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Socioeconomic and household framework influences in school- aged children's eating habits: understanding the role of the father

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Socioeconomic and household framework influences in school-aged children's eating habits: understanding the role of the father

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Table of contents

List of Figures

List of Tables

List of Abbreviations

BMI – Body Mass Index

FFQ – Food Frequency Questionnaire

WHO – World Health Organization

EDF – Energy-dense food

FV – Fruits and vegetables

COSI –Childhood Obesity Surveillance Initiative

IAN-AF – National Food, Nutrition and Physical Activity Survey of the general population

Resumo

Contextualização

Em todo o mundo, o consumo de frutas e hortaliças vem diminuindo entre crianças e pré-adolescentes, enquanto a ingestão de alimentos de elevada densidade energética encontra-se a aumentar, contribuindo para a adoção de hábitos alimentares não saudáveis e a sua manutenção ao longo da vida. Durante a infância, os hábitos alimentares podem ser formados pela consolidação de fatores genéticos, ambientais e socioeconómicos. A compreensão de todas as influências na formação dos hábitos alimentares das crianças favorece ações e intervenções futuras para melhorar hábitos alimentares saudáveis e, consequentemente, evitar a obesidade e outras doenças crônicas não transmissíveis.

Objetivos

A presente tese teve como objetivo principal avaliar as influências socioeconómicas e estrutura familiar no consumo de frutas e vegetais (FV) alimentos de elevada densidade energética em crianças de 10 anos de idade. Para responder a este objetivo foram utilizados dados da coorte de base populacional portuguesa Geração XXI, tendo sido definidos os seguintes objetivos específicos, que resultaram em um artigo:

1. Avaliar as características socioeconómicas do pai e da mãe e a sua associação com os hábitos alimentares das crianças;
2. Analisar se e de que modo a estrutura familiar, incluindo o estado civil dos pais e viver com irmãos, pode predizer o hábito alimentar das crianças.

Métodos

Esta tese inclui dados obtidos da coorte de nascimento de base populacional Geração XXI. Os recém-nascidos de 5 maternidades públicas da zona do Porto, Portugal, nascidos entre 2005 e 2006 e as mães foram convidadas a participar no estudo (n=8647). Aos 4 anos foi realizado a primeira reavaliação de toda a coorte (86% de participação), aos 7 anos a segunda reavaliação (80% de participação) e aos 10 anos a terceira (76% de participação). Em todos as avaliações, as informações foram recolhidas presencialmente por entrevistadores treinados, através de questionários estruturados para recolher informações sobre as características das mães, dos pais e das crianças. Dados sociodemográficos maternos e paternos (idade e anos de escolaridade completos), e o sexo da criança, recolhidos no baseline, foram incluídos na fase inicial do estudo. Da avaliação aos 7 anos, foram consideradas a situação profissional dos pais, o rendimento familiar mensal, o número de irmãos, o consumo alimentar das crianças, o índice de massa corporal (IMC)

dos pais e das crianças e a atividade física. Da avaliação realizada aos 10 anos, foram utilizados dados sobre o consumo alimentar das crianças.

O consumo alimentar das crianças foi avaliado através da aplicação de um Questionário de Frequência Alimentar (QFA) previamente validado e calibrado e foram criados grupos de alimentos comparáveis em ambas as idades, com base nas recomendações da Organização Mundial de Saúde: 'Frutas e vegetais' (sopa de hortícolas, hortícolas crus e cozidos, e frutas); 'Doces' (gelado, açúcar, chocolate, bolos, biscoitos e rebuçados); 'Snacks salgados' (pizzas e batatas fritas) e 'Refrigerantes' (bebidas açucaradas com gás e sem gás, e néctares de fruta). O consumo diário dos grupos anteriores foram categorizados: 'Frutas e vegetais' em 'pelo menos 5 vezes por dia' versus 'menos de 5 vezes por dia'; 'Doces' e 'Refrigerantes' em 'pelo menos uma vez por dia' versus 'menos de uma vez por dia'; e 'Snacks salgados' em 'pelo menos uma vez por semana' versus 'menos de uma vez por semana'.

A associação entre ingestão de FV e alimentos de elevada densidade energética aos 7 anos, características sociodemográficas dos pais, atividade física das crianças, IMC e consumo FV, doces, snacks salgados e refrigerantes aos 10 anos foram avaliados separadamente através de modelos de regressão binária logística – coeficientes de regressão (β) e respetivo intervalo de confiança de 95% (IC). Para avaliar as associações entre as exposições e o desfecho, os grupos de variáveis foram ajustados separadamente, sendo cada grupo ajustado e inserido cumulativamente na análise com uma ordem fixa.

Resultados

O consumo de FV pelas crianças diminuiu dos 7 para os 10 anos. Por outro lado, o consumo de snacks salgados aumentou. Filhos de mães com maior escolaridade (OR=1,11; IC 95%:1,08-1,14), que moravam com irmãos (OR=1,32; IC 95%: 1,07-1,63), tinham maior rendimento familiar (OR=2,00; IC 95%: 1,4-2,71) e comiam pelo menos 5 porções de FV por dia aos 7 anos (OR=4,26; IC 95%: 3,30-5,50) tiveram mais chances de cumprir as recomendações diárias de consumo FV aos 10 anos. Após ajustes para as características da criança, a associação entre morar com irmãos e renda familiar deixaram de ser significativas com o consumo de FV. O desemprego do pai foi associado à redução do consumo de FV aos 10 anos (OR=0,61; IC 95%:0,415-0,90). Ajustes para as características das crianças diminuíram a associação significativa entre emprego do pai e o consumo de FV.

Maior idade (OR=0,95; IC 95%:0,92-0,98) e escolaridade materna (OR=0,94; 95% IC:0,91-0,97), e escolaridade do pai (OR=0,95; 95CI:0,93-0,984) diminuíram as chances de as crianças consumirem bebidas açucaradas diariamente aos 10 anos. O ajuste para as características das crianças cessou a associação entre escolaridade do pai e o consumo de refrigerantes e snacks salgados. As crianças de famílias com rendimento mensal superior a 1500€ tiveram menor probabilidade de consumir snacks salgados

semanalmente (OR=0,63; IC95%:0,49-0,79) e doces diariamente (OR=0,70; IC95%:0,55-0,89) aos 10 anos.

