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UNIVERSITY OF TURKU

EARLY CHILDHOOD DIET QUALITY AND RISK OF OVERWEIGHT – ASSOCIATIONS WITH INDIVIDUAL, FAMILY AND NEIGHBOURHOOD FACTORS

Saija Tarro

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"The best way to see farther,
is by standing on the shoulders of giants."
Modified from the phrase from Sir Isaac Newton

To my dear children Kerttu and Veikko, and
all of you who have inspired me on my journey called life.

UNIVERSITY OF TURKU
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ABSTRACT

The prevalence of overweight is increasing globally already in childhood. Eating habits are established during childhood and provide the basis for healthy lifelong weight development. Family and other environments surrounding the child heavily influence the eating habits and weight development of the child in constant interaction with the child's own characteristics. Diet quality of preschool-aged children in Finland continues to be moderate or poor. However, more research is needed addressing multi-level modifiable factors and their interactions associating with child eating habits and weight development.

The main objective of this study was to provide deeper knowledge of the individual, family and neighbourhood-level factors associated with early childhood diet quality and weight status. This thesis used data from a prospective Steps to Healthy Development (the STEPS) Study from Finland, with 270–883 preschool-aged (ie., 2–6 years old) children and their parents.

Child diet quality and BMI were associated with all three levels: child, family and neighbourhood. Firstly, child "Food approach" appetitive traits were positively associated and "Food avoidance" appetitive traits were negatively associated with child diet quality and BMI. Secondly, both maternal and paternal diet quality and maternal self-efficacy were shown to positively associate with child diet quality. Thirdly, parental restrictive feeding practices were positively associated and parental pressure to eat was negatively associated with child BMI. Fourthly, neighbourhood socioeconomic disadvantage was negatively associated with diet quality among parents and children. Lastly, the interaction results between different levels showed that children with high "Food approach" appetitive trait and living in socioeconomically deprived neighbourhoods had a higher risk for overweight compared with their peers from affluent neighbourhoods.

In conclusion, socioeconomic inequalities between neighbourhoods should be addressed as a part of urban planning and emphasis should be put on creating environments that make healthy food choices easy, as well as guiding and empowering families to make those healthy choices.

KEYWORDS: Eating habits, food behaviour/dietary behaviour, eating behaviour, appetitive traits, diet quality, parental self-efficacy, food environment, socioeconomic status, neighbourhood disadvantage

TURUN YLIOPISTO
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TIIVISTELMÄ

Ylipainon yleisyys kasvaa maailmanlaajuisesti jo lapsilla. Ruokailutottumukset kehittyvät varhaislapsuudesta alkaen tarjoten pohjan terveelle painonkehitykselle. Perhe ja muut ympäristötekijät vaikuttavat vahvasti lapsen ruokailutottumuksiin ja painon kehitykseen vuorovaikutuksessa lapsen yksilöllisten ominaisuuksien kanssa. Esikouluikäisten lasten ruokavalion laatu on Suomessa edelleen kohtalainen tai heikko. Lisää tutkimusta tarvitaan kuitenkin lasten ruokailutottumuksiin ja painon kehitykseen yhteydessä olevien tekijöiden tunnistamiseksi.

Tämän väitöstutkimuksen tavoitteena oli tunnistaa varhaislapsuuden ruokailutottumuksiin ja painoon liittyviä yksilö-, perhe- ja naapurustotason tekijöitä ja niiden keskinäisiä suhteita. Tutkimuksessa käytettiin Hyvän Kasvun Avaimet -seurantatutkimuksen aineistoa, johon osallistui 270–883 esikouluikäistä lasta vanhempineen (ts. 2–6-vuotiaita).

Lasten ruokavalion laatu ja painoindeksi olivat yhteydessä kaikkiin kolmeen tasoon: yksilöön, perheeseen ja naapurustoon. Ensinnäkin lapsen ruoan lähestymiskäyttäytyminen, eli suurempi ruokahalu oli positiivisesti yhteydessä ja ruoan välttämiskäyttäytyminen, eli heikompi ruokahalu oli negatiivisesti yhteydessä lasten ruokavalion laatuun ja painoindeksiin. Toiseksi sekä äidin että isän ruokavalion laatu, että äidin minäpystyvyys olivat positiivisesti yhteydessä lasten ruokavalion laatuun. Kolmanneksi vanhempien rajoittava syöttämistapa oli positiivisesti ja vanhempien painostava syöttämistapa oli negatiivisesti yhteydessä lapsen painoindeksiin. Neljänneksi naapuruston sosioekonominen huono-osaisuus oli negatiivisesti yhteydessä vanhempien ja lasten ruokavalion laatuun. Lopuksi, huono-osaisilla alueilla asuvilla ja suuren ruokahalun omaavilla lapsilla oli suurempi ylipainon riski verrattuna hyväosaisilla alueilla asuviin ikätovereihinsa.

Yhteenvetona voidaan todeta, että asuinalueiden sosioekonomiseen eriarvoisuuteen olisi kiinnitettävä huomiota osana kaupunkisuunnittelua, edistettävä terveellisiin ravitsemusvalintoihin kannustavien ympäristöjen luomista, ja lisäksi perheitä tulisi ohjata ja voimaannuttaa tekemään terveellisiä valintoja.

AVAINSANAT: Ruokailutottumukset, syömiskäyttäytyminen, ruokahalu, ruokavalion laatu, vanhemmuuden kyvykkyys, ruokaympäristö, sosioekonominen asema, naapuruston huono-osaisuus

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Abbreviations

BMI	Body Mass Index
BST	Behavioural Susceptibility Theory of Obesity
CDC	Centers for Disease Control and Prevention
CDQ	Child Diet Quality
CEBQ	Child Eating Behaviour Questionnaire
CFQ	Child Feeding Questionnaire
CL	Confidence Limits
DD	Desire to drink
EF	Enjoyment of food
EOE	Emotional overeating
EPAQ	Eating and Physical Activity Questionnaire
EUE	Emotional undereating
FF	Food fussiness
FR	Food responsiveness
Gwk	Gestational weeks
IDQ	Index of Diet Quality, Parents
IOTF	International Obesity Task Force
OR	Odds ratio
PSE	Parental Self-Efficacy
PSEPAD	Parental Self-Efficacy for Promoting Healthy Physical Activity and Dietary Behaviours in Children
NCD	Non-communicable diseases
NSED	Neighbourhood Socioeconomic Disadvantage
NSES	Neighbourhood Socioeconomic Status
SD	Standard deviation
SDS	Standard deviation scores
SE	Slowness in eating
SES	Socioeconomic Status
SR	Satiety responsiveness
STEPS	The Steps to Healthy Development Study
WHO	World Health Organization

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Tarro Saija, Lahdenperä Mirkka, Vahtera Jussi, Pentti Jaana & Lagström Hanna. Parental feeding practices and child eating behavior in different socioeconomic neighborhoods and their association with childhood weight. The STEPS study. *Health and Place*, Volume 74, March 2022. https://doi.org/10.1016/j.healthplace.2022.102745

II Tarro Saija, Lahdenperä Mirkka, Vahtera Jussi, Pentti Jaana & Lagström Hanna. Diet quality in preschool children and associations with individual eating behavior and neighborhood socioeconomic disadvantage. The STEPS Study. *Appetite*, Volume 172, May 2022. https://doi.org/10.1016/j.appet.2022.105950

III Lagström Hanna, Tarro Saija & Lahdenperä Mirkka. Asuinalueen huono-osaisuuden yhteys lapsiperheiden ruokavalion laatuun. *Sosiaalilääketieteellinen aikakauslehti*, Volume 59, 2/2022. https://doi.org/10.23990/sa.113267

IV Tarro Saija, Lahdenperä Mirkka, Junttila Niina, Lampimäki Antti & Lagström Hanna. Parental self-efficacy and child diet quality between 2 and 5 years. The STEPS Study. *Nutrients*, Volume 14, November 2022 https://doi.org/10.3390/nu14224891

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1 Introduction

> "Childhood world is the basis of everything."
> (Järvinen & Kolbe, 2012)

Diet quality already in early life is an important factor influencing later health and risk of overweight and non-communicable diseases (Birch et al., 2007; De Cosmi et al., 2017; Ness et al., 2005; Scaglioni et al., 2018; Shrestha & Copenhaver, 2015). Children adopt food preferences and dietary habits in the context of family at early age and they may persist into adulthood (Mikkilä et al., 2005; Nicklaus et al., 2005; Nicklaus & Remy, 2013). Infants generally have the highest diet quality (Hauta-Alus et al., 2017; Kyttälä et al., 2010; Miller et al., 2022). However, quality of child diet tends to deteriorate after the age of 12 months, when children start to eat the same food with the family (Kyttälä et al., 2014; Lazarou & Newby, 2011; Vilela et al., 2018). Concurrent evidence shows that the child diet quality is partly a reflection of their parents' diet quality (B. Davison et al., 2017; Jarman et al., 2022; Koivuniemi et al., 2022; Vepsäläinen, Nevalainen, et al., 2018). During recent decades, diet quality has slightly improved globally, both in adults and children (Miller et al., 2022).

As the diet quality has improved, so has caloric intake, and aggregate caloric intake clearly exceeds recommended amounts especially in high-income and middle-income countries (Dave et al., 2016). The prevalence of overweight and obesity has risen substantially during the past four decades and an obesity pandemic constitutes a major public health concern (Finucane et al., 2011; Larqué et al., 2019; Murray et al., 2020). Changes in global food system: increased production, distribution and marketing of cheap, energy-dense foods can be seen as one of the main drivers behind the obesity pandemic (Swinburn et al., 2011). In Europe, almost one out of every four preschool-aged children, have overweight or obesity (Garrido-Miguel et al., 2019). The situation is similar in Finland, where approximately one in four boys and nearly one in five girls were overweight or obese in 2021 (Jääskeläinen et al., 2022). Obesity in children is a major health issue associated with a range of obesity-related diseases and psychosocial burden (Rankin et al., 2016; Swinburn et al., 2011). In addition, obese children tend to grow into obese adults (Simmonds et al., 2016).

Thus, early identification of children at risk of becoming overweight or obese later in life should be an important focus area in public health research.

However, prevalence of overweight is not equally distributed (Plachta-Danielzik & Müller, 2015). In low-income countries, overweight and obesity mostly affects wealthy, urban subpopulations (Swinburn et al., 2011). The higher the country's gross domestic product, the higher is the obesity rate within low socioeconomic status groups (Swinburn et al., 2011). In high-income countries, low individual socioeconomic status and socioeconomic disadvantage of the living environment are associated with overweight already in childhood (Carroll-Scott et al., 2013; Greves Grow et al., 2010; Li et al., 2014; Rautava et al., 2022; Ribeiro et al., 2019). Nutrients cost more than calories and the chances of choosing a healthy diet are not the same for everyone (Darmon & Drewnowski, 2008; Drewnowski et al., 2019).

Identifying modifiable factors behind child diet quality and weight development is essential for the formulation of public policies and the application of food and nutrition education strategies that aim at health promotion. Eating habits evolve during the first years of life (Birch et al., 2007) and unhealthy eating habits increase the risk of developing overweight (Liberali et al., 2019). Socioecological models of health behaviour (Sallis & Owen, 2015; Story et al., 2008) support the idea that individual behaviours emerge within various contexts and multiple levels of influence. This thesis aims at studying factors associated with young child diet quality and risk of overweight on three levels: individual, family and neighbourhood. In this thesis, young children are considered to be 2–6 years of age.

Previous literature suggests that the development of eating habits and weight in childhood are influenced by individual characteristics such as appetitive traits, family characteristics such as parental feeding practices (Hoffmann et al., 2016; Pesch et al., 2020; Ventura & Birch, 2008) and parental self-efficacy (Parekh et al., 2018; Rohde et al., 2018) as well as neighbourhood factors such as neighbourhood socioeconomic status (Carroll-Scott et al., 2013; Timperio et al., 2008). More research investigating the interactions of individual, familial and environmental factors with child diet quality and weight is needed. In this study, interactions between three levels of influence will be studied. Secondly, more research in Finland, a country with traditionally modest income inequalities and a country supporting mothers' work participation after parental leave (Saikkonen et al., 2018; Weckström, 2014), is warranted. This study used data from a prospective Steps to Healthy Development (the STEPS) Study from Southwest Finland. Thirdly, despite an increasing knowledge of fathers' involvement in and impact on their children's feeding, fathers have been widely missing from the previous research in the field of child feeding and obesity prevention (Moura & Philippe, 2023). One of the specific aims of the thesis is to highlight the role of fathers in the child rearing and feeding in addition to mothers.

2 Review of the Literature

2.1 Eating habits among children

The first 1000, or 2000 days, from conception to the age of 5 years, is a critical time for shaping eating habits which influence the health and the risk of non-communicable diseases later in life based on current evidence (Fleming et al., 2018; Laws et al., 2022; Shrestha & Copenhaver, 2015).

Terms such as food behaviour, food habits, dietary habits, dietary behaviour, eating habits and eating behaviour have been used interchangeably in the literature. Eating behaviour can refer to both what a child eats and how a child eats, i.e. child appetitive traits (Wood, 2018), and dietary habits have been defined as individual decisions regarding which foods to eat (Preedy & Watson, 2010).

In the light of earlier literature, eating habits is a term which has been used to characterise multi-level factors affecting the choice and consumption of foods or diets in response to social and environmental influences (Rivera Medina et al., 2020; Vartiainen, H., Virtanen, S. & Alfthan, 2019). It includes the complex interplay of physiological, psychological and social factors that influence meal timing, quantity of food intake, and food preferences (Grimm & Steinle, 2011). In Europe, the WHO highlights the importance of healthy eating habits covering more widely behaviours related to food than just healthy dietary intakes (WHO, 2018a). Thus, the decision was made that in this thesis, the term eating habits will be used as a main term covering the food preferences, food intakes, adherence to food recommendations and appetitive traits (Table 1).

Table 1. The sub-concepts covered by the main term, eating habits.

Concept	Meaning
Food intakes	The amount of food consumed, refers to ingestion of any substance consisting of carbohydrates, proteins, fats, vitamins and minerals.
Food preferences	Attitudes which people express toward foods, liking vs. disliking foods.
Appetitive traits	Child eating and drinking behaviour traits, commonly measured with food approach and food avoidance dimensions. Can be influenced by the context (A. Russell et al., 2023).
Diet quality	Adherence to food recommendations.

In the following chapters I will present previous research related to development of eating habits, and appetitive traits during early childhood, i.e., from toddlerhood to preschool years. In addition, I will describe the measurement of appetitive traits and diet quality, national food recommendations for Finnish families and the research investigating young children's adherence to food recommendations mainly across Europe and in Finland.

2.1.1 Development of eating habits

Food preferences are one of the most important predictors of food acceptance and intake in children (DeCosta et al., 2017; L. Johnson et al., 2011; Lanfer et al., 2012). Food preferences of a child start to develop via maternal food intake already in utero and postnatally via breast milk (Harris & Mason, 2017; Nekitsing & Hetherington, 2022). There is strong evidence that mothers' food intakes in pregnancy and during breastfeeding have been associated with the food acceptance and food intakes of infants (Francis et al., 2021; Spahn et al., 2019; Ventura et al., 2021). It is also suggested that infants who are breastfed for at least 6 months show less food fussiness (Galloway et al., 2003).

Direct exposure to different flavours begins during complementary feeding (Birch et al., 2007). Infants have an innate preference for sweet tastes and are neophobic in a sense that they tend to initially reject new tastes, especially sour and bitter tastes (Birch & Davison, 2001). According to Harris & Mason (2017), during 4–6 months of age there is a sensitive period for offering novel flavours. Thus, early exposure to vegetables during complementary feeding might be especially important in terms of acceptance (Nekitsing & Hetherington, 2022). In addition, the preferences for the majority of foods are shaped by repeated experiences towards new tastes (Berti & Agostoni, 2017; Birch, 1998). New flavours should be presented 6–15 times to start liking them (Ventura & Worobey, 2013). Repeated exposure of new or disliked foods have been shown to positively change children's preferences towards these foods (Cooke, 2007). Therefore, children's food preferences from complementary feeding onwards are shaped largely by the foods parents choose to make available to children and persistence in presenting a food that initially is rejected (Birch & Davison, 2001). Furthermore, individual appetitive traits might affect how children response to repeated exposure (Caton et al., 2014).

2.1.2 Child appetitive traits

Child appetitive traits are partly genetic (Carnell et al., 2008; Llewellyn et al., 2010, 2014; Wardle et al., 2008) and partly influenced by environmental factors (Birch et al., 2007). Previous research indicates that appetitive traits are established during the first years of life and they show individual continuity through childhood and early adulthood and can be compared with personality traits (Ashcroft et al., 2008; Dubois et al., 2022). However, Derks and colleagues (2019) have found distinct patterns of emotional overeating and food responsiveness through childhood and suggest that the developmental patterns might differ between individuals depending on the child's emotional (i.e. internalizing behaviour) and behavioural (i.e. externalizing behaviour) problems.

Individual differences in child eating self-regulation and appetitive traits have been studied using laboratory-observed behavioural measures of eating in the absence of hunger (Carnell & Wardle, 2007a; French et al., 2012) and using parent-report psychometric measures, of which the most popular is Child Eating Behaviour Questionnaire (CEBQ), which was developed by Wardle and colleagues (Wardle et al., 2001). The questionnaire assesses child obesogenic eating behaviours with 35 questions which are all rated on a Likert scale from 1 to 5 (1 = never, 5 = always). The questions have been grouped into 8 subscales, of which 'enjoyment of food', 'food responsiveness', 'emotional overeating' and 'desire to drink' measure "Food approach" appetitive traits and subscales 'satiety responsiveness, 'slowness in eating', 'food fussiness' and 'emotional undereating' measure "Food avoidance" appetitive traits (Somaraki et al., 2018; Viana et al., 2008; Webber et al., 2009). "Food approach" traits characterise an avid appetite and "Food avoidance" traits characterise smaller appetite. A similar questionnaire for younger children has been created, called Baby Eating Behaviour Questionnaire (BEBQ) (Llewellyn et al., 2011).

2.1.3 Food recommendations and child diet quality

Finnish national food recommendations are based on scientific research, taking into account domestic food culture, the availability of food products and different population groups, such as families (Fogelholm et al., 2014). The Finnish food recommendations for families with children cover recommendations for healthy eating habits in families including the children's meals in daycare and schools (THL, 2019). These food recommendations for families emphasise the importance of developing healthy eating habits for the whole family already before pregnancy to ensure good quality diet during pregnancy and during the first years of the child's life. Healthy eating habits are part of a healthy lifestyle including regular meals eaten together with the whole family. Regarding the health benefits of a diet, overall dietary pattern matters, not individual food choices. Vegetables, fruits and berries constitute the foundation of the balanced diet, and they are eaten at every meal. Cereals are selected mainly in the form of whole grains to cover daily fibre intake. Vegetable oils, and other sources of unsaturated fats, as well as milk products with little or no fat are consumed daily. Fish is consumed at least 2–3 times a week, while red meat or sausage and meat products should not be eaten daily. A specific recommendation is also stated for the intake of sugars; energy obtained from added sugar should not exceed ten percent of the total daily energy intake (THL, 2019).

Child diet quality can be measured using food records and food frequency questionnaires. In addition, several dietary indices have been developed to characterise the overall diet quality of children (da Costa et al., 2019; Kranz et al., 2008; Kyttälä et al., 2014; Lazarou & Newby, 2011; Perry et al., 2015; Röytiö et al., 2015). The diet quality of the Finnish adult population is monitored regularly as part of a broad population-based survey (Valsta et al., 2018). The study of diet quality among Finnish children depends merely on individual studies and no comparable systematic monitoring of diet quality in Finnish children exists. According to the most recent Finnish population-based study, the diet quality of young children seems to be modest or poor (Koivuniemi et al., 2022). Similar results have been observed in other Western countries both with preschool- and school-aged children (Fox et al., 2016; Kranz et al., 2008; Pinket et al., 2016; Thomson et al., 2019; van der Velde et al., 2019). Preschool-aged children in Finland are generally consuming too low levels of vegetables, fruits, wholegrains and vegetable oil based spreads and too high levels of added sugars, saturated fat and sodium (Eloranta et al., 2011; Kyttälä et al., 2010, 2014). Further, the daily consumption of legumes and nuts are below sustainable diet targets, whereas the consumption of red meat and dairy foods are above targets (Bäck et al., 2022). A recent global study including the first estimate of global diet quality states that global diet quality among children is modest, with slight improvement during the last few decades in most of the regions (Miller et al., 2022). According to the study, the diet quality of children is substantially lower among children compared with adults in high-income countries typically following a U-shaped curve with age, with the highest diet quality scores observed among the youngest children and oldest adults (Miller et al., 2022). However, comparison between studies regarding child dietary intakes should be done with caution because different methods have been used for dietary data collection and different means of defining dietary quality.

2.2 Overweight and obesity in childhood

2.2.1 Definition of overweight and obesity

Overweight and obesity are defined by excess of adipose tissue, i.e. body fat which may impair health (WHO, 2018b). Overweight can be considered as a milder degree of adiposity than obesity or they can be alternatively considered as overlapping terms (Flegal & Ogden, 2011). Being overweight and obese are consequences of a continuously larger energy intake than expenditure. This results in excessive accumulation of adipose tissue. Methods directly measuring adipose tissue include underwater weighing, dual-energy X-ray absorptiometry (DEXA), air displacement plethysmography and isotope dilution. Of these methods, DEXA is suggested as a gold standard (Jensen et al., 2016; Martin-Calvo et al., 2016). Direct methods provide accurate measurements of adipose tissue but are not feasible to be conducted in large epidemiological studies in children. Methods that provide estimates of adiposity but require equations for calculation of body fat percentage include bioelectrical impedance and skin fold thickness. The most widely used anthropometric methods for defining being overweight and obese in children are body mass index (BMI) and waist circumference. Even though BMI does not measure adiposity directly but is a simple index of weight-for-height, BMI is considered to be a moderately sensitive and specific indicator of adiposity (Freedman & Sherry, 2009; Martin-Calvo et al., 2016).

