). The brain's rapid growth during this period makes children particularly receptive to environmental stimuli. Thus, neuropsychological research yields hypotheses that social and environmental experiences in preschool-aged children shape physiological changes that have long-lasting protective or detrimental effects on children's learning, behavior, health and wellbeing. (Boyce & Ellis, 2005; Knudsen, 2004; Mitchell et al., 2014; Ursache & Noble, 2016.) For instance, SB habits learned during preschool years tend to track later in life and predict SB habits over the life course (Jones, Hinkley, Okely, & Salmon, 2013). There are many opportunities for preschool-aged children to engage in SB throughout the day. Each child needs to engage in SB each day; storytelling and reading/being read to in interaction with adults are especially beneficial for cognitive and psychosocial development (Carson et al., 2015). Still, promoting SB habits in short bouts and limiting prolonged overall SB seem

to be important primary preventions of overweight (Kuzik & Carson, 2016). The associations of other biomedical health indicators with children's extensive SB are still poorly known (Poitras et al., 2017). Children may, however, be at risk for future health problems, but the effects may not manifest themselves until later in life. Because of this latency issue, research has generally focused on outcomes that are directly observable, such as overweight (Chinapaw, Altenburg, & Brug, 2015; Welk & Kim, 2017). Nevertheless, research focusing on the 24-hour combinations of all movement behaviors (e.g. physical activity, or PA, and SB) recommends that replacing daily SB with more active pursuits (especially moderate-to-vigorous PA, or MVPA) is most relevant to healthy development during the preschool years (Kuzik et al., 2017).

Children learn and shape healthy habits in natural, reciprocal social interaction by actively observing and mimicking the behavior of significant others. In their early stages of development, preschool children are highly dependent on the caregivers in their daily settings. (Bandura, 1977a; Bronfenbrenner, 1979.) The two key settings for preschool children's development are home and early childhood education and care services (e.g. preschools, later used to reflect this concept). The behaviors modeled by educators and parents (e.g. co-participation, role modeling, rules) have an especially important influence on shaping children's behaviors (Edwardson & Gorely, 2010; Goldfield, Harvey, Grattan, & Adamo, 2012). The socioecological approach of SB assumes that the attributes of the setting and the social frame around this setting shape the SB (Owen et al., 2011). Setting is defined as a place with exact physical features in which participants engage in particular activities in specific roles for certain periods of time (Bronfenbrenner, 1977). Preschool and home are two distinct settings because they control differently how much SB is individual choice and to what extent constraints are in the social and physical environments of the setting (Owen et al., 2011; Spence, Rhodes, & Carson, 2017). Thus, home and preschool settings modify children's SB differently. Reciprocally, each individual with his/her unique beliefs and practices reacts differently to the influences in the settings (Bronfenbrenner, 1977). Due to this difference, it is essential to understand both how these settings are related to children's SB and also the role of individual characteristics.

Each setting in which children live may vary according to socioeconomic status (SES; Ball, 2015). Parental SES background especially shapes families' social standing, ability to participate in society and access to material and social resources (Cohen, Janicki-Deverts, Chen, & Matthews, 2010; Kristenson, 2006; Siegrist & Marmot, 2004; Stansfeld, 2006). Thus, parental SES may stipulate different social and physical environment exposures for children, which in turn may alter children's behavior. For instance, SES can be considered as a distal factor influencing children's behavior through proximal factors (e.g. parental practices and beliefs; Spence & Lee, 2003). Parental SES can also play a role in the interactions between home and preschool settings. As the socioecological approach assumes, the influence of preschool is dependent on what happens at home, and preschool setting influences practices in the home (Bronfenbrenner, 1979). Therefore, good quality factors in preschool setting (e.g. high numbers of physical education, or PE, lessons) may buffer the associations between parental SES and children's SB (Spence & Lee, 2003). These theoretical

linkages strive to investigate either moderator or mediator relationships between the SES, the home and the preschool settings, and children's SB. Understanding the mechanisms of SES in early childhood and the potential impact on children's SB has a public health and societal importance; a socioeconomic gradient in a wide range of determinants in relation to obesity is found already in early childhood, and early life SES is a strong predictor of adult health (Aizer & Currie, 2014; Brisbois, Farmer, & McCargar, 2012; Cameron et al., 2015; Cohen et al., 2010; Galobardes, Lynch, & Davey Smith, 2004).

SB can be conceptualized as a complex construct influenced by multiple factors across different settings, but how these factors interplay to influence preschool children's SB is still poorly studied (Gubbels, Van Kann, de Vries, Thijs, & Kremers, 2014; Owen et al., 2011; Zhu & Owen, 2017). This dissertation aims to bring novel knowledge about the complex interplays between SES, individual characteristics, and the home and the preschool settings on the preschool children's SB.

2 CONCEPTUAL FRAMEWORK

2.1 EVOLVING DEFINITION OF SEDENTARY BEHAVIOR

The word *sedentary* comes from Latin word *sedentarius/sedere* and means “sitting/to sit.” Although the first study using the term sedentary was published in the 1950s, the focus of this and other studies was on the PA, whereas the concept of SB was sidelined for several decades (Biddle, Pearson, & Salmon, 2018). Research on SB developed rapidly in the 2000s, focusing on multiple aspects, such as measurement, correlates, health outcomes and interventions (Owen, 2017; Sallis, Owen, & Fotheringham, 2000). This development led also to a more integrated approach to comprehending human movement on an energy expenditure continuum (Figure 1). However, the words “sedentary” and “physical inactivity” were mixed until the clear distinction was made in the year 2012. The physically inactive person is the one who is performing insufficient amounts of MVPA or not meeting the PA guidelines. SB is defined as any waking behavior characterized by an energy expenditure ≤ 1.5 metabolic equivalents (METs) while in a sitting or reclining posture. (Sedentary Behaviour Research Network., 2012.) SB is also commonly defined as any waking behavior causing ≤ 1.5 METs without taking any position on the postural position (Gibbs, Hergenroeder, Katzmarzyk, Lee, & Jakicic, 2015).

The new SB update in the year 2017 sharpens the previous definitions. More clarity is added to the distinctions between SB that is measured with context (e.g. questionnaires) and sedentary time at an established level of intensity absent of context (e.g. accelerometer data). **Sedentary time** is defined as the time spent for any duration (e.g. minutes per day) or in any context (e.g. preschool or at home) in SBs. **SB** is defined as any waking behavior characterized by an energy expenditure ≤ 1.5 METs, while in a sitting, reclining or lying posture. (Tremblay et al., 2017.) Following this definition, the children’s behavior in this dissertation is called sedentary time, which is used in the original publications. However, to unify the use of concepts in this summary, the term sedentary behavior, or SB is applied. If necessary, the more precise type of SB (such as screen time) is used.

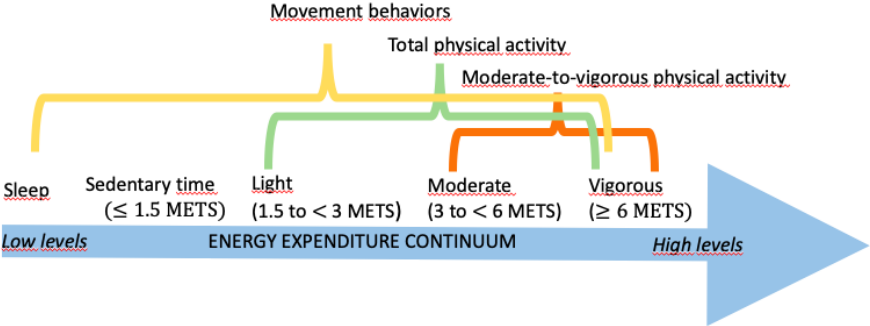


Figure 1 The energy expenditure continuum.

2.1.1 THE MEASUREMENT OF SEDENTARY BEHAVIOR

The typical methods of measuring SB have been questionnaires and accelerometers. *SB questionnaires (and often diaries)* have measured either the specific SB, especially screen time, or, lately, the overall SB in different contexts. (Atkin et al., 2012; Kang & Rowe, 2015.) Because children under ten years of age cannot reliably recall their activities and quantify the time frame of the activity (Trost, 2007), caregivers such as guardians are used for reporting the children's SB (so-called proxy reports). The reliability and the validity of these proxy report questionnaires have, however, been highly variable (Atkin et al., 2012). Beside proxy reports, *observations* (e.g. OSRAC) conducted by researchers are often used to measure children's movement behaviors in preschools (Trost, 2007).

The use of *objective devices* in PA research became popular in the 2000s. Accelerometer-based sensors especially (e.g. Actigraph) have become primary devices for measuring human movement because they are sensitive to both dynamic and static changes. Accelerometers are instruments that measure the frequency and the amplitude of acceleration of the body segment to which they are attached. The magnitude of the acceleration within a set timespan (epochs) is then translated into activity counts. The more the subject has these activity counts, the more physically active the subject has been during this epoch. Current accelerometers can detect movement in up to three orthogonal planes. Because the collected information is time-stamped, specific segments of the day or week. (e.g. preschool-hours, weekend) can be extracted. (Atkin et al., 2012; Chen & Troiano, 2017; Kang & Rowe, 2015; Migueles et al., 2017.)

The accelerometer-measured counts are translated into a metric of interests (e.g. minutes) during the data processing phase. To separate activity counts into the different activity-intensity levels (sedentary, light, moderate and vigorous), different cut-points have been developed. These cut-points and their threshold levels correspond to the energy expenditure levels achieved in the validation studies. (Chen & Troiano, 2017; Migueles et al., 2017.) Currently, there exist no common regulations about the best possible cut-points to be applied, although the results of a comparative study among preschool-aged children recommend the choice of the Evenson cut-point (0–25 counts per 15 seconds) for measuring SB (Janssen et al. 2013). Besides this challenge of the proper cut-points, the measurement error can be produced at any stage of processing the data, such as during the measurement of raw acceleration in the initial stages or during the application of algorithms. Similarly, all the decision rules related to the data collection and reduction applied later can produce errors. (Chen & Troiano, 2017; Kang & Rowe, 2015; Migueles et al., 2017.) Despite these challenges, the accelerometer is currently considered a gold standard for measuring movement behaviors among preschool-aged children (Cliff, Reilly, & Okely, 2009).

2.2 SOCIOECOLOGICAL APPROACH ON SEDENTARY BEHAVIOR

In this chapter, the key thoughts of the socioecological approach and the specific models applied in this dissertation are presented.

2.2.1 THE GENERAL PRINCIPLES OF SOCIOECOLOGICAL APPROACH

The socioecological approach refers generally to an individual being embedded within larger social systems and the nature of the individual's reciprocal interactions with the multiple levels of the environment. The historical roots of the socioecological approach lie back in the 1950s and 1960s. (Richard, Gauvin, & Raine, 2011; J. F. Sallis, Owen, & Fisher, 2008.) Back then, among others, Kurt Lewin presented his thoughts on behavior as a function of the individual and his/her environment (Lewin & Cartwright, 1951). Urie Bronfenbrenner is considered a father of this approach (Richard et al., 2011; Sallis et al., 2008) due to his socioecological concepts related to the multilevel structures of the environment and their interactions presented at the end of the 1970s (Bronfenbrenner, 1977). The socioecological approach became popular in PA research after the 1990s, when it was noticed that individual factors explained only a minor part of the variance in PA (Spence & Lee, 2003).

The socioecological approach is based on some general assumptions. Firstly, the individual interacts with the environment, and the individual is a part of a larger social system. Secondly, the environment is nested in the multiple levels, and thirdly, these multiple levels of the environment interact across the levels. (Richard et al., 2011; Sallis et al., 2008.) The multiple levels of the environment can be illustrated by using an "onion" structure. The innermost layer is the individual. Around this innermost level are the multiple layers of the environment. The closer the layer is to the individual, the more this layer is a part of daily life. This structure means that the closer levels of the environment are embedded in the outermost levels of the environment. How many layers there are depends on the specific socioecological model. The simplest way is to separate person and environment (Spence & Lee, 2003). In many models, the levels of the environment are called intrapersonal, interpersonal, organizational, community, physical and policy (Richard et al., 2011).

Despite the structure of these layers in different socioecological models, certain assumptions can be made. Each level of environment consists of the multiple factors that influence the behavior under examination (Friedman & Wachs, 1999). Each environment influences an individual's behavior differently depending on the individual's beliefs and practices underlying the reciprocal relationship between individual and environment (Kingry-Westergaard & Kelly, 1990). As these levels of environment interact with each other, a wide variety of potential linkages between factors and settings can be created.

A challenge is therefore to recognize on which factors and linkages to focus. One currently recommended solution is to have behavior-specific socioecological models (Sallis et al., 2008), such as the socioecological model of SB (Owen et al., 2011).

2.2.2 SETTINGS AND THE INTERPLAYS

The key element in the socioecological model of SB is *behavior setting* within which the relevant factors operate to influence particular SB and interact with the individual-level factors and other proximal environments around this setting (Owen et al., 2011). Setting is a place with shared social norms, structures and roles, but it also has physical context that defines the boundaries of this setting. Individuals modify, adapt or vary their own behavior according to the role they have in this setting. Social norms, shared meanings and experiences, and structures in each setting reciprocally form how individuals with different roles behave in this setting. These existing social norms are maintained and shaped in the events and occasions happening in this setting. (Kingry-Westergaard & Kelly, 1990.) Social norms are patterns of behavior in a particular group or culture that are accepted as normal and to which an individual is expected to conform (Cialdini, Kallgren, & Reno, 1991). “Environment” and “setting” may partly be overlapping concepts, and thus requires clarification. Setting is geographically defined location in which individual attend regular basis (Barker, 1968). Environment, on the other hand, is an abstract construct. One setting can consist of multiple environments, but environment can also mean the specific layer of a particular socioecological model that can be situated at any level of the model. (Friedman & Wachs, 1999; Richard et al., 2011.)

Each individual affects setting and other individuals in the setting, but setting also influences the individual. A setting affects other settings existing nearby (e.g. preschool and home, through reciprocal influences between children, parents and preschool personnel), but the wider social structures in society. (e.g. the neighborhood SES) can also influence the function of setting (Kingry-Westergaard & Kelly, 1990.) Thus, the linkages within a setting and between settings can be built diversely. When understanding complex behaviors such as SB, neither a single theory nor a single study can cover all the potential linkages, whereas focusing on certain linkages may be relevant (Lewis, 2000; Spence & Lee, 2003). Two theoretical frameworks, the structural model of the environment (Wachs, 1992; Wachs, 1999) and the ecological model of PA (Spence & Lee, 2003), have highlighted that the linkages between factors and settings on children’s behavior can be hypothesized in a hierarchical, multilevel and multidimensional fashion. The linkages based on these models, and relevant for dissertation purposes, are presented next.

Firstly, these frameworks assume that the factors associated with behavior can be viewed so that some factors are more distal and other more proximal towards certain behavior. The more proximal the factor is to the individual, the more influential it is to the behavior. This division is intended to reflect the fact that some distal factors operate on behavior indirectly, by means of their effects on more proximal factors. (Spence & Lee, 2003; Wachs, 1999.) For instance, the settings in which an individual lives may vary according to SES (e.g. neighborhood SES around preschool settings or parental educational background in home settings; Ball, 2015). According to this viewpoint, SES as a distal factor is considered to shape individual’s behavior through the proximal factors (e.g. parental SES influence through parenting practices on children’s behavior).

Secondly, Wachs (1992, 1999) and Spence et al. (2003) emphasize that the influence of distal factors on children's behavior should be buffered by proximal factors. Thus, parental SES as a distal factor shall not influence children's SB if there are good quality proximal factors, such as regular preschool PE lessons or parental support for PA, for instance. It is, however, possible for both distal and proximal factors to serve as moderators of each other, and hypotheses need to be developed for various levels of the environments and settings in order to better understand the movement behaviors. (Spence & Lee, 2003.)

2.2.3 THE STRUCTURE OF HOME AND PRESCHOOL SETTINGS

All the settings an individual lives in are considered to be different in how SB is accepted (Owen et al., 2011). Settings may restrict behavior by promoting and sometimes demanding certain actions and by discouraging or prohibiting others (Wicker, 1979). Consequently, it can be assumed that there are setting-specific correlates associated with SB. The settings are also population-specific (e.g. home and preschool for children whereas workplace and home for adults; Schneider et al., 2017). The factors associated with SB in the *same* setting may be different for each population. For instance, in the home setting, factors related to parental involvement in SB may be relevant to cover when measuring children's SB, as opposed to factors related to individual decisions when measuring adults' SB.

Models may be needed that a) recognize factors associated specifically with preschool children's SB but also b) take into account the uniqueness of each setting in relation to how much SB is accepted. Thus, separate models for home and preschool settings may provide better possibilities for capturing their setting-specific correlates in relation to children's SB. This dissertation constructs the home setting by following the Family Ecological Model, or FEM (Davison, Jurkowski, & Lawson, 2013). The preschool setting is constructed by applying the Analysis Grid for Environments Linked to Obesity (ANGELO) framework (Swinburn, Egger, & Raza, 1999). Both of these models employ the core thoughts of the socioecological approach.