Conclusões

Foi observada uma diminuição geral no consumo de FV de 7 para 10 anos. No entanto, cumprir a recomendação diária de frutas e vegetais aos 7 anos ajudou a manter esse padrão alimentar saudável aos 10 anos. Variáveis socioeconómicas, a escolaridade e a situação de emprego do pai influenciaram o consumo de snacks salgados e frutas e vegetais aos 10 anos. A escolaridade e a idade materna estiveram associadas com a diminuição da ingestão de alimentos de elevada densidade energética e a escolaridade materna esteve diretamente relacionada com o aumento da ingestão de frutas e vegetais aos 10 anos. Foi encontrada uma associação positiva entre um maior rendimento do agregado familiar e o consumo de frutas e vegetais, enquanto uma associação inversa foi observada entre maior rendimento familiar mensal e alimentos de elevada densidade energética aos 10 anos. Ao contrário da idade materna, a idade do pai não se associou com o consumo alimentar dos filhos. De um modo geral, as influências da mãe parecem ter um maior impacto nos hábitos alimentares das crianças do que as do pai. Estudos com objetivo de avaliar a associação das características sociodemográficas dos pais e o padrão alimentar dos filhos são importantes para direcionar melhor as políticas e intervenções para promover hábitos alimentares saudáveis em crianças e pré-adolescentes.

Palavras-chave: Geração XXI; estrutura familiar; hábito alimentar de crianças; influência das mães; influência dos pais.

Abstract

Background

Worldwide the consumption of fruits and vegetables has been decreasing among children and preadolescents, while the energy-dense food intake has been increasing, contributing to unhealthy eating habits formation and its maintenance later in life. During childhood, eating habits can be formed by a consolidation of genetics, environmental and socioeconomic factors. Maternal influences on children's diet have been widely studied, while paternal and other household frameworks are less understood. The comprehension of all the influences on children's eating habits formation supports future actions and interventions to improve healthy eating habits and, consequently, prevent the obesity and other non-communicable diseases.

Aims

The present thesis aims to evaluate the socioeconomic and household framework influences on 10-year-old children's fruit and vegetables (FV) and energy-dense foods (EDF) consumption at 10 years. Data from the Portuguese population-based cohort Generation XXI was used to respond, and the following specific objectives were defined, resulting in one paper:

1. To evaluate the father's and mother's socioeconomic characteristics and their association with children eating habits;
2. To analyze if and how the household framework, including parents' marital status and living with siblings, can predict children eating habits.

Methods

This thesis includes data from the Generation XXI cohort, a prospective population-based birth cohort. The newborns from 5 public maternity units in the Porto area, Portugal born between 2005 and 2006 and the mothers were invited to participate in the study (n=8647). At 4 years old, the first follow-up of the entire cohort was realized (86% of participation); at 7 years of age, the second follow-up (80% of participation), and at 10 years of age, the third follow-up (76% of participation) occurred. In all follow-ups, the information was collected by face-to-face trained interviewers through a structured questionnaires that included information about maternal, paternal and children characteristics. Maternal and paternal sociodemographic data (age and complete years of education), and child's sex were included from the baseline. At the 7-year follow-up parents work status, monthly family income, number of siblings, children's dietary intake, parents and children body mass index (BMI) and children physical activity were evaluated. At the 10-year follow-up the dietary intake was accessed.

Children's food intake was assessed by a validated and calibrated Food Frequency Questionnaire (FFQ) and compared food groups were created at both ages, based on the recommendations of the World Health Organization: 'FV' (vegetable soup, raw and cooked vegetables, and fruit); 'Sweet foods' (ice cream, sugar, chocolate, cakes, cookies, and candies); 'Salty snacks' (pizzas and French fries) and 'Soft drinks' (sweetened carbonated beverages, iced tea and fruit nectar). The daily consumption frequency of the previous groups was categorized: 'Fruit and vegetables' into 'at least 5 times per day' vs. 'less than 5 times per day'; 'Sweet foods' and 'Soft drinks' into 'at least once per day' versus 'less than once per day'; and 'Salty snacks' into 'at least once per week' versus 'less than once per week'.

The association between FV intake and energy-dense foods at 7 years old, parent' sociodemographic characteristics, children's physical activity, BMI, and the consumption of FV, sweet foods, salty snacks, and soft drinks at 10 years were assessed separately via logistic binary regression models regression coefficients (β) and respective 95% confidence interval (CI). To evaluate the associations between exposures and the outcome, groups of variables were fitted separately, with each group adjusted and inserted cumulatively into the analysis in a fixed order.

Results

The children's consumption of FV decreased from 7 to 10 years old while salty snack consumption has increased. Children of mothers with higher education (OR=1.107; 95% CI:1.063-1.152), who live with siblings (OR=1.323; 95% CI: 1.074-1.630) had higher family income (OR=2.007; 95% CI: 1.484-2.713) and ate at least 5 portions of FV per day at 7 years (OR=4.264; 95% CI: 3.301-5.508) were more likely to accomplish the daily recommendations of FV at age 10. After adjustments for children's aspects, living with sibling and family income associations ceased to me significant with FV consumption. However having an unemployed father was associated with a reduction in FV consumption at 10y (OR=0.611; 95%CI:0.415-0.900). Further adjustments for children characteristics, ceased the significant association of paternal employment status and FV consumption.

Higher maternal age (OR=0.955; 95%CI:0.924-0.988) and education (OR=0.942; 95%CI:0.910-0.975), and father's education decreased the odds of consuming soft drinks daily intake (OR=0.95; 95CI:0.93-0.984) and salty snacks weekly consumption (OR=0.974; 95%CI: 0.952; 0.998) at 10 years**.** The adjustment for children' aspects ceased the association between father's education and soft drinks and salty snacks consumption. Children whose family income was higher than 1500€ per month had fewer odds of consuming salty snacks weekly (OR=0.688; 95%CI:0.504-0.938) and sweet foods daily (OR=0.702;95%CI:0.551-0.895) at 10 years.

Conclusions

A general decrease on fruits and vegetables consumption from 7 to 10 years was observed. However, meeting the fruits and vegetables daily recommendation at 7 years helped to maintain this healthy eating pattern at the age of 10. Socioeconomic aspects, father's education and employment influence children's consumption of salty snacks, and fruits and vegetables at 10 years. Maternal education and age were associated with a decrease of energy-dense food intake and maternal education was related with an increase of fruits and vegetables intake at 10 years. A direct association was found between high family income and fruits and vegetables consumption while an inverse association was seen among high family income and energy-dense foods at 10 years. Contrarily to maternal age, the father's age did not was associated with the children's food intake. Overall, mother's influences seem to have a more significant impact on children's eating habits than fathers. Studies focusing on the association of fathers' sociodemographic characteristics and children's dietary pattern are important to better address policies and interventions to promote children and preadolescent healthy eating habits.