For adults, the BMI cut-off points of 25 and 30 kg/m^2 are generally used to classify overweight and obesity (WHO, 2022). However, for children, BMI varies with age, not only with weight (Flegal & Ogden, 2011). Thus, BMI values for children need to be compared with age and sex-specific reference values which are further translated into a Z-score or a percentile relative to the distribution of BMI-for-age (Flegal & Ogden, 2011). There are a number of different reference data sets created nationally and by the World Health Organization, which have been used to collect height and weight, and targeted mainly for clinical monitoring of children's growth (Flegal & Ogden, 2011; C. Ogden et al., 2002; Saari et al., 2011). Growth reference curves vary between different growth charts. The WHO 2007 growth chart is based on data from United States, Brazil, Ghana, Norway, India and Oman, and thresholds for weight status are set on standard deviation spacing from the average. For children aged 5–19 years, overweight and obesity are defined as BMI-for-age above one standard deviation and above two standard deviations, respectively

("WHO Child Growth Standards," 2009). Finnish growth references use cut-off points of ≥ 1.1629 for girls and ≥ 0.7784 for boys (Saari et al., 2011). In addition, International Obesity Task Force (IOTF) have created internationally comparable growth reference curves in order to work as a common basis for overweight and obesity prevalence estimates in children (T. Cole et al., 2000; T. Cole & Lobstein, 2012). Nevertheless, national growth references are useful because the same BMI value may reflect different levels of fat in different ethnic groups (Saari et al., 2011).

2.2.2 The prevalence and trends of childhood overweight

The prevalence of childhood overweight and obesity have risen dramatically during the previous few decades in most developed countries (de Onis et al., 2010; Garrido-Miguel et al., 2019; OECD, 2021). Similar trends have been reported in Finland (Mäki et al., 2017; Vuorela et al., 2011). According to WHO European Region, no single state is on track to reach the target of halting the rise in obesity by 2025, and the majority of the countries have a less than 10% chance of meeting this target (Lobstein T, 2020; WHO, 2022). In Europe, prevalence of overweight and obesity among boys aged 5–19 years increased nearly threefold between 1975 and 2016 and more than doubled in girls (WHO, 2022). Globally, just under 1% of children aged 5–19 were obese in 1975, but already about 6% of girls and 8% of boys were obese in 2016 (WHO, 2018b). The WHO European Childhood Obesity Surveillance Initiative (COSI) has been established in response to the need for standardised surveillance data on the prevalence of overweight and obesity among school-aged children (Breda et al., 2021). According to COSI, overweight affects almost one in three children (WHO, 2022).

In Finland, growth has been monitored systematically in municipal maternity and child health clinics for about a century (Ministry of Social Affairs and Health, 2022). Almost all children attend several preventive childcare visits during the first 6 years of the child's life. Height and weight measurements are saved in the Finnish institute for health and welfare (THL) Primary Health Care Visits register (Avohilmo, since 2011). Thus, the Avohilmo register could be a potential tool for monitoring the prevalence of overweight and obesity among Finnish children. However, only 43% of 2–6-year-olds have currently height and weight information recorded in the system because of the problems in transferring the data into Avohilmo (Jääskeläinen et al., 2020). A nationwide study utilizing Avohilmo register data between June 2014 and May 2015 stated that the prevalence of overweight and obesity was approximately 25% among 2–16-year-old boys and 16% among girls (Mäki et al., 2017). Children had overweight (incl. obesity) if their age and sex adjusted body mass index (ISO-BMI) was 25kg/m^2 or above. Based on the latest THL report, 26% of preschool-aged boys (2–6-year-olds), and 16% of preschool-aged girls had overweight or obesity (Jääskeläinen et al., 2022).

The percentages were unchanged compared to the previous year (Jääskeläinen et al., 2020). Since 2014, the prevalence of overweight has increased by four percentage points in 2–6-year-old boys and three percentage points in girls (Jääskeläinen et al., 2022).

2.2.3 Risk factors for childhood overweight

Risk factors for childhood overweight interact in complex ways, including contributing factors at individual, family, community and wider societal levels (Stein et al., 2014). In this chapter, I will briefly describe the most important risk factors of childhood overweight based on the previous literature. The individual-level factors that affect the increased risk of childhood overweight include genetic factors (Larqué et al., 2019; van der Klaauw & Farooqi, 2015; Vourdoumpa et al., 2023) and eating habits (Liberali et al., 2019), including appetitive traits (Kininmonth et al., 2021). Children with high 'enjoyment of food' and 'food responsiveness' appetitive traits might be at risk of overweight (Kininmonth et al., 2021). It has been suggested that in children a high total energy intake rather than low total energy expenditure is the main determinant of high body weight (Swinburn et al., 2006). Thus, energy and fat intake have been associated with child weight status (Berkey et al., 2000; Klesges et al., 1995; Wilson et al., 2009). In addition, a recent meta-analysis suggested that there might be a causal relationship between high animal protein intake in toddlerhood and higher risk of overweight later in childhood (Arnesen et al., 2022). Further, childhood overweight and obesity have been linked with poor diet quality (Kranz et al., 2008; Perry et al., 2015; Shaban Mohamed et al., 2022). Firstly, a high consumption of energy-dense, micronutrient-poor foods, such as sweet and salty snacks, sugary beverages, fast foods and low consumption of vegetables and fruits are risk factors for overweight (Jakobsen et al., 2023; Roblin, 2007; Wall et al., 2018). Secondly, a systematic review suggests that skipping meals and breakfast might be associated with risk of overweight in children (Verduci et al., 2021). A Finnish study showed that school-aged children who ate all three main meals had a lower risk of overweight or obesity than those who skipped some of the main meals (Eloranta et al., 2012). Thirdly, a European study found that dietary diversity scores were lower in preschoolers with overweight than preschoolers without overweight, indicating that children with overweight might not have adequate intakes of each food group in their diet (Pinket et al., 2016). However, some studies have not found differences in child total diet quality and weight status (Koivuniemi et al., 2022; Pinket et al., 2016). Furthermore, healthier lifestyle patterns might decrease the risk for overweight and obesity already in children (Manios et al., 2010). One lifestyle pattern which has especially been linked with childhood overweight, is sleep duration (Chi et al., 2017). Shorter sleep duration has been associated with childhood overweight (Chi et al., 2017).

Parents play an important role in influencing the health of their children (Love et al., 2018). Previous longitudinal and cross-sectional studies show that parental overweight and obesity increase the risk for child obesity (Fogelholm et al., 1999; Laitinen et al., 2001; Lake et al., 1997; Mamun et al., 2005; Parikka et al., 2015). A systematic review suggested that especially maternal pre-pregnancy overweight and maternal excess gestational weight gain are linked with later childhood obesity (Woo Baidal et al., 2016). Overweight is socioeconomically patterned, and thus, low family socioeconomic status is another important risk factor for child overweight and obesity in high-income countries (Kautiainen et al., 2009; Parikka et al., 2015; Plachta-Danielzik & Müller, 2015). Most commonly used proxies for socioeconomic status (SES) are education and income (Plachta-Danielzik & Müller, 2015), but also other measures have been used, such as occupation (Bann et al., 2018; Laitinen et al., 2001; Steinsbekk & Wichstrøm, 2015). Recent evidence from 24 Member States in the WHO European Region shows that parental education is one important driver of childhood body weight in children (Buoncristiano et al., 2021). In addition, a population-based register study in Finland showed that parents' annual income and education level have the highest influence on child obesity risk compared with other socioeconomic status dimensions (Paalanen et al., 2022). According to a longitudinal study, family social class during childhood might have a long-term influence on child BMI trajectories (Laitinen et al., 2001). In addition, socioeconomic inequalities in overweight have widened post-2000 (Bann et al., 2018; Chung et al., 2016). Thus, children born to parents with overweight and low SES are at a substantially increased risk of having overweight and obesity (Danielzik et al., 2004). A study investigating multi-level risk factors associated with preschool-aged child overweight concluded that sleep duration, parent BMI and parental restrictive feeding should be focus areas for obesity prevention programs (Dev et al., 2013).

Lastly, wider community environment is increasingly obesogenic, i.e. an environment that promotes weight gain (Campbell, 2016). Recent studies from Finland state that living environment might be one important risk factor behind unfavourable BMI development (Kivimäki et al., 2018; Rautava et al., 2022; Virtanen et al., 2015). Rautava et al. (2022) stated that exposure to neighbourhood socioeconomic disadvantage might be one determinant behind childhood overweight.

2.3 Factors affecting child eating habits and weight

The child with his/her own characteristics is embedded in several familial and societal contexts which affect the growth and eating habits of the child (K. Davison & Birch, 2001). Children react differently to their environments based on their partly genetic tendency of "Food approach" or "Food avoidance" (Carnell et al., 2008; Llewellyn et al., 2010, 2014; Wardle & Cooke, 2008). In the following chapters, I describe factors affecting child eating habits and weight in light of socioecological models of health behaviour. Firstly, I concentrate on child appetitive traits as individual-level factors behind child diet quality and weight development. Secondly, I cover home food environment, parental diet, parental feeding practices and parental self-efficacy as family level factors. Thirdly, I describe the literature related to neighbourhood socioeconomic disadvantage as residential area level factor behind child eating habits and weight.

2.3.1 Individual-level factors

Child appetitive traits and BMI

The behavioural susceptibility theory of obesity (BST) suggests that differences in appetite determine why some people are more vulnerable to obesogenic environment (Carnell & Wardle, 2008; Llewellyn & Fildes, 2017; Swinburn et al., 1999). Previous research has identified more than 500 genetic loci associated with overweight and obesity, most of them acting in the brain and having a central role in the control of appetite (Loos, 2018). Thus, appetite is suggested to work as a mechanism explaining how genetic risk of obesity is translated to weight gain in an obesogenic environment (Jacob et al., 2018; Llewellyn et al., 2014).

Child Eating Behaviour questionnaire (CEBQ) has gained wide acceptance as a measure of child appetitive behaviour (A. Russell et al., 2023). It has been validated against laboratory-observed behavioural measures of eating and includes eight subscales: 'food responsiveness', 'enjoyment of food', 'emotional overeating', 'desire to drink', 'satiety responsiveness', 'slowness in eating', 'emotional undereating' and 'food fussiness' (Carnell & Wardle, 2007a; Wardle et al., 2001). Four first subscales represent "Food approach" dimension and four latter ones represent "Food avoidance" dimension of child appetitive traits (Ek et al., 2016; Vilela et al., 2018). Original evidence for BST comes from cross-sectional studies investigating the associations of CEBQ appetitive traits and child adiposity (Table 2). Higher child BMI has been associated with higher levels of "Food approach" appetitive traits, especially 'food responsiveness' and 'enjoyment of food' and lower levels of "Food avoidance" appetitive traits, especially 'satiety responsiveness' and 'slowness in eating' (Boswell et al., 2018; Carnell & Wardle, 2008; Domoff et al., 2015; Eloranta et al., 2012; Hankey et al., 2016; Haycraft et al., 2011; P. W. Jansen et al., 2012; Sleddens et al., 2008; J. Spence et al., 2011; Tay et al., 2016; Viana et al., 2008; Webber et al., 2009). A meta-analysis examining the association between CEBQ and child adiposity states that appetitive traits assessed using CEBQ show consistent cross-sectional relationships with measures of child adiposity (Kininmonth et al., 2021).

Table 2. Cross-sectional studies on the association between child appetitive traits measured with child eating behaviour questionnaire (CEBQ) and BMI.

Author	Year	Country	Sample size	Child age	Outcome	Explanatory variables – CEBQ							
						Food approach traits				Food avoidance traits			
						FR	EF	EOE	DD	SR	SE	EUE	FF
Carnell & Wardle	2008	UK	n=10.364, n=572	8–11 y, 3–5 y	BMI SDS (UK)		+			-*			
Sleddens et al.	2008	Netherlands	n=135	6–7 y	BMI SDS (NL)	+	+	+		-	-		
Viana et al.	2008	Portugal	n=240	3–13 y	BMI SDS (CDC)	+	+	+		-	-	-	-
Webber et al.	2009	UK	n=239, n=167	7–9 y, 9–12 y	BMI SDS (UK)	+	+	+	+	-	-		-
Haycraft et al.	2011	UK	n=241	3–8 y	BMI SDS (CGF)	+		+	+		-		
Spence et al.	2011	Canada	n=1.730	4–5 y	BMI SDS (CDC)	+	+	+		-	-		-
Eloranta et al.	2012	Finland	n=510	6–8 y	BMI SDS (IOTF)	+	+	+		-			
Jansen et al.	2012	Netherlands	n=4.987	4 y	BMI SDS (NL)	+	+			-		-	-
Domoff et al.	2015	USA	n=1.002	3–4 y	BMI SDS (CDC)	+	+	+		-	-	-	-
McCarthy et al.	2015	Ireland	n=1.189	2 y	BMI SDS (IOTF)	+	+			-	-		-
Hankey et al.	2016	USA	n=104	3–5 y	BMI SDS (CDC)	+	+			-			
Tay et al.	2016	Malaysia	n=1.782	7–12 y	BMI SDS (WHO)	+			+	-		-	
Boswell et al.	2018	Australia	n=977	2–5 y	BMI SDS (CDC)	+				-			
Jani et al.	2020	Australia	n=58	4–12 y	BMI SDS (WHO)						-		

SDS, Standard Deviation Score; CDC, Centers for Disease Control and PreventionI; CGF, Child Growth Foundation, IOTF, International Obesity Task Force; FR, Food responsiveness; EF, Enjoyment of food; EOE, Emotional overeating; DD, Desire to drink; SR, Satiety responsiveness; SE, Slowness in Eating; EUE, Emotional undereating; FF, Food fussiness. *SR/SE subscales combined; +, Positive association, explanatory variable increases and the outcome variable increases; -, Negative association, explanatory variable increases and the outcome variable decreases

Responsiveness to external food cues, such as taste, smell, availability and emotions and internal cues of hunger and satiety are key aspects of eating self-regulation and appetite (Carnell & Wardle, 2008; Grammer et al., 2022). Poor child eating self-regulation has been shown to be a risk factor for childhood overweight (Fisher & Birch, 2002; Grammer et al., 2022). Children with overweight have been shown to be more sensitive to external food cues and less responsive to internal satiety cues, eating faster, enjoying eating and overeating in emotional situations (Svensson et al., 2011; Wardle et al., 2001; Webber et al., 2009). Eating onset and eating offset are two important aspects of BST (Llewellyn & Fildes, 2017). Thus, cross-sectional studies support the idea that children with overweight are prone to start eating even in the absence of hunger and display weaker 'satiety responsiveness' (French et al., 2012; Sleddens et al., 2008). In addition, associations between child appetitive traits and child BMI are linear, indicating that there are no clear cutoff values for abnormal eating behaviours, but merely lower 'satiety responsiveness' and higher 'food responsiveness' are associated with progressively higher BMI (Carnell & Wardle, 2008).

According to the BST, appetite is prospectively associated with weight gain (Carnell & Wardle, 2008). Starting from 2010, longitudinal and prospective studies which have examined the bidirectional associations between eating behaviour and child BMI have started to emerge (Table 3). These studies support BST indicating that "Food approach" appetitive traits might be prospectively associated with higher risk for adiposity, whereas "Food avoidance" traits, especially 'satiety responsiveness' and 'slowness in eating', might prospectively protect from later risk of obesity (Derks et al., 2018; Parkinson et al., 2010; Steinsbekk & Wichstrøm, 2015; van Jaarsveld et al., 2011). However, it has been noticed that associations can be bidirectional (Derks et al., 2018; Gregory et al., 2010; Steinsbekk & Wichstrøm, 2015; van Jaarsveld et al., 2011). One of the studies conclude that increased adiposity in early childhood could merely predict "Food approach" appetitive traits later on, rather than vice versa, suggesting that increased adiposity might upregulate appetite (Derks et al., 2018).

Together, the previous research results show preliminary support for BST: appetitive traits working as a bidirectional behavioural mechanism behind individual's susceptibility to obesogenic environment. On the one hand, "Food approach" appetitive traits might lead to higher weight gain and on the other hand, adiposity itself may lead to changes in appetitive traits (Kininmonth et al., 2021). Nevertheless, more studies in the future are needed to confirm the direction of influence.

Table 3. Prospective/longitudinal studies on the association between BMI and child appetitive traits.

Author	Year	Country	Sample size	Child age	Outcome variables	Explanatory variables
Gregory et al.	2010	Australia	n=156	Baseline 2–4 y Follow-up 3–5 y	FR	BMI SDS+
Parkinson et al.	2010	UK	n=506 n=583	5–6 y CEBQ 6–8 y BMI	BMI SDS	EOE +, DD +, SR -
van Jaarsveld et al.	2011	UK	n=2.402	Baseline 8 mo Follow-up 15 mo	Weight SDS FR, EF SR, SE	FR +, EF +, SR -, SE – Weight SDS + Weight SDS -
Steinsbekk & Wichstrøm,	2015	Norway	n=995 n=760 n=687	Baseline 4 y Follow-up 6 y and 8 y	BMI SDS FR SR	FR + BMI SDS + BMI SDS -
Derks et al.	2018	Netherlands	n=3.331	Baseline 4 y Follow-up 10 y	FR, EF SR EOE BMI SDS	BMI SDS + BMI SDS - BMI SDS + EOE +

SDS, Standard Deviation Score
FR, Food responsiveness; EF, Enjoyment of food; EOE, Emotional overeating; DD, Desire to drink; SR, Satiety responsiveness; SE, Slowness in Eating
+, Positive association, explanatory variable increases and the outcome variable increases;
-, Negative association, explanatory variable increases and the outcome variable decreases

Child appetitive traits and diet quality

Earlier studies suggest that child appetitive traits might be associated with food intakes (da Costa et al., 2022; Falciglia et al., 2000; Vilela et al., 2018; Wardle et al., 2003). However, the number of studies conducted with young children are scarce. A prospective European study found that children with a higher diet variety, one aspect of diet quality, were less fussy, had a higher general interest in food and lower 'desire to drink' tendency (Vilela et al., 2018). A longitudinal study suggests that 'enjoyment of food' is associated with higher diet quality in children (da Costa et al., 2022). In addition, 'enjoyment of food' has been associated with increased intake and liking of fruits and vegetables (Cooke et al., 2004; Fildes et al., 2015). Further, 'food responsiveness' has also been linked with diet quality and novel food acceptance (Blissett et al., 2016; Jarman et al., 2022). Perhaps not surprisingly, 'food fussiness' has been associated with lower child diet quality and dietary variety (da Costa et al., 2022; Falciglia et al., 2000). In addition, 'food fussiness' has been associated with lower vegetables and fruit intakes and higher intakes on non-core foods (Jani et al., 2020; Wardle et al., 2003).

2.3.2 Family level factors

Home food environment

Child eating habits develop within the context of the family (K. Davison & Birch, 2001). Parents socialise their children's eating (Hughes & Power, 2021). Dietary habits for young children are highly influenced by parents, as parents provide food and shape the food environments by choosing which foods are available at home and served at the dinner table (Mahmood et al., 2021; Ventura & Birch, 2008; Vepsäläinen, Korkalo, et al., 2018). Home food environment can be conceptualised as including interactive, multi-level domains affecting the dietary habits and weight development of children (Rosenkranz & Dzewaltowski, 2008), including physical and social aspects of the home food environment (Patrick & Nicklas, 2005). However, here with home food environment I refer mostly to physical aspects of the home food environment: availability and accessibility of foods in the home.

Home physical food environment is a significant predictor of child dietary habits and risk of overweight (Campbell, 2016; Ranjit et al., 2015; Vepsäläinen et al., 2015). Availability of foods means that a certain food is present in the home and accessibility means that the consumption of the certain food is made as easy as possible (e.g. pre-sliced fruits or vegetables available) (DeCosta et al., 2017). Children tend to prefer food which are served most often and are easily available and accessible (Patrick & Nicklas, 2005). Previous studies have mostly concentrated on the availability and accessibility of certain food groups, such as fruits and vegetables and found associations between availability, accessibility and higher consumption of fruits and vegetables in preschool-aged children (DeCosta et al., 2017; Goldman et al., 2012; Paasio et al., 2022; Wyse et al., 2011). Some studies suggest that energy-dense food items, such as sugary beverages and unhealthy snacks are consumed less if they are not available at home (Campbell et al., 2013; Story et al., 2008). A recent study from Finland states that the availability of fruits and vegetables in the home is positively associated with a health-conscious dietary pattern. In addition, the availability of sugar-enriched foods seems to have an even more important role than fruits and vegetables considering child dietary patterns. (Vepsäläinen, Korkalo, et al., 2018).

Dietary resemblance in families

In Finland, living in a family with children has been associated with more frequent daily use of vegetables in women (Ovaskainen et al., 2012). However, according to a study from Canada, only a minority of mothers meet dietary guidelines (Nasuti et al., 2014). Parents have reported changes in their eating habits during transition to parenthood, both favourable (more vegetables and fruits) and unfavourable (skipping meals, eating in a hurry) (Versele et al., 2021). Parental diet is important for child diet quality, as family resemblance in dietary habits has been well documented (Jarman et al., 2022; Vauthier et al., 1996; Vepsäläinen, Nevalainen, et al., 2018). In addition, parents and their children might have similar food preferences (Patrick & Nicklas, 2005).

