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Diet quality in preschool children and associations with individual eating behavior and neighborhood socioeconomic disadvantage. The STEPS Study

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ABSTRACT

A good quality diet in childhood is important for optimal growth as well as for long-term health. It is not well established how eating behaviors affect overall diet quality in childhood. Moreover, very few studies have considered the association of diet quality and a neighborhood socioeconomic disadvantage in childhood. Our aim was to investigate how diet quality is associated with eating behaviors and neighborhood disadvantage and their interaction in preschool age children in Finland. The participants were from the Steps to Healthy Development Study at age 2 y (n = 780) and 5 y (n = 653). Diet quality was measured with a short questionnaire on habitual food consumption and eating behavior was assessed with the child eating behavior questionnaire to indicate the child's eating style regarding food approach and food avoidance dimensions. Information on neighborhood socioeconomic disadvantage were obtained from the statistics Finland grid database. We found that diet quality was higher at 5 years compared to 2 years of age ($p < 0.001$). Food approach subscale, enjoyment of food, was positively associated with the diet quality ($p < 0.001$ for 2 and 5 y) while subscale desire to drink was negatively associated with the diet quality ($p = 0.001$ for 2 and 5 y). Food avoidance was negatively associated with the diet quality both at 2 and at 5 years of age ($p < 0.001$). A higher neighborhood disadvantage was negatively associated with the diet quality at the age of 2 years ($p = 0.02$), but not at the age of 5 years. Eating behavior had similar associations with diet quality both in affluent and deprived neighborhoods. Our results suggest that both the eating behavior and neighborhood disadvantage are, already in the early age, important factors when considering children's diet quality.

1. Introduction

Childhood diet quality is an important determinant of child growth and development, and has a long lasting impact on health and well-being later in life (Langley-Evans, 2015; Nguyen et al., 2020; Victora et al., 2008). Dietary habits, established early in childhood, tend to continue throughout childhood and may persist into adulthood (Ashcroft et al., 2008; Mikkilä et al., 2005; Movassagh et al., 2017; Nicklaus et al., 2005). Child eating behavior is partly heritable (Llewellyn et al., 2010, 2014) and partly influenced by caregivers and other environmental factors (Birch et al., 2007). Food approach and avoidance dimensions have been previously used to characterize child eating behavior (Ek et al., 2016; Vilela et al., 2018). Based on earlier studies, child eating behavior might be associated with diet variety (Falciglia et al., 2000; Vilela et al., 2018) as well as fruit and vegetable intake (Wardle et al., 2003). However, most of the studies have focused on specific components in the diet, and thus associations between eating behavior and overall diet quality are not well established in children.

High quality, nutrient rich diets including fish, low-fat dairy products, vegetables and fruit are more likely to be consumed by groups of higher socioeconomic status (SES) in Western societies (Darmon & Drewnowski, 2008; Konttinen et al., 2013). In addition to personal level indicators of SES, the socioeconomic characteristics of neighborhoods influence intake of selected dietary items, such as fruit and vegetables both in adults and children (Kivimäki et al., 2018; Mushi-Brunt et al., 2007). Moreover, there is indication that children in deprived areas

Abbreviations: CEBQ, Child Eating Behavior Questionnaire; SES, socioeconomic status.

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consume less low fat dairy products and more desserts and candies compared with affluent areas (Merchant et al., 2007). In adults, high neighborhood SES is also linked with better adherence to dietary recommendations (Lagström et al., 2019). Further, there is indication that family and neighborhood socioeconomic status might influence child appetite avidity (Kininmonth et al., 2020). In addition, child eating behavior may be associated differently with diet quality in different socio-economic neighborhoods, as the local environments are known to differ in the availability of healthy foods in high (deprived) vs. low disadvantaged (affluent) neighborhoods (Cummins & Macintyre, 2006; Reidpath et al., 2002; Richardson et al., 2014; Wang et al., 2007). To our knowledge, only a few studies on the influence of neighborhood socioeconomic disadvantage on child overall diet quality exist and previous findings on school aged children suggest that neighborhood factors may contribute to diet quality among children (Keita et al., 2009; Merchant et al., 2007). Thus, more studies are needed to confirm the associations especially at an early age and onwards.

The aim of this study was to investigate the association between child diet quality and neighborhood disadvantage (hereafter used to refer to cumulative neighborhood socioeconomic disadvantage). In addition, we examined how eating behavior, specifically the food approach or avoidance dimensions, associate with child diet quality and how these dimensions are associated with diet quality in different socioeconomic neighborhoods.