Keywords: family structure; children eating habits; mothers influence, fathers influence.

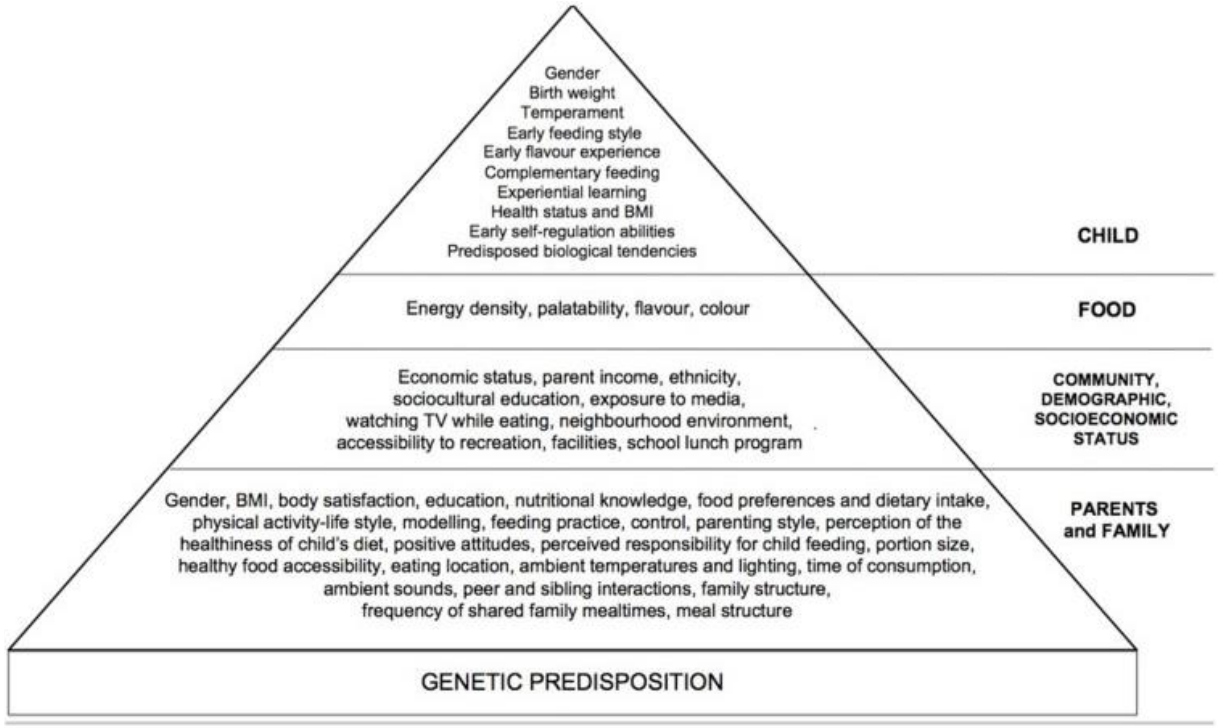
Introduction

1. Children eating habits formation

Childhood is a crucial period in life, where healthy eating habits can be developed and established, contributing to its maintenance over subsequent years. (1). Children are genetically inclined to prefer foods high in sugar and to reject bitter foods such as vegetables. However, this preference can be modified via repeated exposures to various flavors, whether via amniotic fluid or breastmilk, during the weaning period and during childhood through a healthy and varied diet (2, 3).

Adopting good eating habits during childhood is important for children's physical and physiological development. Additionally, healthy eating habits can prevent the appearance of many diseases, such as obesity, diabetes, cardiovascular diseases, and cancer, later in life (4).

Children eating habits can be determined by multiple factors, including biological aspects, such as genetic predisposition, birth weight, sex, and age, and environmental aspects, such as early food experiences and media exposure (figure 1) (5). Several socioeconomic factors have also been associated with children's food preferences and eating habits, such as parents' age and level of education, family income, number of siblings, and parent's marital status, among others (6). Equally important, family aspects such as parents'



BMI: Body Mass Index

Fig. 1 – Children's eating behavior influences (ref: (5))

food consumption and preferences, food availability and accessibility and family sharing meals influence the children's eating habits (5).

The preadolescence phase, comprising 10-14 years old, is associated with children's eating habits changes because, at this age, children have more independence and control over their food (7). Even though not fully understood, peers can influence preadolescents' eating habits positively or negatively due to social norms and interactions present among these groups, such as adopting peer's dietary patterns, friend's nomination or approval (8). A cross-sectional American study concluded that the peers' consumption of whole grains and vegetables was significantly associated with 14-year-old adolescents' consumption of the same food groups (9). Moreover, preadolescents eating habits can be impacted by social media, a virtual place where peers and influencers can share images about food, instigating healthy or unhealthy eating habits (10).

1.1 Development of food preferences

It is believed that during pregnancy, mothers transfer food odors and flavors from their diet to the fetus via the amniotic fluid, helping to develop children's food preferences during the weaning period (2). Mother's healthy food choices during pregnancy can favor the acceptance of fruits and vegetables (FV) during the complementary feeding phase, helping to create and maintain healthy eating habits throughout the child's consecutive years (11).

The development of children's food preferences can also be influenced by early flavor exposure via breastfeeding (12). Breast milk is usually the first food consumed by babies that promotes exposure to various flavor components present in milk, which can help increase babies' vegetable acceptance during the food introduction phase (3). Furthermore, children who have exclusive breastfeeding for less than 4 months have an increase in the odds of consuming less FV and more energy from ultra-processed foods between 4 and 7 years (13).

Maternal socioeconomic characteristics such as age and level of education influences significantly the breastfeeding onset and duration (14). In Europe, a low maternal education level has been associated with lower odds of breastfeeding initiation and early ending (15). Similarly, a longitudinal prospective study stated that highly educated mothers had 21% higher odds of maintaining breastfeeding in children's 3rd and 6th months (16).

1.2 Adherence to healthy eating patterns

Daily exposure to healthy, varied food and lower access to energy-dense foods are some approaches that can help promote children's healthy eating patterns (5). Moreover, encouraging children to try new fruits and vegetables via repeated exposure and affording healthy foods to children throughout the day are some recommendations to stimulate the consumption of fruits and vegetables and healthy eating habits (17).

Therefore, consuming fruits and vegetables, which are rich in fiber and other nutrients that promote satiety and well-being, and reducing the calorie intake from energy-dense foods, can help the children's healthy eating maintenance (18).