Thus, a child's diet can be seen as partly a reflection of their parents' diet (B. Davison et al., 2017; Koivuniemi et al., 2022; Vepsäläinen, Nevalainen, et al., 2018). Previous studies have indicated that children's and parents' intakes of certain foods correlate (Mahmood et al., 2021). Parental fruit and vegetable intakes have been shown to positively predict child intake of fruits and vegetables (Möhler et al., 2020). Secondly, similarities have been found in consumption of unhealthy snacks and sugar-sweetened beverages and fish consumption (B. Davison et al., 2017; Hansson et al., 2016; McGowan et al., 2012). It has also been suggested that parent-child dietary similarity is most consistent on a total diet level (Vepsäläinen, 2018) and higher parental diet quality has been associated with higher child diet quality (da Costa et al., 2019; Vepsäläinen, Nevalainen, et al., 2018; Vollmer, Adamsons, Gorin, et al., 2015).

Most of the studies have investigated dietary resemblance of mothers and their children suggesting that mother-child dietary resemblance might be stronger compared with father-child dietary resemblance (Fisk et al., 2011; Hansson et al., 2016; Kunaratnam et al., 2018). However, a recent Finnish study suggested that these findings might be partly explained by a respondent bias as the diet of the child tends to resemble more of the diet of the parent providing responses for the child (Vepsäläinen, Nevalainen, et al., 2018).

Food-related parenting practices

Parenting styles and parental feeding styles are associated with child obesity risk and child diet quality (Arlinghaus et al., 2018; Hughes & Power, 2021). Firstly, two dimensions of parenting style have been identified: demandingness (level of control) and responsiveness (warmth and acceptance) based on which a four-fold classification of parenting styles have been created (Maccoby & Martin, 1983). Parents who score high on both dimensions are said to have an authoritative parenting style, which is associated with the most positive child outcomes, such as healthy BMI (Mitchell et al., 2013; Shloim et al., 2015) and positive home food environment (R. Johnson et al., 2012). Secondly, feeding styles can be viewed as one domain of parenting styles specific to mealtimes (Shloim et al., 2015). Thus, feeding styles can be determined by a combination of the two dimensions of demandingness and responsiveness (Hughes et al., 2005). Authoritative feeding style (high demand combined with high responsiveness) has been associated with higher child diet quality (Arlinghaus et al., 2018). Thirdly, parenting style and feeding style may influence parents' choice of actual feeding practices (Shloim et al., 2015). Feeding practices, or food-related parenting practices refer to specific behaviours used by parents to influence their child's eating, such as attempts to increase or decrease intakes of certain foods (both healthy and unhealthy) (Gevers et al., 2014; Loth et al., 2014; Mahmood et al., 2021). Parental feeding practices are important modifiable components of a child's food environment (Kininmonth et al., 2023) and they play an important role in the development of child eating habits and subsequent weight status (C. Russell et al., 2018).

Parents might impose higher levels of control in child feeding when the parent is concerned about the child's development and perceive the child to be at risk for overweight. A parent self-report questionnaire focusing on obesity proneness in children was developed by Birch et al. (2001). The Child Feeding Questionnaire (CFQ) assesses parental beliefs, attitudes and practices regarding child feeding. It consists of 31 items which are grouped to 7 factors. Four factors measure parents' perception and concerns regarding child risk for obesity ('perceived responsibility', 'perceived parent weight', 'perceived child weight', 'concern about child weight') and three factors measure parents' attitudes and practices regarding nonresponsive/controlling feeding practices ('restriction', 'pressure to eat', 'monitoring'). The CFQ is the most commonly used measure to assess feeding practices used by parents of young children (Hughes & Power, 2021; Shloim et al., 2015).

Several cross-sectional studies have examined the association of CFQ factors 'restriction' and 'pressure to eat', also called nonresponsive or controlling feeding practices, and child BMI (Table 4). The results indicate that parental controlling feeding practice 'restriction' is generally linked to higher child BMI (Costa et al., 2011; Couch et al., 2014; Dev et al., 2013; P. W. Jansen et al., 2012; Joyce & Zimmer-Gembeck, 2009; Nowicka et al., 2014; Wehrly et al., 2014) and 'pressure to eat' is associated with lover child BMI (Carnell & Wardle, 2007b; Couch et al., 2014; P. W. Jansen et al., 2012; Lee & Keller, 2012; Nowicka et al., 2014; Stringhini et al., 2017; Wehrly et al., 2014). Previous meta-analyses confirm these findings and state that even though the effect sizes regarding the analyses are small, they are statistically significant (Ruzicka et al., 2021).

Table 4. Cross-sectional studies on the association between controlling parental feeding practices and child BMI.

Author	Year	Country	Sample size	Child age	Outcome	Explanatory variables - CFQ	
						RST	PE
Carnell & Wardle	2007	UK	n=439	3–5 y	BMI SDS (UK)		-
Joyce & Zimmer-Gembeck	2009	Australia	n=230	4–8 y	BMI SDS (CDC)	+	
Costa et al.	2011	Brazil	n=110	6–10 y	BMI SDS (CDC)	+	-
Jansen et al.	2012	Netherlands	n=4.987	4 y	BMI SDS (NL)	+	-
Lee & Keller	2012	USA	n=68	4–6 y	BMI SDS (CDC)		-
Dev et al.	2013	USA	n=329	2–5 y	BMI SDS (CDC)	+	
Couch et al.	2014	USA	n=699	6–11 y	BMI SDS (CDC)	+	-
Nowicka et al.	2014	Sweden	n=876	4 y	ISO-BMI	+	-
Wehrly et al.	2014	USA	n=312	4–6 y	BMI SDS	+	-

SDS, Standard Deviation Score
CFQ, Child Feeding Questionnaire; RST, Restriction; PE, Pressure to eat
+, Positive association, explanatory variable increases and the outcome variable increases;
-, Negative association, explanatory variable increases and the outcome variable decreases

Longitudinal studies exploring the bidirectional nature of feeding dynamics support a “child-responsive” model whereby parents tend to adapt their feeding practices in response to their child’s BMI rather than his/her feeding practices influencing the child’s weight gain (Derks et al., 2017; P. W. Jansen et al., 2014; Liszewska et al., 2018; Webber et al., 2010) (see Table 5). Wardle & Carnell (2007) conclude that parents might encourage leaner children to eat, but the relationship between child weight and other parental feeding practices is unclear. It is suggested that the relationship between parental feeding styles and child BMI might depend on child obesity predisposition (Faith et al., 2004). This viewpoint is supported by the studies of Berge (2021) who suggested that parents use different feeding practices with siblings depending on the weight status of the child. In addition, some of the studies suggest that parents both respond and influence child’s weight status (Afonso et al., 2016; Tschann et al., 2015).

In contrary, some studies suggest that parental ‘restriction’ may be protective of unhealthy weight gain in younger children (Campbell, Andrianopoulos, et al., 2010; C. V. Farrow & Blissett, 2008). Moreover, a meta-analysis reported that the association between parental ‘restriction’ and child BMI was stronger with older children (Ruzicka et al., 2021).

Table 5. Prospective/longitudinal studies on the association between parental feeding practices and child BMI.

Author	Year	Country	Sample size	Child age	Outcome variables	Explanatory variables
Faith et al.	2004	USA	n=57	Baseline 5 y Follow-up 7 y	BMI SDS	PE -, RST +
Wardle & Carnell	2007	UK	n=3.175	Baseline 4 y Follow-up 7 y	BMI SDS	PE -
Farrow & Blissett	2008	UK	n=62	Baseline 1 y Follow-up 2 y	BMI SDS	RST - PE -
Webber et al.	2010	UK	n=213	Baseline 7–9 y Follow-up 10–11 y	PE	BMI SDS -
Campbell, Andrianopoulos et al.	2010	Australia	n=204 n=188	Baseline 5–6 y, 10–12 y Follow-up 3 y later	BMI SDS	RST -
Jansen et al.	2014	Netherlands	n=4.166	Baseline 2 y Follow-up 4 y + 6 y	RST PE	BMI SDS + BMI SDS -
Tschann et al.	2015	USA	n=322 mothers n=182 fathers	Baseline 8–10 y Follow-up 1 + 2 y later	BMI SDS	RST + PE -
Afonso et al.	2016	Portugal	n=3.708	Baseline 4 y Follow-up 7 y	BMI SDS PE RST	PE- BMI SDS - BMI SDS +
Derks et al.	2017	Netherlands	n=4.689	Baseline 4 y Follow-up 10 y	RST	BMI SDS +
Liszewska et al.	2018	Poland	n=526	Baseline 6–11 y Follow-up 10 m later	RST PE	BMI SDS + BMI SDS -

SDS, Standard Deviation Score
CFQ, Child Feeding Questionnaire; RST, Restriction; PE, Pressure to eat
+, Positive association, explanatory variable increases and the outcome variable increases;
-, Negative association, explanatory variable increases and the outcome variable decreases

Parental controlling feeding practices might also influence child eating self-regulation (Birch et al., 2003; Hughes & Frazier-Wood, 2016). Parental 'restriction' has been associated with disinhibited eating, eating in the absence of hunger, and it might predict children's higher interest in food in general (Birch et al., 2003; Loth et al., 2014; Wang et al., 2022). 'Pressure to eat' has been associated with dietary restraint and emotional disinhibition in girls (Loth et al., 2014). In addition, a recent research paper indicates that children might be differentially affected by parental feeding practices depending on their appetitive traits (Kininmonth et al., 2023). Specifically, 'pressure to eat' might lead to higher levels of emotional overeating only in children who have a tendency to eat more in response to emotional stressors already in toddlerhood (Kininmonth et al., 2023).

Parental feeding practices which have shown associations with healthier food intakes of children include low parental pressure (Gregory et al., 2011; Kröller & Warschburger, 2008), low overt restriction (can be detected by the child) (J. Ogden et al., 2006), and lower use of foods as rewards (Kröller & Warschburger, 2008; A. Spence et al., 2014). One feeding practice which has been suggested to be beneficial is covert restriction (not detected by the child) (J. Ogden et al., 2006). However, this may be true only for children who are less food responsive (Kininmonth et al., 2023). Further, low maternal 'pressure to eat' has been associated with lower levels of picky eating in girls (Galloway et al., 2005). Further, high parental 'monitoring' has been associated with lower consumption of sweets and fast foods (Slapnicar et al., 2022). In general, a controlling approach to children's eating (restriction, pressure to eat, using food as a reward) might impact child eating negatively (DeCosta et al., 2017).

Parental self-efficacy

Social cognitive theory is widely used to explain health behaviour (Bandura, 2004). Self-efficacy is a central concept in this theory, referring to the subjective feeling of an individual's ability to achieve a desired outcome, largely derived through one's personal accomplishment history in a given task (Bandura, 1997). However, self-efficacy beliefs can also be influenced by observing others and receiving feedback from others (Bandura, 1997). General sense of individual's ability to accomplish goals and manage novel or difficult situations can be measured with general self-efficacy scale (Schwarzer et al., 1995).

As parents play such an important role in their children's behaviour, a type of self-efficacy, parental self-efficacy (PSE), has been defined as parents' appraisal of their competence in the parental role and beliefs regarding their parental capabilities to positively influence the development and behaviours of their children (Coleman & Karraker, 1998). According to Bandura (1982), efficacy beliefs are merely context dependent and thus specific to a certain domain. Parenting has been referred to as one of the self-efficacy domains, and parental self-efficacy beliefs can be measured e.g. with Parenting Task Index Toddlers Scale measure developed by Coleman & Karraker (2003). In addition, several other general, domain-specific and task-specific parental self-efficacy self-report measures have been created (Bohman et al., 2013; Campbell, Hesketh, et al., 2010; Ice et al., 2012; Möhler et al., 2020; Sagui-Henson et al., 2020; Wittkowski et al., 2017).

In addition to an association between parental and child health behaviours, parents influence their child health behaviours through socio-cognitive processes (Rohde et al., 2018). Thus, parental self-efficacy has been linked with child lifestyle factors, such as intakes of vegetables and fruits and lower child intake of non-core foods (Campbell, Andrianopoulos, et al., 2010; Ice et al., 2012; Koh et al., 2014; Möhler et al., 2020; Parekh et al., 2018; Sagui-Henson et al., 2020; Walsh et al., 2019; Xu et al., 2013) and child diet quality (A. Spence et al., 2014). An intervention study suggested that positive changes in parental self-efficacy might be translated to increased consumption of fruits and vegetables both in children and parents (Willis et al., 2014). Based on previous literature, relatively little is known about the change of parental self-efficacy in early childhood. Table 6 highlights the previous studies on the associations between child dietary intakes and parental self-efficacy.

Table 6. Earlier studies on the association between parental self-efficacy and child eating habits.

Author, Publication Year	**Country**	**Participants**	**Child age**	**Sample size**	**Assesment of PSE**	**Assessment of child dietary habits**	**Main findings**
Campbell et al. 2010	Australia	Mothers	1 and 5 y	60 + 80	PSE measure with 12 items	EPAQ – child core foods (water, vegetables & fruits) and non-core foods	Higher maternal self-efficacy was associated with healthier child eating habits at both ages.
Xu et al. 2013	Australia	Mothers	2 y	242	Global parenting self-efficacy	Intakes of vegetables and fruits + soda	Maternal self-efficacy was positively associated with child fruit and vegetable consumption and negatively associated with soft drink consumption.
Ice et al. 2014	USA	Mother (92%), fathers (8%)	6–14 y	820	PSE measure with 7 items	Intakes of vegetables and fruits	Maternal self-efficacy positively predicted child's daily fruit and vegetable intakes.
Koh et al. 2014	Australia	Mothers	Infants	277	Maternal feeding self-efficacy	Intakes of vegetables and fruits	Maternal feeding self-efficacy was positively associated with child vegetable variety and child willingness to eat new foods.
Spence et al. 2014	Australia	Mothers	1.5 y	528	PSE measure with 12 items (Similar to Campbell et al. 2010)	OPDI (obesity protective dietary index, based on 24-hour recalls)	Maternal self-efficacy was positively associated with child diet quality.
Parekh et al. 2018	Sweden	Mother (60%), father (7%) + both (33%)	4 y	301	PSEPAD	Intakes of fruits, unhealthy snacks	Parental self-efficacy was associated with higher child fruit and vegetable intakes and lower intakes of unhealthy snacks.

Author, Publication Year	Country	Participants	Child age	Sample size	Assesment of PSE	Assessment of child dietary habits	Main findings
Rohde et al. 2018	Sweden	Mothers	4 y	420	PSEPAD	Intakes of vegetables and fruits + snacks	Weak positive association between maternal self-efficacy and child healthy dietary habits.
Walsh et al. 2019	Australia	Fathers	3 y	195	PSE measure with 12 items (Similar to Campbell et al. 2010)	Intakes of vegetables and fruits + water and non-core drinks	Persistently high self-efficacy was negatively associated with child non-core drink intakes. Positive association between increasing self-efficacy and child fruit and vegetable intakes.
Möhler et al. 2020	Germany	Mothers and fathers	3–5 y	558	PSEPAD	Intakes of vegetables and fruits + unhealthy snacks	Parental self-efficacy was positively associated with child fruit and vegetable intakes and had a protective effect on child soft drink consumption.
Sagui-Henson et al. 2020	USA	Mothers (75%), Fathers (25%)	6–12 y	159	Parenting Self-Assessment Scale with 15 items	Intakes of vegetables and fruits + sweets and soda	Parental self-efficacy was negatively associated with child sweets and soda intakes.

PSE, Parental Self-Efficacy; EPAQ, Eating and Physical Activity Questionnaire; non-core foods, foods that are eaten more for pleasure than health
PSEPAD, Parental Self-Efficacy for Promoting Healthy Physical Activity and Dietary Behaviours in Children

Fathers and child food-related parenting

In addition to mothers, fathers have an expanding role on young children's nutrition, and fathers are involved in preparing food for their children (Guerrero et al., 2016). Still to date, fathers' perspective continues to be underrepresented in child food-related parenting research (K. Davison et al., 2021). Only few studies have examined paternal food-related parenting practices and child diet or weight status, but their results suggest that fathers might play a critical role in shaping children's diet and risk of overweight (K. Davison et al., 2021).

There is some evidence that fathers might use more controlling feeding practices than mothers (Mallan et al., 2014). Studies examining feeding practices of fathers and child weight status suggest that paternal feeding practices also matter in regard to children's weight status in addition to maternal feeding practices (Penilla et al., 2017; Tschann et al., 2015; Vollmer, Adamsons, Foster, et al., 2015). One study showed that paternal feeding practices were independently associated with children's weight status, even when mothers' feeding practices were taken into account (Penilla et al., 2017). Further, one study suggested that paternal feeding practices might have a moderating effect with child eating behaviours and child BMI z-score (Vollmer, Adamsons, Foster, et al., 2015). For example, child satiety responsiveness was negatively associated with child BMI z-score only if paternal restriction scores were high (Vollmer, Adamsons, Foster, et al., 2015).

Further, most of the previous research findings on parental self-efficacy and child eating habits have included only maternal ratings of self-efficacy and previous research highlights the importance of studying father and mother self-efficacy separately with child eating habits (Möhler et al., 2020). Only one study has examined solely paternal self-efficacy and child dietary intakes, with results suggesting that paternal self-efficacy is important in promoting children's obesity protective dietary habits (Walsh et al., 2019). In the previous few studies comparing mother and father self-efficacy, fathers have reported a lower sense of parental self-efficacy than mothers (Caprara et al., 2004; Junttila et al., 2015). In addition, one study found that fathers reported their self-efficacy higher than mothers (Sagui-Henson et al., 2020). In the latter study, 75% of the participants were mothers, and fathers represented only 25% of the study population (n=159).

2.3.3 Neighbourhood-level factors

The child's ecological niche includes family, grandparents, educators and peers at daycare or at school (Scaglioni et al., 2018). In addition, neighbourhood is the most proximate environmental context for child growth and development (Gu et al., 2023) and features of neighbourhoods may affect health (Diez Roux & Mair, 2010). "You are where you live" is an idea that has raised a lot of interest in the field of health geography since the early 2000's (Jivraj et al., 2020), and in the previous years there has been a growing interest in studying the characteristics of the contexts individuals belong in understanding the determinants of health (Diez Roux & Mair, 2010).

Neighbourhood social environment

Neighbourhood social environment includes the sociodemographic composition of the neighbourhood, social connections between neighbours, social norms, social cohesion and all the social processes that exist between individuals (Suglia et al., 2016). In this thesis, the study of neighbourhood effects is concentrating on the neighbourhood socioeconomic characteristics. According to Suglia et al. (2016) neighbourhood socioeconomic status is directly linked with neighbourhood social environment and health outcomes such as obesity. It has been suggested that children coming from low socioeconomic backgrounds might be even more vulnerable to risks of adverse living environments, a phenomenon called "*double jeopardy*" (Jackson, 2009). On the other hand, living in affluent neighbourhoods might work as a protective factor for children who come from low socioeconomic background (Erola & Kilpi-Jakonen, 2017).

Neighbourhood segregation

Health risks and protective resources are unequally distributed spatially in the residential areas, especially in the cities (Vaalavuo et al., 2021). Neighbourhood segregation is separating certain groups of people (such as racial and ethnic minorities and socioeconomic groups) into separate social spaces increasing the uneven distribution of affluent and disadvantaged social groups across residential areas (Ranjit et al., 2015). Neighbourhood segregation between socioeconomic groups has increased during the last decades in Europe (Tammaru et al., 2020). Finland is a country known forlow or moderate income inequalities and neighbourhood segregation (Saikkonen et al., 2018). However, according to a recent study analyzing the three largest city regions in Finland – Helsinki, Turku and Tampere, income segregation had increased during the study period, 2005–2014 in Turku and Tampere and ethnic segregation was strongest in the Turku region (Saikkonen et al., 2018). Further, socioeconomic differences in health behaviour were greater in Finland than the average in the EU (OECD, 2021).

Neighbourhood socioeconomic disadvantage

Similar to family socioeconomic status, the neighbourhood socioeconomic status can be measured in different ways. The common proxies for neighbourhood socioeconomic status are household income, level of education, and unemployment rate of the neighbourhood (Halonen et al., 2012). Most studies have included a composite measure of the previous, and some indicators include higher amount of different sociodemographic variables indicating neighbourhood deprivation level (Andrews et al., 2020; Jivraj et al., 2020). The lower the SES, the higher is the neighbourhood deprivation. Further, different spatial resolutions have been used in defining neighbourhoods, such as postal code (Vaalavuo et al., 2021), census tracts/districts (Carroll-Scott et al., 2013; Gose et al., 2013), block level or other small areas (Li et al., 2014; Oliver & Hayes, 2008). Recent Finnish studies have used high resolution, 250 m^2 grids in defining neighbourhood socioeconomic position (Halonen et al., 2012; Kivimäki et al., 2018; Lagström et al., 2019; Rautava et al., 2022). It can, however, be stated that there is no consensus on what is the relevant spatial resolution for each particular process and outcomes (Diez Roux & Mair, 2010). In addition, most of the studies report neighbourhood SES only at one point in time and only few include cumulative exposures (Jivraj et al., 2020).

Neighbourhood socioeconomic disadvantage, child eating habits and weight

Previous research indicates that people living in socioeconomically deprived neighbourhoods might be at higher risk for overweight and obesity already in childhood and thus, neighbourhood deprivation might add an independent risk layer on childhood overweight and obesity (Alvarado, 2016; Carter & Dubois, 2010; Curci et al., 2020; Gose et al., 2013; Greves Grow et al., 2010; Li et al., 2014; Nelson et al., 2006; Oliver & Hayes, 2008; Rautava et al., 2022; Schüle et al., 2016). According to a recent meta-analysis including both children and adults, low neighbourhood SES compared to high neighbourhood SES was found to be associated with significantly higher odds of overweight and obesity and higher BMI (Mohammed et al., 2019). A recent Finnish study showed that cumulative neighbourhood disadvantage was associated with childhood BMI trajectories from birth to age 7 (Rautava et al., 2022). However, some studies suggest that neighbourhood disadvantage has a stronger impact on the risk of overweight as children age (Alvarado, 2016).

