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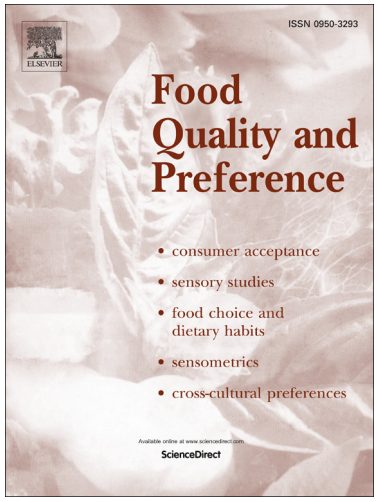

Fruit and vegetable consumption among 3–5-year-old Finnish children and their parents: is there an association?

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Fruit and vegetable consumption among 3–5-year-old Finnish children and their parents: is there an association?

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ABSTRACT

This study investigated the association between the home food environment and the consumption frequency of raw and cooked vegetables, berries and fruit among 3–5-year-old children and their mothers and fathers. The target group consisted of 3–5-year-old children (N=114) attending public early childhood education and care, and their parents (N=100). Cross-sectional data were collected from the parents with questionnaires assessing the home food environment, children and parents' vegetable, berry and fruit consumption, and food neophobia. Linear mixed-effects models and principal component analysis were used to examine the association of parental consumption and the home food environment with children's vegetable, berry and fruit consumption. The results showed low consumption of fruit and vegetables among 3–5-year-old children and their mothers and fathers. Maternal consumption was associated with children's raw and cooked vegetable, berry and fruit consumption, whereas paternal consumption was only associated with cooked vegetables. This study identified that home food environment factors influencing children's consumption habits vary for raw and cooked vegetables, berries and fruit.

KEYWORDS

raw vegetables; cooked vegetables; berries; day care; paternal consumption

1. INTRODUCTION

Children are consuming inadequate amounts of vegetables, berries and fruit in Finland (Kyttälä et al., 2010) and across Europe (Lynch et al., 2013). As the health and nutrition benefits of vegetables, berries and fruit are well-known, increasing children's consumption of these foods is a continuing challenge in many countries. Dietary habits also track from childhood to adulthood, and the period of early childhood is critical for adapting to a diet rich in vegetables, berries and fruit (Grimm, Kim, Yaroch, & Scanlon, 2014; Bjelland et al., 2013).

Children's dietary habits are shaped by both environmental input and individual characteristics (Johnson, 2016). For example, environmental input is affected by both conscious and unconscious food education that children receive in their home environment and early childhood education and care centers. The home environment is the first environment to shape children's relationship with food (Rosenkranz & Dzewaltowski, 2008). The fruit and vegetable consumption of under-school-aged children has been shown to be associated with the home food environment, which includes the serving, availability and accessibility of food, family and child involvement, and parents' fruit and vegetable intake (Kristiansen, Bjelland, Himberg-Sundet, Lien, & Andersen, 2017a; Kristiansen,

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Bjelland, Himberg-Sundet, Lien, & Frost Andersen, 2017b; Wyse, Campbell, Nathan, & Wolfenden, 2011). The association between parents' fruit and vegetable intake and children's consumption of the food items has been mostly studied from a maternal point of view (Ong, Ullah, Magarey, Miller, & Leslie, 2017; Longbottom, Wrieden, & Pine, 2002) or by combining mother's and father's consumption habits to parental intake (Cooke et al., 2004; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002). These studies have repeatedly shown a positive association between maternal intake and children's fruit and vegetable consumption. Some previous studies have also investigated the paternal role in this context; fathers' consumption associated with their children's fruit (Walsh, Cameron, Hesketh, Crawford, & Campbell, 2015; Hall et al., 2011) and vegetable consumption (Harris & Ramsey, 2015), and higher vegetable intake has been found to increase the likelihood of their children to consume vegetables (Svensson et al., 2016). Yet, it remains unclear how paternal modelling associates more specifically with cooked and raw vegetables, berries and fruit. We hypothesised that children's raw and cooked vegetable, berry and fruit consumption is more strongly associated with their mother's consumption of these food items compared to their father's.

Individual characteristics affecting children's dietary habits involve factors such as children's fussiness and food neophobia, which challenge children's learning of eating vegetables, berries and fruit. Children's food neophobia is one of the well-recognized individual determinants associated with fruit and vegetable rejection among children and may explain issues such as siblings' different reactions towards foods (Cooke, Carnell, & Wardle, 2006; Johnson, Davies, Boles, Gavin, & Bellows, 2015; Lafraire, Rioux, Giboreau, & Picard, 2016). Learning to eat vegetables, berries and fruit is further challenged by children's natural tendency to reject bitter-tasting vegetables and prefer sweet flavours (Mennella & Bobowski, 2015). This natural preference for sweet-tasting foods makes children vulnerable in food environments where sweet snacks are frequently available and highlights the importance of conscious food education (Mennella, Bobowski, & Reed, 2016).