1.2.1 Fruits and vegetables consumption

Taking into consideration that FV are important sources of micronutrients, fiber, and other components for human nutrition, higher consumption of these foods helps to reduce the risk not only of obesity but also of several different chronic diseases onsets, such as type 2 diabetes, coronary heart disease and hypertension (19). These associations were confirmed with a recent prospective cohort study, where children who increased by 100g the daily consumption of unprocessed/minimally processed foods (including fresh fruits and vegetables) at 7 years presented lower risks for high blood pressure at 10 years old, compared to those with higher processed foods consumption (20).

Literature has shown that children with a varied diet, including fresh FV during the weaning period of life, tend to eat more vegetables at 6 years compared with those who have low variety meals (21). Moreover, children with a higher daily intake of FV at 4 years tend to maintain the same healthy eating pattern at 7 years old (22). Furthermore, a North American cohort study stated that an increase in 9 to 11-year-old children and pre-adolescent's consumption of FV helped decrease the consumption of energy-dense foods and beverages (23).

Frequent access to FV at home and children's involvement in the preparation of healthy meals can increase their motivation and self-confidence to carry out these activities, promoting healthy eating attitudes and habits (24). Healthy eating habits practiced at home and promoted in the school environments are effective tools to increase FV acceptance and consumption among children (25-27).

In the United States, between 2015 and 2018, about 20% of children between 6 to 5 years of age did not consume a portion of fruit in a day. (28). In a report from the World Health Organization (WHO), only 46% of European and Canadian children with 11 years had FV daily, and 37% of children did not have any FV daily in 2018 (29). In Portugal, according to the National Food, Nutrition and Physical Activity

Survey of the general population (acronym: IAN-AF 2015-2016), the consumption of FV is insufficient among Portuguese children and adolescents, where 72% and 78%, respectively, consume below 400g/day, the minimum recommended by the World Health Organization (WHO) (30). In addition, a more recent Portuguese survey, the European Childhood Obesity Surveillance Initiative (COSI) study, concluded that only around half of the Portuguese children from 6 to 8 years consumed daily FV (31).

1.2.2 Energy-dense food intake

According to the NOVA classification - a method that categorizes foods and ingredients in four different degrees of processing - the consumption of the processed and ultra-processed food group, which includes energy-dense foods such as packaged bread, candies, salty snacks, ice cream, breakfast cereals, soft drinks, and processed meats, has been associated not only with an increased risk of overweight and obesity among children, but also to higher total cholesterol and LDL cholesterol levels, and diseases such as diabetes and hypertension (32, 33). Similarly, a Portuguese prospective study concluded that 7-year-old children who consumed processed food daily, including salty or sweet nuts and seeds, presented higher risks of high blood pressure at 10 years (20).

High energy-dense food consumption, such as French fries and sweet desserts during the weaning period, can predict children's future eating habits and weight, influencing the maintenance of this eating pattern and increasing the prevalence (43%) of overweight and obesity at 6 years (21). For every 10% increase in children's energy intake from ultra-processed foods at 4 years, there is a related addition of 0.7 cm on children's waist circumference at 8 years. This could be considered a good anthropometric indicator to evaluate the association between body fat composition and metabolic diseases (34).

Children who frequently consume sugar-sweetened beverages and overall daily total sugar may be more likely to prefer sugary and less healthy food with the increasing of age (35). The association between early energy-dense food exposure and its pattern maintenance over the years can be explained by the fact that foods rich in fat and/or refined carbohydrates can interfere with the gut-brain signaling, activating neural lines related to reward, desire, and overeating, thus promoting addictive eating behaviors (36).

Between 2011 and 2014, almost 63% of US youth aged 2 to 19 years consumed at least one sugar-sweetened beverage, including soft drinks, sweetened coffee and tea in a day (37). Furthermore, between 2015 and 2018, one-third of American children and adolescents consumed about 14% of their daily calories from fast food restaurants or pizza on a given day (38). In Europe and Canada, the daily consumption of sweet foods and sugary soft drinks by 11-year-old children is around 12% and 13%, respectively, according to a recent WHO report (29).

The IAN-AF 2015-2016 concluded that 13% of Portuguese children between 3 and 9 years of age and one-third of adolescents between 10 and 17 years of age consume more than 220g per day of soft drinks (30). More recently, in 2019, the COSI study stated that around 18%, 7% and 62% of Portuguese children from 6 to 8 years had salty snacks, soft drinks and sweet snacks up to 3 times a week, respectively (31).

2. Environmental aspects on children's eating habits

The environment is an important factor associated with eating habits, and its impacts vary whether related to physical places such as home, work, school, or neighborhood, or socio-cultural structures such as social norms and peer influences (39).

The home environment is essential for helping develop and maintain children's healthy eating habits, seeing that parents and caregivers are responsible for the food acquisition, accessibility and exposure, apart from playing as role models for children (40).

A considerable part of children's daily energy intake comes from the food brought from home or provided at school (41). Considering that school is responsible not only for children's socialization and providing healthy food for children but is also a place where they can learn to make healthy eating choices, this environment is valuable for healthy eating habit formation (42).

2.1. Family environment

Family is a complex system where everyone shares their beliefs, values, and preferences. This environment is one of the factors that help promote and maintain children's healthy eating habits, whether through health education or food availability (5).

Family interaction, such as parents' food choices, family meal sharing, communal exercises and activities, and discussions regarding health and well-being, are family aspects that can positively influence children's food preferences and consumption (43). Children aged 6 to 11 years who have 5 or more family meals per week are more likely to have at least 3 vegetables per day and no sugar-sweetened beverage per day than those who have less frequent family meals (44).

Watching television while eating is linked with children's consumption of sugar-sweetened beverages, high fat and sugary foods intake and lower FV consumption (45).

Having FV available at home is another positive aspect linked to children's FV consumption (46). Every day of FV availability at home increases by 0.06 the number of days the children consume these foods (47). Similarly, home access to sugar-enriched food is positively related to the consumption of sweet biscuits, chocolate, and ice cream (48). Another study has shown that access to chips and sweets at home increases the odds of school-aged children's consumption of fats and sweets (49).

2.2. Physical activity

Regular physical activity is essential for preventing and maintaining non-communicable diseases such as type 2 diabetes, obesity, cancer and cardiovascular diseases (50). Besides, physical activity also promotes a reduction in stress, sedentarism, anxiety, and insomnia, which are behavioral risk factors directly associated with poor eating habits (51).