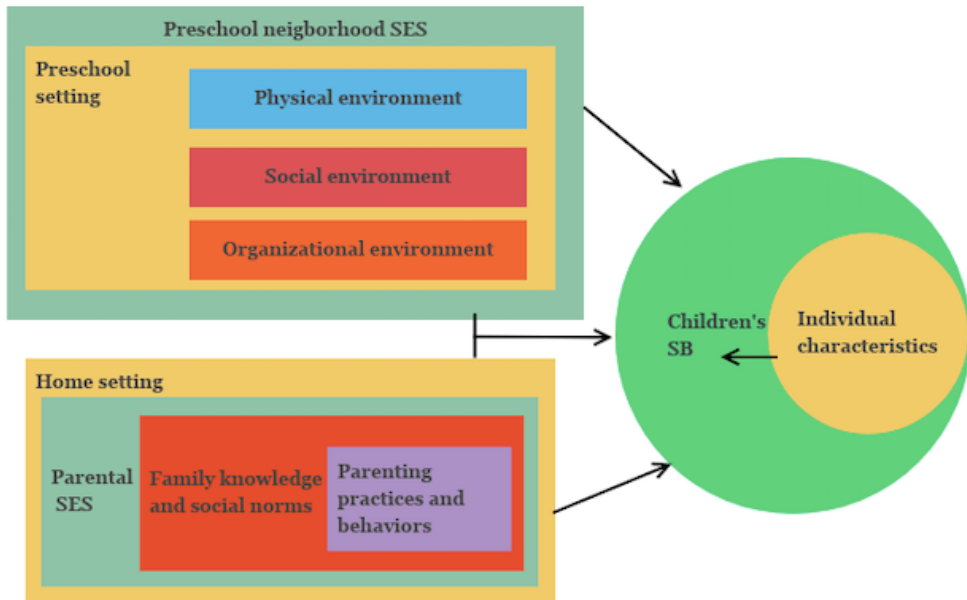


Figure 2 The simplified conceptual framework of this study. The structure of home setting is based on the Family Ecological Model (Davison et al, 2013). The structure of preschool setting is the adapted version of the ANGELO framework (Swinburn et al, 1999). The lines indicate the potential associations with children’s SB.

FEM makes family and its living conditions a central focus in understanding children’s health behaviors. The influence of family on child development can be apprehended by understanding the contexts in which families are embedded. Thus, FEM and its revised version define home setting as being nested in multiple layers of environments. (FEM uses concepts “components and constructs,” but to simplify, “environment” is applied in this dissertation; Davison & Birch, 2001; Davison et al., 2013.)

This dissertation focuses on the following environments of the home setting (Figure 2). The inner environment of the FEM (the closest to children’s behaviors) is parenting practices and behaviors specific to healthy lifestyles (e.g. modeling, rules). The second environment, next to parenting practices and behaviors, is called family knowledge and social norms (e.g. self-efficacy, beliefs, attitudes). This second environment influences daily parenting practices and behaviors. The difference between these environments is that the factors in the second environment are more abstract (parental cognitive and emotional processes), whereas the factors in the first environment are more practical (daily actions happening in the family). Around these environments exists the family ecological environment, covering, for instance, family history and structure (e.g. parental SES, family size and ethnicity). This outermost environment shapes the previously presented environments of home setting, which in turn influence children’s behaviors. (Davison et al., 2013.) As parental SES is only concept of this outermost environment used in this dissertation, this environment is called parental SES later in this dissertation.

The ANGELO framework is applied to construct preschool setting in this dissertation. This framework was originally built to understand the various components of the obesogenic environments. It considers that one setting encompasses physical (*what is available*), economic (*how much does it cost*), political (*which rules are in effect*) and sociocultural (*which values and norms apply*) environments, and each environment comprehends multiple factors that are associated with an individual's behavior. The ANGELO framework includes also the macro-level sectors, which are the broader, upper-level environments that are less subject to the control of individual. (e.g. transportation networks and state support for PA; Swinburn et al., 1999.) Compared to the FEM, the ANGELO framework does not expect that these environments are embedded like layers within a setting; one environment is not expected to be more proximal to behavior than the other environment. Due to this comprehensiveness, the framework has been applied widely for categorizing and recognizing a variety of factors associated with health behaviors within and between environments, settings and sectors (Kremers et al., 2006; Schneider et al., 2017). This framework has also been applied previously to comprehend the preschool setting, as Gubbels et al. (2014) define preschool setting as consisting of social, physical, political and economic environments. As in Gubbels et al. (2014), this widened use of original framework has meant that a variety of concepts have been used to specify environments in different studies; for instance, the terms “organizational” and “policy” have been applied to cover the original “political environment” (Springer & Evans, 2017). Despite the concept used in the studies, the core thought of ANGELO framework is still appreciated – that is the multiple components of environments are considered (Simmons et al, 2009). In this dissertation, the structure of Gubbels et al. (2014) is applied to construct the preschool setting, but instead of “political environment,” the concept “organizational” is used. The aspects of economic environment were not studied in this dissertation. The social, physical and organizational environments are defined in more detail in chapter 2.3.3.

However, the above-presented models, as in other research related to children's development in general (Niermann, Gerards, & Kremers, 2018), assign a passive role to children, although the socioecological approach emphasizes the reciprocal interaction between individual and setting; individuals with different characteristics react inversely to similar influences in the same setting (Bronfenbrenner, 1979). This assumption underscores the importance of measuring children's characteristics (e.g. weight, temperament, gender). Hence, the element of children's individual characteristics is added into the conceptual framework of this dissertation (Figure 2). Another challenge for both presented models, as well as for socioecological models in general (Richard et al., 2011), is that they present broad domains of factors to be considered, but do not provide guidance as to which factors within each setting to focus on. To solve this challenge, it is recommended to integrate other theories (e.g. sociocognitive theories) into socioecological models to provide specificity for selected factors (Conner, 2015; Hamilton, Cox, & White, 2012; Sallis et al., 2008). This recommendation is applied in this dissertation, and the selected factors are defined next by applying the ecological viewpoint and other behavioral theories.

2.3 INDIVIDUAL AND SETTING-BASED FACTORS UNDER FOCUS

The specific factors studied in this dissertation are defined next by applying the socioecological approach and other behavioral theories. Figure 3 summarizes these factors into the conceptual framework of this dissertation.

2.3.1 INDIVIDUAL CHARACTERISTICS

Recent theoretical viewpoints applying both the socioecological approach and systems theories (e.g. Niermann et al. 2018) underline that a child is an active member within the settings, and has reciprocal interactions with other individuals within a setting. Thus, these viewpoints theorize that, for instance, parental behaviors occur in response to children's individual characteristics (e.g. weight, temperament) and children's behavior. (Niermann et al., 2018.) This viewpoint also suggests that measuring children's individual characteristics is relevant. Besides children's age and gender, the individual characteristics used in this dissertation are temperament and body mass index (BMI). Temperament is considered to be a relatively stable construct that is the basic structure of personality. It predicts individual differences in reacting to and managing situations happening in the environment. Temperament is observable as early as infancy and becomes elaborated over the course of development as the individual's skills, abilities, cognitions and motivation become more sophisticated. (Calkins & Degnan, 2006; Rothbart & Bates, 2006.) Depending on the measures used, different types of temperament traits can be separated, such as extraversion, effortful control, anxiousness or overactivity (Rothbart & Bates, 2006). BMI is an estimate of body fat, and also a useful measure of overweight and obesity. It is defined as a child's weight in kilograms (kg) divided by his or her height in meters squared. (WHO, 2000.)

2.3.2 PARENTS AND HOME SETTING

Parenting practices and behaviors. *Parenting practices* are the specific, goal-directed acts of parents through which parents socialize their children. Parenting practices can be operationalized at different levels depending on the hypothesized relationship between a socialization goal and child outcome. (Darling & Steinberg, 1993.) Parenting practices related to children's PA and SB comprise a wide variety of factors, but they can be operationalized as how much, when, what and to what extent children participate in SB or PA (Niermann et al., 2018). Applying dual-process framework, some practices are reflective and cognitive processes whereas others are automatic, nonconscious and nonintentional (Kremers et al., 2006; Kwasnicka, Dombrowski, White, & Sniehotta, 2016; Strack & Deutsch, 2004). For instance, rules related to screen time may be conscious decisions whereas allowing a child to run around the house reflects more automatic, nonintentional practices.

FEM conceptualize the importance of *parental modeling* for children in two ways: a) children's vigorous learning through observation and b) parent and child *co-participation in PA* (Davison & Campbell, 2005). However, a conceptual difference

exists between modeling and parental role modeling. Parental role modeling is a parenting practice with active and intentional processes, whereas modeling is parents' behavior which unintentionally takes place in front of the children (Gevers, Kremers, de Vries, & van Assema, 2014; Vaughn et al., 2016). Despite the conceptual difference between modeling and co-participation, the same theoretical underpinnings exist behind their importance for children's SB. As suggested by the theory of observational learning, children learn skills, habits, behaviors and the consequences of behaviors by observing the behaviors of significant others, such as their parents (Bandura, 1977a). Bronfenbrenner (1979) considers that the central issue in role modeling is how the child experiences the different interactions, activities and roles within a certain setting. Some actions happen infrequently or are less significant, whereas other activities are considered "molar" in that they can have a substantial influence on development. Following this thought, if a child repeatedly sees that parent engage in SB, and the child co-participates in SB together with the parent, that child learns that this habit is relevant to learn.

Family knowledge and social norms. In this dissertation, parental self-efficacy, beliefs and attitudes, and barriers are listed under this environment. *Self-efficacy* is the key concept in the sociocognitive model (Bandura, 1977b), but a similar concept is used in the health action process approach (HAPA; Schwarzer, 1992), in self-determination theory (with the concept "perceived competence"; Ryan & Deci, 2000) and in the theory of planned behavior (with the concept "perceived behavior control"; Ajzen, 1991). Bandura (1977b, 1986) defines self-efficacy as an individual's confidence in his or her ability to execute behaviors necessary to produce specific performance attainments. Self-efficacy develops over time from previous experiences. Feedback received from significant others helps to shape self-efficacy. When it is specifically considered *parental self-efficacy*, it is defined as parents' beliefs in their capabilities of organizing and executing tasks related to parenting a child (de Montigny & Lacharité, 2005). Both a general type of self-efficacy (parents' overall confidence) and specific type of self-efficacy regarding PA and SB may influence children's SB directly or indirectly (acting as mediator or moderator; Niermann et al., 2018; Albanese, Russo, & Geller, 2019). For instance, as an example of indirect influence of self-efficacy, parents with a higher SES background may have higher self-efficacy for limiting children's SB, and thus the children with higher SES background have less SB.

Attitudes and beliefs have been defined in many ways. Attitude is outlined as a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor (Eagly & Chaiken, 1993). A three-component model of attitude suggests that attitude has affective, cognitive and behavioral components (Hovland & Rosenberg, 1960). When applying these three components to SB, the cognitive components are expressions of beliefs concerning SB, and affective components are the feelings concerning SB, whereas behavioral components are the expressions of intention to be sedentary (Ajzen, 1988; Biddle & Mutrie, 2008). Beliefs can therefore be considered as a cognitive part of the three-component-model of attitude. In the FEM, beliefs refer to the importance that parents assign to PA or SB, and their perceptions related to the children's PA and SB (Davison & Campbell, 2005). Ajzen (1991) formulated in the theory of planned behavior that attitudes toward the behavior together with subjective norms and perceived behavioral control produce

intentions. These intentions in turn determine the behavior. Attitudes, subjective norms and perceived behavioral control are underpinned by behavioral (costs and benefits), normative (other's approval and disapproval) and control (motivators and inhibitors) beliefs, respectively. Thus, attitude is measured by perceived outcomes of the behavior and the value placed on those outcomes. (Ajzen, 1988; Ajzen, 1991.) Parental attitudes may influence children's SB either directly or indirectly through different parenting practices (Davison et al., 2013).

Perceived barriers are the individual's assessment of the obstacles to conducting certain behavior. The HAPA model reflects that the perceived benefits of conducting certain behavior must outweigh the perceived barriers in order for behavior to occur (Schwarzer, 2008). The sociocognitive theory and the HAPA model hold that perceived barriers may be personal ones (e.g. no time for PA with children) or environmental obstacles (e.g. poor weather; Bandura, 2004; Schwarzer, 2008). Parental barriers may actually reflect parental attitudes and beliefs (Davison et al., 2013). Similarly, some barriers may be nonconscious and automatic whereas others are reflective and cognitive, as suggested by dual-process framework (Kremers et al., 2006; Kwasnicka et al., 2016; Strack & Deutsch, 2004).

Parental SES. SES is outlined as differences between individuals and groups in the possession of resources – for example, differences in education, income or occupational prestige – without necessarily attributing any causal connection between the positions of one individual in relation to another. *Educational background*, operationalized as either years of schooling or degree credentials, is often used as an indicator of SES. (Glymour, Avendano, & Kawachi, 2014.) FEM (as many other models) theorizes that parental SES characterizes the children's settings in which they live (Cohen et al., 2010; Glymour et al., 2014; Davison et al., 2013). Families with a low SES background on average are exposed to more psychosocial stressors (e.g. daily hassles, negative life events, financial difficulties, low control in life as a whole), have smaller social networks or lower levels of social support, and less effective coping styles than families with a high SES background (Kristenson, 2006; Siegrist & Marmot, 2004; Stansfeld, 2006). Thus, engaging in health-promoting behaviors may not be a priority in families with a low SES background (Taylor & Seeman, 1999). On the other hand, parental higher education may form a set of enduring cognitive or emotional skills (e.g. self-regulation, delay of gratification) that enable parents make healthy decisions (Glymour et al., 2014).

2.3.3 EARLY EDUCATORS, PRINCIPALS AND PRESCHOOL SETTING

Physical environment is defined as encompassing the features of the built and natural environments. It covers buildings, amenities, facilities, landscapes, green spaces, and internal/enclosed spaces, but it may include seasons, or access to PA equipment and/or PA facilities. (Biddle & Mutrie, 2008; Moos, 1979; Schneider et al., 2017; Swinburn et al., 1999.) When considering preschool setting, the typically measured physical environment factors in relation to children's SB are availability of PA equipment (e.g. swings, balls) and screens (e.g. television, computer), the size and structure of outdoor yard, and accessibility for the use of screens and PA equipment

(Tonge, Jones, & Okely, 2016). In this dissertation, the following items were measured: *Availability of PA equipment, availability of screens and active play possibility.*

Social environment is broadly defined as influencing an individual's behavior by promoting a sense of social control, which happens through the creation of social norms. An extensive list of factors has been listed under social environment such as SES, social isolation and crime, social support and social networks; and social cohesion and social capital. Depending on the viewpoint, modeling, attitudes, beliefs, perceptions, values and norms are listed either as individual or social environment factors. (Biddle & Mutrie, 2008; McNeill, Kreuter, & Subramanian, 2006; Springer & Evans, 2016; Swinburn et al., 1999.) In this dissertation, these previously mentioned factors belong to the social environment as it is studied how educators' and principals' modeling, norms, practices, self-efficacy, attitudes and beliefs influence children's SB. *Early educators' practices related to children's SB* can be distinguished on the scale measuring the degree to which a practice is individually implemented or policy-related. Overall, *early educators' practices promoting children's healthy behaviors* have been defined as implementing the best practices leading to healthy children's behavior, based on the knowledge of how children learn and develop (e.g. educators' behaviors modeling healthy behavior and having healthy preschool policies). The implementation of these practices is directly related to the quality of care and education. (Copple & Bredekamp, 2009; Derscheid, Umoren, Kim, Henry, & Zittel, 2010; McWilliams et al., 2009.) The policy-related practices are discussed in more detail in organizational environment, and here it is focused on individual practices.

Principals and early educators have a pedagogical or nursing educational background that guides their practices related to their own behavior and to children's behavior (Derscheid et al., 2010; Sisson, Smith, & Cheney, 2017; Sylva et al., 2006). Many of these "individual" practices are also implemented as daily routines and habits, and may reflect educators' own choices, attitudes and beliefs (Catucci & Ehrlin, 2018; Wen, Elicker, & McMullen, 2011). Following the dual process theories, some of the practices are controlled, conscious, reflective and volitional whereas others are elicited with minimal cognitive effort, awareness, control or intention due to their frequent repetition. These two processes may operate independently or interact to regulate behaviors. (Kremers et al., 2006; Kwasnicka et al., 2016; Strack & Deutsch, 2004.) The repeated behaviors may be largely determined by habit rather than by reasoned action (Catucci & Ehrlin, 2018). Habits are also resistant to change due to their semi-automatic nature (Gardner & Rebar, 2019).

Teachers' or educators' beliefs and attitudes are defined as a compass that provides direction for early educators' decision-making, ideas, curriculum and effectiveness in their daily practices implemented in the (pre)school setting. The beliefs can be professional, originating from education, training and professional development, but also informal, formed through the person's own experiences, values and personal perspectives. (Abu-Jabar, Al-Shwareb, & Gheith, 2010; Bondy et al., 2007; Cassidy & Lawrence, 2000; McMullen et al., 2006.) It is expected that the beliefs an educator holds towards carrying out a specific behavior influence their attitudes towards the practices and, eventually, the degree to which the practice is implemented (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The relationship between beliefs, attitudes and practices is, however, complex. Both intrinsic and extrinsic factors (e.g. stress, self-

efficacy, parental feedback, work atmosphere, subjective norms) modify workers' beliefs and attitudes and thus influence the practices they implement. (McMullen & Alat, 2002; Sansolios & Mikkelsen, 2011; Wen et al., 2011; Wilcox-Herzog, 2002, Godin, Belanger-Gravel, Eccles, & Grimshaw, 2008.)

Early educators' self-efficacy is defined as educators' beliefs in their capabilities to enact certain teaching behavior that may influence children's outcomes (Klassen, Tze, Betts, & Gordon, 2011; Tschannen-Moran & Hoy, 2001). Bandura (1986, 2004) has stated that self-efficacy is a subjective evaluation of one's own capability, although the external factors may influence forming and adjusting them. Therefore, people working in the same setting may have different efficacy beliefs, but the same setting may also affect developing collective efficacy beliefs (Scherer et al., 2016). Early educators need to have sufficient self-efficacy so that their actions can promote healthy practices, but educators also need to believe that these practices lead to healthier children's behavior (Prochaska & Velicer, 1997).