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It is noteworthy that all kind of fruit and vegetable consumption occurring in the home environment setting is usually reported together, and little attention has been given to the difference between the consumption of raw and cooked vegetables. Recent studies have reported on the differences in the fruit and vegetable consumption frequencies among Finnish under-school-aged children (Korkalo et al, 2019). The frequency of consuming raw vegetables was higher than that of cooked vegetables, and fruit consumption frequency was higher than that of berries. In the context of the Nordic cuisine, separating berries from fruit is also valid and interesting. It is likely that there are differences in factors associated with these three food groups (vegetables, berries, and fruit) (Glasson, Chapman, & James, 2011) and the different ways of serving vegetables (raw and cooked). We hypothesized that the consumption of raw vegetables in children and their parents is higher than that of cooked vegetables, and the consumption of fruit is higher than that of berries.

Moreover, parental education levels are associated with the amount and frequency of children's vegetable, berry and fruit consumption (Fernandez-Alvira et al., 2015). Low consumption is particularly related to the mother's low level of education, indicating social inequity in consumption patterns (Sotos-Prieto et al., 2015). Therefore, our final hypothesis is that there is a positive association between parental education level and children's consumption of fruit and vegetables.

Our aim in the present study was two-fold: (i) to explore the home food environment and consumption frequency of raw and cooked vegetables, berries, and fruit among 3–5-year-old children and their mothers and fathers; and (ii) to investigate the associations between parental consumption, parental education level, and children's vegetable, berry and fruit consumption, while also considering children's and parents' food neophobia.

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2. MATERIALS AND METHODS

2.1 Participants

A total of 114 under-school-aged children (from 3 to 5 years old) and their parents (N=100) participated this study. The participants were recruited through ten child groups at six early childhood education and care (ECEC) centres specialised in sensory-based food education in Western Finland and eight child groups at three standard ECEC centres in Eastern Finland (Kähkönen, Rönkä, Hujo, Lyytikäinen, & Nuutinen, 2018). The parents of 343 children in the ECEC centres were invited by letter to participate in the study. Data collection took place in autumn 2014 and autumn 2015. Parental consent was obtained for 183 children (response rate of 53.4%). We received data from 140 children. Children from families with a single parent (n=18) or reconstituted families (n=8) were excluded from the analyses. It was necessary to set this exclusion to investigate the association of both maternal and paternal food consumption with their children's vegetable, berry and fruit consumption. Children with food allergies, type 1 diabetes or coeliac disease were excluded already before the data collection. 14 families included two participating children and the parents were instructed to answer separately for each child (n=28). At the ECEC centres, the ECEC instructors reminded parents about the study around two weeks after the questionnaires were distributed.

Parents signed an informed consent form, and municipal directors of early childhood education and care and the managers of the participating ECEC centres also gave their consent. The University of Eastern Finland Committee on Research Ethics approved the study protocol.

Table 1 presents the characteristics of the children and their parents. Twenty per cent of the families had one child, 47% had two children and 33% had three children or more. Forty percent of the children were girls. The children's ages ranged from 2.5 to 5.75 with a mean age of 4.4 years. The parents' ages ranged from 24 to 49 among mothers and from 25 to 54 among fathers, with the mean

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ages of 35.4 and 37.6 years. Roughly half of the mothers and one third of the fathers had a university degree. Children's food neophobia was notably higher than that of mothers and fathers, which was at an equal level.

TABLE 1 ABOUT HERE

2.2 Measures for the parents

The parents filled out four separate surveys: the Food Frequency Questionnaire on their children's and their own vegetable, berry and fruit consumption, family background and the home food environment (see 2.2.2 in further detail), the Food Neophobia Scale (FNS) (Pliner & Hobden, 1992), and the Food Neophobia Scale whose Finnish version focuses on children (Mustonen & Tuorila, 2010). Family background information consisted of the child's gender, the child's age, parents' age, number of siblings in the household, the number of days per month the children participate in ECEC, parents' level of education and parents' work status.

2.2.1 Vegetable, berry and fruit consumption frequency

The frequency of eating fruit and vegetables was measured with the Food Frequency Questionnaire (FFQ). The FFQ's included questions concerning raw vegetables, cooked vegetables, and potatoes, berries and fruit. Questions concerning potatoes were included in the questionnaires only to exclude them from other cooked vegetables. The frequency scale, adapted from a questionnaire by the Finnish National Institute for Health and Welfare (Paalanen et al., 2006) was as follows: 0= never or rarely, 1= less than once a week, 2=once a week, 3=2-4 times a week, 4=5-6 times a week, 5=once a day, 6=two times or more a day. In the parents' questionnaires, the final option was divided into two parts: 6=two times a day and 7=three or more times a day; however, both of these two variables were recoded as '6=two times or more a day' to make the scale correspond to the children's FFQ scale. The FFQ intakes of the raw and cooked vegetables, berries and fruit were converted to daily frequency equivalents (DFE) calculated by allocating proportional values to the

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original frequency categories with reference to a base value of 1.0, equivalent to once a day (Daly, Parsons, Wood, Gill & Taylor, 2011; Jayasinghe et al., 2017). The DFE scores were calculated as follows: 0=never; 0.07=less than once a week; 0.14=once a week; 0.43=2–4 times per week; 0.78=5–6 times a week;1=once a day; 2=two times or more a day. Parents were asked not to consider their children's eating in ECEC, but to count in their own eating both at home and outside home.