2. Materials and methods

2.1. Study design and subjects

The present study was based on data from children and parents participating in a longitudinal Finland cohort, Steps to Healthy development of Children (the STEPS Study), which has previously been described in detail elsewhere (Lagström et al., 2013). Briefly, all Finnish- and Swedish-speaking mothers, who delivered a living child between January 1, 2008 and April 31, 2010 in the Hospital District of Southwest Finland, formed the cohort population (in total 9811 mothers and their 9936 children). Altogether 1797 mothers (18.3% of the total cohort) and 1658 fathers with 1805 neonates volunteered as participants for the intensive follow-up group of the STEPS study.

Children born at full term (after $36^{6/7}$ weeks of pregnancy) from singleton pregnancies were included in the present study (N = 1687). The number of observations varied between the analyses based on data availability. Diet quality data were available for 888 children at a 2 years age point and for 746 children at a 5 years age point. Data from both age points' were available for 601 children. Diet quality and neighborhood socioeconomic disadvantage at 2 years of age were available for 780 children and at 5 years of age for 653 children.

The study was approved by the Ethics Committee of the Hospital District of Southwest Finland in February 2007. The parents gave their written informed consent for the study. The legal basis for processing of personal data is public interest and scientific research (EU General Data Protection Regulation 2016/679 (GDPR), Article 6 (1)(e) and Article 9 (2)(j); Data Protection Act, Sections 4 and 6).

2.2. Measures

2.2.1. Outcome: child diet quality score

The families reported their children's eating and drinking habits for selected dietary components with a short questionnaire when the child was aged 2 and 5 years. The questionnaire is a modified version of the Index of Diet Quality, validated with Finnish adults (Leppälä et al., 2010). From the 16 individual questions, we chose the following 10 questions concerning food items or dietary habits: 1) how many times did the child eat breakfast per week, 2) how many times per day did the child eat after breakfast (meals and snacks included), 3) the type of drink their child usually drank with meals, 4) the quality of milk their child drank, 5) what was the 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 vegetables did the child eat per day, 9) how many portions of fresh fruits and berries did the child eat per day, and 10) how many times did the child eat unhealthy salty or sweet snacks per week. These 10 dietary items together were used to form a diet quality score to describe how well the child adheres to national dietary recommendations (Table 1). The selected ten dietary items are in line with the Finnish nutrition recommendations for children at the time of the data collection (Hasunen et al., 2004). The questions excluded were not included in the Finnish nutrition recommendations. Each recommended choice provided one point for the score, so the overall score varied from 0 to 10, the higher values indicating greater adherence to the recommendations. The quality score for the child's diet was used as a continuous variable in the analyses.

2.2.2. Child eating behavior

In the present study, eating behaviors at the age of 2 and 5 years were measured by using a validated Finnish version of the *Child Eating Behavior Questionnaire (CEBQ)*, which is a 35-item parent-report questionnaire, rated using a 5-point Likert scale (1 = Never, 5 = Always) (Wardle et al., 2001). CEBQ is clustered into eight subscales, which examine Food approach and avoidance dimensions of child eating behavior. Food responsiveness (5 items), enjoyment of food (4 items), emotional overeating (4 items) and desire to drink (3 items) were grouped into a food approach dimension. Satiety responsiveness (5 items), slowness in eating (4 items), emotional undereating (4 items) and food fussiness (6 items) were grouped into a food avoidance dimension. Mean scores were reported for each subscale and for the summary dimension. The internal consistency was good both for the food approach dimension (16 questions) and food avoidance dimension (19 questions) (Cronbach's alphas for the 2-year-old's food approach was 0.76 and food avoidance 0.78. For the 5-year-old's food approach the Cronbach's alpha was 0.80 and food avoidance 0.78). Child eating behavior variables (dimensions and their subscales) were used as continuous variables in the analyses.

Table 1
Dietary recommendations according to the Finnish nutrition recommendations for children in 2004 (Hasunen et al., 2004) and proportions of the study participants following them. Each recommended response provided one point for the children's dietary quality score, the overall score varied from 0 to 10, and higher scores indicated higher adherence to dietary recommendations.