Children coming from high SES families tend to have better diet quality (Pinket et al., 2016), and the neighbourhood socioeconomic status might influence dietary quality irrespective of the family's own socioeconomic status (Keita et al., 2009). Previous studies have shown that neighbourhood socioeconomic disadvantage is linked with lower adherence to food recommendations (Lagström et al., 2019) and higher soda and lower salad consumption (Drewnowski et al., 2019) in adults. Among children, neighbourhood disadvantage is linked with lower intake of fruits and vegetables (Kivimäki et al., 2018) and lower diet quality (Keita et al., 2009). In addition, soft drink and dessert intakes might be higher and intake of low fat dairy products might be lower in deprived neighbourhoods (Bernsdorf et al., 2016;

Merchant et al., 2007). Further, neighbourhood socioeconomic status might influence child appetite avidity (Kininmonth et al., 2020).

The mechanisms behind neighbourhood effects on child outcomes

According to the latest WHO European Obesity Report (2022), the effects of environments might occur through two basic mechanisms: low-income families are exposed to obesogenic environments and high-income families have the educational, financial and psychological resources to protect them from the adverse effects of obesogenic environment.

Galster (2012) groups neighbourhood effects on individual outcomes into four categories: social interactive, environmental, geographical, and institutional mechanisms. Social interactive mechanisms refer to social processes within individuals and cover peer pressure, social norms, social networks, and social cohesion. Environmental mechanisms refer to natural and built environment physical surroundings. Geographical mechanisms include public services and employment opportunities. Institutional mechanisms refer to actions by those typically not living in the neighbourhood, such as stigmatization, local market actors such as restaurants and food markets, and the local institutional resources, such as schools, daycare facilities and medical clinics (Galster, 2012).

Firstly, neighbourhoods might share social attributes which might further affect the behaviours and social norms shared by residents (Bernsdorf et al., 2016; Diez Roux & Mair, 2010). Unhealthy eating habits may become normative and can lead to unhealthy weight outcomes (Alvarado, 2016) and obesity has been shown to spread through social relationships (Christakis & Fowler, 2007). Social networks, interpersonal connections that individuals have with others, can have important functions in the food choices that parents make for their young children (Reyes et al., 2022). In a recent study from Finland, it was shown that intuition was the most significant information source affecting the feeding decisions of parents of young children (Mäkelä et al., 2023). The opinions and knowledge behind the so-called "intuition" might vary between families and reflect information received either from health care professionals, family, friends, or neighbours. Social support from family and friends has been suggested to be a key factor in the adoption of most behaviour, including healthy eating habits (Lawrence et al., 2009). Moreover, psychosocial factors might also explain why individuals living in deprived neighbourhoods choose to consume energy-dense foods (Caldwell & Sayer, 2019). The neighbourhood disadvantage might affect stress levels of families and thus affect the environment in which children are raised (Galster, 2012).

Secondly, neighbourhoods differ in the built environment characteristics, such as the amount of parks, sidewalks and bike paths available for the residents (Suglia et al., 2016). Thus, physical design of neighbourhoods can affect the amount of exercise that individuals get (Galster, 2012). Previous evidence suggests that access to recreational or playground facilities and walkable neighbourhoods are associated with lower BMI in children (Carroll-Scott et al., 2013). Similarly, availability of parks in the neighbourhood has been associated with child healthy eating (Carroll-Scott et al., 2013).

Thirdly, the food environment with abundant variety of foods available might promote excess eating (Cohen, 2008). It has been suggested that the current food environment explains most of the obesity pandemic (Mustajoki, 2015). According to Glanz et al. (2005), the food environment can be divided into four aspects: community food environment (location and accessibility of food outlets), consumer food environment (price, placement of food choices), organizational food environment (food served in other settings such as schools) and information environment (media and advertising). Deprived neighbourhoods might have unhealthier food environments compared to affluent areas (Drewnowski et al., 2019; Ribeiro et al., 2019) – a phenomenon also referred to as the ‘deprivation amplification’ (Mackenbach et al., 2019). Previous studies have shown that the food environments of deprived neighbourhoods are typically characterised by limited access to retail outlets and by a high density of fast food outlets and convenience stores (Chennakesavalu & Gangemi, 2018; Pearce et al., 2009; Ribeiro et al., 2019; Timperio et al., 2008). This so-called availability hypothesis is commonly used to explain the relationship between socioeconomic disadvantage, higher obesity risk (Caldwell & Sayer, 2019) and inequalities in diet (Drewnowski & Kawachi, 2015).

Fourthly, food choices in a neighbourhood depend highly on the purchasing power of the people living in the neighbourhood (Drewnowski & Kawachi, 2015), and families from lower SES groups are more likely to prioritise price than health in their food choices (Bowman, 2006; Konttinen et al., 2013; Pechey et al., 2015). A large UK-based cohort study concluded that cost was still a significant contributor to food choices, and a large proportion of the socioeconomic inequalities in diet quality could be explained by actual and/or perceived cost of healthy diets (Pechey & Monsivais, 2016). The Seattle Obesity Study found that people did not shop at the nearest supermarket but merely selected one within their price range (Drewnowski et al., 2012). A study among Swedish children showed that healthy eating was associated with higher diet cost (Rydén & Hagfors, 2011). Similarly, in Finland, one challenge parents reported in providing healthy food to their children was the high price of healthy food (Mäkelä et al., 2023). A global meta-analysis confirms these results highlighting the challenges for reducing financial barriers to healthy food choices (Rao et al., 2013). Moreover, it has been suggested that positive attitudes toward healthy eating might be even more important factor than SES affecting eating habits (Aggarwal et al., 2014).

Fifthly, quality of schools and childcare facilities might vary between neighbourhoods. Previous meta-analysis found moderate evidence of the relationship between the community and consumer nutrition environments and dietary intake in children (Engler-Stringer et al., 2014). In Finland, government provides free daycare and school meals. Longitudinal studies from the UK and Norway showed that free school meals improved children's intake of healthy foods and led to small reductions in unhealthy body weight (Holford & Rabe, 2022; Vik et al., 2019). Childcare is an important factor affecting eating habits among children in Finland, as most children eat three meals a day in that setting (Lehto, Ray, et al., 2019). Further, childcare feeding practices might differ between neighbourhood SES (Lehto, Lehto, et al., 2019).

Lastly, the information environment can operate on a regional level affecting attitudes and food choices (Glanz et al., 2005). Previous research suggested that children living in deprived neighbourhoods might be more exposed to unhealthy food advertising (Backholer et al., 2021). This is an important thing to consider since previous research indicates that exposure to advertising of unhealthy foods and beverages might increase children's preference and intake of advertised products (Smith et al., 2019). Further, neighbourhoods may be stigmatised based on the history of the area and regardless of the neighbourhood's current population, such stigma may increase the health inequalities and territorial stigma may turn into a self-fulfilling prophecy (Junnilainen, 2019).

2.4 Summary of the reviewed literature

Child eating habits are mainly formed during early years (Birch et al., 2007; Scaglioni et al., 2018). Diet quality of preschool-aged children in Finland continues to be moderate or poor (Koivuniemi et al., 2022). Overweight among preschool-aged children is increasing in Europe, including Finland (Garrido-Miguel et al., 2019; Jääskeläinen et al., 2022). Previous research has identified several modifiable factors influencing childhood overweight development, including child eating habits, parental restrictive feeding practices, parent BMI, family socioeconomic status and neighbourhood socioeconomic disadvantage (Carroll-Scott et al., 2013; Dev et al., 2013; Jakobsen et al., 2023; Kininmonth et al., 2021; Paalanen et al., 2022).

Figure 1 presents the conceptual model of this thesis based on the existing literature described in earlier chapters. Socioecological models can be used to explain how multiple contexts that interact with each other affect the risk of child overweight (K. Davison & Birch, 2001) and eating habits (Story et al., 2008). Socioecological models suggest that children interact with their environments and individual behaviour can only be understood based on the interrelationships between multiple people in multiple level contexts (Bronfenbrenner & Ceci, 1994; Egger &

Swinburn, 1997; Sallis & Owen, 2015; Story et al., 2008). Children are genetically predisposed with either "Food approach" or "Food avoidance" appetitive traits and are thus differently vulnerable to environmental effects (Llewellyn et al., 2010). Children who have weaker satiety signals are more likely to overeat in response to multiple opportunities to eat, i.e. to obesogenic environment (Llewellyn et al., 2014; Llewellyn & Fildes, 2017), and a more avid appetite has been linked with higher child adiposity in Western countries such as England, Netherlands, Ireland, USA, Canada and Australia (Boswell et al., 2018; Domoff et al., 2015; P. W. Jansen et al., 2012; McCarthy et al., 2015; Tay et al., 2016; Webber et al., 2009). According to current knowledge, the relationship between appetitive traits and child weight might be bidirectional, meaning that the influence on appetite on weight development is greater during toddlerhood and adiposity level becoming more important in shaping appetite in later childhood (Kininmonth et al., 2021).

However, young children cannot be considered to be fully responsible for their own lifestyle choices. Child eating habits develop within the context of the family (K. Davison & Birch, 2001). Parents shape the food environments of the children and the availability of sugar-enriched foods is suggested to have an important role concerning child eating habits (Vepsäläinen, Korkalo, et al., 2018). The birth of a child might be a favourable point for parents to improve their dietary habits. On the contrary, some parents have reported unfavourable changes in their diets during transition to parenthood (Versele et al., 2021). Firstly, family resemblance in dietary habits is well documented, meaning that parental diet quality is reflected in child diet quality (Vepsäläinen, Nevalainen, et al., 2018). Secondly, the way how parent and child interact while eating might affect the weight status of children and vice versa. Parents might react with nonresponsive feeding practices if concerned about child weight, and on the other hand, parents might influence child BMI by an increased level of control in child feeding (Afonso et al., 2016). Thirdly, parents' belief in their ability to positively influence their children's daily habits (parental self-efficacy) might positively impact their child eating habits (A. Spence et al., 2014). Parents who have higher self-efficacy might be more willing to offer their child an increased variety of foods and thus, the child is exposed to a variety of foods and tastes and might through repeated exposure learn to like them (Bahorski et al., 2018; C. G. Russell & Worsley, 2013). In addition, parents focusing less on picky eating behaviour and modelling healthy eating might increase the child's intake of fruits and vegetables (Galloway et al., 2005).

Neighbourhood is one of the most important environmental contexts for the child (Gu et al., 2023). Accumulating evidence indicates that improving neighbourhoods in early life would be of great benefit from the public health perspective (Jivraj et al., 2020). Neighbourhood disadvantage has been associated with significantly higher risk of child overweight (Mohammed et al., 2019) and unhealthy eating habits (Galán et al., 2021; Keita et al., 2009; Kivimäki et al., 2018).

Thus, multiple factors influence child diet quality and weight, and they should be viewed together. More research is needed addressing a variety of individual, parental, and environmental-level factors affecting childhood diet and weight development. We are lacking consensus on how different appetitive traits are associated with child diet quality. In addition, we need more information regarding how psychosocial aspects such as parental self-efficacy might be related to child overall diet quality. Further, the perspective of fathers is widely missing from previous studies investigating the association of food-related parenting, parental self-efficacy and child health outcomes. Regarding the environmental context of the families, we are lacking data on how neighbourhood disadvantage might be associated with diet quality in families with young children. In addition, the interactions between child appetitive traits, food-related parenting practices and neighbourhood socioeconomic disadvantage are not known.

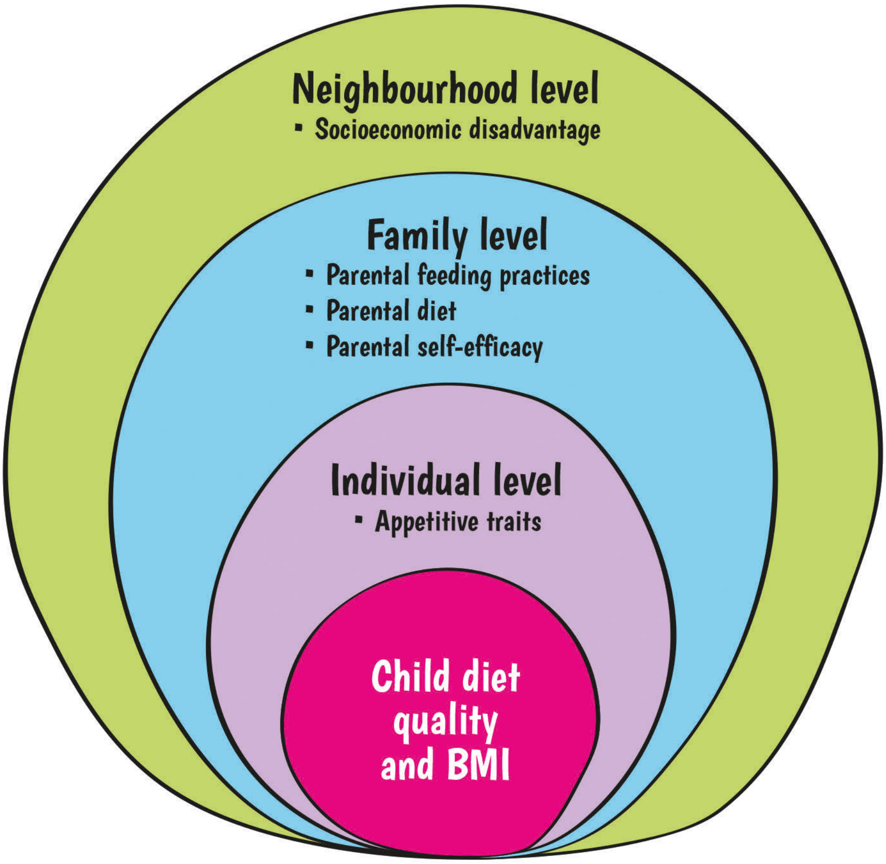


Figure 1. Conceptual model of the thesis based on socioecological models of health behaviour. Figure by Saija Tarro & Reima Honkasalo, modified from Davison & Birch 2001 and Story et al. 2008.

3 Aims

My thesis aimed at gaining better understanding of the multi-level factors associated with eating habits in families with small children and BMI in children. My main aim was to investigate the associations of individual, family and neighbourhood-level factors affecting child diet quality and risk of overweight at preschool age (Figure 2). The specific objectives of the thesis were:

1. *Individual level*: To investigate the association of child appetitive traits with child BMI and risk of overweight at 5–6 years of age and diet quality between ages 2 and 5 years. (Studies I and II)
2. *Family level*: To examine the association of parental feeding practices with child BMI at 5–6 years of age. To study the association of parental diet quality with child diet quality and parental self-efficacy with child diet quality between ages 2 and 5 years. (Studies I, III and IV)
3. *Neighbourhood level:* To study the association of neighbourhood socioeconomic disadvantage together with child appetitive traits and parental feeding practices on child BMI and risk of overweight at 5–6 years of age. To investigate the association of neighbourhood socioeconomic disadvantage with parental diet quality and child diet quality between pregnancy and child age of 2 and 5 years. (Studies I, II, III)

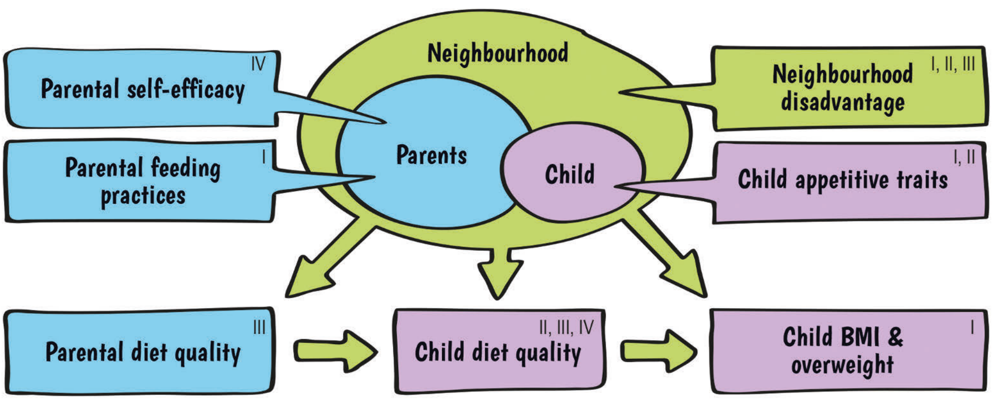


Figure 2. Different-level factors studied in studies I–IV. Figure by Saija Tarro & Reima Honkasalo.

4 Materials and Methods

4.1 Study design and participants

This study was based on data from parents (both mother and father), and children participating in a prospective Steps to Healthy Development follow-up study (Lagström et al., 2013). The Steps to Healthy Development (STEPS) Study is an ongoing parent-child cohort study which includes all children born in the Hospital District of Southwest Finland between January 2008 and April 2010 and their parents. Briefly, all Finnish- and Swedish-speaking mothers, who delivered a living child between 1 January 2008 and 31 April 2010 in the Hospital District of Southwest Finland, formed the cohort population (in total 9,811 mothers and their 9,936 children). Altogether 1,797 mothers (18.3% of the total cohort) and 1,658 spouses with 1,805 neonates were recruited to an intensive follow-up group during the first trimester of pregnancy or soon after delivery. All subjects in this study were non-Hispanic Caucasians.

In Studies I, II, III and IV, preterm infants and twins were excluded (Figure 3). In addition, in Study IV, divorced parents were excluded. To maximise the number of participants, all the available answers were used depending on the study question. Thus, the number of participants varied between research questions in the studies. Subjects for the Study I, investigating the association of child appetitive traits, parental feeding practices, neighbourhood disadvantage and child BMI, were selected from the total sample group based on whom we had the mother's and/or father's answers on the questionnaires, neighbourhood SES and child BMI data available (n=682 children, 680 mothers and 520 fathers). For Study II, the children who had answers from mother or father regarding diet quality and neighbourhood SES data available, were included (n=601–780 depending on the study question). For Study III, the number of families who had data on neighbourhood SES, mother and father diet quality and child diet quality, varied between 389–645 depending on the study question. In Study IV, children who had data on parental self-efficacy questionnaire and child diet quality varied between 270–883 depending on the study question. Figure 3 shows the flowchart of the studies and the number of children in each age point based on questionnaire data availability. Both longitudinal (Study III, IV) and cross-sectional (Study I, II) study design were used in this thesis.

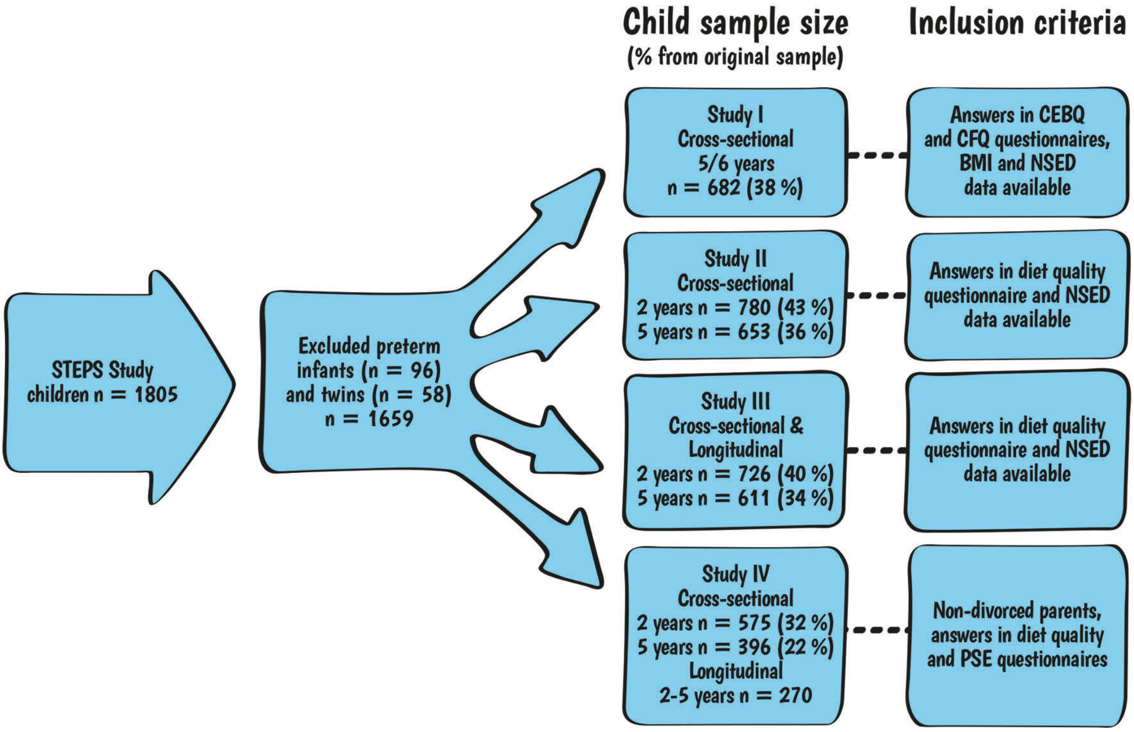


Figure 3. Flowchart of the study design. Figure by Saija Tarro & Reima Honkasalo. PSE, Parental Self-Efficacy; CEBQ, Child Eating Behaviour Questionnaire; CFQ, Child Feeding Questionnaire; NSED, Neighbourhood Socioeconomic Disadvantage.

4.2 Data collection and methods

Data in this study was collected with parent self-report questionnaires from the STEPS Study. Anthropometric measures were obtained from municipal follow-up clinics and data regarding neighbourhood socioeconomic disadvantage was derived from Statistics Finland grid database. The questionnaire data collection points and procedures are presented in Table 7.

Table 7. The questionnaire data collection time points in studies I–IV.