2.2.2 The home food environment

The home food environment factors in this study included the accessibility to, and availability and serving of, vegetables, berries and fruit, family and child involvement in the shopping, preparing, cooking and eating food at home, and parental consumption of the food items. Availability, accessibility, and serving, and family and child involvement were measured using multiple choice questions answered by the parents of the participating children. The included questions, such as *How often do you serve vegetables, berries or fruit at dinner in your family?* with answer alternatives *never, 1-2 days a week, 3-4 days a week, 5-6 days a week, every day*, were developed by the research team and inspired by a questionnaire by Mustonen, Oerlemans and Tuorila (Mustonen, Oerlemans, & Tuorila, 2012) and the School Health Promotion study (Luopa et al., 2014) by the Finnish National Institute for Health and Welfare.

2.2.3 Food neophobia

Food neophobia was measured with the Food Neophobia Scale (FNS, Pliner & Hobden, 1992). The FNS is a validated and widely used measure of willingness to try novel and unfamiliar foods. Parents rated their level of agreement to 10 statements on their children's and their own behaviour, for example, *My child doesn't/I don't trust new foods*, on a 7-point Likert scale (*1=strongly*

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disagree, 7= strongly agree). We combined the scale items (partly reverse-coded) to arrive at a food neophobia score ranging from 10 to 70 with higher scores indicating higher food neophobia.

2.3 Statistical analysis

Differences in the children's, mothers' and fathers' raw and cooked vegetable, berry and fruit consumption frequencies were tested with the Wilcoxon signed-rank test. Associations with children's vegetable, berry and fruit consumption were analysed using linear mixed-effects models. This method was used due to statistical dependencies found among the children within the ECEC centres and child groups in the data. Dependencies were detected on two levels in this study. First, children socially influence each other in the ECEC groups, and second, the ECEC centres place the participants in specific areas geographically and infrastructurally (e.g. local grocery stores' size and selection). The linear mixed-effects model analysis method allowed us to take these dependencies into account. The model consists of ~~systematic~~ fixed and random part. The ~~systematic~~ fixed part of the model assimilates to a regression model where observation units must be independent. The random part in our linear mixed-effects models considers the dependencies among children in the child groups and ECEC centres. The raw or cooked vegetable, berry or fruit consumption y_{ijk} of child k in group j within the ECEC centre i was analysed using the linear mixed-effects model as follows:

$$y_{ijk} = \boldsymbol{x}'_{ijk}\boldsymbol{\beta} + u_i + v_{ij} + e_{ijk},$$

where u_i and v_{ij} are normally distributed random effects of ECEC centre and child groups within ECEC centre, $u_i \sim N(0,\sigma^2_{ECEC})$ and $v_{ij} \sim N(0,\sigma^2_{childgroup})$ ~~random effects and child groups are nested within centres~~ and e_{ijk} is a zero-mean residual error with constant variance.

Identical procedures were carried out for raw and cooked vegetables, berries and fruit models. Firstly, the children's and parents' vegetable, berry and fruit consumption, child characteristic and

home food environment variables were entered into the mixed model simultaneously as fixed factors and model diagnostics were done. Statistically least significant fixed factors were removed from the model one at a time. The mixed model was re-run with all the remaining factors until only variables with significant ($\alpha<0.05$) or close to significant ($\alpha<=0.08$) association remained in the final model. The fixed part $\boldsymbol{x}'_{ijk}\boldsymbol{\beta}$ of all the models included the following variables: the raw vegetables consumption model included maternal consumption, the serving of vegetables, berries and fruit at dinner and as evening snacks, the cooked vegetables consumption model included maternal consumption, the serving of vegetables, berries and fruit at dinner and the child's food neophobia, the berries consumption model included maternal consumption, the serving of vegetables, berries and fruit at dinner, and the number of days the child participates in ECEC per month, and the fruit consumption model included maternal consumption, the child's age, the style of dinner eaten by the family, and the serving of vegetables, berries and fruit as evening snacks. In addition, paternal consumption and sensory-based food education were retained in all the models. Variable serving vegetables, berries and fruit as an evening snack had a not linear association in the raw vegetable and fruit models. This non-linear association was taken into account by using a structure *serving as evening snacks + serving as evening snacks * frequency of serving as evening snacks* in the model, where *serving as evening snacks* = 1, when vegetables, berries and fruit were served at least once a week and *serving as evening snacks* = 0, when vegetables, berries and fruit were served never. This structure implied never serving vegetables, berries and fruit at evening snacks as its own category and handled association with the frequency of serving linear, when vegetables, berries and fruit were served. When model residuals showed heteroscedasticity, variance functions (Pinheiro & Bates, 2000) were included in the models to receive correct error estimates and p-values.