Dietary item	Dietary recommendation	Response alternative in the questionnaire	N (%) following recommendation	
			2 years	5 years
Breakfast	Daily regular meals are import for children	Daily	824 (93%)	715 (97%)
Regular meals		4-5 meals per day	663 (75%)	530 (71%)
Drink with meals	Milk products are necessary to supply the need for calcium.	Milk or sour milk or plant milk	794 (90%)	683 (92%)
Milk quality	Use fat-free or low fat dairy products.	Max 1% fat	607 (68%)	491 (66%)
Primary beverage	Use water as primary beverage.	Water	671 (76%)	597 (80%)
Fat spread	Use unsaturated fat table spreads.	>60% unsaturated fat	328 (37%)	247 (33%)
Fish	Fish 2–3 times per week.	2-3 times per week	276 (32%)	401 (54%)
Vegetables	Vegetables, fruits and berries daily 5–6 portions.	≥2 times per day	341 (40%)	367 (49%)
Fruits and berries		≥2 times per day	357 (41%)	338 (46%)
Snacks[a]	Avoid the habit of eating snacks between the meals.	max 1 times per week	448 (51%)	356 (48%)

[a] Unhealthy snacks like potato chips or candies.

2.2.3. Neighborhood disadvantage

Data on neighborhood disadvantage were obtained from the Statistics Finland's grid database for the year 2009, which contains socioeconomic information on Finnish residence at a spatial resolution of 250 m × 250 m. The neighborhood disadvantage is based on the proportion of adults with primary education only, the unemployment rate, and the median household income in each 250 m × 250 m grid area (Halonen et al., 2012). Annual income was reverse-scaled to indicate the disadvantage in a similar manner to the other two variables. For each of the three variables, a standardized z score based on the total Finnish population (mean = 0, SD = 1) was derived for each address the participant had lived at between birth and the measurement of the outcome, diet quality, at the age of 2 and 5 years. A score for cumulative neighborhood socioeconomic disadvantage was then calculated by taking the mean value across the three z-scores weighted by residential time at each address. Missing data (i.e. areas with fewer than 10 residents in the neighborhood) were replaced with the mean neighborhood disadvantage score of the eight adjacent map squares. The neighborhood disadvantage variable was used as continuous variable in the analyses.

2.3. Covariates

Based on earlier literature (Kyttälä et al., 2014; Lazarou & Newby, 2011; Northstone et al., 2005; van der Velde et al., 2019), we selected the following factors affecting young child dietary quality as covariates 1) parental age, 2) family income, 3) parental education and 4) number of siblings. Information regarding the mother's and father's age and parental education were obtained from self-administered questionnaires upon recruitment during pregnancy. The mother's age was classified into two categories by the mean age of women giving birth in Finland 2019 (29.6 years of age) (Tilastokeskus, 2019). The same cut-off age was used with the father's age. The mother's and father's categorical ages were used in Table 2 and as continuous variables in the analyses. Information regarding the total family income, and number of siblings were obtained from self-administered questionnaires at the 2- and 5-years age points. Income remaining in the household after obligatory expenses (taxes) was measured with a five-point scale (under 1000 €, 1000–2000 €, 2000–3000 €, 3000–4000 € and over 4000 €). The average income (including both parents) were then divided into two categories, under 3000 € and 3000 € or higher. Parental education was classified into advanced education or low education based on the highest education that one of the parents had completed for their professions. Those who had no professional training or a maximum of an intermediate level of vocational training were classified as "low" (answer options 1 = no education, 2 = vocational courses/apprenticeship training, 3 = vocational upper secondary education, 4 = vocational college). Those who had studied at a University of Applied Sciences or higher were classified as "advanced" (answer options 5 = University of applied sciences, 6 = bachelor's degree, 7 = master's degree, 8 = PhD). The advanced level included any academic degree (bachelor's, master's, licentiate or doctoral degree). Parental education and family income were both used as an indication of family SES.

2.4. Statistical analysis

We used independent t-tests to examine the cross-sectional associations of the child diet quality with the demographic variables at 2 and 5 years of age. Paired t-tests were used to test the similarity of diet quality and eating behavior variables between 2 and 5 years. Pearson's correlations were used to assess the association between diet quality at the age of 2 and 5 years and to test the correlations of child diet quality and neighborhood disadvantage.