Organizational environment (or policy environment) is defined as legislative environment, but it consists of the rules, legal guidance, policies and codes of conduct and acceptable standard practices and behaviors (Swinburn et al., 1999). In a recent Canadian study, the *policies* and *common practices* are separated so that policies are written statements or documents that are used to regulate behavior opportunities whereas common practices are programming and/or guidelines (written or non-written) that are frequently undertaken (Ott, Vanderloo, & Tucker, 2019). This viewpoint is applied in this dissertation as well.

Policy provides guidance for collective and individual behavior and can be informal or formal legislative or regulatory actions taken by governmental or nongovernmental organizations (Bauman et al., 2012; Bellew et al., 2011). *PA policy* is defined as a formal statement or decision related to PA within organizations that set the priorities and the set of actions to be carried out to fulfill those priorities (Tremblay, Boudreau-Larivière, & Cimon-Lambert, 2012; WHO, 2008). More specifically, *PA policies of preschool* refer to preschool written statements and guidelines related to PA or SB (Mikkelsen, 2011), such as *policies related to screen time, healthy PA and guidance-to-families* that are measured in this dissertation.

The *common practices* are frequently conducted programs in preschool (Ott et al., 2019), such as *frequent visits to places where PA is encouraged, PE lessons, weekly schedules or theme weeks*. PE lessons are early educator-led PAs that promote physical fitness and motor skill development and are part of (pre)school weekly schedule (Anderson, 1989). Frequent visits to different places nearby encouraging for PA are regular activities included as part of the weekly, monthly or yearly schedules. Weekly schedules are the program's planned order or sequence of activities implemented in preschool groups during the week. Theme weeks are preschool-based decisions to focus on a certain subject, when most of the implemented activities are tied into the theme and integrated into the daily schedules and curriculum over a certain timespan. Themes may be very specific or more general, and include multiple types of activities under the focus area. (Finnish National Agency for Education, 2016.)

Preschool neighborhood SES is usually outlined as an index that reflects the key socioeconomic dimensions of income, education and/or occupation of people living in a certain geographic area which is delimited by postal code, census tracts or other similar measures (Minh et al., 2017; Glymour et al., 2014). There are multiple models to explain the mechanisms through which neighborhood SES may influence children’s SB (Minh et al, 2017). The neighborhoods with high levels of advantage are considered to have either a) better quantity of and quality of places encouraging for PA (e.g. playgrounds), b) stronger parental characteristics (e.g. parental support for PA), or c) greater collective efficacy and social norms (e.g. willingness to promote health and common good) compared to the deprived neighborhoods (Leventhal & Brooks-Gunn, 2000; Leventhal & Brooks-Gunn, 2001).

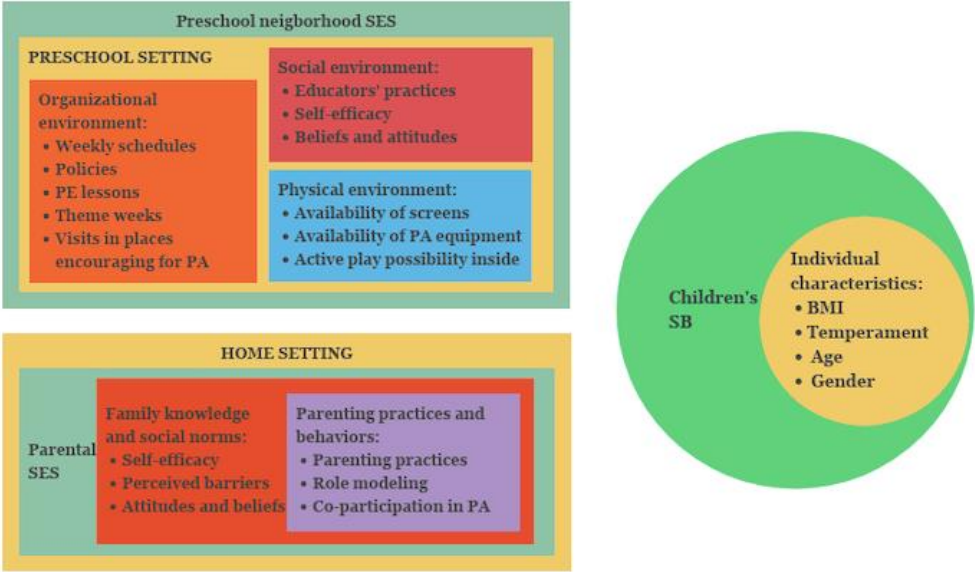


Figure 3 The key concepts and conceptual framework studied in this dissertation

3 PREVIOUS EMPIRICAL FINDINGS

Research on the correlates of preschool children's SB is still novel. A review in 2010 stated that the associations of potential correlates with SB are studied too infrequently to determine an overall connection with SB (Hinkley, Salmon, Okely, & Trost, 2010). However, a number of studies were conducted after this review. This section will focus on the studies conducted in recent years and having objectively measured SB as an outcome, because the correlates of children's objectively measured SB are different than that of specific SBs (e.g. screen time; Downing, Hinkley, Salmon, Hnatiuk, & Hesketh, 2017; LeBlanc et al., 2015; Verloigne et al., 2016). This empirical section is limited to preschool children. That is, only the studies that explicitly state the focus as being on preschool-aged children are included.

3.1 INDIVIDUAL CHARACTERISTICS

The strongest research evidence indicated that girls were more sedentary than boys (Pereira et al., 2018). Also, the correlates of SB seemed to be distinct between boys and girls (Byun, Dowda, & Pate, 2011; Downing et al., 2017). A review focusing on the determinants of SB among children under the age of 18 concluded that children engaged more in SB as they got older (Stierlin et al., 2015). However, the cross-sectional findings of preschool children's age and SB were inconsistent, and many found nonsignificant association (Arhab et al., 2018; Dias et al., 2019; Downing et al., 2017; Nilsen, Anderssen, Ylvisaaker, Johannessen, & Aadland, 2019).

A review on whether prenatal, birth and early life factors predicted children's SB concluded that heritability and early childhood BMI predicted SB, while birth weight and gestational age were unlikely to be important predictors of SB (Hildebrand, Oglund, Wells, & Ekelund, 2016). However, there were still a low number of good-quality longitudinal studies that could affirm the actual direction of BMI and SB (Biddle, Garcia Bengoechea, & Wiesner, 2017). According to the Hildebrand et al. review (2016), associations between temperament and SB had been inconsistent. After this review, Schmutz et al. (2017, 2018) found in their studies that a high level of activity temperament was associated with lower SB both cross-sectionally as well as longitudinally. In addition, high levels of anxious temperament were related to higher SB in the third conducted study after this review (Gubbels, Van Kann, Cardon, & Kremers, 2018).

Children's other energy-balance related behaviors (EBRBs, behaviors regulating weight, such as sleep and diet) seemed to be associated with children's SBs (Biddle et al., 2018; Downing et al., 2017; Eichinger, Schneider, & De Bock, 2018). Multiple indicators of PA, such as more time being outdoors and better athletic coordination or motor skills, were found to be associated with lower SB (Byun et al., 2011; Cerin et al., 2016; Hinkley, Brown, Carson, & Teychenne, 2018; Leeger-Aschmann et al., 2016;

Schmutz et al., 2017). However, the associations of other EBRBs and SB might be bidirectional or the behaviors might act as confounders or mediators (Biddle et al., 2018). EBRBs tended to co-occur and cluster at this age group, meaning that the same group of children had a higher prevalence than expected for unhealthy behaviors such as higher sugar-rich food intake and lower levels of PA (Miguel-Berges et al., 2017). Additionally, children with lower parental educational background tended to have the unhealthy behavior clusters (Gubbels et al., 2009; Gubbels et al., 2012; Miguel-Berges et al., 2017).

3.2 PARENTS AND HOME SETTING

Table 1 summarizes the results of recent studies focusing on the parental correlates of preschool children's SB. All these studies have measured children's SB using an accelerometer. If parents have worn an accelerometer, it is reported in Table 1. These studies have used parental questionnaires covering either parental practices, behaviors, norms or knowledge.

Only 15 studies were found to fulfill these requirements. The most often recognized factor associated with children's SB was related to parental SB (modeling). Three studies (Barkin et al., 2017; Hnatiuk, Hesketh, & van Sluijs, 2016; Matarma et al., 2016) indicated that higher parental SB was associated with children's higher SB, and one study (French, Sherwood, Mitchell, & Fan, 2016) indicated that frequent park use together was associated with children's lower SB. Three studies (Cerin et al., 2016; Eichinger et al., 2018; Schmutz et al., 2017) recognized that higher parental concern about neighborhood safety was associated with children's higher SB. Otherwise, associations were mostly statistically nonsignificant. Most of these studies had measured the different aspects of parental practices, behaviors, norms and knowledge. Also, the concepts (e.g. parental SB) were operationalized differently between studies. The low number of conducted studies and also the few recognized factors associated with children's SB indicates that there is actually a gap in the knowledge of how parents and home setting are associated with children' SB, supporting the rationale for this dissertation.

According to reviews, the studies focusing on the associations of parental SES and preschool children's objectively measured SB are scarce, and the results of these studies are partly inconsistent (Cameron et al., 2015; Stierlin et al., 2015). However, parental SES seems to influence parenting behaviors, practices, and family knowledge and norms in relation to children's SB (Gebremariam et al., 2015; Mantziki et al., 2015). As an example, multiple studies have noticed SES differences in parental attitudes related to outdoor play (Tandon, Saelens, & Copeland, 2017; Tappe et al., 2013; Wijtzes et al., 2014). Tandon et al. (2017), for instance, concluded that parents of lower SES, compared to parents with higher SES, were less comfortable with their child playing outside.

Table 1 The recent studies studying the associations of parental factors and preschool children's objectively measured SB.

Study	Study characteristics	Main results in relation to children's objectively measured SB
French et al., 2016	N= 534 children. Parents with the accelerometer.	Frequent park use together is associated with children's and parents' lower SB.
Eichinger et al., 2017	N=738 children, aged 3 to 6. Weekends and weekdays SB.	SB decreased if child had greater levels of MVPA, participated in organized sports, their parents had higher leisure time PA and parents had greater parental traffic safety perceptions. None of the <i>objective</i> social and physical environmental correlates were associated with SB.
Cerin et al., 2016	N= 84 children aged 3 to 5. Children additionally wore the GPS unit.	Children were most active outdoors, especially in parks and playgrounds. Parental perceptions about the safety of their neighborhood and parenting practices discouraging children's PA acted as moderators in reducing the difference between outdoor and indoor SB.
Barkin et al., 2017	N=1,003 parent-child pairs. Parents with the accelerometer.	Parental SB was related to preschool-aged children's SB.
Matarma et al., 2016	N= 140 children, aged 5 to 6. Parents with the accelerometer.	Mother's higher SB associated with children's higher SB. Father's higher SB associated with children's higher SB, but only among fathers with high education.
Leeger-Aschmann et al., 2016	N= 476 children, aged 2 to 6.	Children from the French-speaking part of Switzerland had more SB than that of German-speaking. None of measured parental correlates were associated with SB (studied separately for German-speaking and French-speaking families).
Dolinsky et al., 2011	N=337 children, aged 2 to 5.	Boys had less SB than girls. No other correlates of SB.

Previous empirical findings

Maltby et al., 2018	N=30 children. Mothers with the accelerometers.	Higher maternal support in relation to PA promotion was associated with children's lower SB.
Hnatiuk et al., 2016	N=153 children, aged 3 to 4. only home hours SB.	Having older siblings was associated with children's lower SB. Separate analyses for paternal data showed that father's TV viewing before 6 pm was associated with children's higher SB.
Downing et al., 2017	N=1002 children, aged 3 to 5.	No common correlates of SB were identified for boys or girls. Higher sleep duration was associated with lower SB for girls. Higher paternal age was associated with higher SB for boys.
Downing et al., 2015	N=1002 children, aged 3 to 5.	No associations were found between parental correlates and children's SB.
Schmutz et al., 2017	N= 476 children, aged 2 to 6.	Greater time spent outdoors, higher children's activity temperament and parental sports club membership were associated with lower children's SB. More living area per person and greater concerns about neighborhood safety were associated with higher SB.
Schmutz et al., 2018	N=555 children, aged 2 to 6. A follow-up after 12 months.	Children's higher activity temperament was associated with lower SB. Children were more sedentary in spring and fall months compared to summer.
Tandon et al., 2017	N= 388 parents, children, mean age 4.3.	No significant associations between parental attitudes and SB. Lower income parents felt less comfortable than higher income parents with child playing outside.
Byun et al., 2012	N= 331 children, aged 3 to 5.	No common SB correlates for boys and girls. No significant associations between parental measures and SB. Higher child's weekday TV/video games and lower amount of PA equipment associated with boys' higher SB. Higher BMI and poorer athletic coordination associated with girls' higher SB.

3.3 EARLY EDUCATORS, PRINCIPALS AND PRESCHOOL SETTING

A review based on 55 studies concluded that children's SB ranged from 12 minutes to 55 minutes per hour in preschool (O'Brien et al., 2018). Multiple factors in the preschool setting may explain this variance. This section recaps the recent reviews and adds knowledge of studies conducted after these reviews.

Physical environment. Tonge et al. (2016) conducted a review focusing on the factors in a preschool setting associated with children's movement behaviors covering 27 studies published between 1992 and 2015. Inclusion criteria for studies were that children's behavior was measured objectively – either conducting observation or using an objective device. According to this review, most of the previous studies had studied the associations between physical environment (e.g. natural features/surfaces, indoor environment, portable and fixed equipment inside and outside, gradient, shade and markings or sedentary items) and children's SB. However, the presence of outdoor environment was the only strong correlate associated with children's lower SB. Some support existed that a larger size of play area and a higher number of active opportunities (e.g. indoor space for PA) were related to a children's lower SB. (Tonge et al., 2016.) Another review (Broekhuizen, Scholten, & de Vries, 2014) focusing on the yards in schools and preschools concluded that having sufficient space (and time) to play was enough for increasing activity among preschool children, supporting the findings of Tonge's review. A meta-analysis from the year 2018 stated that children spent more time in SB when they were indoors in preschool (Pereira et al., 2018). Another meta-analysis based on the results of 26 studies concluded that about 53% of the outdoor time in preschool was sedentary when measured by accelerometers (11 studies). If these results were applied in a one-hour window, preschool children would be sedentary, on average, 28 minutes per hour while outdoors. (Truelove et al., 2018.)

Social environment. Tonge et al. (2016) discovered that none of the identified social environment factors (the educator training and qualification and educators' prompts and feedback) had a strong association with children's SB. Another systematic review by Ward et al. (2015) focusing on educators' practices concluded that the educators might play a positive role in promoting children's healthy behaviors, but the influence of the specific practices remained inconclusive due to a low number of studies. Of the practices, only educators' promotion of PA was found to be associated with children's lower SB. After this review, Ward et al. (2017) conducted a study including different types of educators' practices (e.g. informal promotion of PA, formal promotion of PA) and found that none of them were significantly associated with children's SB. Mixed evidence existed on the influence of educators' role modeling on children's SB. Some studies stated that the children were more active when the educators often or always played with children, whereas the opposite results had also been found. (Bell et al., 2015; Bower et al., 2008; Fossdal, Kippe, Handegård, & Lagestad, 2018; Goldfield et al., 2012; Tandon, Saelens, & Christakis, 2015.) When the educators supervised children's play in a sedentary way, the children, especially girls, tended to be sedentary as well (Brown et al., 2009; Cardon et al., 2008; Soini et al., 2017). There was also

research evidence from Finnish, Dutch and American preschools that educators were relatively sedentary in preschool settings, especially on playgrounds, and rarely implemented early educator-arranged activities to enhance children's PA (Brown et al., 2009; Soini et al., 2017). At least two studies highlighted that the role of other children might be more important than that of educators for children's movement (Arhab et al., 2018; Ward et al., 2017).

Organizational environment. Tonge et al. (2016) stated in their review that organizational environment had little or no association with children's SB, but some support existed that a better quality of preschool, having recess during the preschool program and being in a Montessori-type preschool were associated with children's lower SB. Recent studies found that policies supporting PA opportunities were associated with less time in SB (Arhab et al., 2018; Bell et al., 2015; Ott et al., 2019). Multiple studies indicated also that early educator-led PE lessons were associated with children's lower SB (Bell et al., 2015; Chow, McKenzie, & Louie, 2015; Kain et al., 2017; Van Cauwenberghe et al., 2013). There seemed to be sociocultural differences in how preschool influenced children's SB. For instance, the most sedentary contexts in the US preschool were naptimes, group activities, indoor transitions, snack and table toys sessions (Brown et al., 2009). On the other hand, Finnish children were mainly sedentary in art or in group activities organized by an early educator (Soini, 2015). Röttger et al. (2014) concluded that children in school-type preschools were more sedentary in the mornings, but children in these preschools gained similar amounts of PA to open-based preschools, suggesting that PA was integrated into their teaching. Raustrop (2012) noticed that structured periods of play, recess and group teaching influenced children's higher SB, whereas Hesketh et al. (2015) stated that preschool had limited influence on children's movement behaviors, suggesting that the preschool policies in the UK supporting child-driven play and children's individual preferences might play a bigger role.

Preschool neighborhood SES. Although there were multiple studies showing that particular neighborhoods had increased rates of childhood obesity and risks for unhealthy behavior (Minh et al., 2017), only a few studies focused on studying the preschool neighborhood SES. One of these studies reported area-level SES was not associated with preschool children's SB (Eichinger et al., 2018). At least two studies indicated that higher neighborhood SES was associated with better quality of preschool, and thus with children's better language and cognitive development (Minh et al., 2017). In addition, many studies stated that school SES had greater effect on adolescents' health behavior than individual SES background (Krist et al., 2017; Moore & Littlecott, 2015; Salvy et al., 2017).