~~Because of a lack of linearity in the association with serving vegetables, berries and fruit as an evening snack, we had to divide this into two categories; 1=level change from never to once a week~~

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~~and 2=linear change from once a week to daily. In the raw vegetable and fruit consumption models, this led to a situation where category 1 has its own coefficients and category 2 can be handled linearly.~~ Mixed effects model analysis was performed using R and its nlme package (Pinheiro, Bates, DebRoy, & Sarkar, 2013). Model checking was based on visual inspection of different residual plots and diagnostic plots on random effects.

Relationships between selected variables were also studied with the PCA (principal component analysis) method (Unscrambler x10.3, Camo Process AS, Oslo, Norway). The data (consumption of raw and cooked vegetables, berries and fruit, food neophobia, age, the education of mother and father, the serving of vegetables, berries and fruit at dinner and as part of an evening snack, the style of dinners in the family and family meals) comprising of the questionnaire responses from 114 children was autoscaled and full cross-validation was used.

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3. RESULTS

3.1 Vegetable, berry and fruit consumption

The frequency distribution for children's, mother's and father's raw and cooked vegetable, berry and fruit intake is presented in Figure 1. According to the reported frequency, over 70% of the children consumed raw vegetables and fruit at least 5-7 times/week, whereas only 26% of the children consumed cooked vegetables and 19% berries as often. Only few children (2%) consumed raw vegetables and fruit once a week or less, but cooked vegetables and berries were eaten once a week or less frequently by a third of the children.

~~While the children consumed fruit significantly more often than their fathers, their raw and cooked vegetable and berry consumption did not differ from their fathers' intake (Table 2). As for mothers, the children's consumption frequency was significantly lower for raw and cooked vegetables and berries, but no difference was found in fruit.~~ On average, mothers consumed the most raw and cooked vegetables and berries, and significantly more than fathers, as well as more than the children except for fruit (Table 2). Fathers consumed as much raw and cooked vegetables and berries as the children but significantly less fruit. Between the parents, mother's consumption frequencies were significantly higher than father's in all four groups. No statistically significant differences were found in consumption frequencies between boys and girls (data not shown).

FIGURE 1 ABOUT HERE

TABLE 2 ABOUT HERE

3.2 Accessibility, availability and serving, and family and child involvement

Table 3 displays descriptive data on the home food environment of the families. The majority of the families cooked daily at home. Roughly one third of the mothers were solely responsible for both cooking meals and doing the family's grocery shopping. Fathers' sole responsibility for these tasks was rare, but half of the parents shared or alternated the responsibility for cooking and shopping.

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Two thirds of the families planned their meals weekly, purchased vegetables, berries and fruit 2-4 times per week, had shared family dinners, and served vegetables, berries and fruit daily at dinners. ~~Interestingly,~~ Vegetables, berries and fruit were more often served at dinner than at evening snack.

TABLE 3 ABOUT HERE

3.3 Associations between the home food environment, food neophobia and children's vegetable, berry and fruit consumption

Home food environment variables were analysed with the mixed-effects model, but only serving showed significant associations and remained in all of the final models (Table 4). ~~In addition, the style of dinners in the family was kept in the fruit model, but its association with children's fruit consumption was not significant.~~ Serving vegetables, berries or fruit at dinner showed a positive association with raw vegetable and negative association with berry consumption (Table 4). Serving vegetables, berries and fruit as an evening snack at least once a week (compared to never) was negatively associated with children's raw vegetable and fruit consumption, whereas serving vegetables, berries and fruit from once a week to daily had a positive association with children's fruit consumption. In the PCA model, the frequency of shared family meals was more related to fathers' than children's fruit and vegetable consumption (PC1-PC2, Figure 2A). However, the relation between fathers' vegetable consumption and shared family meals is getting weaker on PC1-PC3 (Figure 2B) and PC2-PC3 (not shown here). PC3 describes family meals that is moving together with style of dinners in every plot.

Maternal consumption showed a positive association with children's consumption of raw and cooked vegetables, berries and fruit, whereas paternal consumption was only associated with children's cooked vegetable consumption (Table 4). This is also seen in Figure 2A, where children's and their mothers' consumption of raw and cooked vegetables were positively correlated

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in the PCA model. When all the selected variables were studied together, the first principal component alone explained 22% of the variance and the three PCs together explained 42% of the variance in the data. Although the PCA model was not that strong, it indicated that children's consumption habits were more similar to those of their mothers than of their fathers.

Children's food neophobia showed a negative association with cooked vegetable consumption (Table 4). No statistically significant difference between boys and girls was found in food neophobia (data not shown). No significant association was found between mothers' and fathers' food neophobia and children's food consumption (data not shown).

Mothers' and fathers' educational level showed no significant associations with children's vegetable, berry and fruit consumption neither in the mixed model (Table 4) analysis nor in the PCA (Figure 2A and 2B).