Linear regression models were used to model the associations between the child diet quality, child eating behavior and neighborhood disadvantage at 2 and 5 years of age. Child eating behavior and neighborhood disadvantage variables were used as continuous explanatory variables in the models and child diet quality was used as the continuous dependent variable. Separate models were run for each eating behavior variables. In addition, we included 2-way interactions between neighborhood disadvantage and child eating behavior variables to investigate whether the associations of child eating behavior on child diet quality changes with neighborhood disadvantage. All models were adjusted for sociodemographic factors (mother's age, father's age, family income, parental education, and number of siblings). Normal distribution assumption was checked from studentized residuals. The sample of children being compared at 2 and at 5 years of age differed by timepoint due to missing data, thus the comparison of key outcome variables was replicated as a sensitivity analysis including only the children who had complete data from both ages.

Statistical analysis was performed using SAS software for Windows version 9.4 (SAS Institute Inc.). The level of significance was set at a p value of <0.05.

3. Results

Descriptive characteristics of the families in the study in relation to diet quality are presented in Table 2. The child diet quality was higher, 6.33 (SD = 1.66), at 5 years, compared to 5.98 (SD = 1.72), at 2 years ($p < 0.001$), although there was a strong correlation of 0.50 between the diet scores at these ages. Only 5 children (out of 888) at the age of 2 years and 16 children (out of 746) at the age 5 years reached the maximum possible diet quality score of 10. In general, those children having a higher i.e., a better diet quality at the age of 2 and 5 years were characterized by a family with a high education level and a high income. In addition, fewer siblings at the age of 2 years were associated with higher child diet quality (Table 2).

Descriptive characteristics of the food approach and food avoidance dimensions and subscales at both age points are presented in Table 3. All food approach variables were higher at 2 years of age compared with 5 years of age ($p < 0.001$). A similar difference was seen in the food avoidance subscale 'emotional undereating' ($p < 0.001$). However, the subscale 'food fussiness' increased from 2 to 5 years of age ($p < 0.001$). Other food avoidance subscales remained stable.

Associations of diet quality with eating behavior at 2 and 5 years of age are shown in Table 4. Overall the food approach dimension was not associated with child diet quality at 2 and 5 years of age. More detailed investigation concerning the separate items on the food approach subscales showed that the subscale 'enjoyment of food' was associated with a higher diet quality while the subscale 'desire to drink' was associated with a lower diet quality both at 2 and at 5 years of age. The food avoidance dimension was associated with a lower diet quality at 2 and 5 years of age (p-value < 0.001). Subscales 'satiety responsiveness' and 'food fussiness' were associated with a lower diet quality both at 2 and 5 years of age. In addition, the subscale 'emotional undereating' was associated with a lower diet quality at 5 years of age.

Further, the child diet quality was negatively associated with neighborhood disadvantage at 2 years of age (beta (95% CL) = −0.22 (−0.40 to −0.03), p = 0.02), meaning the higher the disadvantage, the lower the diet quality (Fig. 1). At 5 years of age the association between diet quality and neighborhood disadvantage did not reach significance (beta (95% CL) = −0.18 (−0.38 – 0.02), p = 0.09).

Our final investigation concerned whether the food approach and avoidance dimensions associated differently with diet quality in low (affluent) and high disadvantage (deprived) neighborhoods. However, we did not find any statistically significant interactions [Food approach dimension*neighborhood disadvantage interaction p-value 0.60 (2 years) and 0.26 (5 years), Food avoidance dimension* neighborhood disadvantage interaction p-value 0.45 (2 years) and 0.82 (5 years)].

The sensitivity analyses including only children with data from both age points (2 and 5 years) replicated the results and the directions of the associations remained the same (See Supplementary Tables 1–4).

Table 2
Descriptive characteristics of the study participants and diet quality with means and standard deviations (SD). Statistical differences were tested with t-tests.

Variable		Diet quality [a]					
		2 years			5 years		
		N (%)	Mean (SD)	P	N (%)	Mean (SD)	P
All		888	5.98 (1.72)		746	6.33 (1.66)	**<0.001**
Sex	Boy	458 (52%)	6.02 (1.79)	0.42	387 (52%)	6.35 (1.67)	0.73
	Girl	430 (48%)	5.93 (1.64)		359 (48%)	6.31 (1.65)	
Mother age							
	17–29	358 (40%)	6.11 (1.61)	0.07	284 (38%)	6.43 (1.59)	0.23
	30–45	528 (60%)	5.89 (1.78)		462 (62%)	6.28 (1.70)	
Father age							
	17–29	249 (28%)	5.94 (1.65)	0.57	201 (27%)	6.38 (1.59)	0.61
	30–45	628 (72%)	6.01 (1.74)		538 (73%)	6.31 (1.68)	
Family education [b]							
	Advanced	637 (73%)	6.18 (1.67)	**<0.001**	559 (76%)	6.50 (1.66)	**<0.001**
	Low	238 (27%)	5.44 (1.74)		180 (24%)	5.84 (1.55)	
Family income							
	<3000 EUR	465 (55%)	5.78 (1.74)	**<0.001**	269 (40%)	5.99 (1.62)	**<0.001**
	≥3000 EUR	376 (45%)	6.21 (1.68)		406 (60%)	6.54 (1.62)	
Number of siblings							
	0–1	728 (82%)	6.09 (1.70)	**<0.001**	510 (68%)	6.40 (1.64)	0.12
	2 or more	160 (18%)	5.46 (1.70)		236 (32%)	6.19 (1.69)	