Children and adolescents with medium to high levels of physical activity are more likely to consume more dairy, water, fruits, fruit juices, whole pasta, brown rice, whole grain bread and vegetables than those with low levels (52) (53). Physical activity is also associated with an inverse of children's preference for unhealthy snacks, fast food, and sweets (53, 54).

Insufficient physical activity among children and adolescents has been seen worldwide, and a decrease in the level of physical activity has also been observed with children's ageing (55). The European Childhood Obesity Group and the European Academy of Pediatrics evidenced that children's sedentary habits tend to increase during adolescence (56).

Only 24% of American children and adolescents from 6 to 17 years engage in 60 minutes of physical activity every day, and there has been a significant decrease in physical activity levels as the children's age increases (57). According to a WHO report, only 38% and 12% of 10-11-aged children and 14-15-aged adolescents met the 60 minutes of moderate to vigorous physical activity daily recommendation in 2018 (58). Furthermore, the COSI study stated that only 41.7 % of Portuguese children between 6-8 years old practiced 1-to-3 hours of organized physical exercise per week in 2019 (31).

3 Socioeconomic factors

3.1 Family structure

3.1.2 Siblings

The siblings' relationship represents an important part of children's and adolescents' development, including aspects such as socialization interplay and food choices (8). The development of children eating practices can be influenced by the sibling's framework at home, including the number and age of siblings (59).

Siblings can influence positively or negatively on children's eating habits and this effect can vary according to the number and age of siblings and the characteristics of the relationship between the siblings (8). A systematic review concluded that having siblings can negatively impact children's eating habits (60). Moreover, a cross-sectional study described that the number of siblings is linked with increased fast-food consumption among Portuguese children aged 6-8 years old. (61). In a prospective cohort study, European children aged 7 years had similar eating habits to their siblings. However, at 11 years older, those children's eating habits were more similar to their peers, especially when the difference of age between the siblings was more than 2 years (62).

A Portuguese cross-sectional study found that having older siblings is associated with higher consumption of soft drinks, sweets, and salty snacks by 2-year-old children compared to those without siblings. (63). It is important to elucidate that parents' lack of time and resources can directly influence their kids' devotion and education, mainly when it is divided by two or more children, consequently impacting their eating consumption and habits (64).

3.1.3 Parental marital status

Family is an important predictor of children's development, influencing their diet, physical activity, sedentary behavior, health, and weight (65). The traditional family model has been changing in the last decades, and there has been an increase in the number of children who live in a one-parent family or with one of the parents and a step-parent (66).

A previous cross-sectional study reported a higher parent divorce frequency among 11-year-old overweight children compared to normal-weight ones (10.8% vs 7.3%), where a high prevalence of overweight children (47%) from divorced parents was observed (67).

Single parents tend to take care of and spend more time with their children but can also offer more food to compensate for the other parents' absence (68). Children around 10 years old from divorced parents can consume more sugar-sweetened beverages compared to those from married families (69). In a systematic review, children and adolescents aged 0 to 18 years from single families presented a significantly higher consumption of calories, sugar and total fat than children from married families (70).

Daily breakfast is a moment where a family can improve communication and connection, positively impacting children's health and well-being (71). However, children from 11 to 15 years old from single mothers, single fathers, or reconstituted families are less likely to have daily breakfast than those who live with both parents (71). Moreover, living in single families is associated with skipping breakfast and having fewer family dinners among children from 7 to 11 years of age which might be explained by lack of time due to more responsibility and tiredness (72).

The association between parents' marital status and children's weight could be seen in a Norwegian cross-sectional study where 8-year-old children of divorced parents presented a 54% higher prevalence of overweight and 89% higher prevalence of abdominal obesity than those of married parents (73). Indeed, children from single families are 23% more likely to be obese than children from married families (70).

Some researchers suggest that unhealthy weight and food consumption patterns among children from single families can be explained by single parents' higher demands and lower income, impacting a reduction in the available time to prepare healthy foods, make meals together and practice exercise (70). It is believed that poor eating habits and weight gain can also be linked to higher fast-food consumption encouraged during the father's visitations (74).

3.2 Family income

On the one hand, low-income families are more susceptible to higher energy-dense food intake and fewer fresh FV, which can be correlated to parents' low educational level, reduced access to healthy food varieties, more fast-food stores availability, and energy-dense foods with poor nutritional value cheaper than FV, making it challenging to maintain a healthy and varied diet (75-77). Compared with low-income families, those with high-income present significantly higher scores on a Healthy Eating Index and higher

total vegetable scores (78). On the other hand, the consumption of at least five portions of FV per day is higher among people with higher incomes in European countries (79).

Higher family income is also correlated to a reduction in children's consumption of energy-dense food (80). Indeed, Portuguese children aged 4 years from families with a monthly income of at least 1500 euros have higher odds of maintaining a healthier dietary pattern (81). Another similar study found a positive association between high socioeconomic status among families and Portuguese 3-9-year-old children's FV consumption (82).

Moreover, preadolescents and adolescents aged 11-15-year on the higher Family Affluence Scale, which includes family income, had higher odds of daily FV intake and lower probability of consuming sweets in a cross-sectional Czech Republic study (83). A 2021 global systematic review concluded that 10-19-year-old preadolescents and adolescents from low-income families are more likely to maintain unhealthy eating habits, probably because of lack of knowledge, and parents' price worry, leading to EDF choices (84).

3.3 Mother's influences

Mothers are still considered the main caregiver who can directly impact children's dietary intake because, in many families, she is still the one who decides which kind of food and preparation their child is going to receive during the meals and these choices are made based on their own education, eating habits and experiences (85).

Lower maternal education level is directly associated with increased odds of children following an energy-dense food and snacking dietary pattern (81). Besides, low maternal education can increase the risk of early childhood obesity (86). A higher level of maternal education has been positively associated with an increase in the quality of children's diet (87). Children whose mothers have higher educational levels are more likely to consume 'FV' than the offspring of a mother with lower educational level (5). An Australian randomized trial found that 3 and 5-year-old children whose mothers pursued a university degree or beyond consumed more vegetables (+30.3 g per day) and fewer snacks (–9.3 g per day) than those from mothers with lower educational levels (88). Furthermore, sweet beverage consumption is lower among 7-14-year-old children from mothers with a high-level education (89). A Portuguese prospective cohort study also concluded that a higher maternal educational level is significantly associated with 4-year-old children's healthy diet pattern adherence, including fruits, vegetables on the plate and vegetable soup (81). Further, a previously comprehensive review of the literature concluded that children and adolescents aged 6-18 years

whose mothers had higher educational levels were more likely to consume a higher amount or frequency of FV (90).