Study	Outcome variables		Explanatory variables	
	Parent	**Child**	**Parent**	**Child**
I	CFQ child 5/6 y	BMI z-score 5/6 y	CFQ child 5/6 y	CEBQ 5/6 y NSED cumulative from child birth BMI z-score 3 y
II		CDQ 2 + 5 y		CEBQ 2 + 5 y NSED cumulative from child birth
III	IDQ Gwk 30, child 2 + 5 y	CDQ 2 + 5 y	IDQ child 2 + 5 y	NSED cumulative from child birth + child birth
IV		CDQ 2 + 5 y	PSE child 1.5 + 5 y	

CEBQ, Child Eating Behaviour Questionnaire; CFQ, Child Feeding Questionnaire; NSED, Neighbourhood socioeconomic disadvantage; PSE, Parental self-efficacy; CDQ, Child diet quality; IDQ, Index of diet quality; Gwk, Gestational weeks

4.2.1 Main outcome variables

Child BMI and overweight

For Study I, child growth data (height and weight) were obtained from municipal follow-up clinics. 6-year age point was used as the primary value, but if the data were missing, 5-year age point was used instead (19%). There was a strong correlation in weight (r = 0.9) between the time points (including children with information from both timepoints). The data -2 months /+3 months from the time point of 5/6 years of age were used to include as many children as possible from the cohort population. The Finnish growth references (Saari et al., 2011) were used to determine children BMI Z-score. Sex-specific cut-off points were used for overweight categorization; ≥ 1.1629 for girls and ≥ 0.7784 for boys. Child BMI z-score was used both as continuous variable and dichotomous variable (normal weight, overweight) in the analyses.

Child Diet Quality

For Studies II, III and IV, the quality of the children's diet was surveyed using a questionnaire completed by parents (mother or father) at the age of 2 and 5 years of age. The questionnaire was a modified version of the Index of Diet Quality, validated with Finnish adults (Leppälä et al., 2010). From the 16 individual questions, a set of 10 questions was formed to describe the quality of the child's diet as follows: 1) how many days a week the child ate breakfast, 2) number of meals per day after breakfast (snacks included), 3) the type of drink with meals, 4) the quality of milk, 5) primary beverage, 6) the type of fat used on bread, 7) how many times did the child eat fish per week, 8) how many portions of fresh fruits and berries did the child eat per day, 9) how many portions of vegetables did the child eat per day and 10) how many times did the child eat unhealthy salty or sweet snacks per week (Table 8). The Child Diet Quality score, formed from these ten diet-related factors, describes the implementation of children's diet in relation to food recommendations for families with children during the study's implementation (Hasunen et al., 2004). One point was awarded for each item if the answer followed the recommendations. The total score varied from 0 to 10 so that higher values indicated better implementation of recommendations. Child diet quality was used as a continuous variable in the analyses.

Parent Diet Quality

For Study III, the quality of the parents' diet was assessed at 30 weeks of pregnancy, child age of 2 years and 5 years with a validated Index of Diet Quality (IDQ) questionnaire (Leppälä et al., 2010). The questionnaire includes 18 questions and measures the adherence to the health-promoting diet according to Finnish food recommendations (Fogelholm et al., 2014). The questions cover consumption of whole grain cereals (0–3 points), fat-containing foods (0–4 points), vegetables, berries and fruits (0–3 points), sugar (0–3 points) and dairy products (0–1 points), and regular meal rhythms (0–1 points) (Table 8). Based on the responses, the diet was scored from zero to fifteen so that a higher score describes a better diet quality. IDQ scores from 10 to 15 indicate adherence to the health-promoting diet, whereas scores below 10 indicate non-adherence. The IDQ was used as a continuous variable in the analyses (0–15).

Table 8. Proportion of study participants following Finnish food recommendations[1] based on the child diet quality questionnaire

Dietary item	**Recommendation**	**Recommended response alternative in the questionnaire**	**N (%) CHILDREN following recommendation**		**N (%) MOTHERS following recommendation**		**N (%) FATHERS following recommendation**	
			2 y	**5 y**	**child 2 y**	**child 5 y**	**child 2 y**	**child 5 y**
Breakfast		Daily	824 (93%)	715 (97%)	NA	NA	NA	NA
Regular meals	It is important to have regular meals.	4–5 meals per day, not skipping meals	663 (75%)	530 (71%)	384 (40%)	414 (50%)	299 (37%)	312 (51%)
Drink with meals	Milk products are necessary to supply the need for calcium.	Milk/sour milk/plant milk	794 (90%	683 (92%)	NA	NA	NA	NA
Milk quality	Use fat-free or low-fat dairy products.	Max 1% fat	607 (68%)	491 (66%)	651 (66%)	485 (59%)	515 (60%)	348 (57%)
Thirsty drink	Use water as primary beverage.	Water	671 (76%)	597 (80%)	NA	NA	NA	NA
Fat spread	Use unsaturated fat table spreads with > 60% fat.	> 60% fat	328 (37%)	247 (33%)	330 (18%)	471 (57%)	240 (28%)	332(55%)
Fish	Fish 2–3 times per week.	2–3 times per week	276 (32%)	401 (54%)	242 (25%)	439 (53%)	205 (24%)	305 (51%)
Vegetables	Vegetables, fruits and berries daily 5–6 portions.	≥ 2 times per day	341 (40%)	367 (49%)	702 (71%)	638 (77%)	470 (55%)	316 (52%)
Fruits and berries	Vegetables, fruits and berries daily 5–6 portions.	≥ 2 times per day	357 (41%)	338 (46%)	363 (37%)	365 (44%)	211 (25%)	136 (22%)
Unhealthy snacks	Avoid the habit of eating snacks between the meals.	max 1 time per week	448 (51%)	356 (48%)	194 (29%)	206 (25%) [2]	203 (35%)	190 (32%) [2]

[1] (Hasunen et al., 2004); [2] Only sweet snacks included
NA, Not available. Question asked only regarding children.

4.2.2 Main exposure variables

Child Appetitive Traits

In Studies I and II, child appetitive traits were measured using Child Eating Behaviour Questionnaire (CEBQ), which is a 35-item parent-report questionnaire measuring "Food approach" and "Food avoidance" dimensions of child appetitive behaviour (Wardle et al., 2001). Each question is answered on a Likert scale from 1 to 5 and the questions are clustered into eight subscales: 'enjoyment of food' (4 questions, e.g. My child loves food), 'food responsiveness' (5 questions, e.g. My child is always asking for food), 'emotional overeating' (4 questions, e.g. My child eats more when worried), 'desire to drink' (3 questions, e.g. If given the chance, my child would drink continuously throughout the day), 'satiety responsiveness' (5 questions, e.g. My child gets full up easily), 'slowness in eating' (4 questions, e.g. My child eats slowly), 'food fussiness' (6 questions, e.g. My child is difficult to please with meals) and 'emotional undereating' (4 questions, e.g. My child eats less when upset). The scores for each of the subscales were obtained by calculating the mean score for the questions. In addition, four first subscales were grouped into "Food approach" dimension and four latter subscales into "Food avoidance" dimension by taking the mean of the subscales based on the questionnaire availability when at least 50% of the subscales were completed. CEBQ variables were used as continuous variables in the analyses.

For Study I, CEBQ questionnaire data from child age of 5 or 6 years was used. If data was available at child age of 6 years, it was used as a primary value. When empty, questionnaire data at child age of 5 years was used instead (27%). The correlation in CEBQ dimensions between 5 and 6 years of data points was strong ($r > 0.6$) (including children with information from both timepoints). For Study II, CEBQ questionnaire data from child age of 2 and 5 years was used.

Parental Feeding Practices

In Study I, parental feeding practices were measured with a parental self-report questionnaire: Child Feeding Questionnaire (CFQ) (Birch et al., 2001). The questionnaire is designed to be used for assessing the parental beliefs, attitudes and practices towards small and school-aged children's feeding and their relationships to children's eating behaviour and weight. The validated questionnaire includes altogether 7 factors: Perceived responsibility, Perceived parent weight, Perceived child weight, Concern about child weight, Restriction, Pressure to eat, and Monitoring. Two factors from the questionnaire were used to assess parental controlling feeding practices separately for mother and father: Restriction (8 questions), measuring the extent to which parents restrict their child's access to foods (e.g. 'I intentionally keep some foods out of my child's reach') and Pressure to eat (4 questions), measuring the parents' tendency to pressure their children eat more food (e.g. 'My child should always eat all the food on her plate') (Birch et al., 2001). All questions were measured on a Likert scale, answers ranging from 1 to 5. The factor scores for Restriction and Pressure to eat were obtained by calculating the mean score for the questions.

In case the CFQ questionnaire was available at child age of 6 years, it was used as a primary value. When empty, questionnaire data at child age of 5 years was used instead (mothers 26%, fathers 30%). The correlation in CFQ factors between 5 and 6 years of data points was strong ($r > 0.6$) (including children with information from both timepoints).

Parental Self-Efficacy

In Study IV, the parents (both mother and father) evaluated their parental self-efficacy (PSE) at the child age of 1.5 and 5 years, using the Finnish validated version of the Self-Efficacy for Parenting Tasks Index Toddler Scale (SEPTI-TS) (Junttila et al., 2015). The validated scale includes 20 questions which are grouped into five dimensions of PSE: Presence (4 items, e.g., When my child needs me, I am able to interrupt what I am doing.), Emotional support (4 items, e.g., My child knows that I understand when her/his feelings have been hurt.), Routines (4 items, e.g., I have managed to create daily routines that are suitable for me, as well as for my child.), Playing (4 items, e.g., I easily invent different games with my child.), Teaching (4 items, e.g., I believe that my child learns a lot while I show her/him examples and teach her/him things.). All questions were answered on a Likert scale from 1 to 5. The maximum score for each dimension in the mother's or father's PSE is 20. To create a composite score for mother's or father's PSE, the items were summed up when all the dimension scores were available (scores ranging from 51 to 100 with mothers and from 48 to 100 with fathers). Further, a composite score for family level PSE was created by taking a mean of the mother's and father's PSE total scores (scores ranging from 60 to 100).

Neighbourhood Socioeconomic Disadvantage

The information on the socioeconomic status of the neighbourhood (NSES) was obtained from a grid database established and maintained by Statistics Finland. The database contains socioeconomic data for each neighbourhood at a spatial resolution of 250 x 250 meters (Statistics Finland, 2013). The measure of neighbourhood disadvantage (NSED) is based on the proportion of adults with only primary education, the unemployment rate and the median annual household income (coded as additive inverse) in each 250 m x 250 m areas (Halonen et al., 2016). For each of these three variables, the standardised z-value (mean = 0, SD = 1) was derived based on the total Finnish population. A score for neighbourhood disadvantage was then calculated by taking the mean value across the three z-scores. The missing data (i.e., areas where fewer than 10 residents lived in the neighbourhood) were replaced with the mean neighbourhood socioeconomic disadvantage score of the eight adjacent map squares. Higher scores on the variable indicate greater disadvantage. Using open-source Geographical Information Systems (QGIS, http://www.qgis.org/en/site/), data on the neighbourhood disadvantage were linked to the cohort participants' home addresses by the latitude and longitude coordinates.

For Studies I, II and III, cumulative neighbourhood disadvantage scores between child birth and two, five or six years of age were calculated, based on the complete history of the residential addresses. Child cumulative neighbourhood disadvantage score was also used as a measure of the parent's neighbourhood disadvantage. Neighbourhood disadvantage was classified into two categories based on national averages as follows: ≤ 0 SD (affluent neighbourhoods) and > 0 (deprived neighbourhoods). Neighbourhood disadvantage was used both as categorical variable (Studies I and III) and continuous variable (Study II) in the statistical analyses. Cumulative neighbourhood disadvantage score was used in all analyses, except in the longitudinal analysis of Study III, where neighbourhood disadvantage score at the childbirth was used.

4.2.3 Covariates

The demographic information of mothers and fathers, including parental age, parental BMI, parental education, family income and number of children in the family, were collected from self-administered questionnaires at the recruitment, at 10^{th} gestational week and child age of 2–5 years. Parental age was used as a continuous variable in statistical analyses. Maternal and paternal pre-pregnancy BMI was used as a continuous variable and classified as normal weight or overweight based on cut-off value of ≥ 25 kg/m^2.

Parental education and family income were used separately to indicate family SES. Information regarding education was collected from parent-report questionnaires upon recruitment, at 10^{th} gestational week and at child age of 2 and 5 years. Parental education was classified as advanced education or low education. Those who had no professional training of maximum of an intermediate level of vocational training were classified as "low education". Those who had studied at university were classified as "advanced education". Depending on the analysis, parental education was used both as a separate variable both for mother and father or as a parental education variable illustrating the highest education that one of the parents had completed for their professions. Information regarding family income (after taxes, including both parents) was obtained from parent-report questionnaires upon recruitment and at the child age of 2 and 5 years. Total family income was measured ona five-point scale (under 1000 EUR, 1000–2000 EUR, 2000–2999 EUR, 3000–4000 EUR and over 4000 EUR per month). For the statistical analyses, family income was classified as low income (< 3000 EUR per month) and high income (≥ 3000 EUR per month).

4.3 Statistical analyses

Statistical analyses were mainly conducted using SAS software for Windows version 9.4 (SAS Institute Inc.). For Study I, descriptive analysis was carried out using tools implemented in the R package (R Core Team 2018). The level of significance was set at p-value < 0.05.

The distributions of the variables were explored to check the normality. To examine the associations between neighbourhood disadvantage, diet quality and sociodemographic characteristics of the participants, chi-square tests were used for categorical variables and t-tests for continuous variables. T-tests were used to check the similarity of feeding practices between mothers and fathers. Paired t-tests were used to test the similarity of diet quality, CEBQ and PSE variables between 2 and 5 years. Cronbach's alpha estimates were computed for CEBQ food approach and food avoidance dimensions.

4.3.1 Linear regression modeling

For the present thesis, the cross-sectional associations between child appetitive traits, parental self-efficacy, parental diet quality, parental feeding practices, neighbourhood disadvantage and child BMI or diet quality were explored using linear regression models. Further, longitudinal associations between parental self-efficacy and child diet quality were tested with generalised linear mixed models. Similarly, parental diet quality change between gwk 30 and child age of 5 years was analysed with generalised mixed models. The models were adjusted for parental age, parental pre-pregnancy BMI, parental education, family income and number of siblings.

In Study I, the associations between parental feeding practices, child appetitive traits, neighbourhood disadvantage and child BMI were studied using linear regression (SAS Genmod procedure). First, in order to study the main effects of explanatory variables and child BMI, neighbourhood disadvantage, parental feeding or child food approach/avoidance variables were used as explanatory variables and child BMI z-score as dependent variable in the model. Secondly, 2-way interactions between neighbourhood disadvantage and parental feeding or child food approach/avoidance were used to investigate whether the associations change with neighbourhood disadvantage. To examine the bidirectionality in the association between child BMI and parental feeding practices, BMI z-score at age of 3 years was used as a predictor of parental feeding practices when the child was at age of 6 years.

In Study II, the associations between neighbourhood socioeconomic disadvantage, child appetitive traits and child diet quality were studied using linear regression models. In addition to the main effects, interaction effects between neighbourhood disadvantage and child appetitive traits on child diet quality were included.

In Study III, the cross-sectional association between neighbourhood socioeconomic disadvantage and parental diet quality was studied using linear regression models. Further, similarity of parental diet quality and child diet quality at 2 and 5 years of age were examined using linear regression models. In addition, changes in parental diet from pregnancy to the child's preschool age were analysed with generalised mixed models.

In Study IV, the cross-sectional associations of parental self-efficacy and child diet quality were tested with linear regression models. Similarly, generalised linear mixed models were used to study the longitudinal associations of PSE at the child age of 1.5 and 5 years and child diet quality at the child age of 2 and 5 years.

Coefficients of determination (R^2) were calculated for the thesis for all linear models with SAS Glm procedure.

4.3.2 Logistic regression modeling

In Study I, the child's risk of being overweight at 6 years of age was studied using logistic regression modeling. First, we studied the main effects of parental feeding or child appetitive traits or neighbourhood SES on child risk of overweight by adding the child BMI at 6 years of age as a binary dependent variable to the model. Secondly, 2-way interactions between neighbourhood disadvantage and parental feeding or child appetitive trait variables were used to investigate whether the risk changes with neighbourhood disadvantage. Odds ratios (ORs) and their 95% confidence limits (CLs) were calculated for each model to represent an average of the risk of being overweight.

4.3.3 Additional analyses

Sensitivity analyses

For Study I, the answers both from 6 and 5 years were used to maximise the number of participants. Sensitivity analyses were done to confirm the findings including only children with 6-year of age data. Similarly, for Study II, all the available answers were used depending on the study question. Thus, sensitivity analyses were done including only children with data from both age points.

Non-response bias

Sample dropout analysis was conducted to check the differences between the 2-year age point sample and the longitudinal sample in Study IV (including both 2- and 5-year age points). To estimate the potential effect of non-response, differences in sociodemographic variables (sex, age, education, income) between respondents and non-respondents were tested with independent t-tests for continuous variables and chi-square test for categorical variables. No statistically significant differences between respondents at 2 and 5 years and non-respondents were found (Study IV).

4.4 Ethical Considerations

The study was conducted according to the ethical principles of good research practice described in the declaration of Helsinki and the National Advisory Board on Research Ethics in Finland. The STEPS study has been approved by the Ethics committee of Hospital District of Southwest Finland (2/2007). Written informed consent was obtained from all the participants. The children's consent was given by their parents. Subjects were free to quit the study at any time without giving any specific reason.

5 Results

5.1 Characteristics of the study participants

Descriptive characteristics of the families who formed the baseline population in this thesis are presented in Table 9. The sample was restricted to those families who had answered the child diet quality questionnaire and had neighbourhood socioeconomic disadvantage data available at 2 years of age. Most of the participants lived in affluent neighbourhoods (71%). The proportion of boys in the sample was 52%. Child diet quality was higher in affluent neighbourhoods than in deprived neighbourhoods ($p = 0.004$).

The mean age of mothers at the child age of 2 years was 31.0 years and fathers 32.8 years. Mothers and fathers in deprived neighbourhoods were younger than in affluent neighbourhoods ($p < 0.0001$ and $p = 0.04$, respectively). The mean BMI for mothers was 24.1 and fathers 26.2. Maternal BMI was lower in affluent neighbourhoods compared with deprived neighbourhoods ($p = 0.02$). Further, maternal diet quality was higher in affluent neighbourhoods than in deprived neighbourhoods ($p = 0.02$). Most of the families (74%) had advanced education level, and education level was higher in affluent neighbourhoods compared with deprived neighbourhoods ($p < 0.0001$). In addition, family income was higher in affluent neighbourhoods compared with deprived neighbourhoods ($p < 0.0001$).

Table 9. Descriptive characteristics of the study participants and cumulative neighbourhood socioeconomic disadvantage. Sample includes families who had answered the child diet quality questionnaire and had neighbourhood socioeconomic disadvantage data available at 2 years of age. Statistical differences were tested with chi-square tests for categorical variables and t-tests for continuous variables.

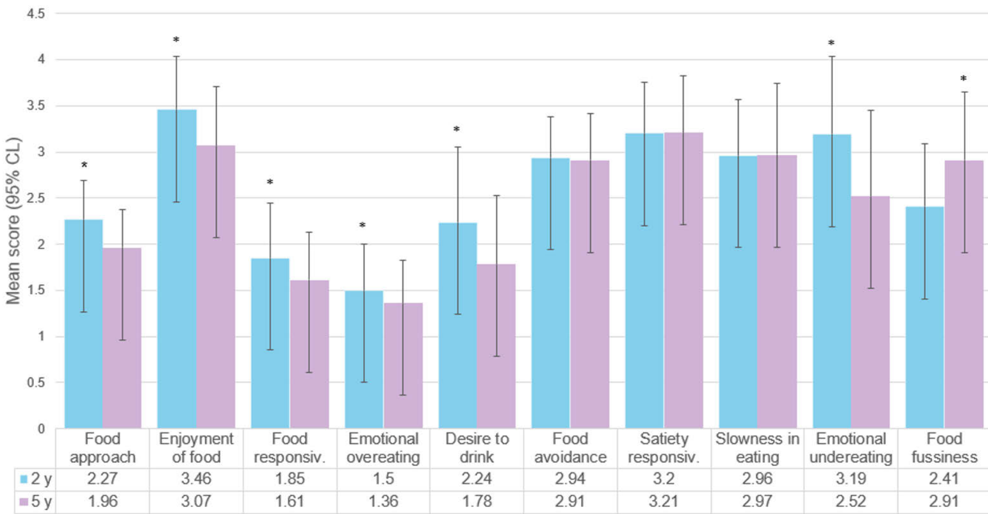
Variable	**All**	**Neighbourhood disadvantage[4]**		***p***
		Low (≤ 0) n (%)	**High (>0) n (%)**	
	734	523 (71%)	211 (29%)	
Child characteristics				
Boys, n (%)	383 (52%)	281 (54%)	102 (48%)	0.19
Child diet quality[1], Mean (SD)	6.04 (1.7)	6.15 (1.7)	5.75 (1.7)	**0.004**
Mother characteristics				
Mother age (years), Mean (SD)	31.0 (4.3)	31.4 (4.1)	30.0 (4.6)	**< 0.001**
Mother BMI (kg/m²), Mean (SD)	24.1 (4.6)	23.8 (4.4)	24.7 (5.1)	**0.02**
Mother overweight – Yes, n (%)	204 (28%)	135 (26%)	69 (33%)	0.06
Mother diet quality[2], Mean (SD)	9.8 (2.1)	10.0 (2.1)	9.5 (2.1)	**0.02**
Father characteristics				
Father age (years), Mean (SD)	32.8 (5.2)	33.1 (4.9)	32.2 (5.9)	**0.04**
Father BMI (kg/m²), Mean (SD)	26.2 (7.2)	25.8 (3.8)	27.0 (12.1)	0.059
Father overweight - Yes, n (%)	378 (54%)	271 (54%)	107 (55%)	0.87
Father diet quality[2], Mean (SD)	9.0 (2.2)	9.1 (2.3)	8.8 (2.0)	0.18
Family characteristics				
Parental education[3], n (%)				
Advanced	533 (74%)	409 (79%)	124 (60%)	**< 0.001**
Low	189 (26%)	106 (21%)	83 (40%)	
Family income, n (%)				
≥ 3000 EUR	321 (46%)	264 (54%)	57 (28%)	**< 0.001**
< 3000 EUR	372 (54%)	227 (46%)	145 (72%)	

[1] Mean score for adherence to the Finnish food recommendations for children in 2004; total points based on 10 individual dietary items for the dietary score. The range of diet quality score varied between 1–10 points in children.
[2] Mean Index of Diet Quality (IDQ) score, describing the implementation of a health-promoting diet in accordance with food recommendations. The range of diet quality score varied between 1–15 points in adults.
[3] Measured at the recruitment, at 10th gestational week. Highest education that one of the parents had completed for their professions.
[4] Cumulative neighbourhood socioeconomic disadvantage at child age of 2 years. Low disadvantage = affluent neighbourhoods, high disadvantage = deprived neighbourhoods.