TABLE 4 ABOUT HERE

FIGURE 2 ABOUT HERE

When exploring the statistical dependencies in the data with mixed-effects model analysis, little variation was found between the ECEC centres and between the child groups within the ECEC centres. No differences were found in the standard deviations across the ECEC centres, except for cooked vegetables, in which context the SD was 0.15. Between the child groups in the centres, standard deviations were as follows: 0.07 for the raw and 0.09 for cooked vegetables, 0.05 for berries and 0.06 for fruit. Based on the berry model, there is a negative association between days in ECEC and children's berry consumption. In other words, more days spent in ECEC indicates lower consumption of berries at home. Finally, sensory-based food education showed no significant associations with children's vegetable, berry and fruit consumption at home.

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4. DISCUSSION

This cross-sectional study examined associations between the home food environment and children's fruit and vegetable consumption, also taking food neophobia into account as an individual characteristic. The results showed low fruit and vegetable consumption among 3–5-year-old children and their mothers and fathers. Consumption frequencies were particularly low for cooked vegetables and berries. Therefore, it is likely that under-school-aged children and their parents eat less fruit and vegetables than recommended by the dietary guidelines. Associations between parents' and children's fruit and vegetable consumption indicated that consistent support from both parents promotes children's fruit and vegetable consumption. In this study, no association between parental education level and children's fruit and vegetable consumption was found.

Our findings support the hypothesis that the consumption of raw vegetables is higher than that of cooked vegetables, and the consumption of fruit is higher than that of berries. This finding was consistent among the children and their mothers and fathers. Although cooked vegetable consumption was relatively low in our sample, cooking has been found to increase children's affinity for vegetables (Poelman, Delahunty, & de Graaf, 2015), since it alters sensory properties such as flavour and texture (Poelman et al., 2017). In our study, cooked vegetables were especially challenging for those children who had high food neophobia. That food neophobia may hinder children's vegetable, especially cooked vegetable, consumption, is in line with previous studies (Koziol-Kozakowska, Piorecka, & Schlegel-Zawadzka, 2018; Johnson, Davies, Boles, Gavin, & Bellows, 2015). It seemed that children with high food neophobia need more support from their food environment in learning to eat cooked vegetables.

~~In this study, serving was also found to associate with the food environment and children's fruit and vegetable consumption.~~ In this study, serving vegetables, berries and fruit in the home environment was also found to associate with children's fruit and vegetable consumption. The positive

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association between serving and children's fruit and vegetable intake is supported by previous studies conducted among under-school-aged children (Kristiansen, Bjelland, Himberg-Sundet, Lien, & Andersen, 2017a; Wyse, Campbell, Nathan, & Wolfenden, 2011). Surprisingly, serving vegetables, berries and fruit as part of an evening snack was not linearly associated with children's raw vegetables and fruit consumption. This finding is non-logical.

At the same time, the association between shared family meals and children's fruit and vegetable consumption was weaker than expected. ~~Shared family meals were more related to fathers' than children's fruit and vegetable consumption in this sample.~~ The result related to children is not in line with previous findings, where family meals have been associated with dietary quality and the fruit and vegetable intake of children (de Jong, Visscher, HiraSing, Seidell, & Renders, 2015; Futrell Dunaway et al., 2017). It could be that family meals do not set the demographic of under-school-aged children apart, as they nearly always eat with their parents anyway; the results might have been different with older children.

As hypothesised, our study supports the well-established association between the mothers' and children's vegetable, berry and fruit consumption (Ong, Ullah, Magarey, Miller, & Leslie, 2017). The association found between fathers' and children's consumption was limited to cooked vegetables. This is in line with previous findings indicating that fathers' higher vegetable consumption increases children's vegetable consumption (Harris & Ramsey, 2015; Svensson et al., 2016) and that a higher fruit and vegetable consumption level is achieved by consistent support from both parents (Schoeppe & Trost, 2015). Therefore, our results support the view that fathers' role should not be belittled, but considered equally with mothers instead.

It is somewhat surprising and contrary to our hypothesis that parental education was not linked to children's consumption of fruit and vegetables. Previously, parents with a lower education level have been found to be less likely to consume fruit and vegetables (Miguel-Berges et al., 2017), and

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fathers' lower educational level has been linked with children's lower fruit consumption (Valmorbida & Vitolo, 2014). Parental educational level is an indicator of parental socio-economic status that is noted to associate positively with children's consumption of vegetables (Sotos-Prieto et al., 2015).

4.1 Strengths and limitations

One of the strengths of this study was that it investigated both maternal and paternal fruit, vegetable and berry intake and its association with the consumption of the food items in under-school-aged children. Moreover, as a novelty, this study examined raw and cooked vegetables separately instead of as combined use, and separated berries from fruit. Other strengths included the consideration of the use of two-fold statistical analysis methods, which involved backing up mixed-effects model analysis with PCA that exposed the inter-relationships between variables.