Maternal age is another factor that can influence children's eating habits. Pre-school children from mothers with 30 years of age or older present lower unhealthy eating patterns and higher adherence to a healthy eating pattern compared to those of younger mothers (91, 92). In a prospective cohort study, mothers aged less than 25 years were significantly associated with a 53% increase of 4-year-old children following an EDF dietary pattern than those whose mothers were older than 29 years (81). It has also been observed that children from old mothers decrease savory snack consumption (-5.56 g/day) compared to children from young mothers (88). A cross-sectional study concluded that 7-8- year old children from mothers aged 30-39 years had 18% lower odds of consuming soft drinks daily, in contrast to children from younger mothers (93).

Children from mothers who worked 21-35 hours per week had significantly more energy intake from energy-dense foods and beverages during snacks (β = 0·11, P = 0·03) and at the main meals (β = 0·10, P = 0·04) compared to those children from mother who did not work in a cross-sectional Australian study (94). North American research has shown that an increase in 20 hours of maternal work increased 3.3% and 4% of the odds of children from 5^{th} and 8^{th} grades having fast-food at least once per week (95). A systematic review stated that children's unhealthy eating habits are associated with maternal employment and, contrarily, the consumption of EDF can vary from low to high among children of unemployed mothers, demonstrating adversity results (96). Although some studies have shown that the mother's work status is associated with poor eating habits, most studies do not consider that women's employment can help increase the family income, and so, improving the quality of children's diet, and providing better childcare and physical activities for their kids (97, 98).

Maternal eating habits and physical exercises are also related to children's food and exercise habits, directly impacting the risk of overweight and obesity (99, 100). Moreover, mothers' Body Mass Index (BMI) can influence their children's eating behavior and weight via genetics or environmental aspects (101). According to a review study (102), some possible explanations for the link between mothers' BMI and children eating habits and weight are genetics; less awareness of obese mothers of their own and their children's hunger and satiety signs; and children's higher exposure and consumption of sugar-sweetened drinks, pastries and sweets compared to those of normal-weight mothers.

3.4 Father's influences

Fathers and children can build an early connection in life, sharing the same eating pattern, also impacting on child's food preferences (103). An Australian cross-sectional study has shown that fathers recognize themselves half the time as responsible for the management, portions and the type of food their 2-5-year-old children have and realize they are responsible for their child's feeding practice (104).

Fathers who practice physical activities and maintain a healthy diet act as role models for their children, significantly improving their kids' engagement in a healthy diet and physical activity (105, 106). Nevertheless, fathers' consumption of fruit, vegetables, sweet snacks, and sugar-sweetened beverages is positively associated with these same food patterns in their children (107). A European cross-sectional study evidenced that school-aged children from fathers who consume FV daily have higher chances of consuming fresh FV one to two times daily (108).

Regarding the fathers' age, positive associations have been seen between older fathers and children's vegetable consumption (109). A systematic review concluded that 2-5-year-old children of younger fathers and mothers were more likely to consume more sugar-sweetened beverages or to maintain an unhealthy eating pattern. Moreover, it stated that the quality of children's diet quality was positively associated with having older father and mother (96)

Education is an important aspect that helps improve health and prevent obesity (110). It has been seen that father's low level of education is associated with the prevalence of children's overweight (111), (112). A Polish cross-sectional study observed that 5-9-year-old-children whose fathers had a low level of education presented higher odds of being overweight than those with higher educational levels (113). Indeed, children of fathers with low academic levels are more likely to consume sugar-sweetened beverages daily and to prefer less healthy foods than those of fathers with a higher level of education (114, 115). According to a cross-sectional study, 7-8-year-old children from fathers who completed graduation were less likely to consume soft drinks and had a 64% higher probability of having fruits and vegetables daily compared to those from fathers with only high school (93). However, in a systematic review, the influence of a father's education was studied in six papers, of which only one identified a positive association (90).

Regarding fathers' employment status, a cross-sectional study stated that 2-5-year-old children from part-time and unemployed fathers had lower odds of having FV than those of full-time employed fathers (116). Furthermore, children from fathers who work 40 hours or more per week present lower energy-dense and nutrient-poor food consumption at meals than those who work 40 hours maximum per week (94). A systematic review described that 2 studies showed a positive association between father's working status and children's and adolescent's fruits and vegetable consumption (90).

4. The gaps of literature

Given the complexity of the predisposing factors of children's eating habits formation and maintenance, this thesis will focus on the socioeconomic and household characteristics that influence children's consumption of FV and energy-dense foods (1, 6, 117).

Most current studies still count only on mothers as the main caregiver responsible for the children's development, where fathers represent only 17% of the parents who participate in children-related studies, with only 10% of the papers including father-specific information, consequently resulting in a lack of fathers' participation in studies and impacting the knowledge of all factors that influence children's eating habits. Since the father's presence in studies is still deficient and limits the knowledge of all the determinants of children's eating habits formation, this thesis will evaluate the role of the father on children's eating habits (107, 108, 118).

Eating habits tend to change in pre-adolescence when peers and the media seem to have more influence over their eating patterns. Therefore, it is important to understand whether socioeconomic characteristics and father influences are maintained during the pre-adolescent phase (8-10).

Aims

The present thesis aims to evaluate socioeconomic influences on children's consumption of FV and energy-dense foods. Data from the Portuguese population-based cohort Generation XXI was used to respond to this major objective and the following specific objectives:

1. To evaluate the father and mother's socioeconomic characteristics and its association with children eating habits.

2. To analyze if and how the household framework, including parental marital status, can predict children eating habits.

Paper

Socioeconomic and household framework influences in school-aged children's eating habits: understanding the role of the father

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ABSTRACT

Maternal influences on children's diet have been widely studied, while paternal and other household frameworks are less understood. This study aimed to evaluate the socioeconomic and household structure influences on children's fruit and vegetables (FV) and energy-dense foods (EDF) intake at 10 years (y), distinguishing maternal and paternal influences, with a sample of 2750 children evaluated at 7 and 10y in the population-based birth cohort Generation XXI.