5.2 Individual-level factors

5.2.1 Child appetitive traits

Child appetitive traits were included in Studies I and II. Descriptive characteristics of “Food approach” and “Food avoidance” appetitive traits at both age points are presented in Figure 5. Child food approach dimension and all its subscales were higher at 2 years compared with 5 years of age ($p < 0.001$). Food avoidance dimension ($p = 0.11$), satiety responsiveness ($p = 0.66$) and slowness in eating ($p = 0.52$) subscales were stable during the follow-up period. In contrast, emotional undereating decreased and food fussiness subscales increased from 2 to 5 years of age ($p < 0.001$).



*p < 0.001

Figure 4. Comparison of the mean of Food approach and Food avoidance dimensions and their subscales at 2 and 5 years of age from Study II. Statistical differences were tested with paired t-tests. Figure includes only children who had data on both age points (n = 575).

5.2.2 Child appetitive traits and BMI

Mean (SD) of child BMI z-score at 5/6 years of age was -0.05 (1.03). 16% of children had overweight (n = 111). Child appetitive traits were associated with child BMI z-score at 5/6 years of age in Study I (Table 10). Child “Food approach” dimension, subscales ‘enjoyment of food’, ‘food responsiveness’ and ‘emotional overeating’ were positively associated with child BMI z-score ($p < 0.001$ for all), meaning the higher the child Food approach score, the higher the BMI. However, subscale ‘desire to drink' was not associated with child BMI (p = 0.17). The model for "Food approach" dimension explained 14% of the variance in child BMI z-score. Child "Food avoidance" dimension (p = 0.003) and subscales 'satiety responsiveness' (p < 0.001) and 'slowness in eating' (p < 0.001) were negatively associated with child BMI z-score, meaning the higher the satiety responsiveness and slowness in eating scores, the lower the child BMI. 'Emotional undereating' (p = 0.38) and 'food fussiness' (p = 0.46) subscales were not associated with child BMI. The model for "Food avoidance" dimension explained 9% of the variance in child BMI z-score.

Table 10. The cross-sectional linear regression associations between child appetitive traits and child BMI z-score at 5/6 years of age from Study I. Food approach and Food avoidance subscales analysed additionally in this thesis. Adjusted for sex, mother's age, mother and father pre-pregnancy BMI, parental education and family income, each of them collected at 10th gestational week.

CEBQ variables	**BMI z-score BETA (95% CL)**	***p***	**R^2**
Food approach	0.63 (0.44–0.82)	**< 0.001**	0.14
Enjoyment of food	0.25 (0.13–0.36)	**< 0.001**	0.11
Food responsiveness	0.47 (0.34–0.60)	**< 0.001**	0.16
Emotional overeating	0.43 (0.26–0.59)	**< 0.001**	0.12
Desire to drink	0.08 (-0.03–0.20)	0.17	0.08
Food avoidance	-0.23 (-0.38–-0.08)	**0.003**	0.09
Satiety responsiveness	-0.38 (-0.51–-0.26)	**< 0.001**	0.13
Slowness in eating	-0.17 (-0.27–-0.07)	**< 0.001**	0.10
Emotional undereating	0.04 (-0.05–0.13)	0.38	0.08
Food fussiness	-0.04 (-0.14–0.06)	0.46	0.09

CEBQ, Child Eating Behaviour Questionnaire; CL, Confidence limits; R^2, Coefficient of determination

5.2.3 Child appetitive traits and diet quality

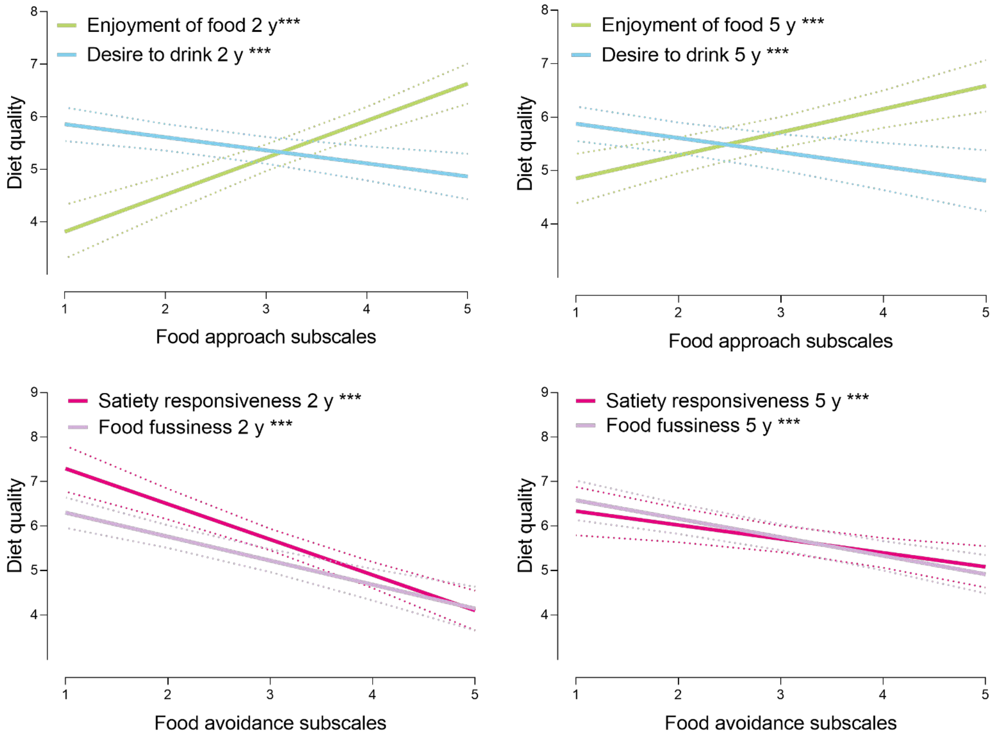
Child diet quality was higher, 6.33 (SD = 1.66), at 5 years compared to 5.98 (SD = 1.72), at 2 years (p < 0.001). Associations between child appetitive traits and child diet quality were investigated in Study II. Child "Food approach" dimension was not associated with child quality at 2 and 5 years of age (p-values 0.07 and 0.63, respectively). "Food avoidance" dimension was negatively associated with child diet quality both at 2 and 5 years of age (p < 0.001 for both), meaning the higher the food avoidance score, the lower the child diet quality. The model for "Food avoidance" dimension explained 11% of the variance at 2 years and 9% of the variance at 5 years in child diet quality score (Table 11).

Table 11. The cross-sectional linear regression associations between child appetitive traits and child diet quality at 2 and 5 years of age from Study II. Adjusted for mother's age, father's age, parental education and family income and number of siblings.

CEBQ variables	**Diet quality 2 years**			**Diet quality 5 years**		
	Beta (95% CL)	***p***	**R^{2*}**	**Beta (95% CL)**	***p***	**R^{2*}**
Food approach	0.25 (-0.02–0.52)	0.07	0.07	-0.07 (-0.37–0.23)	0.63	0.06
Enjoyment of food	0.71 (0.52–0.89)	**<0.001**	0.13	0.43 (0.25–0.62)	**<0.001**	0.09
Food responsiveness	0.15 (-0.04–0.34)	0.13	0.07	-0.12 (-0.36–0.12)	0.32	0.06
Emotional overeating	-0.03 (-0.27–0.21)	0.78	0.07	-0.24 (-0.51–0.04)	0.09	0.07
Desire to drink	-0.25 (-0.39–0.11)	**<0.001**	0.08	-0.27 (-0.43–-0.11)	**<0.001**	0.08
Food avoidance	-0.76 (-1.01–-0.51)	**<0.001**	0.11	-0.51 (-0.75–-0.27)	**<0.001**	0.09
Satiety responsiveness	-0.80 (-1.01–-0.59)	**<0.001**	0.13	-0.31 (-0.52–-0.11)	**0.003**	0.07
Slowness in eating	-0.12 (-0.32–0.07)	0.20	0.07	-0.07 (-0.22–0.09)	0.42	0.06
Emotional undereating	-0.13 (-1.01–-0.51)	0.07	0.07	-0.16 (-0.30–-0.03)	**0.01**	0.07
Food fussiness	-0.54 (-0.71–-0.37)	**<0.001**	0.12	-0.42 (-0.58–-0.25)	**<0.001**	0.09

CEBQ, Child Eating Behaviour Questionnaire; CL, Confidence limits; R^2, Coefficient of determination

More detailed investigation concerning the "Food approach" subscales showed that 'enjoyment of food' was positively associated with child diet quality, meaning the higher the enjoyment of food score, the higher the child diet quality (p < 0.001) at both age points (Figure 5). 'Desire to drink' was negatively associated with diet quality, meaning the higher the child desire to drink score, the lower the child diet quality (p < 0.001) at both age points (Figure 5). Regarding "Food avoidance" subscales, 'satiety responsiveness' and 'food fussiness' subscales were negatively associated with child diet quality, meaning the higher the satiety responsiveness or food fussiness scores, the lower the child diet quality (p < 0.001) at both age points (Figure 5). In addition, 'emotional undereating' was negatively associated with diet quality at child age of 5 years (p = 0.01), meaning the higher the emotional undereating score, the lower the child diet quality.



*** p-value < 0.001

Figure 5. The cross-sectional linear regression associations between child appetitive traits and child diet quality at 2 and 5 years of age from Study II. Figure includes only Food approach subscales: enjoyment of food, desire to drink and Food avoidance subscales: satiety responsiveness and food fussiness. Mean values with 95% confidence limits adjusted for covariates (mother's age = 30.81 and father's age = 32.89, family income < 3000 EUR, parental education = low education, number of siblings = 0.44 (2 years), 0.58 (5 years)).

5.3 Family level factors

5.3.1 Parental diet quality

Parental diet quality was investigated in Study III. Maternal diet quality was better than paternal diet quality during the follow-up period from 30th gestational week to child age of 5 years ($p < 0.001$). The diet quality of mothers decreased slightly during the follow-up period ($p < 0.001$) and the diet quality of fathers remained stable ($p = 0.96$) (Figure 6).

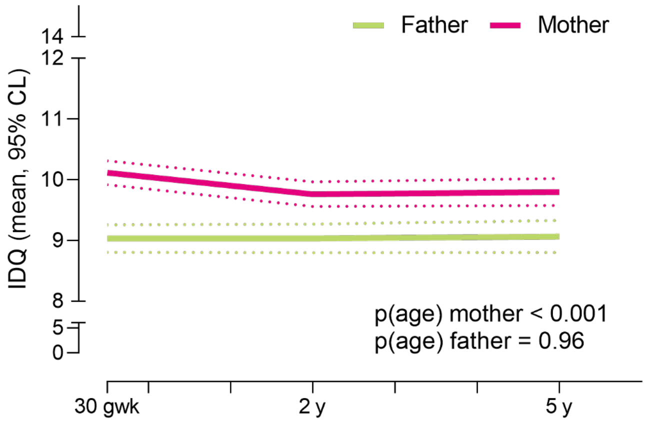


Figure 6. Longitudinal linear regression analysis of parental diet quality (IDQ, index of diet quality) changes from 30th gestational week until child age of 5 years. Mean values with 95% confidence limits adjusted for covariates (parental education, family income and the number of children).

5.3.2 Parental diet quality and child diet quality

Associations between parental diet quality and child diet quality were investigated in Study III. Both parents and children had a modest diet quality score during the study period. The percentage shares of the original diet quality scale maximum values for parents and children are presented in Figure 7.

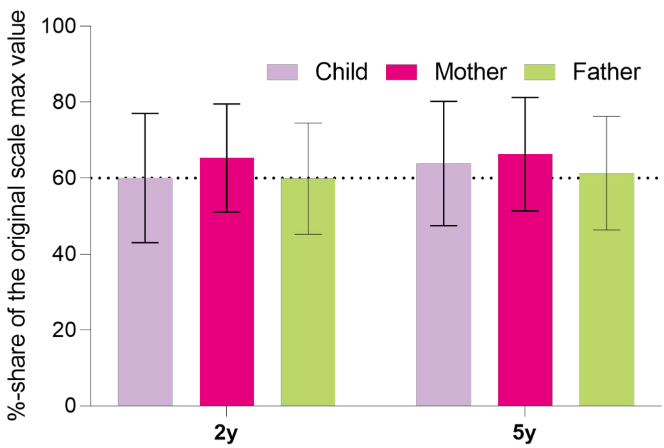


Figure 7. The similarity of the child and parent diet quality measured as the percentage share of the original diet quality scale max values. Percentage shares for parents and children at 2 and 5 years of age with confidence limits. The data are based on the unadjusted mean values of child and parent diet quality scores at child age of 2 and 5 years. Child diet quality max value is 10 and parent diet quality max value is 15.

In linear regression analyses adjusted for neighbourhood disadvantage, parental education, family income and number of children, diet quality of both mothers and fathers was positively associated with child diet quality both at 2 and 5 years of age, meaning that the higher the parental diet quality, the higher the child diet quality (Table 12). The model of mother diet quality explained 20–23% of child diet quality variance. The model of father diet quality explained 8–9% of child diet quality variance.

Table 12. The cross-sectional linear regression associations between parental diet quality and child diet quality at 2 and 5 years of age from Study III. Adjusted for neighbourhood disadvantage, parental education, family income and number of children.

Parental diet quality	**Child diet quality**		
	Beta (95% CL)	*p*	R^2
IDQ Mother 2 y	0.29 (0.23–0.36)	**< 0.001**	0.20
IDQ Father 2 y	0.16 (0.09–0.24)	**< 0.001**	0.08
IDQ Mother 5 y	0.32 (0.26–0.38)	**< 0.001**	0.23
IDQ Father 5 y	0.16 (0.09–0.23)	**< 0.001**	0.09

IDQ, Index of Diet Quality; R^2, Coefficient of determination

5.3.3 Parental feeding practices at preschool age

Parental feeding practices were investigated in Study I. Maternal 'restriction' score at child age of 5/6 years was 2.57 (SD = 0.72) and paternal 'restriction' score was 2.58 (SD = 0.72). Both parents used similar amounts of 'restriction' ($p = 0.33$).
Maternal 'pressure to eat' score at child age of 5/6 years was 2.85 (SD = 0.88) and for paternal 'pressure to eat' score was 2.91 (SD = 0.88). Fathers used more 'pressure to eat' feeding practice at child age of 5/6 years ($p < 0.005$).

5.3.4 Parental feeding practices and child BMI

In linear regression analyses adjusted for sex, mother's age, parental BMI, parental education and family income, parental controlling feeding practices were associated with child BMI z-score at 5/6 years of age (Table 13). Parental restrictive feeding practices were positively associated with child BMI z-score both with mother ($p < 0.001$) and father ($p = 0.002$), meaning the higher the 'restriction' score, the higher the child BMI. The model for maternal 'restriction' explained 12% and paternal 'restriction' explained 9% of the variance in child BMI z-score. Parental 'pressure to eat' was negatively associated with child BMI z-score both with mother and father ($p < 0.001$ for both), meaning the higher the 'pressure to eat' score, the lower the child BMI. The model for maternal 'pressure to eat' explained 14% and paternal 'pressure to eat' explained 10% of the variance in child BMI z-score.

Further, maternal restrictive feeding practices at the child age of 6 years were associated with higher risk of child overweight at the age of 6 years (OR (95% CL):

1.74 (1.25–2.43), $p < 0.001$). However, paternal restrictive feeding practices at the child age of 6 years were not associated with child risk of overweight ($p = 0.31$). In addition, maternal 'pressure to eat' at the child age of 6 years was associated with decreased risk of child overweight at the age of 6 years (OR (95% CL): 0.45 (0.33–0.60), $p < 0.001$). The corresponding figures for paternal 'pressure to eat' were OR (95% CL): 0.66 (0.46–0.95), $p = 0.03$.

Prospective analyses showed that child BMI z-score at the age of 3 years was positively associated with parental 'restriction' at the age of 6 years both for mother (beta (95% CL): 0.15 (0.08–0.21), $p < 0.001$) and father (beta (95% CL): 0.09 (0.01–0.16), $p = 0.02$), meaning the higher the child BMI, the higher the parental restriction score. Further, child BMI z-score at the age of 3 years was negatively associated with parental 'pressure to eat' both for mother (beta (95% CL) = -0.20 (-0.27–-0.12), $p < 0.001$) and father (beta = -0.19 (-0.28–-0.10), $p < 0.001$), meaning the lower the child BMI, the higher the parental 'pressure to eat' score.

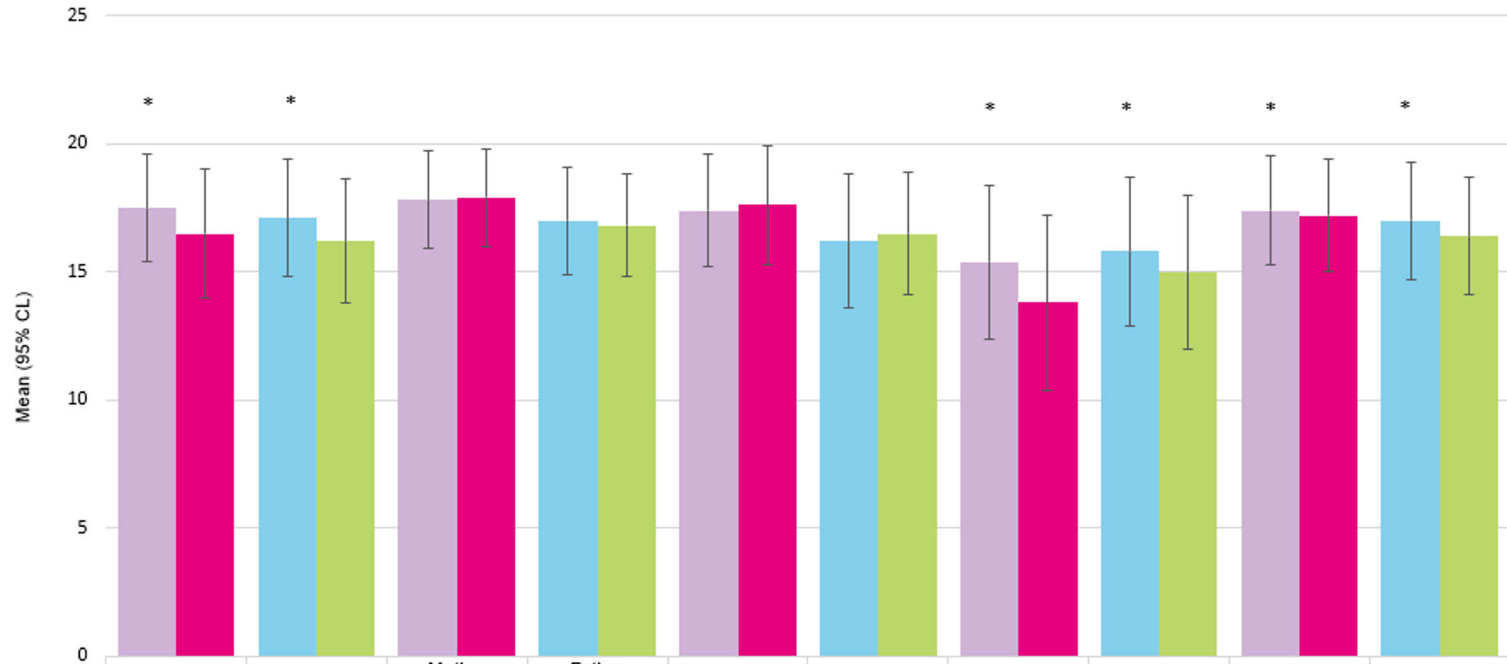
Table 13. The cross-sectional linear regression associations between parental feeding practices and child BMI z-score at 5/6 years of age from Study I. Adjusted for sex, mother's age, mother & father pre-pregnancy BMI, parental education and family income, each of them collected at 10th gestational week.

CFQ variables	**Child BMI z-score**		
	Beta (95% CL)	***p***	**R^{2*}**
Restriction			
Mother	0.26 (0.16–0.37)	**<0.001**	0.12
Father	0.19 (0.07–0.30)	**0.002**	0.09
Pressure to eat			
Mother	-0.29 (-0.37–-0.2)	**<0.001**	0.14
Father	-0.19 (-0.29–-0.09)	**<0.001**	0.10

CFQ, Child Feeding Questionnaire; CL, Confidence limits; R^2, Coefficient of determination

5.3.5 Parental self-efficacy

Parental self-efficacy, separately for mothers and fathers, was investigated in Study IV. Maternal self-efficacy was slightly higher at child age of 1.5 years (mean = 85.7) compared to 5 years (mean = 83.1, $p < 0.001$). Further, maternal PSE dimensions: 'presence', 'playing' and 'teaching' were all higher at child age of 1.5 years ($p < 0.01$ for all). However, the differences in dimensions: 'emotional support' and 'routines' were not statistically significant (p-values 0.24 and 0.06, respectively) (Figure 8). Paternal self-efficacy was higher at child age of 1.5 years (mean = 83.1) compared to 5 years (mean = 80.9, $p < 0.001$). Further, PSE dimensions: 'presence', 'playing' and 'teaching' were all higher at child age of 1.5 years ($p < 0.001$ for all). However, the differences in dimensions: 'emotional support' and 'routines' were not statistically significant (p-values 0.11 and 0.09, respectively) (Figure 8).