To summarize, compared to the home setting, more research has been conducted in the preschool setting. However, most of these previous studies had a limited sample size (the participating preschools between 2 to 63 and the number of children less than 800; Tonge et al., 2016). In addition, most of the presented items had been measured infrequently, many of them in only one study. Studies often focused on certain environments of preschool setting without covering multiple environments within one study. Most of the studies were conducted in the US, limiting the generalizability of the findings. Thus, this summary underlines that there is still a need to better recognize how factors in the preschool setting are associated with children's SB.

3.4 INTERPLAYS BETWEEN SES, SETTINGS AND SEDENTARY BEHAVIOR

A systematic review from 2015 covering 37 studies focusing on SES and the correlates of SB among children under 18 recognized five mediation and three moderation studies. Of the five recognized mediation studies, only one study had objectively measured SB as an outcome, but the children under focus were aged 8 to 10 years. (Gebremariam et al., 2015.) After this review, at least two mediation studies among children under the age of 10 years were conducted, but both of these studies had screen time as an outcome (De Lepeleere et al., 2018; Määttä et al., 2017). All three of the moderation studies that Gebremariam et al. (2015) recognized in their review had used TV viewing as an indicator of SB. Many studies had, however, indicated the moderating role of the children's characteristics (e.g. temperament traits, gender) in the relationships between preschool setting and children's objectively measured movement behaviors (e.g. Cardon et al., 2008; Gubbels et al., 2011; Gubbels et al., 2018; Van Cauwenberghe, Labarque, Gubbels, De Bourdeaudhuij, & Cardon, 2012).

There were no quantitative studies focused on the interaction between home and preschool settings, and its potential influence on children's SB (Gubbels et al., 2014). However, some studies indicated that early educators had more favorable attitudes and practices related to EBRBs than did the parents (Gubbels et al., 2018; Tandon et al., 2017). The interaction between home and preschool was often brought up in discussion in qualitative studies (Hesketh, Lakshman, & van Sluijs, 2017). Educators stated the importance of communication with parents as a key strategy for promoting children's healthy habits, but parents were also mentioned as an obstacle. Similarly, parents considered that preschool practices influenced home practices and children's behavior at home both positively and negatively. (e.g. Copeland et al., 2012; Määttä, Ray, Roos, & Roos, 2016; Tucker, van Zandvoort, Burke, & Irwin, 2011; van de Kolk et al., 2018; Wilke, Opdenakker, Kremers, & Gubbels, 2013.) Overall, most of the quantitative studies presented in this chapter 3 have explored the influence of either preschool OR home whereas the combination of these settings within one study is lacking, although the exploration of correlates across multiple settings is the key principles of socioecological approach (Sallis et al., 2008).

4 AIMS OF STUDY

This dissertation examines the interplays of factors within and between home and preschool settings, and their associations with children’s SB. More specifically, a variety of preschool factors including both educators’ and principals’ perspectives as well as the parental factors in the home setting are involved in the sub-studies. The interplays within and between settings are studied by implementing mediation and moderation analyses and taking into account the multilevel design of the study sample. In addition, the role of children’s individual characteristics on children’s SB will be studied. The outcome of these studies is the objectively measured preschool children’s SB.

The main research focus of this dissertation is to examine how SES, individual factors, and home and preschool settings combine to shape preschool children’s SB. The following sub-questions are investigated (Figure 4):

1. **Sub-study I:** Which individual-, home- and preschool-level factors are associated with preschool children’s overall SB? To what extent do these factors explain variance in children’s overall SB?
2. **Sub-study II:** Which organizational, social and physical environment factors in the preschool setting are associated with preschool children’s SB during preschool hours? Do these factors in the preschool setting act as moderators in the associations between parental SES and SB during preschool hours?
3. **Sub-study III:** Does co-participation in PA as a parenting practice act as a mediator in the associations between parental SES and children’s SB?
4. **Sub-study IV:** Are the frequent visits to places where PA is encouraged and weekly common practices in preschool groups associated with preschool children’s SB during preschool hours?

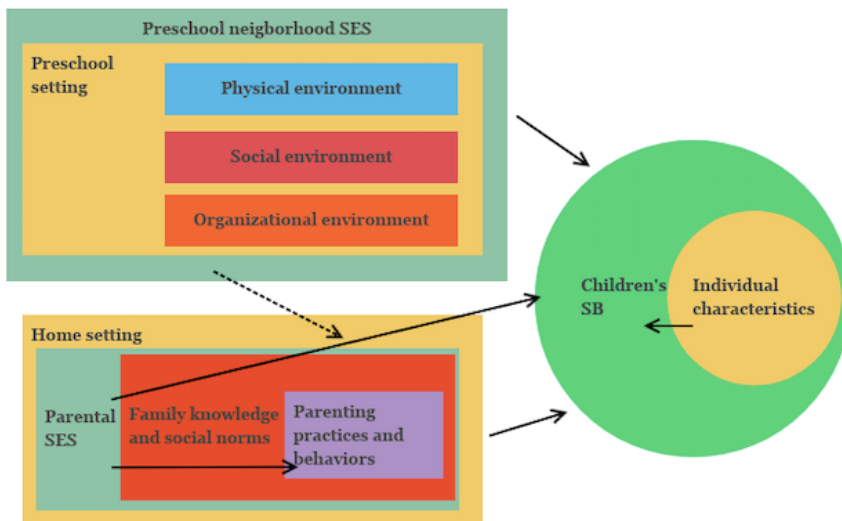


Figure 4 The associations aimed to study. Dashed line indicates test of moderation.

5 DATA AND METHODS

5.1 STUDY CONTEXT

Preschool care is defined as education, upbringing, teaching and care that is pedagogically planned with carefully considered goals supporting children's development and nourishment. In Finland, each preschool group has a mandatory number of trained early education teachers (with university degree) and practical nurses (in this dissertation, "early educator" is used to cover both teachers and nurses) Municipalities in Finland are responsible for organizing early childhood education in preschools for children under school age – that is, before the age of seven. Each child in Finland has the right to early childhood education. Families pay fees that for the full-day provision vary between 0 and €289 per month (as of 2018), depending on the size and income of the family. (Ministry of Education and Culture, 2019.) According to the OECD statistics, 79% of children, aged three to five-years in Finland are enrolled in preschools (OECD, 2016).

The Finnish preschool system is based on the learning by playing model. Thus, children usually have free play times, without educator instruction, when they can choose activities they like to be involved in. There is also a range of organized activities – for example games, PA, music, crafts and excursions. Compulsory pre-primary education in preparation for official schooling begins at the age of six, but before this, the children do not attend school-type classes. Children usually have a nap time or rest during the day. If children are in full-day care, they eat three meals at school. They also have regular outdoor time, usually twice a day. (Finnish National Agency for Education, 2016; Ministry of Education and Culture, 2019.)

5.2 STUDY DESIGN AND PARTICIPANTS

The DAGIS (Increased Health and Wellbeing in Preschools) research project consisted of multiple phases between the years 2014 and 2018. Because the data used in this dissertation is based on a cross-sectional survey conducted in 2015 and 2016, only its key recruitment and participant criteria are described. More about the overall project and its key foundations can be read elsewhere (Lehto et al., 2018; Määttä et al., 2015). The DAGIS cross-sectional survey was approved by the University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences (6/2015, approved in 25th February, 2015). The power and sample size calculations for this survey were conducted separately for different EBRBs and took into account the possibility to compare the highest and lowest tertiles of SES. The sample size varied in these calculations between 600 and 800 children. As the largest required sample size was for estimating the intake of fruits, it was set as an aim to have at least 800 children participating in this cross-sectional survey.

The cross-sectional survey was conducted in eight municipalities in Finland (11 municipalities were contacted, 73% participation rate). Municipalities with a larger variation in educational level and income level and a higher Gini coefficient were selected by applying national statistics (National Institute of Health and Welfare, 2019). Municipalities gave a list of the preschools, and based on this list, preschools were randomized. Multiple eligibility criteria for preschool participation were set: 1) at least one group with three-to-six-year-olds, 2) open only in the daytime, 3) official spoken language either Finnish or Swedish. After randomization, a total of 169 preschools were contacted. Of them, 16 preschools did not meet the eligibility criteria, and thus 153 were invited to participate. A total of 86 preschools (56%) gave consent for participation. All the families with a child aged three to six years in recruited preschools were invited to participate. Written consent was received from a total of 983 children. However, preschools with a total parental consent rate of less than 30% in all of the groups were excluded. Preschools with a too-low-consent rate accounted for 20 preschools involving 91 children. Therefore, the total number of preschools participating in the cross-sectional survey was 66 (43% of invited), and the number of the children with parental consent was 892 (25% of invited). There was at least some form of data on 864 children, which was considered the final participation number of children (24% of invited).

5.3 MEASURES

The DAGIS cross-sectional survey covered multiple data collection methods, such as biological measures, accelerometers, observations, and questionnaires (Määttä et al., 2015). In this section, the methods used in this dissertation are presented.

5.3.1 SEDENTARY BEHAVIOR ASSESSMENT

Children's SB was measured by using Actigraph W-GT3X accelerometers (Actigraph, LLC, Fort Walton Beach, Florida). Actigraph and its different models are widely used as an SB measure for different age groups and in different contexts (Kang & Rowe, 2015; Migueles et al., 2017; Trost, 2007). The DAGIS research assistants set the accelerometers on children's waist. Children were asked to wear the accelerometers 24 hours per day for the next seven days.

The selections of data handling are presented next with a supporting evidence for the decisions based on the previous studies. Firstly, the epoch length was set at 15 seconds due to the sporadic nature of children's movement (Cliff et al., 2009; Migueles et al., 2017). Secondly, periods of ten minutes or more at zero accelerometer counts were considered non-wear times (the periods of continuous zero counts) and were excluded; however, possible nap-times were not excluded. The studies with children's populations can use short timespans for non-wear definition due to children's sporadic movement (Migueles et al., 2017; Rich et al., 2013). Thirdly, the Evenson ST cut-point (0–25 counts per 15 seconds; Evenson et al., 2008) were applied due to its highest classification accuracy for SB (Kim et al., 2014).

Reported sick days or other unusual events during the week (e.g. overnight trips) and night sleeping hours were excluded when forming the variables. During the analyzing phase, the accelerometer data was partly time-stamped with the help of the parental completed diary. Parents reported the daily waking hours and preschool hours during the measurement week. Based on this information, multiple different outcome measures were formed, applying the recommendations for suitable time frames (Byun, Beets, & Pate, 2015; Hinkley et al., 2012; Rich et al., 2013). The outcomes used in this dissertation are presented in Table 2 with the wear time criteria. Because there was a wide variation in the wearing hours between children, the final outcome measures were formed so that the total ST minutes was divided by the total accelerometer wearing time and multiplied by 60 to create outcome variables expressed as average minutes per hour (min/h).

Table 2 *The definitions of the SB measures used in this study*

Measure	Criteria	Study
Overall SB	At least 600 minutes of wearing hours in at least four days, with at least one weekend day	I
Preschool SB	At least 240 minutes per day in the preschool, and at least two preschool days.	II, IV
Weekday SB	The same days as included in the above-mentioned preschool SB, but consisting of waking hours before and after preschool on at least two days.	III
Weekend SB	At least 600 minutes of data per day on both weekend days	III

5.3.2 ASSESSMENT OF INDIVIDUAL CHARACTERISTICS

The guardian reported the gender and age of the participating child. The age was transformed as continuous in years. The measures of child's age and gender were used as covariates in studies II, III and IV and as explanatory factors in study I. The guardian reported how many days per week and how many hours per day the child attended preschool. The answers to these two questions were combined to yield average daily preschool attendance hours. This measure was used in studies I and IV. Research assistants measured the weight and the height of the participating children. These measurements allowed calculation of children's BMI, which was used in study I. Guardians completed the Child Behavior Questionnaire (Putnam & Rothbart, 2006). In this questionnaire, guardians were asked to consider their children's reactions to 36 situations in the past six months. All these items had an answer scale from extremely untrue of your child (1) to extremely true of your child (7). Theoretically, this questionnaire conceptualizes temperament into three domains; negative affectivity, effortful control and surgency. Negative affectivity is characterized by discomfort, frustration, fear, sadness, and difficulty to soothe. Surgency means high activity levels,

high-intensity pleasure seeking, low shyness, and impulsivity. Effortful control includes high inhibitory control, high attentional focusing, low-intensity pleasure and perceptual sensitivity. (Putnam & Rothbart, 2006.) These temperament domains were used in study I.

5.3.3 ASSESSMENT OF HOME SETTING

One guardian in each participating family completed the guardian's questionnaire. The questionnaire consisted of multiple items about attitudes, beliefs, self-efficacy, practices and availability of items related to children's EBRBs and also questions about family SES. However, the parental educational backgrounds were reported in the consent form so that the parent who gave consent for the study reported his/her highest educational level and the educational level of the partner living in the same household.

The guardian's questionnaire could be completed either through the web or on paper. The questions were based on the formative work of the research group, the previously validated questions and the items specific to the Finnish context (Crawford et al., 2012; Gonzalez-Gil et al., 2014; Lampard, Jurkowski, Lawson, & Davison, 2013; Määttä et al., 2016; Pinard et al., 2014; Ray, Määttä, Roos, & Roos, 2016; Ray, Kalland, Lehto, & Roos, 2013). The test-retest reproducibility of some items included in this questionnaire was moderate to good, according to a sub-study from the year 2018 (Määttä et al., 2018).

In Table 3, the specific home setting measures used in this dissertation are presented. The concept "parent" will mainly be applied when presenting the measures and the results of the studies.

Table 3 *The home setting measures used in this doctoral dissertation*

Measure	Items	Original answer options	in the analyses	Study
Parenting practices				
Rules for limiting children's screen time	Do you have limits on how much time your child can spend: a) Watching television. b) Using other screens.	yes, no, and don't have the equipment.	Dichotomous. "don't have the equipment" answers [TV = 20 and other screens = 15] as missing.	I
Parental practice for allowing child run around inside	How much do you agree or disagree with the following statement? a) My child is allowed to run around and be physically active inside our house.	from strongly disagree to strongly agree	Continuous	I
Parental modeling and co-participation				
Parental screen use in front of children	Approximately how many hours a day do YOU usually use electronic devices during leisure time when your child is around a) During weekdays. b) During weekends.	none, less than 30 minutes, 30 minutes-1 hour, 1-2 hours, 3-4 hours, 5 hours or more	1 = less than 30 min, 2 = 30-60 min, 3 = more than 60 min. Treated as dummy variable.	I
Parental PA in front of children	During the past week, how often did your child see you being physically active?	never, 1-2 times, 3-4 times, 5-6 times, daily	Continuous	I
Frequent co-visits in PA places and co-participation in PA	How often does your child go to the following places with at least one adult in the family? a) Nature/forest. b) Park and playground. c) Own yard. d) An indoor facility	less than once a month, 1-3 times per a month, 1-2 times a week, 3-4 times a week, 5-6 times a week, daily	Study I: combined average weekly visits. Study III: recorded based on the answer distribution ¹	I & III

Parental self-efficacy

Parental self-
efficacy for
activating child
for PA

How confident are you that you could do the following? a) I can get my child to do something physically active no matter how busy his/her day is. b) I can get my child to be physically active no matter what the weather is like. c) I can get my child to be physically active even if he/she wants to use electronic devices. d) I can get my child to be physically active even if he/she wants to stay inside. e) I can get my child to be physically active even when there are no other children playing outside.

from strongly disagree to strongly agree

Continuous, the items were combined and divided by the number of items. Based on factor analysis.

I

Parental self-
efficacy for
limiting
children's
screen time

How much do you agree or disagree with the following statements? a) I am concerned about my child's use of electronic devices. b) I find it difficult to limit my child's screen time if he/she does not want to stop and starts whining. c) I find it difficult to restrain myself from using electronic devices when my child is around.

from strongly disagree to strongly agree

Continuous, the items were combined and divided by the number of items. Based on factor analysis.

I

Parental attitudes and beliefs

Parental
attitude for
importance of
PA

How much do you agree or disagree with the following statement? a) It is important for me to make sure my child gets enough PA each day.

from strongly disagree to strongly agree

Continuous ²

I

Parental
attitude toward
societal
pressures for
screen time

How much do you agree or disagree with the following statements? a) Sport as a hobby and the related costs are too expensive. b) There is pressure from society to purchase and use different electronic devices. c) It is important for my child to learn how to use electronic devices, because I am not very good at using them myself.

from strongly disagree to strongly agree

Continuous, the items were combined and divided by the number of items. Based on factor analysis.

I

Parental perceived barriers related to children's outside PA	How much do you agree or disagree with the following statements? a) Poor weather limits my child's opportunities to play outside. b) I find it difficult to let my child be physically active outside as I always have to be there to supervise him/her.	from strongly disagree to strongly agree	Continuous, the items were combined and divided by the number of items.	I
Parental beliefs of unhealthy EBRBs as a problem	To what extent do you think the following matters are generally a problem among 3-to-6-year-old children? a) Being overweight. b) Excessive screen time. c) Physical inactivity	from not at all a problem to a very big problem	Continuous, the statements were combined and divided by the number of items.	I
Parental SES Educational background	What is your highest educational achievement?	comprehensive school, vocational school, high school, bachelor's degree, master's degree licentiate/doctor	In the study I continuous. other studies recoded based on the answer distribution ³	I, II, III

¹ the visits in nature and to parks and playgrounds dichotomized: often= "1–2 times per week" to "daily," all other values = seldom. The visits to own yard into three groups: daily; three to six times a week, and from between one and two times a week to less than once a month. The visits to an indoor sport facility into three groups: visits at least once a week, visits of 1 to 3 times per month, and visits less than once a month.