The children's food intake was evaluated via a validated food frequency questionnaire applied at 7 and 10y, where four food groups were defined: 'FV', and 'Sweet foods', 'Salty snacks'; and 'Soft drinks' as EDF. The associations between FV and EDF intake at 7y, parents and children's characteristics, and food consumption at 10y were evaluated through binary logistic regression, obtaining Odds Ratios (OR) and confidence interval (CI). Offspring of mothers with higher education (OR=1.107; 95% CI:1.063-1.152), who live with siblings (OR=1.323; 95% CI: 1.074-1.630) , had higher family income (OR=2.007; 95% CI: 1.484-2.713) and ate at least 5 portions of FV per day at 7y (OR=4.264; 95% CI: 3.301-5.508) were more likely to have 5 servings of FV daily at age 10y. After adjustments for children's aspects, living with sibling and family income associations ceased to me significant with FV consumption. Contrarily, having an unemployed father was negatively associated with FV intake at 10y (OR=0.611; 95%CI:0.415-0.900). Further adjustments for children characteristics, ceased the significant association of paternal employment status and FV consumption. Higher maternal age (OR=0.955; 95%CI:0.924-0.988) and education (OR=0.942; 95%CI:0.910-0.975), and father's education decreased the odds of consuming soft drinks daily intake (OR=0.95; 95CI:0.93-0.984) and salty snacks weekly consumption (OR=0.974; 95%CI: 0.952; 0.998) at age 10**.** The adjustment for children' aspects ceased the association between father's education and soft drinks and salty snacks consumption. A child whose family monthly income is higher than 1500€ has fewer odds of having salty snacks weekly (OR=0.688; 95%CI:0.504-0.938) and sweet foods daily (OR=0.702;95%CI:0.551-0.895) at 10y. Living with siblings, higher family income and FV and EDF consumption at 7 y impacted children's FV and EDF intake at 10y. Father's education and employment, and maternal education and age seem to be associated with children's eating habits, and mothers' influences may be stronger than fathers.

Keywords: Family structure; children eating habits; mothers influence, fathers influence.

Introduction

Childhood is a crucial period of life where healthy eating habits can be developed, established, and maintained throughout the subsequent years (1). A healthy and varied diet during this period is essential for children's cognitive and physical development (2). It can also impact the appearance of chronic diseases, such as diabetes, cardiovascular diseases, and cancer, later in life (3).

Between 2015 and 2018, about 20% of children from 5 to 6 years of age did not consume a portion of fruit in a day in the United States (4). According to World Health Organization (WHO), only 46% of 11-year-old European and Canadian children ate FV daily, and 37% of children did not have FV daily in 2018 (5). The National Food, Nutrition and Physical Activity Survey of the Portuguese Population (IAN-AF 2015-2016) stated that the consumption of fruits and vegetables (FV) is insufficient among Portuguese children and adolescents, where 72% and 78%, respectively, consume below 400g/day, the minimum recommended by the WHO (6, 7). More recently, the 2019 European Childhood Obesity Surveillance Initiative (COSI) study concluded that only around half of the Portuguese children from 6 to 8 years consumed FV daily (8).

According to the 2018 WHO report, the daily consumption of sweet foods and sugary soft drinks by 11-year-old children was around 12% and 13%, respectively, in Europe and Canada (5). Moreover, 22% of Portuguese children and one-third of the adolescents consume more than 220g per day of soft drinks, and 6-8-year old children consume salty snacks (18%) and sweet foods (62%) at least 1 time per week (6, 8).

Several factors have been associated with children's food consumption. In particular, family characteristics, such as parents' age and level of education, family income, number of siblings, among others, have been studied in relation with children's eating habits (9). A higher maternal educational level has been associated with an increased diet quality throughout childhood (10). Children whose mothers have higher educational levels tend to eat more FV (11). The same seems to be true for fathers, where higher academic levels can positively influence children's food intake. (12).

Additionally, the family income also influences the family's diet quality and, consequently, the children's food consumption (13). Low-income families are more susceptible to unhealthy energy-dense food intake, probably due to parents' low educational level, reduced access to healthy food varieties, cheaper meal availability and lower physical activity practice among this group (14).

The family structure has been experiencing some changes with the decrease of the traditional nuclear family and the increase of single-parent families. A link between family structure and children's eating habits has been described in a cross-sectional study, where children living with both parents presented higher consumption of fruits compared to children from single parents (15). Children living in a single motherhouse

may present poorer eating habits (16). It is believed that it can happen due to single mothers having more tasks, impacting a lack of time to prepare and share meals with their children. Another reason might be the higher fast-food consumption encouraged during father's visitations. Therefore, including both mother and father characteristics in assessing determinants of children's food consumption is crucial to understanding parental influences (17).

Fathers play an important role in the children's eating habits, where both tend to create an early connection in life, directly impacting the child's food preferences (18). When fathers emphasize healthy foods and eating habits, children tend to increase FV consumption (19). According to a recent systematic review on children's physical activity and diet, fathers represent only 17% of the parents participating in studies, and only 10% of the papers had father-specific information (20). Another systematic review asserted that only 1% of studies, among 600 studies regarding children's obesity, included only the father's characteristics, against 36% of studies which included only the mother's information (21). Most current studies still count only on mothers as the main participant in children's development, which can be explained by studies' assumption that women are still the main child's caregivers, resulting in a lack of fathers' participation. The absence of the father's data in studies leads to a poor understanding of the determinants of children's eating habits, limiting the effectiveness of interventions to improve the children's diet and prevent childhood overweight (20).

The preadolescence phase, comprising between 10-14 years old, is another factor associated with changes in children's eating habits, seeing it is a period when children usually have more independence and control over their diet (22, 23). Even though not fully understood, peers can also influence positively or negatively preadolescents eating habits, due to social norms and interactions present among these groups, such as adopting peers' dietary patterns, friends nomination or peers' approval (24). Preadolescents' eating patterns can also be modified by social media influence, via peers or influencers' share of images about food consumption, provoking healthy or unhealthy eating habits (25).

Thus, the present study aimed to evaluate individual and socioeconomic influences on 10-year-old children's consumption of FV and energy-dense foods, and specifically: i) to distinguish different influences from mother and father's socioeconomic characteristics and their association with children eating habits; ii) to analyze if the household framework influence children eating habits.