	Mother Presence	Father Presence	Mother Emotional support	Father Emotional support	Mother Routines	Father Routines	Mother Playing	Father Playing	Mother Teaching	Father Teaching
1.5 y mean	17.5	17.1	17.8	17	17.4	16.2	15.4	15.8	17.4	17
5 y mean	16.5	16.2	17.9	16.8	17.6	16.5	13.8	15	17.2	16.4

*p < 0.01

Figure 8. Comparison of the mean with 95% confidence limits the mother and father PSE (Parental Self-Efficacy) dimensions at 1.5 and 5 years of age from Study IV. Statistical differences were tested with paired t-tests. Figure includes only parents who had data on both age points (mother n = 593, father n = 429).

5.3.6 Parental self-efficacy and child diet quality

Cross-sectional linear regression analyses between PSE and child diet quality, in Study IV, showed that family-level PSE was positively associated with child diet quality at 2 and 5 years of age (2 years: beta (95% CL) 0.24 (0.04–0.45), p = 0.02; 5 years beta (95% CL) 0.37 (0.14–0.60), p = 0.002). Similarly, mother PSE was positively associated with child diet quality at both time points (2 years: beta (95% CL) 0.32 (0.16–0.49), p = 0.001; 5 years: beta (95% CL) 0.24 (0.09–0.39), p = 0.002). This means that the higher the family-level PSE and mother PSE scores, the higher the child diet quality. However, father PSE was not associated with child diet quality (2 years: beta (95% CL) 0.09 (-0.07–0.24), p = 0.28; 5 years: beta (95% CL) 0.14 (-0.04–0.32), p = 0.13). Longitudinal analyses confirmed cross-sectional results (Table 14).

More detailed investigation on PSE subscales showed that maternal 'presence', 'emotional support', 'routines', 'playing' and 'teaching' were all positively associated with child diet quality. For fathers, 'routines' was the only subscale which was positively associated with child diet quality (Table 14).

Table 14. The longitudinal associations between mother's and father's PSE at 1.5 and 5 years of age and child diet quality at 2 and 5 years of age from Study IV. Adjusted for the sex of the child, the mother's age, the father's age, family income, parental education, and the number of siblings.

	Mothers, **n = 411**		**Fathers**, **n = 286**	
	Beta (95% CL)	***p***	**Beta (95% CL)**	***p***
Total PSE score	0.27 (0.14–0.39)[1]	**<0.001**	0.10 (-0.02–0.23)[1]	0.11
Presence	0.05 (0.01–0.10)	**0.02**	0.01 (-0.03–0.06)	0.58
Emotional support	0.07 (0.02–0.12)	**0.009**	-0.004 (-0.06–0.05)	0.88
Routines	0.09 (0.05–0.13)	**<0.001**	0.08 (0.04–0.12)	**<0.001**
Playing	0.04 (0.01–0.07)	**0.007**	0.01 (-0.03–0.05)	0.67
Teaching	0.06 (0.02–0.10)	**0.01**	0.03 (-0.02–0.08)	0.19

[1] Estimate calculated per 10 PSE points.
PSE, Parental Self-Efficacy; CL, Confidence limits

5.4 Neighbourhood-level factors

5.4.1 Neighbourhood disadvantage and family diet quality

The associations of neighbourhood socioeconomic disadvantage (NSED) and diet quality in families were investigated in Studies II and III. NSED was negatively associated with child diet quality at 2 years of age (beta (95% CL) -0.22 (-0.40–-0.03), p = 0.02), meaning the higher the disadvantage, the lower the child diet quality. However, at 5 years of age the association between neighbourhood disadvantage and diet quality did not reach significance (beta (95% CL) -0.18 (-0.38–-0.02), p = 0.09) (Figure 9).

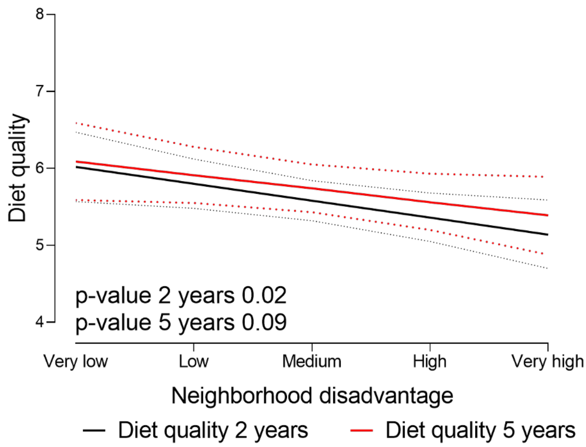


Figure 9. Child diet quality score at 2 and 5 years of age and cumulative neighbourhood disadvantage from Study II. Mean values with 95% confidence limits adjusted for covariates (mother's age = 30.81 and father's age = 32.89, family income < 3000 EUR, parental education = low education, number of siblings = 0.44 (2 years), 0.58 (5 years)).

The quality of both parents' diet was better in affluent neighbourhoods compared to those living in deprived neighbourhoods at all time points of the study (NSED $p < 0.05$). At each time point, fathers living in deprived neighbourhoods had the lowest diet quality and mothers living in affluent neighbourhoods had the highest diet quality. Only mothers living in affluent neighbourhoods adhered to a health-promoting diet (IDQ more than 10) during pregnancy.

5.5 Neighbourhood-level interactions

5.5.1 Child appetitive traits and child BMI

The association between child "Food approach" appetitive trait and BMI z-score was different between affluent and deprived neighbourhoods (interaction p = 0.02). In deprived neighbourhoods, "Food approach" tendency was more strongly associated with child BMI z-score (beta (95% CL) = 0.93 (0.60–1.26), $p < 0.0001$) than in affluent neighbourhoods (beta (95% CL) = 0.46 (0.24–0.69), $p < 0.0001$). The model explained 13% of the variance in child BMI z-score ($R^2 = 0.13$). However, the interaction effect between child "Food avoidance" appetitive traits and child BMI z-score or child risk of overweight was not statistically significant (interaction p = 0.13), meaning "Food avoidance" traits were similarly associated with child BMI z-score in affluent and deprived neighbourhoods (Figure 10).

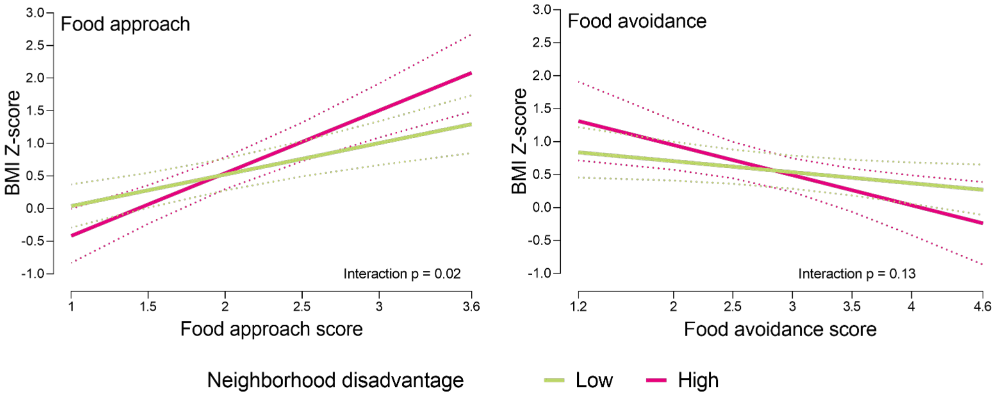


Figure 10. Cross-sectional linear regression analysis between child appetitive trait dimensions "Food approach" and "Food avoidance" in affluent and deprived neighbourhoods and child BMI z-score at 5/6 years of age with 95% confidence limits from Study I. Adjusted for covariates (sex = boys, mother pre-pregnancy BMI = overweight, father BMI = overweight, mother age = 17–29 years, parental education = low education, family income < 3000 EUR).

In addition, child risk of overweight was greatly increased with higher "Food approach" score in deprived neighbourhoods compared with affluent neighbourhoods (interaction p = 0.019). "Food approach" tendency increased the risk of overweight in deprived neighbourhoods (OR (95% CL): 11.17 (3.65–34.22), p < 0.0001), compared to affluent neighbourhoods (OR (95% CL): 2.54 (1.30–4.97), p = 0.006).

5.5.2 Parental feeding practices and child BMI

The interaction effect between neighbourhood disadvantage, parental feeding practices and child BMI z-score or child risk of overweight was not statistically significant (interaction p > 0.05), meaning parental feeding practices were similarly associated with child BMI z-score in affluent and deprived neighbourhoods (Figure 11).

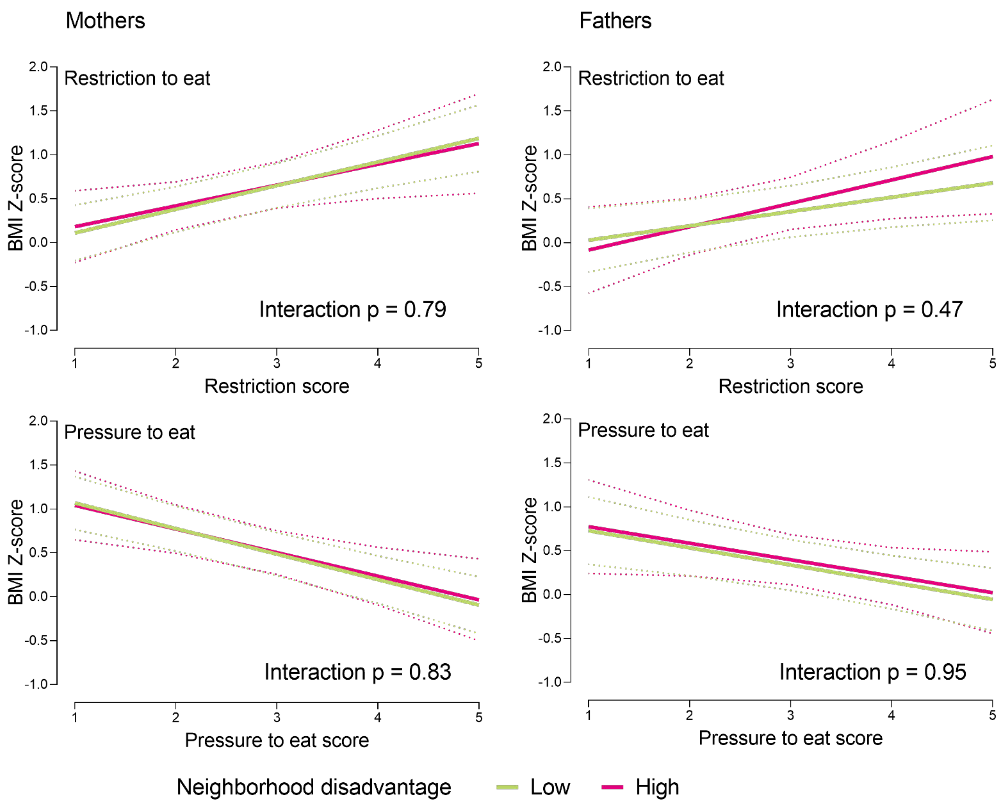


Figure 11. Cross-sectional linear regression analysis between parental feeding practices "Restriction" and "Pressure to eat" in affluent and deprived neighbourhoods and child BMI z-score at 6 years of age with 95% confidence limits from Study I. Adjusted for covariates (sex = boys, mother pre-pregnancy BMI = overweight, father BMI = overweight, mother age = 17–29 years, parental education = low education, family income < 3000 EUR).

5.6 Summary of the results

The summary of associations found in Studies I–IV is presented in Figure 12. To conclude, the results showed that both parental feeding practices and child appetitive traits are important factors which might affect child weight development (Study I). Parental feeding practice 'restriction' was positively associated with child BMI and 'pressure to eat' negatively associated with child BMI. Further, child "Food approach" dimension was positively associated with child BMI and "Food avoidance" negatively associated with child BMI. In addition, the neighbourhood disadvantage might enhance the effects of child "Food approach" appetitive traits on child BMI and risk of overweight at preschool age (Study I). Secondly, child diet quality is positively associated with child "Food approach" subscale 'enjoyment of food' and negatively associated with 'desire to drink'. In addition, child diet quality was negatively associated with "Food avoidance" dimension and subscales 'satiety responsiveness' and 'food fussiness' (Study II). Thirdly, child diet quality was positively associated with parental diet quality (Study III), parental self-efficacy (Study IV) and inversely associated with neighbourhood socioeconomic disadvantage (Study II).

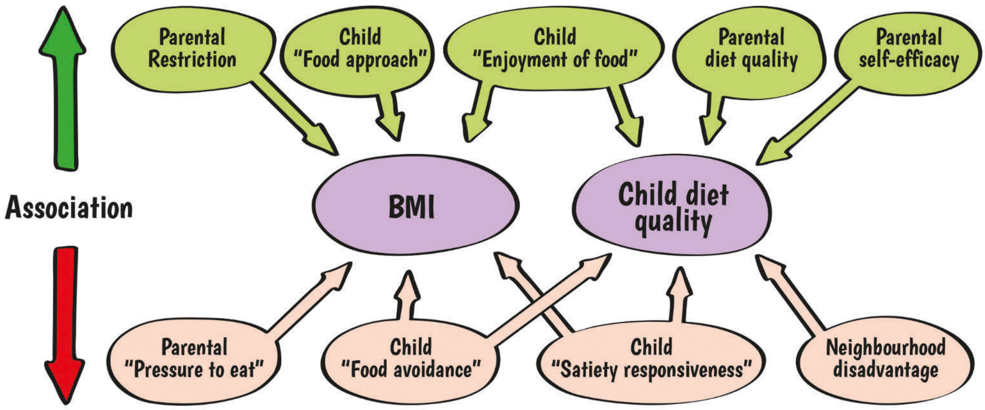


Figure 12. The summary of the main findings of the present study. Figure by Saija Tarro & Reima Honkasalo. The figure includes only statistically significant associations. BMI & child diet quality as outcome variables. Explanatory variables in green represent the variables which were positively associated with outcome variables. Explanatory variables in red represent the variables which were negatively associated with outcome variables.

6 Discussion

The present thesis aimed at studying the associations of individual, family and neighbourhood-level factors affecting diet quality and BMI with young (i.e., 2–6 years old) children. The primary results support a socioecological framework (Story et al., 2008) suggesting that child diet quality and BMI are associated with all three levels: individual, family and neighbourhood. Child appetitive traits, parental diet, parental self-efficacy and neighbourhood socioeconomic disadvantage are all associated with child diet quality. In addition, child appetitive traits and parental feeding practices are important factors affecting child weight development. Further, the neighbourhood disadvantage might increase the effects of child "Food approach" appetitive traits on child BMI at preschool age.

6.1 Individual-level factors

6.1.1 Child appetitive traits

We found that child "Food approach" appetitive traits and "Food avoidance" trait 'emotional undereating' were slightly higher at 2 years compared with 5 years of age. In addition, "Food avoidance" appetitive trait 'food fussiness' increased slightly from 2 to 5 years of age. Other "Food avoidance" subscales remained stable. Our results partly support earlier studies suggesting that appetitive traits show individual continuity during childhood (Ashcroft et al., 2008; C. Farrow & Blissett, 2012; E. Jansen et al., 2023). However, earlier research suggests that "Food approach" appetitive traits tend to increase with age and "Food avoidance" appetitive traits tend to decrease with age (Ashcroft et al., 2008; E. Jansen et al., 2023). The different results might, however, be explained by the different age range between the studies.

6.1.2 Child appetite associated with BMI and diet

As the first study among Finnish preschoolers, we found that higher levels of child "Food approach" appetitive traits were associated with higher child BMI and higher risk of overweight. This is in line with previous studies showing positive association between "Food approach" traits and child BMI (Boswell et al., 2018; Carnell & Wardle, 2008; Domoff et al., 2015; Ek et al., 2016; P. W. Jansen et al., 2012; J. Spence et al., 2011; Tay et al., 2016; Viana et al., 2008; Webber et al., 2009). This study did not include prospective or longitudinal analysis, but according to the previous studies there is some evidence that the association might be bidirectional (Derks et al., 2018; Gregory et al., 2010; Steinsbekk & Wichstrøm, 2015; van Jaarsveld et al., 2011). Higher levels of "Food approach" subscales 'enjoyment of food', 'food responsiveness' and 'emotional overeating' were all associated with higher BMI. However, subscale 'desire to drink' was not associated with BMI. Both 'enjoyment of food' and 'food responsiveness' have been linked to overweight and obesity in children in previous studies (McCarthy et al., 2015). In our study, the effect sizes between "Food approach" and BMI seemed to be highest for 'food responsiveness' and 'emotional overeating', suggesting that those two subscales might be important factors considering prevention of childhood overweight.

Regarding the associations of child appetitive traits and diet quality, only subscale 'enjoyment of food' was positively associated with child diet quality, meaning the higher the 'enjoyment of food' tendency, the higher the diet quality. 'Enjoyment of food' trait also had a reasonably high effect size. This result is supported by previous research from the UK, Portugal and Australia, indicating that 'enjoyment of food' might be associated with increased intake and liking of fruits and vegetables (Cooke et al., 2004; Fildes et al., 2015), a higher diet quality (da Costa et al., 2022) and a higher diet variety (Vilela et al., 2018). It is especially interesting that higher 'enjoyment of food' trait was associated both with increased diet quality and higher BMI. This might be explained by the fact that 'enjoyment of food' characterises a more avid appetite and greater interest in food in general (Kininmonth et al., 2023), which might increase the total amount of calories consumed. A previous study supports this idea suggesting that 'enjoyment of food' might be associated with higher energy intakes especially with children with a high BMI (Fogel et al., 2018). In our study, subscale 'food responsiveness' was not associated with child diet quality. This is partly contrary to earlier studies suggesting that 'food responsiveness' might have a positive association with diet quality and novel food acceptance (Jarman et al., 2022). According to the child eating behaviour questionnaire, 'food responsiveness' refers to the child's willingness to eat palatable, energy dense foods (Wardle et al., 2001) and could thus have an effect on dietary intakes. On the other hand, in this study, subscale 'desire to drink' was negatively associated with diet quality. 'Desire to drink' tendency in children has been linked with increased consumption of sweetened beverages (Sweetman et al., 2008) and lower diet variety (Vilela et al., 2018). In addition, higher intake of sugar-sweetened beverages and higher intake of fast food have been suggested to be the main dietary risk factors for child overweight (Jakobsen et al., 2023). It was surprising that in our sample, the ‘desire to drink’ tendency was not associated with child BMI. Previous research having found positive association between ‘desire to drink’ and child BMI (Tay et al., 2016; Webber et al., 2009) has been mostly concentrated on school-aged kids, and the sample of this study consisted of small children for whom parents are still important “nutritional gatekeepers” influencing types and amounts of foods consumed.

Regarding “Food avoidance” traits, we noticed that both the “Food avoidance” dimension and subscales ‘satiety responsiveness’ and ‘slowness in eating’ were associated with lower child BMI. This is in line with previous studies showing negative associations with ‘satiety responsiveness’, ‘slowness in eating’ and child BMI (Carnell & Wardle, 2008; Domoff et al., 2015; Jani et al., 2020; P. W. Jansen et al., 2012; Sleddens et al., 2008; J. Spence et al., 2011). In addition, we found that subscales ‘satiety responsiveness’, ‘emotional undereating’ and ‘food fussiness’ were negatively associated with child diet quality. This is consistent with a previous study suggesting that lower ‘satiety responsiveness’ was associated with higher child diet quality (da Costa et al., 2022). ‘Emotional undereating’ has been inversely associated with adherence to the Mediterranean diet in children (Buja et al., 2022). Secondly, emotional eating has been associated with an unhealthy dietary pattern in a sample of about 5,500 children from 12 countries (Jalo et al., 2019). In our study, the effect sizes between “Food avoidance” and child BMI and child diet quality seemed to be highest for ‘satiety responsiveness’, suggesting that this trait might act as one possible target for creating healthy eating habits and maintaining a healthy body weight. Further, concurrent evidence shows that ‘food fussiness’ is associated with lower fruit, vegetables and fish intake, lower diet quality and diet variety (Cardona Cano et al., 2015; N. Cole et al., 2017; da Costa et al., 2022; Jani et al., 2020; Jarman et al., 2022; Oliveira et al., 2015). ’Food fussiness’ at early childhood has also been shown to positively predict ‘food fussiness’ and negatively predict diet quality in adulthood (Dubois et al., 2022). Thus, ‘food fussiness’ is another important construct in developing healthy eating habits.