² The "somewhat disagree" was treated as a reference category as there were no "strongly disagree" answers.

³ Studies I and II used mothers' educational background and study III used parental educational background. In studies I and III, the answer options were reorganized into three groups: a low education = comprehensive schooling (usually from ages 7–16) to secondary education (usually ages 16–19); a medium level= a bachelor's degree; a high education = at least a master's degree.

5.3.4 ASSESSMENT OF PRESCHOOL SETTING

There were multiple assessment methods for the preschool setting: early educators' and principals' questionnaire, questionnaire related to the group practices, weekly program and an observation. The items in the presented questionnaires were constructed by applying the previously used questionnaires, conducting a formative pilot study and designing items relevant to the Finnish context (Androutsos et al., 2014; Benjamin et al., 2007; Manios et al., 2014; Määttä et al., 2016; D. Ward et al., 2008). Most of the items indicated having a good test-retest reliability according to a sub-study (Määttä et al., 2018). In addition, the observation was based on the selection of items from the EPAO (Ward et al., 2008), but multiple additional items were developed to meet the aims of this study and be relevant for Finnish context. More about the overall observation procedures can be read elsewhere (Määttä et al., 2019). The items used in this dissertation from these presented assessment methods are presented in Table 4.

The early educators' questionnaire was paper-based. All the early educators in the preschool group had the possibility to complete it. Principals were asked to select if they wanted to complete their questionnaire on the web or on paper. One early educator in each preschool group was asked to complete an additional questionnaire about the group practices. In addition, each group reported the activities the group conducted each day by completing the semi-structured weekly program. Two research assistants conducted observation in the preschool during the first day of the measurement week.

5.3.5 ASSESSMENT OF PRESCHOOL NEIGHBORHOOD SES

Preschool neighborhood SES was obtained from Statistics Finland (Statistics Finland, 2015a). This grid database contained coordinate-based statistical data that was calculated on a map grid within a one-kilometer radius from the participating preschools. The score for the preschool neighborhood SES was calculated using the database information on 1) median population income level in area 2) educational level and 3) area unemployment rate so that the higher SES neighborhood score indicated higher income, higher educational level and lower unemployment rate. This neighborhood SES measure was used in study I.

Table 4 *The preschool setting measures used in this doctoral dissertation*

Measure	Items	Original answer options	in the analyses	Study
Principals' questionnaire				
<i>Policies</i>				
Screen time policy	Do you have instructions on the following themes in your preschool: a) Permitted screen time for the children, b) Supervision of the children's use of electronic devices, c) Staff's use of own electronic devices, d) In-service training for the staff on screen time, e) Bringing electronic devices to the preschool on a toy day	no, oral, own written or other written instructions	summed up, maximum score = all asked items are other written instructions.	I
Guidance for families' policy	Do you have instructions on the following themes in your preschool: a) Guidance for families on children's PA, b) Guidance for families on screen time.	no, oral, own written or other written instructions	summed up, maximum score = all asked items are other written instructions.	I
PA policy	Do you have instructions on the following themes in your preschool: a) Children's daily amount of PA indoors and outdoors, b) Limiting children's SB, c) Staff's practices in encouraging PA, d) Planned physical education for children, e) In-service training for staff on children's PA, f) Ensuring sufficient outdoor play time regardless of the weather conditions. g) Limiting children's PA/running outdoors. h) Limiting children's PA/running indoors.	no, oral, own written or other written instructions	summed up, maximum score = all asked items are other written instructions.	I
PA theme weeks	How often preschool has had organized PA theme weeks during the last two years.	none, once or twice, and more than twice	more than twice (1); other (0)	II

SB theme weeks	How often the preschool has had organized SB theme weeks (including screen time) during the last 2 years.	none, once or twice, and more than twice	at least once (1); none (0)	II
<i>Beliefs, attitudes and self-efficacy</i>				
Principal's efficacy to influence children's behaviors	To what extent can you, as the principal, impact the following? a) How physically active the children are, b) The number of electronic devices in the preschool, c) The use of electronic devices in the preschool.	from not at all to very much	The items were combined and divided by the number of items. Continuous	I
Principal's beliefs of unhealthy EBRBs as a problem	To what extent do you think that following matters are generally a problem among 3-to-6-year-old children? a) Being overweight; b) Excessive screen time; c) Physical inactivity	from not at all a problem to a very big problem	The items were combined and divided by the number of items. Continuous	I
Principal's personal interest in health	How much do you agree or disagree with the following statement? a) I am personally interested in nutrition, PA, and health.	from strongly disagree to strongly agree	Continuous	I
Principal's attitude about the importance of children's PA	How much do you agree or disagree with the following statement? a) In my opinion, it is important to increase children's PA in preschool.	from strongly disagree to strongly agree	Continuous	I
Principals' attitude about the importance of decreasing children's SB ¹	How much do you agree or disagree with the following statement? a) In my opinion, it is important to decrease children's sedentary time in preschool.	from strongly disagree to strongly agree	Continuous	I

Early educators' questionnaire

Practices

Early educators' practice to break children's SB ¹	I have a habit to plan activities during which the children do not have to be still for longer than 30 min	from totally disagree to completely agree	Continuous	II
Early educators' practice of being active with children	I have a habit to be active together with the children when I am out with them.	from not at all to very much	Continuous	II
<i>Beliefs, attitudes and self-efficacy</i>				
Early educators' efficacy for children's PA	I can persuade my group's children to be physically active when they want to play sitting still.	from not at all to very much	Continuous	II

Questionnaire about group practices

Common practices

Number of PE lessons	Consisted of four separate questions: How many PE lessons the children in the group had per week a) indoors, and b) outdoors? How long (in minutes) is one PE lesson? a) indoors and b) outdoors	Open ended questions	The number of weekly lessons multiplied by the length of one lesson separately for indoors and outdoors, combined to a continuous variable.	II
Active play possibility during free play	Do children always have the possibility to play actively during free play time? a) In the group facilities. b) Elsewhere than in the group facilities	Yes, possible to play actively at least in one place, or no possible at all.	1=no at all possible, 0=others	I
Frequency of visits in nature, play park, neighborhood	How often does your preschool group visit the following places: a. Forest/place for a nature trip. b. Park. c. Neighborhood sports facilities or Gym. d. Other indoor facility for PA.	the times as open answer and the frequency from options: weekly, monthly, yearly.	Study I : combined average weekly level visits. Study IV, recorded based on the answer distribution ²	I, IV

sport facility, and gym					
Field trips to neighborhoods	Do you conduct neighborhood visits in their group and if so, how often these visits are conducted?	the times as open answer and the frequency from options: weekly, monthly, yearly.	Continuous		IV
Weekly programs	The weekly activities in preschool group	open ended	recorded ³		IV
Observation					
<i>Physical environment</i>					
Availability of indoor PA equipment	the portable equipment in the group facilities (n=10 observed equipment) and the fixed equipment inside (n=5).	The equipment in the group facilities: yes, in the view; yes, in the closet and no. The fixed equipment: yes or no.	The EPAO-scoring procedures ⁴		II
Availability of outdoor PA equipment	a composite score of two equipment categories that is fixed equipment outdoors (n=9) and portable equipment outdoors (n=8).	yes or no	The EPAO-scoring procedures ⁴		II
Availability of screens	a composite score of observed screens: television, tablet computers, game consoles/DVD/video players, and computer	in group facilities, in common facilities and none at all.	The EPAO-scoring procedures ⁴		II

¹ In the original publication, ST (sedentary time) was used instead of SB (sedentary behavior).

² If no facility existed nearby, recorded to zero. If a facility existed nearby but is not used, recorded to zero. Frequencies of visits were recorded to times per week. Visits in nature and parks treated as continuous, sport facilities and other indoor facilities: 1=others, 0=no visits at all

³ From open ended answers were recorded into outdoor activity, teacher-led activity, PA lessons, free play, and mixed activities. The daily number of each activity was calculated and summed up for the week level. Score was divided by the number of the days (from three to five) to form the average daily activity amount.

⁴ The adjusted score was formed so that the items in each category were summed up and divided by the number of items and multiplied by ten. After this, these categories were summed up measure. (Bower et al., 2008)

5.4 STATISTICAL METHODS

To answer the presented research questions in this dissertation, the design of the collected data in the multiple levels of the environment needed to be taken into account. In this chapter, the multilevel design as it is applied in the studies is briefly illustrated. In addition, the statistical concepts of mediation and cross-level interactions are defined under the relevant sub-studies. All the main analyses in this dissertation were conducted with Mplus statistical software version 7.13 – 7.14 (Muthén & Muthén, 2017, 2018). The statistical program R, version 3.2.3 (R Foundation for Statistical Computing, Vienna, Austria) was used for calculating the marginal and conditional R^2 in study I. In all the studies, SPSS statistical program versions 23–24 (SPSS Inc., Chicago, IL, USA) was used for descriptive analyses, Spearman correlations, and multicollinearity tests. The collinearity of variables included was tested using tolerance and variance inflation factors (VIFs). No issues with collinearity were identified. MLR (maximum likelihood with robust standard errors) was used as an estimator in all the main analyses.

Multilevel approach. Multilevel data exists when responses are nested within one or a series of higher-level units of responses such as the children in the preschools or preschool groups. Typically, the higher level is a random sample; preschools are a random sample of all the potential preschools. It is assumed that the children in the same preschool will be more alike than the children from other preschools, and thus the preschool in which child is partly predicts the children's score that they will likely get. (Geiser, 2012; Muthén & Asparouhov, 2009; Raudenbush & Bryk, 2002; Stride, 2013.) If the regression analysis is in general about explaining why individuals' scores in an outcome measure differs, multilevel regression analysis separates out the variance according to the multilevel data structure, and then explains it. Thus, multilevel approach takes into account the non-independence of observations within preschools, but allows the investigation of individual and preschool settings simultaneously. (Stride, 2013.) The need for multilevel design is decided by calculating the intraclass correlations which indicate the relative amount of variance attributable to between-group effects. If the intraclass correlation is small (less than 0.12), there is no need to multilevel approach (Geiser, 2012). As the ICCs of measures in this dissertation were generally higher than 0.12, all the analyses were controlled for clustering by the preschool, by preschool group or by family level (participating siblings). The choice of clustering depended on the measurement level of explanatory factor. In sub-studies I, II and IV, individual-level (child-level) was group-mean centered (Enders & Tofghi, 2007).

The main analyses **in sub-study I** were conducted in multiple steps. Firstly, multilevel linear regression analyses were done to examine the associations between each explanatory factor and children's SB. The analyses based on the guardian questionnaire were clustered by the family level. The analyses based on the principals' questionnaire or the preschool neighborhood SES were clustered by preschool whereas the analyses based on the questionnaire about the group practices were clustered by preschool group. Secondly, the explanatory factors for which there was at least some indication for an association with the outcome (P-value < 0.10) from the previous phase were included in the same model to build the complete multilevel model. In this phase, the marginal and the conditional R² were calculated (Nakagawa, Schielzeth, & O'Hara, 2013). Marginal R² is the variance explained by fixed factors in the model, and conditional R² is the variance explained by fixed and random factors (random=preschool). The sum square of each fixed factor was used to calculate the explained variance for each independent variable. The percentage of explained variance between all fixed factors was firstly calculated. As these fixed factors explained a small amount of the variance, the variance explained was estimated to the full model. All the analyses in this study were adjusted for the average daily preschool attendance hours and study season.

In sub-study II, multilevel linear regression models with cross-level interactions were conducted. This method allowed testing the moderation effect of preschool factors in the associations between parental SES and children's SB. The analyses were adjusted for child's age, gender and study season. In these analyses, the children were treated as the first-level unit, and the preschools or preschool groups as the second-level unit. The individual answers of each early educator questionnaire were aggregated on the group-level by calculating the group means of the answers received in each group. The analyses, including preschool factors based on the early educators' questionnaire or the questionnaire about the group practices, were clustered by preschool group, whereas the analyses including the preschool factors based on the principal questionnaire were clustered by preschool.

The analyses were conducted step-by-step following the recommendations by Stride (2013). First, the main effects were examined by applying random intercept and fixed slope models. In this phase, each preschool factor was entered separately into the model, and parental SES was also included as an independent variable. Secondly, the cross-level interactions were examined by applying random intercept and random slope models. Cross-level interaction means testing whether the associations of parental SES and children's SB (both the first-unit levels) depends on the preschool factors (the higher-level factor) To test this effect, a slope variable of the associations between parental SES and children's SB was built. Each preschool factor was entered separately into the model to explain the variance in this slope. This method allowed therefore to test whether the strength and the direction of parental SES and

children's SB association varied according to the preschool factors. In the third phase, statistically significant ($P < 0.05$) cross-level interactions were interpreted by estimating the slope at the different values of the preschool factors. If the preschool factor was dichotomous, the low and high values were 0 and 1. The low, middle and high values for continuous variables were the minus and plus one standard deviation from the sample mean. (Stride, 2013.)

All the analyses in **sub-study III** were clustered at the family level (nested design of participating siblings from a family). The highest education group was treated as a reference category in the mediator models. Mediation is defined as a causal model in which the explanatory factor causes the single or multiple intervening factors (mediators), which in turn cause the dependent variable. For instance, in this sub-study, it was expected that parental SES is associated with co-participation in PA, which in turn is associated with children's SB. Following the current recommendations (Cerin & MacKinnon, 2009; Rucker, Preacher, Tormala, & Petty, 2011), the mediation analyses were conducted despite the non-significant association between parental SES and children's SB. Mediation analyses were conducted with the following steps; a) the associations between explanatory factor and potential mediator, b) the associations between mediator and children's SB when adjusted for explanatory factor and c) the indirect associations between explanatory factor and children's SB through potential mediators. A statistically significant indirect effect (mediation effect) existed, if the confidence interval did not include zero (95% bias-corrected confidence intervals; Rucker et al., 2011). All the analyses were adjusted for children's gender, age, the gender of guardian questionnaire respondent (mother/father) and study season.

In **sub-study IV**, the multilevel linear regression analyses were applied. All analyses were adjusted for each child's age and gender, average daily preschool attendance hours, and study season. In the analyses, children were designated as the first-level unit, and preschool groups as the second-level unit.

6 RESULTS

6.1 CHARACTERISTICS OF PARTICIPANTS

Children and their parents, early educators and principals participated in the study in the years 2015 and 2016 (Table 5).

Table 5 *The participant characteristics in the DAGIS cross-sectional survey*

Participant characteristics	Descriptive
Children (n=864)	
Gender and age	48% girls, mean 4.7 years (SD ¹ =0.9)
preschool attendance	65% (n=515) 5 days, averagely 34.6 hours (SD=8.8)
Siblings in the DAGIS study	11% had at least one participating sibling
Parents (n=808)²	
Gender and age	88% women (n=704), mean 35 years (SD=10.6)
Parental educational background ³	29% at least master's degree 40% bachelor's degree or equivalent 29% high school level or less
Mother's educational background ⁴	3% (n=24) licentiate or doctoral degree 26% (n=226) master's degree 41% (n=358) bachelor's degree 18% (n=150) vocational school degree 9% (n=79) high school 3% (n=22) comprehensive school
Early educators (n=379, 79% of the personnel)⁵	
Gender and age	3% (n=11) male, mean 42 years (SD=13.7)
Education related to preschool	6% (n=21) did not have education
Work experience	Average 13,5 years in preschools (SD=14.6)
Principals (n=53, 88% of the principals)⁶	
Gender and age	4% (n=2) male, mean 48 years (SD=7.7)
Work experience	Average 21 years in preschools (SD=9)

¹ Standard deviation

² The respondents in the guardians' questionnaire, 57% completed online, 12% (n=95) were fathers

³ Other guardians than mother or father(n=four) were excluded. used in sub-study III.

⁴ Mothers' educational background was used in sub-studies I and II.

⁵ The respondents in the early educators' questionnaire

⁶ The principal questionnaire was received from 58 preschools. Five principals completed questionnaire twice, one for each preschool that she/he led.

Of the participating children, 821 had accelerometer data, but not all the children achieved the specific time criteria. Figure 5 illustrates the average SB minutes per hour in the different contexts with minimum and maximum values and the sample size of each measure. Those who did not produce valid accelerometer data for overall SB and weekend SB were more likely to have a mother with a lower educational background than those who produced valid accelerometer data. Otherwise, there were no statistically significant differences between the children who produced valid data and those who did not.

About 43% of the accelerometer data was collected between September and October whereas about 36% in November and December in the year 2015. The rest of the data (21%) was collected in January–April in the year 2016. There were seasonal differences in the amounts of children’s SB so that children participating in between November and December had on average more SB than children participating during early autumn or spring.