This study has four main limitations that may weaken the generalisability of the findings. First, we used FFQ to measure vegetable, berry and fruit consumption, and cannot exclude the possibility of social desirability or recall bias related to this method (Slimani, Freisling, Illner, & Huybrechts, 2015). It is possible that when parents report their children's fruit and vegetable consumption, they mirror their own consumption, which may lead to misreporting. Moreover, higher fruit and vegetable consumption is socially desired, which may lead to especially mothers exaggerating their children's (Vepsalainen et al., 2018) and their own (Di Noia, Cullen, & Monica, 2016) consumption habits. Despite its limitations, FFQ is widely used to assess both children's and parents' food consumption. To our knowledge, no validated, culturally appropriate FFQs with an emphasis on fruit and vegetable intake among 3–5-year-old children were available. In this study, children's FFQ measurements were limited to eating at home, which resulted in excluding fruit and vegetable consumption in ECEC from the measurements, whereas the parents' measurements also included their eating outside the home. Indeed, the finding that ECEC reduces children's berry consumption

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might be caused by the fact that parents were guided not to consider their children's eating in ECEC when assessing their children's food consumption. To take this into account, we included the number of days children participate in ECEC in the analyses. In the Finnish food culture, berries are often eaten with oatmeal at breakfast, and breakfast is served to children in ECEC. We sought to use a similar FFQ scale for children and parents, and therefore decided to adapt a scale from a questionnaire by the Finnish National Institute for Health and Welfare. Second, the present study sample was quite highly educated, which might have introduced some bias in our results. According to earlier studies, less educated families and those with a busy lifestyle are easily left outside studies (Rönkä, Sevõn, Malinen, & Salonen, 2014). If that is the case here, one can assume that the picture we got might be overly positive, as lower education is known to be linked with lower fruit and vegetable consumption. Third, the sample was relatively small, and participants were recruited solely through ECEC centres and limited to nuclear families. Excluding families with a single parent may have limited variation in our data. While there were 14 families with two children participating, due to the limited number of participants, we ignored the issue of family affiliation and decided not to exclude half of these children. Finally, the study design is cross-sectional, which limits observing long-term effects.

4.2 Practical implications

When promoting vegetable consumption in families with under-school-aged children, this study suggests placing greater emphasis on the serving of vegetables at dinner. For example, vegetables can be served as a main dish, as an accompaniment to a main dish and as salad. In addition, it would be beneficial to consider raw and cooked vegetables separately, as our findings show that different factors may affect their consumption. Previous studies have identified the challenging sensory properties of vegetables, such as bitterness and hard texture (Poelman, Delahunty, & de Graaf, 2013; Poelman, Delahunty, & de Graaf, 2017), which should be considered when preparing them. Serving both raw and variously cooked vegetables could diversify their consumption at different

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meals and snacks, which could be beneficial for vegetable consumption in families. Such more individually tailored practices aiming to promote vegetable use might particularly benefit children with high food neophobia.

This study also proposes that interventions and campaigns concerning children's vegetable consumption should target both fathers and mothers, as it was found in this study that paternal consumption is associated with children's cooked vegetable consumption.

Future research should address both mother's and father's role in promoting children's consumption of vegetables, fruit and berries. Furthermore, future research should explore the different factors affecting children's fruit and vegetable consumption separately for raw and cooked vegetables, and berries should be separated from fruit when culturally valid, as was done in this study.

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TABLES

Table 1. Background information of the 3–5-year-old children participating in early childhood education and care (ECEC) (n=114) and their parents (n=100).

	Children (n=114)	Mothers (n=100)	Fathers (n=100)
	mean±standard deviation		
Age, years	4.4 ± 0.8	35.4 ± 5.2	37.6 ± 5.9
Family size	~~4.4 ± 1.4~~		
Participation in ECEC, days/month	16.6 ± 4.3		
		n (%)	
Participating in sensory-based food education in ECEC	64 (56.1)		
Child sex			
Male	68 (59.6)		
Female	46 (40.4)		
Level of education			
University		53 (53.0)	35 (35.0)
Lower than university		47 (47.0)	65 (65.0)
Working full time		77 (77.0)	92 (92.0)
Working hours			
Regular day job		51 (51.0)	59 (59.0)
Irregular (e.g. shift work)		37 (37.0)	35 (35.0)
	mean±standard deviation		
Food neophobia score[a]	38.9 ± 11.3	24.9 ± 10.5	25.2 ± 12.0

[a] Score range 10-70, higher score indicates higher food neophobia

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Table 2. Raw and cooked vegetable, berry and fruit consumption of 3–5-year-old children and their mothers and fathers (means ± standard deviations).

	Mean±SD	**P-value[1]**		
Raw vegetables[a]		Children vs. mothers	Children vs. fathers	Mothers vs. fathers
Children, n=114	1.0±0.6	**<.001**	.086	**<.001**
Mothers, n=100	1.3±0.6			
Fathers, n=100	0.9±0.6			
Cooked vegetables[a]				
Children	0.6±0.4	**.037**	.76	**.046**
Mothers	0.7±0.6			
Fathers	0.6±0.4			
Berries[a]				
Children	0.5±0.3	**.005**	.71	**.026**
Mothers	0.7±0.4			
Fathers	0.5±0.4			
Fruit[a]				
Children	1.0±0.5	.122	**<.001**	**<.001**
Mothers	1.1±0.7			
Fathers	0.7±0.5			

[1] Wilcoxon signed rank test
[a] Scale 0-2 (0= never or rarely, 0.07= less than once a week, 0.14=once a week, 0.43=2-4 times a week, 0.78=5-6 times a week, 1=once a day, 2=two times or more a day)
p values in bold are significant

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Table 3. Factors describing the home food environment of the families (n=100) of under-school-aged children.