6.1.3 Child diet quality was moderate but increased slightly with age

We found that child diet quality was at a moderate level in early childhood, which is in line with previous studies (Jarman et al., 2022; Koivuniemi et al., 2022). Most of the children had regular meals, ate breakfast daily, used water as a primary beverage and used fat-free or low-fat dairy products with meals. However, only about a third of the children used unsaturated fat table spreads and less than half consumed recommended amounts of vegetables, fruits and berries daily. In addition, the consumption of fish was low especially at 2 years of age. However, the number of children consuming the recommended amount of fish per week was higher at 5 years of age. That might be one reason why child diet quality was slightly higher at 5 years of age compared to 2 years in our sample. Previous results show that the child's younger age have been associated with better diet quality (Hauta-Alus et al., 2017; Koivuniemi et al., 2022; Kyttälä et al., 2010, 2014; Pitt et al., 2018; Thomson et al., 2019). Most of the 5-year old children (89%) in this study sample attended daycare (Matarma et al., 2018). According to a large cohort study from Europe, children who attended daycare had a better diet quality compared with children eating mostly at home (Moreira et al., 2015). Similar evidence exists in Finland, suggesting that the diet of children attending daycare might be closer to the Finnish food recommendations than the diet of home-cared children (Kyttälä et al., 2014; Lehtisalo et al., 2010). According to a recent Finnish study, daycare meals accounted for about 50% of the weekday's energy intake (Korkalo et al., 2019). Moreover, availability and accessibility of fruits and vegetables in daycare centers differs somewhat between municipalities even in Finland (Ray et al., 2016). A recent Finnish study has also found that several factors in the daycare mealtime environment, such as personnel's opinions, might play an important role in children's dietary intakes at daycare (Lehto, 2020). In addition, other factors might play an important role at this age point, such as food eaten by child's peers and child personality (Ray et al., 2016).

6.2 Family level factors

6.2.1 Socioeconomic gradient in child BMI and diet

The studies of the present thesis show that parental pre-pregnancy BMI, mother age, family income and parental education at the time of childbirth were all significantly associated with child BMI at preschool years. In addition, we found that the children having better diet quality were characterised by a family with high education level and high income. According to a recent review by Jarman et al. (2022), previous research consistently showed a positive relationship between parental education and child diet quality, whereas lower family income was associated with poorer diet quality. Further, similar results have been found in a previous Finnish study suggesting that child dietary intakes are associated with socioeconomic position of the family (Eloranta et al., 2011). Lastly, economic and psychosocial challenges, lack of resources, knowledge and skills, often accumulate in the same families (Rantala et al., 2020).

6.2.2 Parental diet is reflected in child diet

In this sample, maternal diet quality decreased slightly from pregnancy to child age of 5 years, while the diet quality of fathers remained stable. On the contrary, diet quality of children improved slightly during 2 and 5 years of age. However, the changes both in maternal and child diets were modest and our results support earlier research findings suggesting a positive relationship between the diet quality of parents and their preschool-aged children, meaning that the higher the parental diet quality, the higher the child diet quality (Jarman et al., 2022; Vepsäläinen, Nevalainen, et al., 2018).

Earlier studies from Europe and the US have suggested that the transition to motherhood has been associated with positive changes in eating habits (Hartmann et al., 2014; Olson, 2005; Versele et al., 2021). Some studies, however, have suggested that the changes in dietary intakes throughout pregnancy until postpartum period might be unfavourable, such as decreases in fruit and vegetable intakes and skipping meals (Jardí et al., 2019; Versele et al., 2021). Transition to fatherhood might not change food consumption patterns in similar ways as for mothers (Hartmann et al., 2014). Previous studies suggest that mother's diet might have the key influence on the child diet quality (Fisk et al., 2011). Similarly, in our sample, the mother's diet quality explained a higher amount of variance in child diet quality compared with the father's diet quality. However, this might be partly explained by the so-called respondent bias, i.e. a stronger resemblance with the parent who reported the child's diet (Vepsäläinen, Nevalainen, et al., 2018). In this study, it was not controlled for which parent responded to the child dietary questionnaire.

6.2.3 Parents respond to child BMI both short and long-term

The results of this study support earlier cross-sectional findings (Carnell & Wardle, 2007b; Costa et al., 2011; Couch et al., 2014; P. W. Jansen et al., 2012; Nowicka et al., 2014; Wehrly et al., 2014) suggesting that parental (both mother and father) feeding practice 'restriction' is positively associated with child BMI meaning the higher the parental 'restriction' the higher the child BMI. In addition, feeding practice 'pressure to eat' is negatively associated with child BMI meaning the higher the parental 'pressure to eat' the lower the child BMI. High levels of maternal 'restriction' also increased the child risk of being overweight at preschool age. In addition, high levels of parental (both mother and father) 'pressure to eat' decreased the child risk of being overweight at preschool age. Moreover, in prospective analysis, a positive association between child BMI at 3 years of age and parental 'restriction' at 6 years of age was found. Further, a negative association with child BMI at 3 years of age and parental 'pressure to eat' was found. Based on the cross-sectional results, the direction of the effects cannot be stated, but based on prospective analysis, our results support the child-responsive model by which parents adapt their feeding practices in response to their child's BMI (Derks et al., 2017; P. W. Jansen et al., 2014; Liszewska et al., 2018). Therefore, it can be suggested that parents might use different feeding practices as a response to their child BMI both short and long-term.

6.2.4 Higher parental self-efficacy might improve child diet quality

Parental self-efficacy for both mothers and fathers was higher at child age of 1.5 years compared to child age of 5 years. This finding is similar to earlier research paper by Junttila et al. (2015). Similarly, one other study by Campbell et al. (2010) suggested that maternal self-efficacy regarding child healthy habits might decline during the first few years of a child's life.

The results of this thesis suggest that family-level and maternal PSE were positively associated with child diet quality both at 2 and 5 years of age, meaning that the higher the PSE, the higher the child diet quality. For mothers, 'routines', 'playing' and 'teaching' subscales were all associated with child diet quality at both age points. For fathers, only the subscale 'routines' was positively associated with child diet quality. Our results support earlier findings (Campbell, Hesketh, et al., 2010; Ice et al., 2012; Koh et al., 2014; Möhler et al., 2020; Parekh et al., 2018; Sagui-Henson et al., 2020; A. Spence et al., 2014; Walsh et al., 2019), suggesting that parental self-efficacy might be an important modifiable factor behind child dietary intakes. However, the effect sizes were small, possibly reflecting the fact that child diet quality is influenced by a variety of other factors.

There is a considerably high amount of variation in the domains of self-efficacy assessed in previous studies. Parental self-efficacy can be assessed and measured from different levels of specificity: global, domain and task-specific self-efficacy (Wittkowski et al., 2017). Task-specific efficacy beliefs refer to specific tasks, whereas domain-specific efficacy beliefs represent a more multidimensional index of parenting self-efficacy, and global efficacy beliefs refer to parenting competence beliefs in general. Our study used a domain-specific PSE scale by Coleman & Karraker (2003) taking into account the developmental phase of a child. Except for one study using a global parental self-efficacy measure (Xu et al., 2013), most of the previous studies investigating the association of PSE and child dietary habits have used task-specific measures (Campbell, Hesketh, et al., 2010; Ice et al., 2012; Koh et al., 2014; Möhler et al., 2020; Parekh et al., 2018; Sagui-Henson et al., 2020). Thus, it is especially interesting that we were able to show associations between PSE and child diet quality using a broader scale on PSE than previous studies.

6.2.5 Mothers might have bigger effect on child diet and weight than fathers

The results of this thesis support the view that both mothers' and fathers' controlling feeding practices might affect child BMI and vice versa. Nevertheless, there were some differences between mothers' and fathers' feeding practices. Partly contrary to earlier findings (Khandpur et al., 2016; Scaglioni et al., 2018), fathers used more 'pressure to eat' feeding practice compared with mothers. Secondly, the odds of having overweight at preschool age was significantly higher for the children whose mothers used higher levels of restrictive feeding practices as compared to mothers who used lower levels of restrictive feeding practices. On the other hand, the risk of having overweight was not visible with fathers' restrictive feeding. This might reflect the view that mothers may still have the main role in establishing the home food environment and they are responsible for determining how much food is offered to their children (Campbell, 2016; Scaglioni et al., 2018).

Regarding parental self-efficacy, maternal self-efficacy was clearly associated with child diet quality, but no similar association was seen with paternal self-efficacy. This might reflect the fact that although fathers are increasingly involved in family work, women have to date remained mainly responsible for the health and well-being of family members (K. Davison et al., 2021). According to Finnish Institute of Health and Welfare, the division of household tasks still remains traditional in Finland, and Finnish mothers are still more likely to be responsible for cooking than men (Attila et al., 2019).

6.3 Neighbourhood-level factors

6.3.1 Decreasing neighbourhood disadvantage might enhance child diet

We found that neighbourhood socioeconomic disadvantage was negatively associated with diet quality in early childhood, at the age when most of the STEPS study children were still cared for at home. Thus, the results suggest that children living in deprived neighbourhoods have lower diet quality compared to their peers from affluent areas. In many cases, individual food groups are monitored at the population level, although the overall quality of the diet is the one that promotes health. A previous cohort study in Finland suggests that intake of fruits and vegetables might be lower in children exposed to high socioeconomic disadvantage neighbourhoods (Kivimäki et al., 2018). However, only one previous study regarding child whole diet quality exists, with results suggesting that neighbourhood socioeconomic disadvantage might be negatively associated with child diet quality

(Keita et al., 2009). It is particularly interesting to study how the wider neighbourhood socioeconomic position affects diets of the families in addition to the family's own socioeconomic status. The results of this study suggest that living in deprived neighbourhoods might act as an independent risk factor for poor diet irrespective of the family's own socioeconomic status.

6.3.2 Neighbourhood disadvantage might increase the food approaching children's risk for overweight

We did not find a main effect between neighbourhood socioeconomic disadvantage and child BMI. The results did not support earlier findings according to which neighbourhood disadvantage is positively associated with child BMI (Alvarado, 2016; Carter & Dubois, 2010; Greves Grow et al., 2010; Rautava et al., 2022). The different results can be partly explained by non-standardised usage of growth charts in studies (i.e., differences between national, IOTF or WHO growth reference curves and cutoff values). Nevertheless, the novel finding of this study was that the association between child "Food approach" appetitive traits and child BMI was significantly higher in deprived neighbourhoods compared with affluent neighbourhoods. This means that the food approaching children growing up in the most deprived neighbourhoods had the highest BMI z-scores at preschool years. In addition, the risk of having overweight was highest among the same children. The effect was seen even though the families' own socioeconomic status was controlled for in the analyses. It is especially interesting that we were able to indicate that the living environment might add up a layer of its own to the risk factors in Finland. The study population lives in Southwest Finland, one of the most affluent provinces of Finland, and overall, Finland is a country known for a low level of socioeconomic inequalities (Saikkonen et al., 2018). However, income and ethnic segregation have increased during last years in the City of Turku region (Saikkonen et al., 2018).

It has been suggested that a high total energy intake rather than low total energy expenditure might constitute the main risk factor behind overweight development in children (J. Spence et al., 2011). Typically, the association between neighbourhood socioeconomic disadvantage and higher risk for overweight is explained by the so-called availability hypothesis (Caldwell & Sayer, 2019). As earlier research suggests, deprived neighbourhoods might have less access to healthy food and greater availability of fast-food restaurants (Black et al., 2014; Glanz et al., 2007; Travert et al., 2019). Secondly, the intake of soft drinks and other non-core foods might be higher in deprived neighbourhoods compared with affluent neighbourhoods (Bernsdorf et al., 2016; Drewnowski et al., 2019; Ranjit et al., 2015). However, many previous studies are mainly based on American and European samples, so it is difficult to mirror them directly to the results obtained in Finland. There is a lack of studies in Finland regarding the location of fast-food restaurants or various food stores. Among adolescents, proximity to a fast-food outlet close to school has been associated with irregular eating habits and higher risk for overweight, especially concerning adolescents coming from low SES families (Virtanen et al., 2015). In addition to the location, product price and placement strategies in food stores are important factors affecting food choices (Drewnowski et al., 2012; Shaw et al., 2020).

Psychosocial factors can help in understanding the neighbourhood effects on BMI. People in the neighbourhoods might have shared values and norms (Ribeiro et al., 2019) and overweight has been shown to spread through social relationships (Christakis & Fowler, 2007). In addition, humans tend to eat more and unhealthier food when stressed (Torres & Nowson, 2007) and higher parental stress in deprived neighbourhoods might explain why food-approaching children are more susceptible to an obesogenic environment (Boswell et al., 2018; Gemmill et al., 2013). The link between stress and unhealthy diet has been shown also in Finland with preschool-aged children as high hair cortisol concentrations in children were associated with lower scores in a health-conscious dietary pattern (Vepsäläinen et al., 2021). Further, child temperamental traits, such as impulsivity, might increase the child's susceptibility to an obesogenic environment (Zhou et al., 2019). A Finnish study suggested that children with high levels of negative affectivity might be more vulnerable to food cues in the home environment (Pajulahti et al., 2021).

6.3.3 Parental feeding practices were similarly associated with child BMI in deprived and affluent neighbourhoods

Based on our results, the association of parental feeding practices on child BMI did not differ in deprived and affluent neighbourhoods. This finding is partly contrary to earlier research suggesting that food insecurity and low socioeconomic status are associated with increased controlling feeding practices (Arlinghaus & Laska, 2021; Cardel et al., 2012). However, some previous studies indicate that food parenting practices might be more related to personal and other contextual factors, such as parent dieting status (Roberts et al., 2018), parent' own childhood experiences and family health concern (Mena et al., 2015).

6.4 Strengths and limitations

Firstly, the large sample size and utilization of a high-resolution cumulative socioeconomic disadvantage information from Statistics Finland's grid database (250 x 250 meters) where the subject's home address is linked to each time point are major strengths of this study. Using cumulative information, the effect of moving history was taken into account in the analyses. However, the size of the households has not been accounted for when assessing the median annual household income. Secondly, studying the interactions between different levels of socioecological model (individual, family, neighbourhood) can provide a deeper view into the factors associated with child diet quality and weight. Thirdly, the sample data included answers to a child feeding questionnaire and parental self-efficacy from both parents and thus widened previous understanding on the similarities and differences between mothers and fathers. In addition, the inclusion of fathers highlights the importance of both parents as the key role players in child obesity prevention. Lastly, we have assessed several sociodemographic and family-related factors affecting child eating habits and included several covariates in the analysis, thus decreasing the likelihood of bias due to unadjusted confounders.

This study has also some limitations. The results of this study must be considered in the light of the fact that the families that participated in the STEPS study differed to some extent from the cohort of children born at the same time: the children were mostly the first in the family and the parents' professional status was higher (Lagström et al., 2013). Thus, the generalizability of our findings to other populations and cultures needs to be confirmed in other studies. Regarding the questionnaire data, we cannot put aside self-report bias as it may be possible that parents provided socially desirable responses. The self-report bias may have affected some appetitive trait, parental feeding practices or parental self-efficacy questions more than others and this might affect our results. The child diet quality was assessed by individual questions that were partly derived from the adult validated questionnaire "Index of Diet Quality" (Leppälä et al., 2010). However, it can be assumed that the questions derived from the Finnish food recommendations for infants and young children (Hasunen et al., 2004) proved at least a reasonable overview of the child diet quality. In addition, the child diet quality questionnaire used in this study did not specifically exclude daycare hours. Thus, the results could be partly explained by the fact that most of the 5-year old children (89%) from the study population attended daycare (Matarma et al., 2018). The IDQ questionnaire used with parents can be considered as a good overview of the implementation of an adult health-promoting diet. Compared to other dietary indicators, IDQ form can be easily filled and used independently. This study did not include home food environment, such as food availability, which might be a moderating factor between neighbourhood socioeconomic status and child diet quality (Ranjit et al., 2015). Lastly, regarding parental self-efficacy and child diet quality, there was a small gap: PSE was measured at the child age of 1.5 years and diet quality at 2 years of age. Nevertheless, according to previous studies, PSE is fairly stable within such a short time period (Junttila et al., 2015; Pierce et al., 2010).

6.5 The contribution of this study

Previous studies have mostly included child's own and/or family level factors when studying child dietary intakes or BMI. However, the novelty of this study lies in investigating the interactions of multi-level factors with child outcomes within the same study population. In addition, we are lacking studies investigating the role of parental psychosocial factors, such as parental self-efficacy, with early childhood diet (Table 15).

Table 15. The contribution of this study compared to previous knowledge.

LEVEL	WHAT WAS KNOWN BEFORE THIS STUDY	THE NOVELTY OF THIS STUDY
Child	Child "Food approach" appetitive traits are positively associated and "Food avoidance" traits are negatively associated with child BMI. Indication of bidirectional mechanisms between appetitive traits and child BMI. Child appetitive traits might be associated with dietary intakes. 'Enjoyment of food' and 'food responsiveness' are positively associated with diet quality. 'Food fussiness' is negatively associated with diet quality.	First study among Finnish preschool-aged children on the associations between child appetitive traits, BMI and diet quality. Among the first studies to include composite scores of "Food approach" and "Food avoidance" in addition to the subscale scores.
Family	Parental restriction is positively associated and pressure to eat is negatively associated with child BMI. No consensus on the direction of the effects.	First study among Finnish preschool children on the associations of parental feeding practices and child BMI. Evidence on child-responsive model by which parents adapt their feeding practices in response to their child's BMI.
	Maternal self-efficacy is positively associated with fruit and vegetables intakes and negatively associated with non-core food intakes in children. Some evidence for paternal self-efficacy and child dietary intakes.	First study to analyze separately for fathers and mothers and a composite score for both mother and father self-efficacy. Among the first studies to suggest that domain-specific parental self-efficacy might be positively associated with child overall diet quality.
Neighbourhood	Neighbourhood socioeconomic disadvantage (NSED) is positively associated with child BMI.	
	NSED is inversely associated with fruit and vegetable intake in children.	Among the first studies to show inverse association between NSED and child overall diet quality.
	NSED is inversely associated with fruit and vegetable intake and adherence to food recommendations in adults.	First study to show inverse association between NSED and diet quality of parents of young children.
	Results are based mostly on cross-sectional NSED variable.	Among first studies using cumulative NSED variable highlighting the cumulative effects of NSED.
Interactions	No earlier studies on interaction effects between different levels.	First study to suggest that associations between child appetitive traits and BMI differ with NSED.

6.6 Future directions

As knowledge about the multilevel factors affecting child eating habits and weight development accrue, the mechanisms of action will be better understood, and eventually more intervention options will become available targeted for the parents to be and families with young children. Families might benefit from a positive guidance towards healthy eating rather than negative guidance to reduce unhealthy habits (Erkkola et al., 2019). However, providing individuals with the motivation and skills to change behaviour might not be effective if environments make it difficult to choose healthful behaviours. Socioeconomic inequalities between neighbourhoods should be addressed as part of policies, and emphasis should be put on creating environments that make healthy choices easy, as well as guiding and empowering families to make those healthy choices (Erkkola et al., 2019; Glanz et al., 2015; Rantala et al., 2020). Altogether, a network of professionals from many sectors in municipalities and wellbeing services counties are needed to combine their efforts and identify and implement important contributions in the broad target of improving child eating habits and preventing overweight (Koivusilta et al., 2022; Mäki et al., 2021).

Since several factors behind child eating habits and weight status still remain understudied, there would be room for further research. Especially longitudinal, prospective studies following the same individuals over prolonged time periods are needed combining different environmental and individual factors affecting child eating and weight over time. There are several ways to improve the current assessment methods of child eating habits. Firstly, the measures of child eating behaviours need refining, and the validity of different measures needs confirming (C. Russell et al., 2023). Secondly, novel data analysis techniques could be used to examine the profiles of child eating behaviours and their associations with weight. For example, latent profile analysis using a person-centered approach would be a good tool in addition to current variable-centered methods. In addition, most of the previous studies have assessed child and parent characteristics as static variables. However, there may be day-to-day fluctuations in the behaviour requiring the assessment of intra-individual variation to identify deeper nuances within behaviour and its correlates. Thus, using innovative methodologies, such as ecological momentary assessment (EMA) in the future, might provide new viewpoints to the complex phenomenon of child eating habits and weight (Berge, 2021).

Further studies should have a deeper look into the relationship between families with different backgrounds (e.g., divorced families, single parents) and the neighbourhood socioeconomic disadvantage regarding the quality of the diet and weight. It is particularly important to take into account the long-term moving history of parents. The ways to define disadvantage can be considered in the future studies. For example, England Index of Multiple Deprivation (IMDP) contains several domains in addition to income, employment and education, such as crime, health deprivation, barriers to housing and services, as part of deprivation index (GOV.UK, 2019). Lastly, other measures of neighbourhood characteristics could be used in the future studies, such as the stability of the neighbourhoods and social cohesion, which might act as relevant characteristics regarding healthy eating habits and weight development in families (Goldstein et al., 2019).

7 Conclusions

This study showed that child diet quality and BMI are associated with child, family and neighbourhood-level factors. The main conclusions were:

1. *Individual level:* The child appetitive traits associate with child diet quality and weight status already during preschool years. “Food approach” appetitive traits ‘enjoyment of food’, ‘food responsiveness’ and “Food avoidance” trait ‘satiety responsiveness’ might be the most important appetitive traits to consider in the future studies and in interventions aimed at improving child eating habits and supporting healthy weight development.
2. *Family level*: Firstly, parents might adapt their feeding practices in response to their child’s BMI. Secondly, parental self-efficacy is suggested to be an important factor behind child eating habits already at an early age. Thirdly, especially maternal diet quality might be an important factor affecting child dietary intakes.
3. *Neighbourhood level*: Neighbourhood socioeconomic disadvantage might add up a risk layer of its own on top of the family’s own socioeconomic position and might decrease the parent and child diet quality even further. Lastly, deprived neighbourhoods might expose the food approaching children to higher risk of overweight compared with their peers from affluent areas.

Overall, the results suggest that more efforts are needed to improve children’s diet quality and prevent overweight development. The results of these studies can help to guide the efforts of child nutrition researchers, practitioners, and other stakeholders. In addition, the results could be utilised in training the personnel of municipal maternity and child health clinics. Interventions to support the development of healthy eating behaviours may be most effective if they target both parents’ food-related parenting practices and parenting self-efficacy during early childhood. In addition, young parents to be, especially mothers, might be a good target audience for nutrition education.

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Kaarina, August 2023

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