[a] Mean score for adherence to the Finnish nutrition 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 and 10 points in children.
[b] Highest education that one of the parents had completed for their professions.

Table 3
Comparisons of the mean of both the food approach and food avoidance dimensions and their subscales at 2 and 5 years of age. Statistical differences were tested with paired t-tests.

Variable	2 years		5 years		
	N	Mean (SD)	N	Mean (SD)	P
Food approach	880	2.26 (0.43)	741	1.94 (0.41)	**<0.001**
Food responsiveness	859	1.84 (0.61)	718	1.60 (0.51)	**<0.001**
Enjoyment of food	846	3.46 (0.60)	725	3.04 (0.65)	**<0.001**
Emotional overeating	839	1.50 (0.49)	731	1.35 (0.45)	**<0.001**
Desire to drink	852	2.25 (0.83)	732	1.79 (0.76)	**<0.001**
Food avoidance	869	2.94 (0.45)	740	2.91 (0.50)	0.08
Satiety responsiveness	829	3.22 (0.55)	722	3.23 (0.60)	0.61
Slowness in eating	857	2.95 (0.62)	730	2.99 (0.77)	0.55
Emotional undereating	830	3.18 (0.84)	720	2.48 (0.92)	**<0.001**
Food fussiness	826	2.41 (0.68)	725	2.92 (0.75)	**<0.001**

4. Discussion

In this study, we investigated how child eating behavior, neighborhood disadvantage and their interactions were associated with child diet quality in a Finnish cohort of preschool aged children. Our main findings were that the child's eating behavior and neighborhood disadvantage were associated with the child diet quality. However, child eating behavior was similarly associated with diet quality in affluent and deprived neighborhoods.

The food approach dimension and all subscale variables were higher at 2 years of age compared with 5 years of age. In addition, food avoidance subscale 'emotional undereating' decreased with age and subscale 'food fussiness' increased with age. Other food avoidance subscales remained stable. These findings are contrary to a previous research paper validating the CEBQ questionnaire, where it was found that 'food responsiveness' and 'enjoyment of food' increased linearly with age and 'satiety responsiveness' and 'slowness in eating' decreased

Table 4
Associations between child eating behavior and child diet quality at 2 and 5 years of age. Adjusted for the mother's age, the father's age, family income, parental education, and the number of siblings.

Variable	Diet quality[a]					
	2 years			5 years		
	N	Estimate (95% CL)	P	N	Estimate (95% CL)	P
Food approach	809	0.25 (−0.02–0.52)	0.07	659	−0.07 (−0.37–0.23)	0.63
Emotional overeating	771	−0.03 (−0.27–0.21)	0.78	649	−0.24 (−0.51–0.04)	0.09
Food responsiveness	788	0.15 (−0.04–0.34)	0.13	639	−0.12 (−0.36–0.12)	0.32
Enjoyment of food	775	0.71 (0.52–0.89)	**<0.001**	646	0.43 (0.25–0.62)	**<0.001**
Desire to drink	783	−0.25 (−0.39–−0.11)	**<0.001**	652	−0.27 (−0.43–−0.11)	**0.001**
Food avoidance	798	−0.76 (−1.01–−0.51)	**<0.001**	658	−0.51 (−0.75–−0.27)	**<0.001**
Emotional undereating	761	−0.13 (−0.27–0.01)	0.07	644	−0.16 (−0.30–−0.03)	**0.01**
Satiety responsiveness	761	−0.80 (−1.01–−0.59)	**<0.001**	644	−0.31 (−0.52–−0.11)	**0.003**
Slowness in eating	786	−0.12 (−0.32–0.07)	0.20	650	−0.07 (−0.22–0.09)	0.42
Food fussiness	759	−0.54 (−0.71–−0.37)	**<0.001**	644	−0.42 (−0.58–−0.25)	**<0.001**

[a] Mean score for adherence to the Finnish nutrition recommendations for children 2004; total points based on 10 individual dietary items for the dietary score. The range of diet quality score varied between 1 and 10 points in children.