Availability and accessibility	**%**
Family purchases vegetables, berries and fruit	
Once a week or less often	14.0
2-4 times/week	63.0
5-7 times/week	23.0
Family grows vegetables	
In a garden or a vegetable patch	26.0
In a vegetable planter box or pot	25.0
Nowhere	49.0
Family grows berries	
In a garden or a vegetable patch	69.0
Nowhere	31.0
Family has vegetables, berries of fruit chopped in the fridge	
Never or rarely	64.0
Sometimes	26.0
Often or always	10.0
Serving	
Meal planning	
Daily	24.0
Weekly	65.0
Rarely or never	11.0
Cooking frequency in the family	
Daily	85.0
Couple of times/week	15.0
Family serves vegetables, berries or fruit at dinner	
Never to 1-2 days/week	11.0
3-4 days/week	29.0
5-7 days/week	60.0
Family serves vegetables, berries or fruit at evening snack	
Never to 1-2 days/week	28.0
3-4 days/week	30.0
5-7 days/week	42.0
Family and child involvement	
Responsible for grocery shopping	
Parents together or alternately	54.0
Mother	35.0
Father	3.0
Family together	8.0
Child engaging in grocery shopping	
Never to rarely	44.0
Sometimes	48.0
Often	8.0
Cooking in the family	
Parents together or alternately	51.0
Mother	41.0

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Father	3.0
Family together	5.0
Child engaging in preparing foods (e.g. chopping vegetables)	
Never to rarely	43.0
Sometimes	49.0
Often	8.0
Family meals	
1-4 times/week	22.0
5-6 times/week	20.0
≥7 times/week	57.0
Style of dinner in the family	
We don't eat dinner	1.0
We cook a meal, but eat at different times	32.0
We have a shared family dinner	67.0

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Table 4. Variables related to the consumption of raw vegetables, cooked vegetables, berries and fruit in 3-5-year-old children participating in early childhood education and care (ECEC) assessed by their parents, linear mixed-effects model.

Dependent variable	**Estimate**	**Standard error**	**p-value**
Raw vegetables, n=114			
Maternal consumption[1,a]	0.40	0.07	**<0.001**
Paternal consumption[1,a]	0.06	0.06	0.297
Family serves vegetables, berries or fruit at dinner[1,b]	0.08	0.03	**0.023**
Family serves vegetables, berries or fruit as evening snacks[2,c]	-0.30	0.16	0.058
Family serves vegetables, berries or fruit as evening snacks[1,d]	0.04	0.03	0.150
Sensory-based food education[2]	-0.12	0.07	0.112
Cooked vegetables, n=113			
Maternal consumption[1,a]	0.28	0.06	**<0.001**
Paternal consumption[1,a]	0.25	0.07	**0.001**
Family serves vegetables, berries or fruit at dinner[1,b]	0.06	0.03	0.069
Child's food neophobia[1]	-0.01	0.00	**0.014**
Sensory-based food education[2]	-0.13	0.13	0.351
Berries, n=113			
Maternal consumption[1,a]	0.20	0.07	**0.005**
Paternal consumption[1,a]	-0.02	0.07	0.788
Family serves vegetables, berries and fruit at dinner[1,b]	-0.06	0.03	**0.034**
Days in ECEC[1]	-0.02	0.01	**0.023**
Sensory-based food education[2]	-0.04	0.07	0.574
Fruit, n=114			
Maternal consumption[1,a]	0.32	0.06	**<0.001**
Paternal consumption[1,a]	-0.04	0.08	0.617
Style of dinner in the family[2,e]	-0.15	0.08	0.082
Family serves vegetables, berries or fruit as evening snacks[2,c]	-1.04	0.21	**<0.001**
Family serves vegetables, berries or fruit as evening snacks[1,d]	0.25	0.04	**<0.001**
Child's age[1]	-0.08	0.04	0.075
Sensory-based food education[2]	-0.10	0.08	0.239

p values in bold are significant
[1] Continuous variable
[2] Categorical variable
[a] 0=never; 0.07=less than once a week; 0.14=once a week; 0.43=2–4 times per week; 0.78=5–6 times a week;1=once a day; 2=two times or more a day

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[b] 0=never, 1=1-2 days a week, 2=3-4 days a week, 3=5-6 days a week, 4=every day
[c] 0=never, 1=at least 1-2 days a week
[d] 1=1-2 days a week, 2=3-4 days a week, 3=5-6 days a week, 4=every day
[e] 1=we don't eat dinner, 2=we cook a meal, but eat at different times, 3=we have a shared family dinner

FIGURES

Figure 1. Percentage of consumption frequencies of raw and cooked vegetables, berries and fruit among under-school-aged children (n = 114), their mothers (n = 100) and fathers (n = 100).