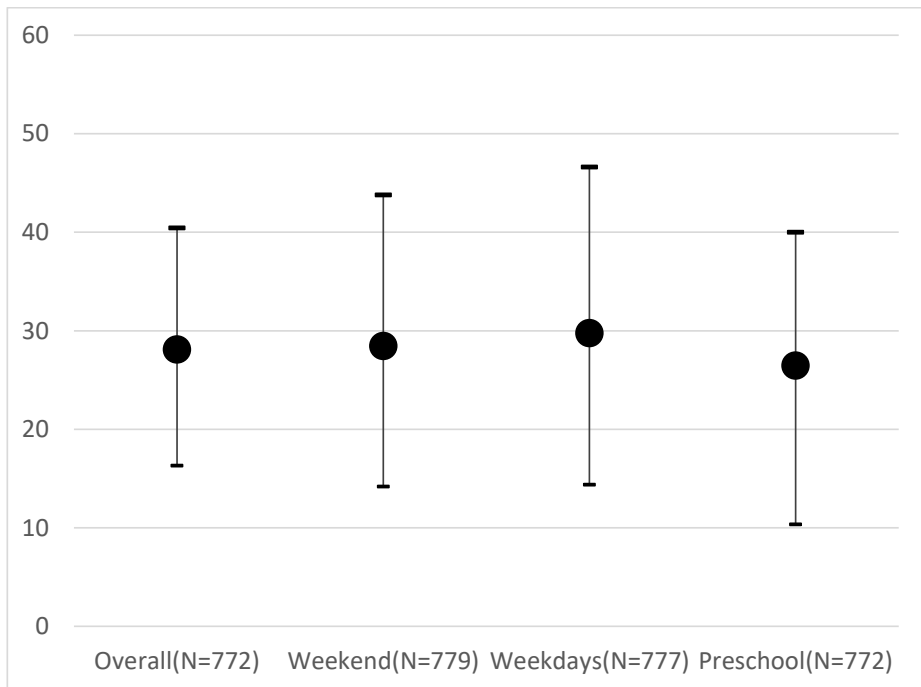


Figure 5 The mean value with minimum and maximum values of each SB measure used in this dissertation in the scale of minutes per hour

6.2 INDIVIDUAL, PRESCHOOL AND HOME FACTORS AND SEDENTARY BEHAVIOR (STUDY I)

Sub-study I examined which individual, home, and preschool factors were associated with children's SB and discovered the extent to which these factors explained the variance in SB. The outcome of this study was overall children's SB (n=772). The associations of a total of 29 factors were studied in phase I (Table 6). It was aimed that these 29 factors covered widely individual characteristics, home and preschool settings. Of the tested associations, 11 factors had at least some indication for an association with the outcome (P-value < 0.10), and four remained significant in the second phase. Being a boy and having a high level of surgency temperament were associated with children's lower SB. Of the home factors, the more frequently conducted co-participation in PA was associated with children's lower SB whereas the higher parental perceived barriers related to children's outside PA was associated with children's higher SB. The fixed effects explained 29.8% of the variance in children's SB whereas the proportion of variance in the full model (fixed effects plus the random effect) was 53.5% indicating that the random factor (preschool) caused much of the total variance. However, the variance of preschool factors used in this study remained low (2%). The home level explained about 5% of the variance. Individual characteristics explained about 11% of the variance in SB.

Table 6 *The associations of individual, home level and preschool factors and preschool children's overall SB in multilevel linear regression analyses, and explained variance in % in the full model*

Measure	Phase I ¹ ,		Phase II ²		%
	β (95% CI)	p-value	β (95% CI)	p-value	
Individual characteristics					
Gender (girl=0, boy=1)	-0.98 (-1.47 - -0.49)	0.000	-1.07 (-1.61 - -0.52)	0.001	
Age	0.09 (-0.17 - 0.36)	0.497			
BMI	-0.00 (-0.05 - 0.05)	0.945			10.7
Surgency	-0.81 (-1.11 - -0.50)	0.000	-0.60 (-0.92 - -0.27)	0.001	
Negative affectivity	0.11 (-0.20 - 0.41)	0.497			
Effortful control	0.69 (0.31 - 1.08)	0.000	0.24 (-0.16 - 0.64)	0.232	

Home setting

Parental beliefs and attitudes

Self-efficacy for activating child for PA	-0.09 (-0.18 - -0.01)	0.036	0.18 (-0.24 -0.61)	0.403
Self-efficacy for limiting children's screen time	0.07 (-0.00 -0.13)	0.052	0.35 (-0.05 -0.74)	0.085
Attitude on importance of PA (ref: somewhat disagree)				
Neither agree or disagree	-0.51 (-2.53 -1.51)	0.619		
Somewhat agree	-0.63 (-2.49 -1.22)	0.503		
Strongly agree	-1.09 (-2.95 -0.76)	0.248		
Attitude on societal pressures regarding screen time	-0.00 (-0.09 -0.08)	0.960		
Perceived barriers related to children's outside PA	0.13 (0.06 -0.02)	0.001	0.35 (0.03 -0.67)	0.032
Beliefs of unhealthy EBRBs as a problem	-0.07 (-0.47 -0.32)	0.724		
Parenting practices				
Rules for limiting children's screen time	0.43 (-0.19 -1.04)	0.173		
Practice on allowing child to run around inside	0.09 (-0.23 -0.40)	0.586		
Parental screen use in front of children (ref: high parental screen use)				
Low	-0.47 (-1.14 -0.20)	0.171		
Middle	-0.56 (-1.22 -0.11)	0.103		
Parental PA in front of children	-0.09 (-0.31 -0.13)	0.420		
Frequent co-visits in PA places	-0.12 (-0.12 - -0.04)	0.002	-0.14 (-0.26 - -0.03)	0.014
Parental SES (ref: high SES)				
Low	0.16 (-0.53 -0.84)	0.499		
Middle	-0.21 (-0.81 -0.40)	0.648		

5.3

Preschool setting**Principals' beliefs and attitudes**

Personal interest in health (ref: neither disagree or agree)

Somewhat agree	0.54 (-0.22 -1.29)	0.162	-0.18 (-3.58 - 3.21)	0.916	
Strongly agree	1.07 (0.44 -1.70)	0.001	0.26 (-3.11 - 3.64)	0.879	
Attitude on the importance of increasing children's PA	0.02 (-1.34 -1.37)	0.982			
Attitude on the importance of decreasing children's SB	-0.23 (-2.24 -1.77)	0.820			
Self-efficacy for influencing children's behaviors	-0.18 (-0.81 -0.45)	0.570			
Beliefs of unhealthy EBRBs as a problem	0.81 (0.12 -1.51)	0.021	0.70 (-0.36 - 1.76)	0.200	1.7
Organizational policies and practices					
Frequency of visits in PA places	-0.19 (-0.37 --0.01)	0.047	-0.20 (-0.44 - 0.04)	0.104	
Screen-time policy	0.16 (-0.03 -0.35)	0.103			
Guidance for families' policy	-0.21 (-0.38 --0.04)	0.039	0.05 (-0.35 - 0.45)	0.817	
Healthy PA policy	0.06 (-0.04 -0.13)	0.200			
Active play possibility during free play	0.29 (-0.48 -1.06)	0.466			
Preschool neighborhood SES (ref: high)					
Low	0.62 (-0.65 -1.89)	0.339			
Middle	0.32 (-0.73 -1.37)	0.554			

¹ All the explanatory factors were individually in the models, adjusted for the daily preschool attendance hours and study season, results in bold indicate that there was at least some indication for an association with the outcome (P-value < 0.10).

² All the explanatory factors (n=11) for which there was at least some indication for an association with the outcome (P-value < 0.10) from phase I were included in the same model, results in bold indicate the statistically significant association with the outcome.

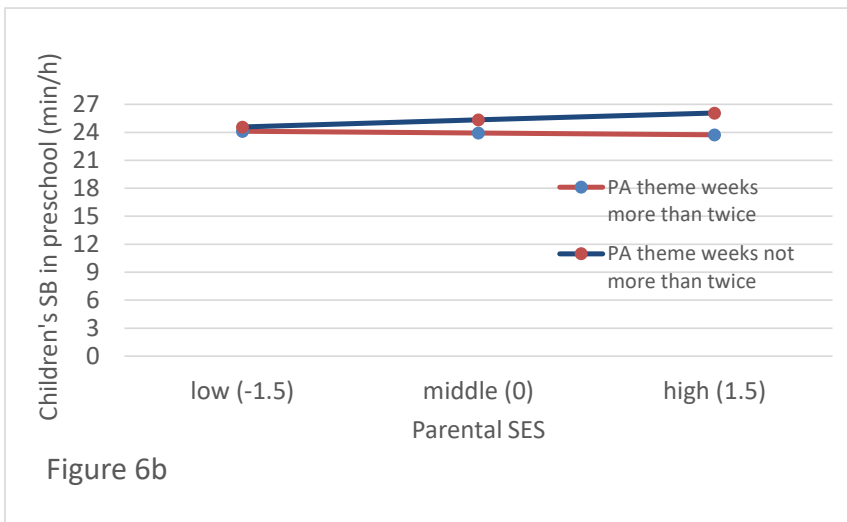
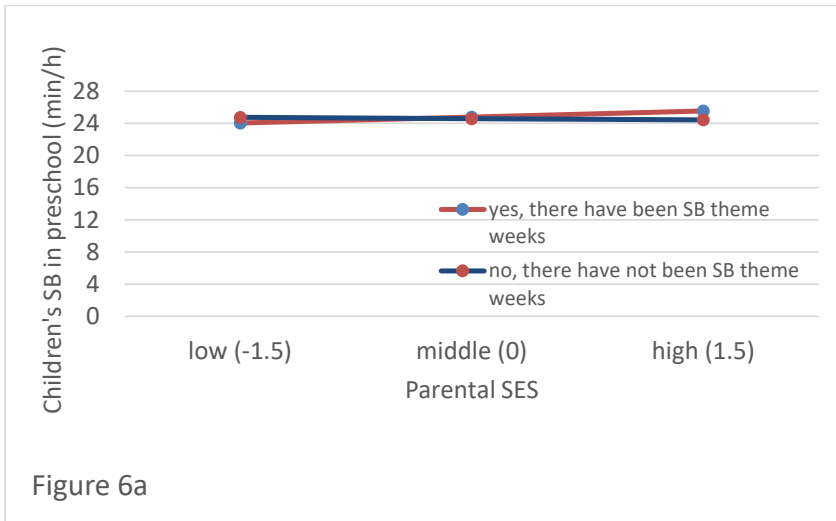
6.3 CROSS-LEVEL INTERACTIONS BETWEEN PARENTAL SES, PRESCHOOL SETTING AND SEDENTARY BEHAVIOR (STUDY II)

Sub-study II studied the associations of nine preschool factors with children's SB during preschool hours (n=772). Additionally, the moderating effect of preschool factors in the associations between parental SES and children's SB were investigated. The nine preschool setting factors covered physical (availabilities of indoor PA equipment, outdoor PA equipment and screens), social (early educators' practice to break SB, practice of being active with children and efficacy for children's SB) and organizational (SB theme weeks, PA theme weeks and PE lessons) environments in preschool setting. The previous studies guided the selection of these factors as they are often stated as possible strategies to diminish children's SB (Ward et al, 2015; Määttä et al, 2016).

Firstly, three out of nine studied factors had significant associations with children's SB. Early educators' practice to break children's SB ($\beta=-1.10$, 95% CI: -2.01, -0.11), more often conducted PA theme weeks ($\beta=-1.30$, 95% CI: -2.58, -0.02) and higher minutes of PE lessons ($\beta=-0.01$, 95% CI: -0.02, -0.00) were associated with children's lower SB.

Secondly, three out of nine tested factors had a significant effect on the slope of the association between parental SES and children's SB. These factors were PA theme weeks, SB theme weeks and PE lessons. To test the significance of these cross-level interactions, the slope at different values of these factors was estimated. SB and PA theme weeks were treated as dichotomous. For PE lessons, the low, middle and high values for PE lessons were the minus and plus one standard deviation from the sample mean. Higher parental SES was associated with children's higher SB in the preschools with organized SB theme weeks ($\beta=0.47$, 95% CI: 0.11, 0.84, Figure 6a). Parental SES and children's SB were unrelated in the preschools without SB theme weeks ($\beta=-0.13$, 95% CI: -0.51, 0.26). Higher parental SES was associated with children's higher SB in preschools with a lower amount of PA theme weeks ($\beta=0.55$, 95% CI: 0.12, 0.98, Figure 6b). Parental SES and children's SB were unrelated in the preschools with higher numbers of PA theme weeks ($\beta=-0.19$, 95% CI: -0.55, 0.17). Higher parental SES was associated with children's higher SB, if preschools had low minutes of PE lessons ($\beta=0.55$, 95% CI: 0.19–0.92, Figure 6c). Otherwise, parental SES and children's SB were unrelated in the preschools with average $\beta=0.16$, 95% CI: -0.12 – 0.44) and high minutes of PE lessons ($\beta= -0.24$, 95% CI: -0.52 – 0.05).

Results



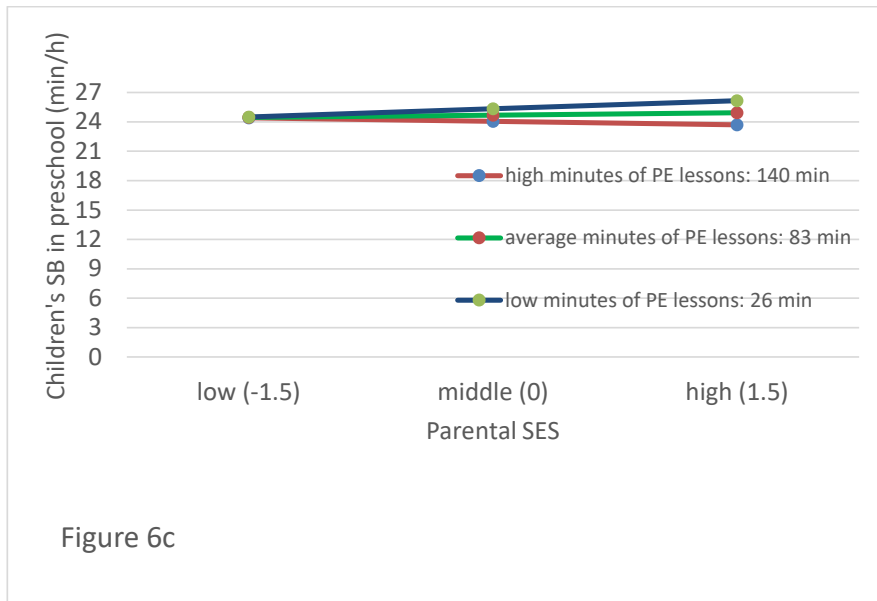


Figure 6 The associations between parental SES and children’s SB in the groups of 1) SB theme weeks (Figure 6a), 2) PA theme weeks (Figure 6b) and 3) PE lessons (Figure 6c). These figures are slightly adapted versions of the figures reported in Määttä et al. 2018 (Määttä et al., 2018) .

6.4 MEDIATION BETWEEN SES, HOME SETTING AND SEDENTARY BEHAVIOR (STUDY III)

Sub-study III aimed at answering three specific questions: 1) Were there SES differences in co-participation in PA? 2) Was the co-participation in PA associated with preschool children’s SB when adjusted for parental SES? and 3) Did co-participation in PA act as a mediator in the associations between parental SES and children’s SB? The co-participation in PA consisted of four different PA places: nature, park, own yard and indoor sport facilities. The outcomes were children’s SB during weekdays (n=777) and weekends (n=779). To answer the first research question, parents with high SES background reported visiting more often an indoor sport facility than parents with middle or low SES backgrounds. Parents with high SES background reported visiting less frequently their own yards than that of parents with low SES background. Secondly, on weekdays, more frequent visits in nature and more frequent visits in families’ own yards were associated with children’s lower SB. On weekends, the more frequent visits in their own yards were associated with children’s lower SB. Thirdly, of the indirect associations, compared to parents with high SES backgrounds, parents with low SES background reported visiting more frequently their own yards, and this was associated with their children’s lower SB on weekdays and weekends (Figure 7).

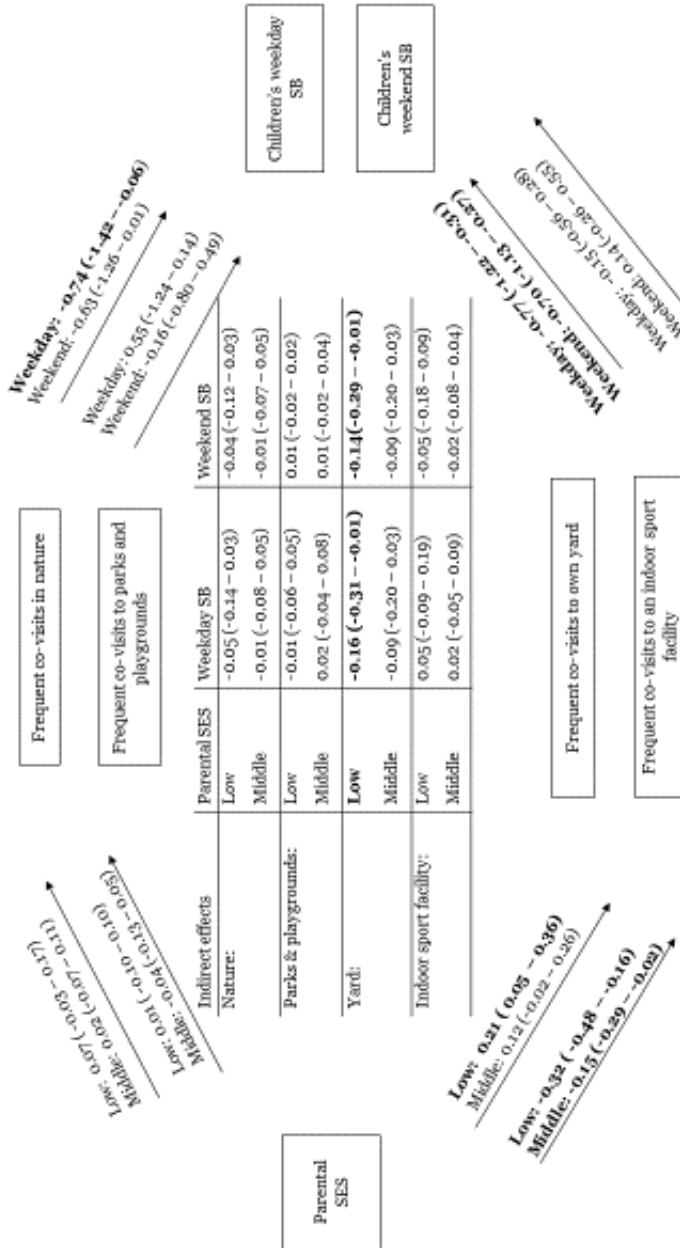


Figure 7 The associations of parental SES, co-participation in PA and children's SB during weekdays and weekends, the statistically significant associations in bold.