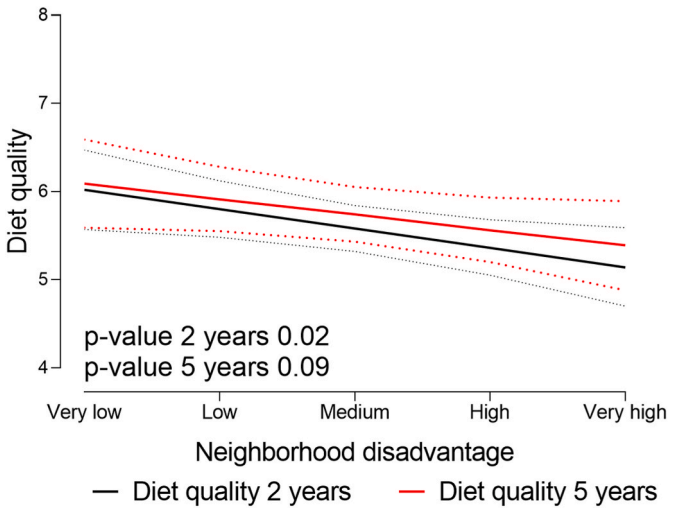

Fig. 1. Diet quality at 2 and 5 years of age and neighborhood disadvantage. Mean values with 95% confidence intervals adjusted for covariates (mother's age = 30.81 and father's age = 32.89, family income <3000 EUR, family education = low education, number of siblings = 0.44 (2 years), 0.58 (5 years)).

with age (Wardle et al., 2001). However, another research paper suggests that there is a similarity in child eating behaviors between 2 and 5 years of age (Farrow & Blissett, 2012) and similar to our findings that the 'desire to drink' seems to decrease with age (Farrow & Blissett, 2012; J.; Wardle et al., 2001).

When studying the associations between diet quality and eating behavior we found that the food approach subscale, 'enjoyment of food', was positively associated with the child diet quality. This might be partly explained by earlier research indicating that 'enjoyment of food' is linked with increased intake of fruits and vegetables (Cooke et al., 2004) and a greater liking for fruits and vegetables (Fildes et al., 2015). However, children who had high scores on the subscale 'desire to drink', had a lower diet quality. This might reflect the fact that the desire to drink in children is linked with increased consumption of sweetened beverages (Sweetman et al., 2008). The food avoidance dimension and subscales 'emotional undereating', 'satiety responsiveness' and 'food fussiness' were negatively associated with the child diet quality. This is consistent with previous research suggesting that 'food fussiness' is associated with lower fruit, vegetables and fish intake and a lower diet variety (Cardona Cano et al., 2015; Cole et al., 2017; Jani et al., 2020; Oliveira et al., 2015; J.; Wardle et al., 2001).

We found that the diet quality of 5-year-old children was better compared with 2-year-old children. This might reflect the fact that most of the children (about 89%) in the STEPS study population attended day care at 5 years of age (Matarma et al., 2018). This finding is in line with the study of Kyttälä et al. (2014) where they found that the lowest diet quality was among 3- and 6-year-olds being cared for at home. Meals are at regular times in day-care centers and the quality of the food served in day-care centers should also follow the national dietary recommendations (Hasunen et al., 2004). However, contrary to our findings, generally the younger children tend to have better diet quality scores (Lazarou & Newby, 2011; Vilela et al., 2018).