Figure 2. Principal component analysis (PCA) correlation loading plots between selected variables of PC1 against PC2 (A) and PC1 against PC3 (B) from the questionnaires. C=children, M=mothers, F=fathers, vbf= vegetables, berries and fruit, FFQ_raw= raw vegetables consumption frequency, FFQ_cooked= cooked vegetables consumption frequency, FFQ_berries= berries consumption frequency, FFQ_fruit= fruit consumption frequency.

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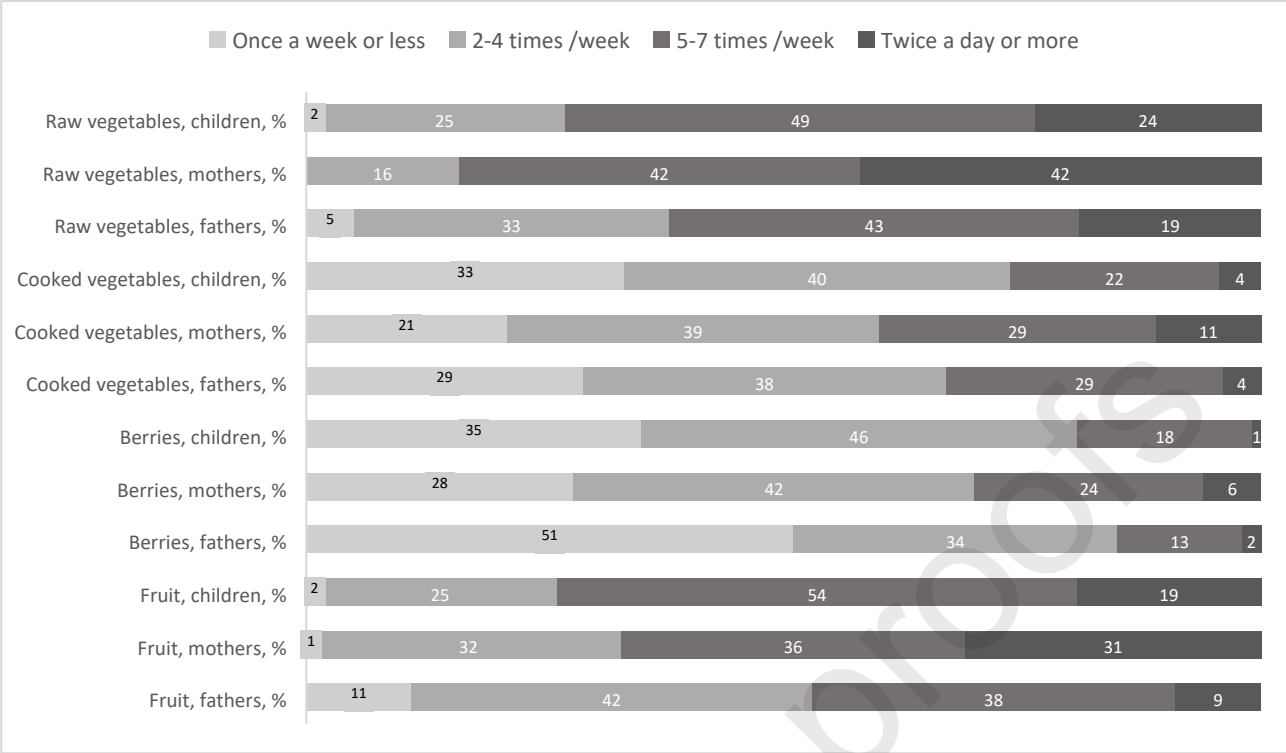

Figure 1. Percentage of consumption frequencies of raw and cooked vegetables, berries and fruit among under-school-aged children (n = 114), their mothers (n = 100) and fathers (n = 100).

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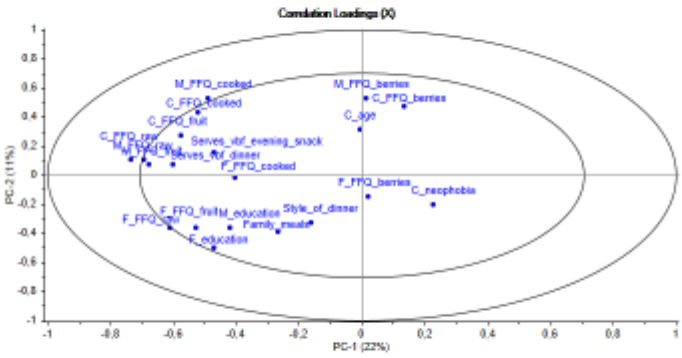

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HIGHLIGHTS

- Raw and cooked vegetables, berries and fruit were assessed separately.
- The consumption of raw vegetables and fruit was the highest.
- Mothers' and children's consumptions of the four food types associated significantly
- Father's consumption was associated with children's cooked vegetable consumption.
- Children's food neophobia was negatively linked to their cooked vegetable consumption

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CRediT author statement

Kaisa Kähkönen: Visualization, Writing - Original Draft, Formal analysis, Investigation
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