6.5 PRESCHOOL-GROUP PRACTICES AND SEDENTARY BEHAVIOR (STUDY IV)

The aim of the fourth sub-study was to examine if the frequent visits to places where PA is encouraged and weekly common practices in the preschool group were associated with preschool children's SB. The outcome of this study was children's SB during preschool hours (n=772).

The weekly schedules were based on the weekly programs reported by preschool groups (out of 159 possible, 131 returned programs, 82% response rate). For the analyses, it was required that at least three days were completed in the weekly program. Therefore, 96 groups had complete information from at least three days (73% of the possible programs). Based on these answers in the weekly schedules, the activities were categorized into five groups (times of outdoors, teacher-led sessions, free play, organized PA lessons and mixed activities).

The frequency of visits to places encouraging PA was asked in the questionnaire related to group practices (total 146 returned questionnaires, 92% response rate). The associations of five different frequencies of visits in places encouraging PA (nature trips, play parks, neighborhood sport facilities, visits to gym or other indoor facility, and field trips to neighborhoods) were studied. The visits in these five places are often conducted in the Finnish preschools throughout the year, and thus selected for this sub-study.

When the associations between weekly schedules and frequencies of visits to places encouraging PA and children's SB were examined, only the more frequently conducted visits in nature were associated with children's lower SB during preschool hours ($\beta=-1.026$, 95% CI:-1.804, -0.248).

7 DISCUSSION

7.1 MAIN FINDINGS

The main research question of this dissertation was to examine how SES, individual factors, home and preschool settings together shaped preschool children's SB. To answer this question, the key findings were: 1) Being a boy and having high levels of surgency temperament were associated with lower SB. Children's individual characteristics explained the variance in children's SB more than settings did (study I). 2) The parental perceived barriers related to outdoor PA was associated with higher SB (study I). 3) Parental practices related to co-participation in PA, especially in nature and the family's own yard, were associated with children's lower SB (studies I and III). 4) Three common practices and one educator practice were associated with children's lower SB during preschool hours. The common practices were PE lessons, PA theme weeks and frequent nature trips, whereas the educator practice was early educators' practice to break children's SB (studies II and IV). 5) There were parental SES differences in the co-participation practices related to the frequency of visits to the family's own yard and indoor sport facilities. Compared to parents with high SES, parents with low SES background reported more frequent visits to their own yard, and these visits were associated with children's lower SB (study III). Parents with higher SES reported more frequent visits to indoor sport facilities compared to parents with middle or low SES backgrounds. 6) Higher parental SES was associated with children's higher SB if preschools had either a) a lower number of PA theme weeks, b) a lower number of PE lessons or c) a higher number of SB theme weeks (study II). These findings are discussed in more detail next.

7.2 INTERPRETATION OF RESULTS

The interpretation of the main findings begins from individual characteristics followed by home and preschool settings. Figure 8 summarizes the main findings.

7.2.1 INDIVIDUAL CHARACTERISTICS

Supporting the findings of multiple other studies (Pereira et al., 2018), study I recognized that girls had more SB than boys. Biologically conditioned play patterns may explain this difference – that is, boys like rough-and-tumble play and girls tend to choose sitting-based activities and social play such as family role-playing games (Barbu, Cabanes, & Le Maner-Idrissi, 2011; Broekhuizen et al., 2014; Storli & Sandseter, 2015). On the other hand, social norms and

expectations may determine differences. That is, parents and educators consider that some play is more suitable for girls than for boys (Cardon et al., 2008; Golombok et al., 2008; Mattocks et al., 2010). Parents seem to allow boys more freedom take risks in play, especially outdoors (Soori & Bhopal, 2002). A Finnish preschool observation study noticed that boys were instructed for play that requires space, and they were allowed more freedom to move by placing the toys that were stereotypically meant for boys (e.g. cars) in the middle. The toys stereotypically meant for girls (e.g. family role-playing) were placed in corners and near the adults. (Lappalainen, 2004.) As girls enjoy being close to the educators, educators' sedentary supervision may be associated with girls' higher SB (Brown et al., 2009; Cardon et al., 2008; Soini et al., 2017). The preschool interventions have gained good results, especially increasing girls' PA when the physical environment has been modified by allowing more potential for girls to implement PA (Broekhuizen et al., 2014). According to study I, high levels of surgency were associated with children's lower SB. Children with high levels of surgency temperament are among others constantly exploring their environment, have low levels of shyness, and tend to get frustrated easily when facing challenges (Putnam & Rothbart, 2006). High levels of surgency are found to be associated with increased outdoor play among preschool children (Sharp et al., 2018). Another study reported that high levels of surgency at age of five predicted higher PA in adolescent males (Janssen et al., 2017). Interestingly, it is suggested that surgency increases individuals' receptiveness to obesogenic eating because high levels of surgency promote frequent eating, support the overeating in response to external cues and escalate the potential to eat even in the absence of hunger (Burton et al., 2011). Research findings from preschool-aged children to adulthood support this suggestion (Guerrieri et al., 2007; Hetherington, 2007; Leung et al., 2014; Ouwens, van Strien, & van Leeuwe, 2009). On the other hand, high levels of surgency are recognized as affecting healthy food consumption by facilitating acceptance of new fruits and vegetables (Vollrath, Stene-Larsen, Tonstad, Rothbart, & Hampson, 2012) and increasing the likelihood of daily vegetable consumption (Kaukonen et al., 2019). These previous study results, as well as the result of this study, urge studying more profoundly how children's temperament influences EBRBs.

7.2.2 PARENTS AND HOME SETTING

Parenting practices and behaviors. Besides studies I and III, at least one study had focused on studying co-participation in PA among preschool children, recognizing that co-participation in PA was low (Hnatiuk, DeDecker, Hesketh, & Cardon, 2017). Study I of this dissertation detected that more frequent co-participation in PA, no matter the type of activity, was associated with children's lower SB. In study III, separate types of activities during weekdays and weekends were studied more specifically. More frequent visits

to the family's own yard were associated with children's lower SB on weekends and weekdays, as were more frequent visits in nature on weekdays.

Previous research proposes that parents and their children spend most of their time together in SBs indoors (Barkin et al., 2017; Cerin et al., 2016; Dunton et al., 2012; Jago, Fox, Page, Brockman, & Thompson, 2010). Co-participation in PA encourages families to move outside, and thus may support children's lower SB. Study III suggests paying attention to the place of co-participation. Yard and nature are indicators of unstructured outdoor activities. Strong evidence exists that time in the outdoors is associated with lower SB (e.g. Pereira et al., 2018; Truelove et al., 2018). In addition, unstructured play (e.g. in nature and yard) increases preschool children's PA (Burdette & Whitaker, 2005; Clements, 2004; French, et al., 2016; Pellegrini & Smith, 1998). Both contexts are usually easily accessible, not requiring much if any sitting-based traveling. Thus, children have the potential to play for longer times in these places compared to indoor sport facilities and playgrounds that usually require sitting-based traveling. Especially on weekdays, there is a limited time frame when families can co-participate in PA, and time saved from traveling provides children longer play time. Both places may also encourage parents to be active differently than at indoor sport facilities and playgrounds (French et al., 2016; Hnatiuk et al., 2017). Although it was not specifically measured in this study, parents might have a more sedentary-type supervising role at playgrounds and indoor sport facilities. In nature and yard, parents have better potential for movement and thus can provide physically active role models for their children (Beets et al., 2007; Davison, Cutting, & Birch, 2003). Overall, co-participation in PA is indicated as being beneficial for parents' and children's PA and enhances parent-child communication and social interactions among family members (Beets, Cardinal, & Alderman, 2010; Bingham et al., 2016; Golan & Crow, 2004; Masse et al., 2017), and based on the findings of this dissertation, is important in diminishing children's SB.

Family knowledge and social norms. Many qualitative studies support the study I finding about parental perceived barriers related to children's outside PA (Hesketh et al., 2017). The items included in this sum variable consisted of attitude related to poor weather or the difficulty of supervising a child outside. Another recent study found that very few of the parents were willing to allow children to play outside in rainy, snowy or cold weather conditions (Jayasuriya, Williams, Edwards, & Tandon, 2016). Qualitative studies also raise the question if the weather is actually a barrier for parents whereas children enjoy being outdoors anyway. Variety in weather conditions together dressing up children may feel time-consuming for parents amid the daily hassle, whereas staying indoors and providing access to screens is an easier option. (Hesketh et al., 2017.) Multiple studies have noticed that children are more sedentary in winter and autumn months (Dias et al., 2019; Harrison et al., 2017; Nilsen et al., 2019). In addition, children spend fewer minutes in SB when the hours of daylight are longer (Dias et al., 2019; Goodman, et al. 2014).

To summarize, of the sixteen studied parental or home setting factors, only a few provided statistically significant association with children's SB. This result is in line with other research (e.g. Downing et al., 2017; Hnatiuk, et al. 2016; Schmutz et al., 2017). Following FEM, it can be hypothesized that parental beliefs and attitudes actually mediate through parenting practices and behaviors on children's SB (Davison et al., 2013). The studied factors measured practices, attitudes or behaviors related to children's screen time or PA rather than overall SB. Thus, parents may have difficulties evaluating their own practices and attitudes related to overall SB. It may be possible that parents actively restrict screen time, but not non-screen SB. Thus, more specific factors focusing on overall SB may have provided better correspondence, as it is suggested that the measurement needs to be highly specific to the relevant behavior (Ajzen, 1988).

7.2.3 EARLY EDUCATORS, PRINCIPALS AND PRESCHOOL SETTING

Physical environment. None of the physical environment items measured in study II had significant associations with children's SB, which was partly distinct to other studies. However the presence of outdoor environment, size of play area and number of active opportunities shown to be associated with children's lower SB (Tonge et al., 2016) were not measured in this dissertation. One potential reason for non-significance may be that each individual item included in one composite score may have opposite associations with children's SB. For instance, seesaws and skipping ropes produced opposite results in relation to PA (Määttä et al., 2019), but these types of equipment were included in the same composite measure in study II.

Social environment. Study II recognized that early educators' practice to break SB often was associated with children's lower SB, whereas other measured social environment factors in studies I and II had nonsignificant association with children's SB. This non-significance is in line with previous research (Tonge et al., 2016; Ward et al., 2015). Educators and principals may answer the way that is expected in pedagogy rather than how they act in practice, leading to the limited variance in the answers between respondents. The policies and regulations set by preschool or municipality may also guide and constrain the work (Mikkelsen, 2011; Sansolios & Mikkelsen, 2011). Thus, educators may have a limited role in how much they can actually affect children's behavior. Principals may be too distanced from the daily practices, and cannot accurately estimate the influence of the practices on children's behavior. For instance, previous research indicated preschool policies reported by principals were not known by early educators, and thus rarely implemented in the daily practices (Benjamin Neelon et al., 2016; Joseph et al., 2019). Most of the items measured in study I were based on the principals' viewpoint.

However, the practice related to breaking SB is a beneficial strategy in future interventions, as it is currently widely recommended to break children's SB as often as possible (WHO, 2019). There is no research evidence as to how often and how educators actually break children's SB, but studying in more detail the lengths of sedentary bouts and the number of sedentary breaks in accelerometer data could provide important information about this topic. It can be pondered how conscious or unconscious this practice is. Following the dual process theory, if this practice is conscious, it means also that educators recognize the situations when it is relevant to break SB (Kremers et al., 2006; Kwasnicka et al., 2016; Strack & Deutsch, 2004). Early educators participating in the formative phase of the DAGIS study discussed that there were multiple daily habitual practices when children were expected to sit. If these situations were not paid attention to, the children might be highly sedentary. (Määttä et al., 2016.) On the contrary, many studies have stated that educators do not consider SB as a problem (Ellis, Cliff, & Okely, 2018; Sisson et al., 2017).

Organizational environment. Tonge et al. (2016) stated in their review that organizational environment had little or no association with children's SB. Contradictory to this statement, studies II and IV recognized three organizational factors associated with children's lower SB. These factors were PA theme weeks, PE lessons and frequent visits in nature. Multiple other studies have also recognized the role of the early educator-led PE lessons in children's lower SB (e.g. Chow et al., 2015; Kain et al., 2017). One reason for this result is that the children are not allowed to decide their activities individually during PE lessons; children follow early educators' pre-planned activities. Thus, these activities may also activate children differently who prefer more sedentary-type activities during free play sessions (Frank, Flynn, Farnell, & Barkley, 2018). For instance, the gender differences in PA levels are found to happen especially during unstructured activities, but not during PE lessons (Van Cauwenberghe, Labarque et al., 2012). Consequently, early educator-led PE lessons may be relevant to have in the weekly schedules so that all children decrease their SB. Study IV in this doctoral dissertation summarized that none of the weekly activities were associated with children's SB. The reason for this nonsignificance may be related to the children's potential to self-select their activities. Other studies suggest that a preschool system based on freedom compared to a more school-type system has a minor role in explaining children's movement behaviors (Hesketh & van Sluijs, 2015; Raustorp et al., 2012).

Study II suggests PA theme weeks are associated with children's lower SB. The actual content, length and topics of the PA theme weeks are unknown, but this measure can be understood as an indicator of the value of PA. There is a common practice in Finnish preschools to have theme weeks, but the topics vary between preschools. The selected topics of the theme weeks may reflect principals' and educators' own interests, beliefs and attitudes (Chow & Humbert, 2011; Mikkelsen, 2011). In general, it seems that integrating PA into the preschool schedule is more beneficial for children's activity than having a

stand-alone PA program (Pate et al., 2016; Trost, Fees, & Dziewaltowski, 2008; Wadsworth, Robinson, Beckham, & Webster, 2012).

According to reviews, being outdoors and playing in a natural environment are associated with children's lower SB (Pereira et al., 2018; Truelove et al., 2018). Study IV brought novel knowledge that frequent nature trips were associated with children's lower SB during preschool hours. Frequent visits in nature were also associated with children's lower SB during weekdays in study III. The benefits of nature in children's development are manifold; frequent visits in nature develop children's gross motor activity and fundamental movement skills, advance resiliency and self-regulation, and improve skills for dealing with stress (Bento & Dias, 2017; Brussoni et al., 2015; Gray et al., 2015). Compared to other physical surroundings, nature does not provide easy access to be sedentary. There are typically sandboxes, swings and other sedentary-type equipment in yards and playgrounds, which may attract some children to be sedentary. Boredom may also be the reason. The similar daily alternatives for playing in the preschool yard may be less challenging and cause boredom for children attending preschool regularly (Wilke et al., 2013). The educators' beliefs about the value of outdoor activities have a strong impact on the practices. If educators believe that children develop naturally without their constant presence or educators do not understand the potential for learning in outdoors, they tend to perceive their role in the outdoors as being sedentary supervision rather playing actively with children. (McClintic & Petty, 2015; Norling & Sandberg, 2015.) In nature, educators may provide a more physically active role model, which can inspire children to move more. However, research on this topic is warranted.

To summarize, this dissertation recognized one social environment and three organizational environment factors in preschool associated with children's SB. This result is partly opposite to previous findings, but also supports the previous research findings (e.g. Tonge et al, 2016). One reason for this difference between findings may be the international differences in preschool structures (discussed in chapter 3.3). Thus, other factors may be more relevant in different sociocultural context than in Finland. Related to this, in study I, it was noticed that preschool captured substantial amounts of variance in children's SB, but the factors studied in this study were not the most relevant indicators to explain this variance in SB. This aspect underlines the importance of formulating better questions that also take into account the sociocultural context of preschool. This topic is discussed in more detail in chapter 7.3.

7.2.4 INTERPLAYS BETWEEN SES, SETTINGS AND CHILDREN'S SEDENTARY BEHAVIOR

Study I observed that parental or preschool neighborhood SES were not significantly associated with children's SB. This result is in line with other studies (Cameron et al., 2015; Stierlin et al., 2015). However, studies II and III continued to study whether parental SES played a role. Study III recognized that higher parental SES was associated with more frequent co-participation in the indoor sport facilities but less co-participation in their own yard compared to parents with lower SES backgrounds. This latter association was associated with children's SB, so that children of parents with high SES backgrounds had higher SB compared to children of parents with low SES backgrounds. Other studies partly support these findings. Parents' higher SES is found to be associated with children's lower outdoor play and higher engagement in organized PA (Brockman et al., 2009; Lampinen et al., 2017). Parents with lower SES often report a higher amount of unstructured activities partly due to monetary costs (Brockman et al., 2009), and their own yard or facilities near home are important for increasing PA among children with low SES background (Barkin et al., 2017; Cerin et al., 2016; French et al., 2016). Study II acknowledged that higher parental SES was associated with children's higher SB in the preschools 1) with organized SB theme weeks, 2) with a lower number of PA theme weeks, or 3) with a lower number of PE lessons. This result encourages to ponder if preschool setting is similar to all children. It is suggested that children with higher parental SES backgrounds concentrate and pay attention to cognitive tasks longer than children with lower SES backgrounds (Starksen, Ellingsen, Wanless, & McClelland, 2015). This concentration may lead to longer times in sedentary behavior during free play times. The preschools with lower minutes of PE lessons may provide more activities allowing children's individual freedom to choose activities during the time slots when the preschools with higher minutes of PE lessons have their PE lessons. This may also explain the findings related to PA theme weeks. PA theme weeks integrated as a part of the preschool curriculum can "force" children with higher SES backgrounds to break their SB and conduct movement. It seems also that children with lower SES backgrounds are more restless and may therefore gain the frequent movement throughout the day and break their SB despite the PA theme weeks (Hartman, Winsler, & Manfra, 2017). However, there were no SES differences in children's SB during preschool hours (Määttä et al., 2017), and the recognized moderation effects were small. There may be other factors influencing in the associations of the parental SES and SB. Overall, the results of this dissertation encourage further study into how SES is related to children's SB.