Further, there was an association between neighborhood disadvantage and diet quality of children. The association with neighborhood disadvantage and diet quality was more evident at 2 years of age compared with 5 years of age. It is especially interesting that we were able to indicate that neighborhood disadvantage is associated with diet quality in addition to family level socioeconomic status. This suggests, that neighborhood disadvantage is negatively associated with diet quality for all children regardless of the socioeconomic status of their families, i.e. in both low and advanced education families as well as low- and high-income families. Our results are in line with the previous study indicating that neighborhood disadvantage might be negatively associated with diet quality among children (Keita et al., 2009). The underlying reasons for the differences at an early age in diet quality according to the childhood neighborhood disadvantage are complex. Human health in general can be seen as a social matter (Bandura, 2004). People do not operate alone, but have shared beliefs (Bandura, 2004). The socioeconomic structure of neighborhoods might influence the behaviors and social norms shared by residents and in here, particularly parents (Bernsdorf et al., 2016). In addition, earlier research suggests, that neighborhoods differ in the availability of healthy foods (Cummins & Macintyre, 2006; Reidpath et al., 2002; Richardson et al., 2014; Veugelers et al., 2008; Wang et al., 2007). Moreover, the role of the home food environment, such as the availability of healthy foods for the children at the family dinner table might partly explain the difference (Ranjit et al., 2015). In addition, a recent study in Denmark found that soft drink intake was more frequent among residents in deprived neighborhoods compared to residents in affluent neighborhoods (Bernsdorf et al., 2016). However, we did not find any interaction effects between child eating behavior and neighborhood disadvantage, meaning that eating behavior had similar effects on diet quality both in affluent and deprived neighborhoods.

The low consumption of vegetables, fruits and vegetable oil -based spreads and high consumption of snacks among Finnish children (Kyttälä et al., 2014) also became evident in this study. Less than half of the children at both age points met the Finnish dietary recommendations for fruit and vegetable intake. Vegetable-based fat spreads were consumed by only one third of both age groups, and about half of the participants ate salty and sweet snacks more than once per week. In addition, fish and skimmed milk have been suggested as good indicators of a healthy diet (Kyttälä et al., 2014). Consumption of fish was specifically low at the age of 2 years and only one third of 2-year-olds and half of the 5-year-olds consumed fish at the recommended level.

The present study has several strengths and limitations. The large sample size in combination with the use of a population registry, make the study particularly robust. The utilization of a high-resolution 250 m × 250 m grid database containing cumulative neighborhood disadvantage information from each participant is the major strength of this study. In addition, we have assessed several sociodemographic and family related factors affecting child dietary choices and included several confounding factors in the analysis. However, this study also has some limitations. Capturing all the aspects related to diet quality is challenging (Alkerwi, 2014) and we have used a self-generated measure of child diet quality in our study. Use of self-reported dietary data may have resulted in bias, as parents may have systematically under- or over-reported their children's consumption of individual food items (social desirability). Furthermore, although short dietary questionnaires do not assess absolute intake, they are useful for ranking individuals according to relative consumption within a study population (Hu et al., 1999). We included in our diet quality score all those food groups for which the justification for the recommendation was obtained (Hasunen et al., 2004).

Our large population-based sample consisted mainly of individuals of European origin living in a welfare society, thus, the generalizability of our findings to other populations and cultures needs to be confirmed in other studies. Generalizability to Finns (children) is likely to be good as the overall consumption levels of the individual food items in this study population were in line with another population based study that assessed children's food consumption in Finland (Kyttälä et al., 2010; Lehto et al., 2019).

5. Conclusions

Our results suggest that child eating behavior is associated with child diet quality and that the socioeconomic living environment is an important factor already at an early age for children's diet quality. As dietary patterns might persist from childhood to adulthood, early

interventions might help not only to improve diet quality in childhood but also later in adulthood. It is possible that diet quality might constitute one explanatory pathway linking socioeconomic disadvantage to poor health outcomes. In addition, the results imply that neighborhood disadvantage is an important measure, which should be considered in future studies, as it may be negatively associated with the child diet quality regardless of the family level socioeconomic status. Families living in socioeconomically deprived neighborhoods and with a history of low parental education and income may require special attention. Further, special focus should be paid to children with food avoidance tendency, especially fussy eaters. These results suggest that public policies aimed at improving local environments may offer an important tool in reducing the link between neighborhood disadvantage and the risk of poor diet.

Authorship statement

All authors are responsible for reported research. ST, ML, HL conceptualized the study. HL participated in the data collection and ST, ML, JV, JP and HL in data analysis. Original draft was written, and statistical analyses were performed by ST. The manuscript was reviewed and edited by ST, ML, JV, JP, HL. Funding was provided by HL. All authors have had sufficient access to the data to verify the manuscript's scientific integrity and they approved the final manuscript as submitted and agree to be accountable for all aspects of work.

Ethical statement

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. STEP 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 or their parents in the STEP study. All the data have been collected, maintained and stored (in a locked space) at the University of Turku.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2022.105950.

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