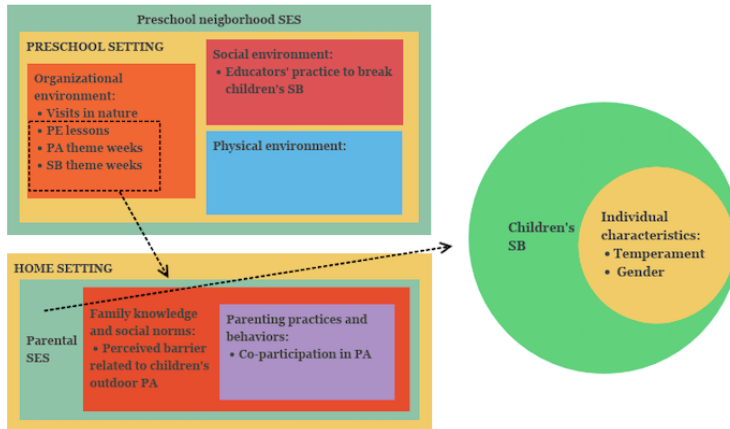


Figure 8 The key findings of this study placed in the conceptual framework of this dissertation. The dots specify the specific factors in each environment being associated with children's SB. The dashed lines indicate the moderation effect of the three organizational factors on the associations between parental SES and children's SB.

7.3 METHODOLOGICAL CONSIDERATIONS

The objective measurement of SB including also the separate SB measures for each setting and methods covering both home and preschool settings in the same study are the primary strengths of this dissertation. However, several methodological limitations need to be mentioned when interpreting the results of this dissertation. These limitations are discussed next. **The sample and statistics.** This cross-sectional study assessed only the statistical associations, but did not provide evidence of causal relationships between the factors and behavior. The found associations were overall quite small, and the confidence intervals of some estimates were large. Thus, despite the statistically significant association, the practical importance of these findings can be pondered. However, SB is a complex behavior influenced by multiple factors (Zhu & Owen, 2017), and thus it is unrealistic to expect one factor to explain a large amount of variation. In some studies (e.g. study II and study I), the number of statistical tests performed may have increased the potential for Type 1 error that is incorrectly rejecting the null hypothesis. The large number of conducted tests may lead to falsely narrow confidence intervals and predicted values or biased regression coefficients (Altman & Andersen, 1989). Thus, for instance, conducting the Benjamini-Hochberg procedure to discover false discovery rates may have been valuable (Benjamini, Y., & Hochberg, 1995).

The DAGIS study was potentially underpowered to identify preschool level effects, given the sample size of only 66 preschools versus a sample size of 864

children for the individual-level correlates. There was limited variance in some of the preschool-level variables measured in this study. Thus, a study with a larger sample size of preschools, and with greater variability among preschools in relation to the environmental measures, may provide better possibilities to detect preschool correlates. The analyses did not consider the influence of municipalities, which are responsible for organizing preschool care.

There is no information on the preschools or families who did not consent to the study, and thus it cannot be estimated how representative a sample of families with preschool children or Finnish preschools this is. The participation rate of families was low, and a selective group of participants according to parental SES background may have participated. About 29% of the parents in the DAGIS study had at least a master's degree or equivalent. Most of the parents were in the age group of 25–44. According to the National Statistics in the year 2015, 15% of the population in this age group had at least a master's degree or equivalent (Statistics Finland, 2015b).

The questionnaires. Although the test-retest reproducibility of some items in the questionnaires is reasonable (Määttä et al., 2018), the validity and reliability of many items is unknown. Although the measure about co-participation in PA covered both the frequency of co-participation and the type of activities done together as recommended by a review (Uijtdewilligen et al, 2017), objective measurements such as Bluetooth and GPS devices could have provided more detailed knowledge about the co-participation practices. As mentioned, there was a limited variance in the preschool-level variables measured in this study. It is suggested that there are inconsistencies between what educators actually do (observed practices) and what educators represent that they have done (self-reported practices) encouraging reconsideration of the assessment methods (Wen et al., 2011). More attention may need to be paid to how to measure preschool setting – that is, if observations provide more variation between settings, and who (principal, early educator) is the relevant source for the questionnaires. It shall be acknowledged that the individual's perception of the environment is important information just as the results of objective measurements are (Spence & Lee, 2003). Thus, the combination of the observational and subjective assessment tools may have provided a better picture of the social environment.

The measurement of attitudes and beliefs should be highly specific to the behavior in question in order to achieve correspondence or compatibility between the assessed attitude and the behavior (Ajzen, 1988). The questions related to attitudes and beliefs may have been assessed on a broad level, whereas the practices with a specific focus in the DAGIS study. Bandura (1986) encourages measuring self-efficacy by applying the dimensions of magnitude, strength and generality. Not all of these components were included in the self-efficacy measures of this study. Similarly, some of the measured items were treated as single statements whereas other items were combined as sum variables in the analyses. Thus, some measures were more specific, and some more general. SB is still quite a new concept, and how it is understood may

need better specification when designing the questions. This mismatch between generality and specificity may have led to misinterpretations between and among the respondents.

The measurement issues related to outcome. A number of methodological choices during accelerometer data processing and handling can bias the outcomes, and thus influence the reported associations. For instance, a waist/hip-worn accelerometer does not properly distinguish sitting versus standing. The potential nap times were not separated from the accelerometer data, which might overestimate the time spent in SB. Several validated cut-points for SB exist, and these cut-points are noticeably different from one another. Different objective devices and different models of the same device may produce distinct results, and do not capture equally children's behaviors. (Migueles et al., 2017; Vanderloo et al., 2016.) To sum up, different devices, cut-points, wear-time criterion and epoch length are, for instance, decisions that may explain the variation between studies; it may not be appropriate to make direct comparisons between studies (Vanderloo et al., 2016) and needs to be taken into account when interpreting the findings of this dissertation.

7.4 IMPLICATIONS FOR FUTURE STUDIES

It is widely stated that the key aspect of the current research is to recognize the correlates of SB in the different age groups and different settings (De Craemer et al., 2018; Zhu & Owen, 2017). Although this doctoral dissertation recognizes some potentially important factors to be considered, there is still a need to implement more research in the field of the preschool children's SB; for instance, hardly any longitudinal studies have been implemented (Stierlin et al., 2015).

Multilevel, moderation and mediation studies. The socioecological model of SB assumes that SB is influenced by multiple factors in the multiple levels of the environment (Owen et al., 2011), but more comprehensive multilevel studies may need to be conducted to study further how the different levels of the environment actually influence children's SB. Beside individual and the closest settings, covering the neighborhood surroundings and the community level may produce important knowledge. There is, for instance, less knowledge of how, where and for whom neighborhoods in which children live are important (Minh et al., 2017). However, a challenge relates to the statistical methods and the analyses that properly take into account the nested designs of this approach and the interplays between the factors (Gubbels et al., 2014; Minh et al., 2017; Owen et al., 2011; Sallis et al., 2008).

The socioecological approach underlines that individuals are in reciprocal interaction with their environment. This viewpoint means that children and their individual characteristics (e.g. temperament, gender) may influence the interplays between settings on children's SB. (Bronfenbrenner, 1979; Gubbels

et al., 2014.) Future studies should study the role of children's individual characteristics better. Similarly, as there is strong qualitative research evidence about the interplays between home and preschool settings (Hesketh et al., 2017), conducting moderation analyses provides important knowledge if the effect of certain factors on children's behavior is reduced by the moderating influences of other factors (Gubbels et al., 2014). In addition, the role of SES factors may need to be studied further, both in moderation and mediation studies. This dissertation used education and neighborhood SES as indicators of SES, but other SES factors such as equivalent income may produce valuable knowledge as well.

The development of study design and questionnaires. There seems to be difference in the daily and the weekly patterns of SB, but it is uncertain whether the setting or the time of the day influence these patterns more (Dias et al., 2019; Hesketh, Griffin, & van Sluijs, E. M. F., 2015; Pereira et al., 2018; Van Cauwenberghe et al., 2012). Thus, it would be fruitful to collect comparison data consisting of children from different settings (e.g. children cared for at home, cared for at preschool or cared for at other places) and compare potential differences in the patterns of SB. Future studies may aim to collect data around different neighborhoods covering both urban areas and the countryside so that a wide variety of settings are covered. Future studies may also encourage all the guardians in the family to participate in the study. The role of fathers in encouraging PA is different than that of mothers (Morgan et al., 2016), for instance. The role of other children should not be forgotten either (Ward et al., 2015; Ward et al., 2017). The development of more specific questions about overall SB may be needed. Similarly, more specific questions about breaking children's SB could provide relevant knowledge about parental or educators' practices. Based on multiple research evidence (e.g. Hesketh & van Sluijs, 2015; Raustorp et al., 2012), there seem to be sociocultural differences in preschool systems across countries, thus international measures (e.g. the EPAO) may not be the best possible methods to use in each context, whereas culturally tailored measures are desirable. Thus, the development of proper measurement tools with a specificity in the operationalization of the theoretical backgrounds may be the essential starting point in the development of the study.

Understanding the concept of SB and measuring it. Multiple SBs are implemented as daily routines throughout the day. Thus, SB may partly be an unconscious and hedonic choice (Conroy et al., 2013; Spence et al., 2017). When considering preschool children, it may be relevant to understand more about parents' and educators' unconscious processes and hedonic factors that influence children's SB. For instance, study I pointed out that parental perceived barriers to children's outdoor PA were associated with children's higher SB. It can be questioned how parental hedonic factors (e.g. motivation to relax inside after the workday, feeling of laziness at dressing children for outdoors) influence parents' perceptions behind this barrier. Similarly, most of the SBs are behaviors that preschool children can implement without any

parental involvement compared to PA (e.g. providing outdoor clothes, supervision, traveling to facility). Thus, the children's individual hedonic preferences may play a bigger role in SB. The difference between PA and SB challenges the development of intervention methods. Is it more efficacious to focus on reducing SB by increasing MVPA or by changing the position from sitting to standing? (Spence et al., 2017). A meta-analysis concluded that intervention studies had produced good results when focused on increasing children's PA rather than decreasing SB (Downing et al., 2018).

The measurement of SB is a challenge. Hnatiuk et al. (2014) concluded that preschool children's objectively measured SB (including objective devices and observations) ranged from 34% to 94% partly due to the differences in the study designs and the methods of data processing between the studies (Hnatiuk et al., 2014). Although accelerometers are considered a gold standard for measuring movement behaviors (Cliff et al., 2009), proxy reports and observations may provide valuable additional knowledge of the context and the type of SB. As it is currently recommended to break SB often (WHO, 2019), the research methods to study bouts of SB or breaks in SB are beneficial to apply in future studies. Multiple new technological solutions and applications could also be harnessed for the use of research (John & Intille, 2017; Zhu, 2017). For instance, it would be fruitful to explore better the social context of the SB.

7.5 IMPLICATIONS FOR PRACTICE

The practices in preschool. Preschool is designed to provide equal opportunities for all children to be active. Although children's individual characteristics are not modifiable, the social and physical surroundings in each setting are. The results of this dissertation suggest that the shared social norms and physical structures in the preschool setting need to be modified so that being sedentary is partly prohibited or discouraged whereas movement is promoted and demanded, if the socioecological model of SB is applied (Owen et al., 2011). Consequently, it may be necessary to pay attention to current preschool practices. The results of this dissertation encourage implementing common practices related to PA theme weeks, nature trips and early educator-led PE lessons in the preschools. All of these practices have the potential to diminish children's SB.

In addition, study II recognized that educators' practice of breaking children's SB was associated with children's lower SB, which could be a beneficial habit to include in the daily practices. Thus, future interventions may provide knowledge about the harmful effects of prolonged SB, and supply tips on how to break it often in the daily practices in preschool. It seems that the most active children benefit more from having less structure in free play sessions whereas more sedentary children benefit from the structured-type of free play organized by educators (Frank et al., 2018). The research evidence suggests

also that adults are mainly supervising in a sedentary way, at least in some contexts (e.g. preschool yards), which leads to higher SB, especially among girls (e.g. Brown et al., 2009; Soini et al., 2017). Thus, finding the optimal balance between educators being overinvolved and underinvolved in PA promotion and decreasing SB is an important goal. This evidence also highlights that children with diverse characteristics respond differently to similar influences in the same setting (Bronfenbrenner, 1979). Future interventions may focus on educating educators in promoting healthy habits for all the children, as research evidence suggests that educators may be unaware of the role they play (e.g. Ellis et al., 2018; Sisson et al., 2017).

Co-participation in PA and being outdoors. Although children enjoy spontaneous and freely chosen outdoor play (Bergen, 2009), multiple factors are shown to hinder children's engagement in the outdoors or co-participation in PA. This dissertation pointed out the parental perceived barriers related to children's outside PA being associated with children's higher SB. Other studies have suggested that daily hassle after workday makes it easier to provide access to screens (Hesketh et al., 2017), or that parents are overprotecting their children to keep them safe from external harms (e.g. crime, injury) by occupying them with structured activities inside controlled by adults (Bento & Dias, 2017; Jolleyman et al., 2019; Tremblay et al., 2015; Wyver et al., 2010). Parents have, however, the intention to be active, especially in the outdoors with their children, but it seldom happens (Jayasuriya et al., 2016; Rhodes et al., 2016), indicating intention-behavior gap.

Intervention strategies may consider how beliefs and attitudes in relation to outdoor play and co-participation in PA are modified so that the positive aspects overcome the presented barriers (Ajzen, 1991; Gallagher & Updegraff, 2012). Parents seem to value organized PA due to its developmental benefits for children (Watchman & Spencer-Cavaliere, 2017; Wyver et al., 2010), whereas the knowledge of outdoor play in their own yard and nature as an important source of children's movement may need to be underlined better. Secondly, providing strategies to balance co-participation in PA and managing the daily hassle could be beneficial. Good results have been gained when parents are taught to set specific goals for their daily lives so that they can control their time use (Cowie, White, & Hamilton, 2018; Michie et al., 2009). The specific plans and goals are especially important for parents with low self-efficacy, who may struggle more to overcome the perceived barriers (Sheeran, Trafimow, & Armitage, 2003).

Providing social support may be another relevant strategy in future interventions (Schwarzer, 2008). Social support can encourage individuals to make healthy decisions through comfort, assistance and information provided by these important others (Andrews, Silk, & Eneli, 2010; Hamilton, Thomson, & White, 2013; Hamilton et al., 2016). Social support is related to better engagement for PA among parents with preschool-aged children and is especially important for low SES families or for parents with higher perceived

stress levels and poorer family functioning (Ball, 2015; Cameron et al., 2019; Hamilton et al., 2016; Li, Jurkowski, & Davison, 2013).

Early educators and preschool form important social supports for parents with preschool-aged children, although the research evidence is mixed; perceived social support from educators is considered either valuable or unhelpful (Hesketh et al., 2017). The child could act between the preschool and home settings by transferring the learned habits of nature visits in preschool to the home setting. The interventions have gained good results when a child activates their parents to become physically active (Morgan et al., 2016). Similarly, other family members contribute important social support (Cameron et al., 2019; Hamilton et al., 2016). When one family member becomes more physically active, prompting others to follow and engage in activity themselves, this leads to a virtuous cycle activating the whole family (Morgan et al., 2016). Additional social support sources are the other families in the neighborhoods or in the preschool. The research evidence suggests that when families share similar practices regarding their children, strong collective norms develop, leading to better children's health and wellbeing (Ceballo & McLoyd, 2002; Ross & Jang, 2000). Parents also acknowledge that a high social cohesion in the neighborhood is associated a higher amount of children's outdoor play (Boxberger & Reimers, 2019). Overall, parental motivation and encouragement are more important than the built environment as predictors of positive change in time spent outdoors by children (Cleland et al., 2010).

8 CONCLUSIONS

This dissertation brings novel knowledge of how individual factors, SES, and home and preschool setting together shape children's SB. The results of this dissertation suggest on focusing practices in both home and preschool settings. Future interventions could develop strategies aiming to increase frequent co-participation in PA, especially in the yard and nature. Common practices related to frequently conducted nature trips, PE lessons and PA theme weeks were beneficial for diminishing SB in the preschool setting, and hence should be guaranteed in each preschool. Although parental SES did not have a direct association with children's SB, parental SES had an indirect effect on children's SB, and factors in the preschool setting modified the associations between parental SES and children's SB. Future work may be needed to study more profoundly the interplay between parental SES and home or preschool settings on children's SB. Finally, the children's individual characteristics, especially gender and temperament traits, explained more the variance in children's SB than factors in home and preschool settings. Thus, the results of this study encourage taking these individual characteristics into account better in daily social interactions and future studies.

Preschool age is a period of growth and development when health behavior habits are beginning to take shape (Knudsen, 2004), and habits learned at this age tend to track later in life (Jones et al., 2013). Thus, this age period is considered critical in the promotion of healthy habits. All children engage in SB daily, and some aspects of SB are educational and beneficial for healthy development. The question is rather how to find the optimal amount of SB and how to break it as often as possible. The caregivers in home and preschool settings play a key role in regulating these habits, and thus should focus on future interventions and public health programs aiming to decrease or break children's SB. The results of this dissertation encourage focusing on the public health messages and intervention strategies related to parental and preschool practices supporting all preschool children to play more actively – outdoors.

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