Methods

Study design and participants

The present study was based on the population-based birth cohort Generation XXI (26). All the newborns from the five public maternity units in the metropolitan area of Porto (Portugal) born between 2005 and 2006 were invited to participate in this cohort. Of the invited mothers, 91.4% accepted to participate in the study, with 8647 children at the baseline. The first follow-up of the entire cohort was realized at 4 years old, with 86% of participation. The second follow-up was performed at 7 years old, with the reevaluation of 80% of the children. The third follow-up was performed when the children were 10 years old, with 76% of participation. Children and main caregiver were invited to participate in face-to-face interviews during all the follow-up assessments. Trained interviewers performed face-to-face interviews using a structured questionnaire to collect information about maternal, paternal and children characteristics. Data were collected by telephone with a shorter version of the questionnaire for families who could not participate in person. The present study comprises a prospective analysis with data from the baseline and 7 and 10-year-old follow-ups. For the final sample, we considered all children with complete information on food consumption evaluated through a validated food frequency questionnaire (27) (FFQ) at 7 and 10 years old, achieving a total of 2750 children.

Data collection

Socioeconomic variables and household framework

The mother's and father's level of education and age were collected on the baseline and described as the total of completed schooling years (used as continuous). Parent's working status was accessed at 7 years follow-up, categorized, and converted into 'employed' (full-time work, part-time work, less than part-time work) or 'unemployed' (student, domestic, pre-retired, retired, unemployed and domestic worker). Family income was determined as an ordinal variable and categorized into ≤1000, 1001-1500 or ≥ 1501 euros per month.

The household framework at 7 years follow-up was also considered for the study. Family structure was defined as 'living with both parents' or 'not living with both parents' (living only with the mother, living only with the father, living with none of them). Having siblings or not was categorized according to the number of siblings.

Children's dietary intake

Children's food consumption data were collected through a Food Frequency Questionnaire (FFQ), previously calibrated in this sample (28), applied by trained interviewers to the main child caregiver, referring to the 6 months prior to the interview, at both ages.

The FFQ included thirty-eight food items/groups at 7 years of age (28). For each food item the response options were ‘4 times or more per day’, ‘2-3 times per day’, ’1 time per day’, ‘5-6 times per week’, ‘2-4 times per week’, ‘1 time per week’, ‘1-3 times per month’, and ‘less than once per month/never’. At the 10-year-old evaluation, the FFQ comprised 41 food items and the response option included ‘4 times or more per day’, ‘3 times per day’, ‘2 times per day’, ‘1 time per day’, ‘5-6 times per week’, ‘2-4 times per week’, ‘1 time per week’, ‘1-3 times per month’ and, ‘less than once per month/never’. All response options were converted into daily frequency (e.g., 5-6 times per week was converted into a 0.78 times per day).

Comparable food groups were created at both ages, based on the recommendations of the WHO (29). The groups included ‘Fruit and vegetables’ (vegetable soup, raw and cooked vegetables, and fruit); ‘Sweet foods’ (ice cream, sugar, chocolate, cakes, cookies, and candies); ‘Salty snacks’ (pizzas and French fries) and ‘Soft drinks’ (sweetened carbonated beverages, iced tea and fruit nectar). The daily consumption frequency of the previous groups was categorized: ‘Fruit and vegetables’ into ‘at least 5 times per day’ vs. less than 5 times per day; ‘Sweet foods’ and ‘Soft drinks’ into ‘at least once per day’ versus ‘less than once per day’; and ‘Salty snacks’ into ‘at least once per week’ versus ‘less than once per week’.

Anthropometrics measurements

According to standard procedures, a team of trained examiners measured anthropometrics at 7- and 10-year follow-ups (30) and objective measurements of children’s weight and height were performed. Children’s BMI was categorized according to specific cut-offs for age and sex, as defined by the WHO [Underweight/Normal weight (≤1Standard Deviation (SD); Overweight (>1SD to ≤2SD); and Obesity (>2SD)] (31).

Ethical considerations

The Generation XXI project was conducted according to the Declaration of Helsinki guidelines, and all the procedures that involved humans were authorized by the Ethical Committee of the Hospital São João/University of Porto Medical School. Explanation about the purpose, benefits and discomfort during the evaluations was delivered to each child’s legal representative or parents via written informed consent at baseline and during the follow-up evaluations.

Statistical analysis

Categorical variables were described as frequencies. Continuous variables were compressed by means and standard deviations (SD) or median and interquartile range (IQR). Comparison between the groups was achieved using Student’s t-test for paired samples or the Wilcoxon test.

The association between FV intake and energy-dense foods at 7 years old, parent and children characteristics, and the consumption of FV, sweet foods, soft drinks, and salty snacks at 10 years were assessed separately via logistic binary regression models – regression coefficients (β) and respective 95% confidence interval (CI). A step-by-step process was made to evaluate the associations between exposures and the outcome: groups of variables were fitted separately, with each group adjusted and inserted cumulatively into the analysis in a fixed order. Model 1 included maternal and paternal age and education and child's sex. Model 2 comprised the previous characteristics plus parent's working status, live with both parents and live with siblings. Model 3 comprehended the variables in model 2 and was further adjusted for child's physical activity, BMI, and previous food consumption at 7y. To avoid a potential multicollinearity effect, the family income was not adjusted for parent's education in the model 2 and model 3.

The software utilized was the Statistical Package for the Social Sciences (released 2021. IBM SPSS Statistics for Windows, version 26.0, IBM Corp.). We considered a significance level lower than 0.05.

Results

The family sociodemographic and child characteristics are presented in Table 1. At baseline, mothers and fathers had a mean age of 30 (± 4.8) and 32 (±5.3) years, respectively, and an average of 11.9 (± 4.3) and 10.6 (± 4.2) years of complete education, respectively. At the 7-year follow-up, most mothers (81%) and fathers (90%) were working. Among the children included in the study (52% girls), the overweight percentage increased from 7 to 10 years old (32% vs. 40%, $p < 0.001$), while the proportion of children with obesity decreased.

FV were consumed at least five times a day by less than half of the participants (42%) at 7 years of age and at 10 years only one-quarter of the participants accomplished this daily recommendation (Figure 1). At age 7, around 43% of the children had salty snack at least once a week, while at 10 years, there was an increase in weekly consumption for almost half of the children (48%). The daily consumption of sweet food and soft drink decreased from 7 to 10 years (59.6% vs. 58.1% and 40.8% vs 38.2%, $p<0.001$, respectively (Figure 1).

Tables 2 and 3 present the crude and adjusted associations between sociodemographic characteristics and food consumption at 10 years old. After adjustment for household variables (Table 2, model 2), higher maternal education was significantly associated with the consumption of FV at age 10. Also, having a higher family income (OR=2.007, 95%CI: 1.484-2.713) and living with siblings (OR=1.323, 95%CI: 1.074-1.630) increased the odds of accomplishing the FV daily recommendation. Children of unemployed

fathers presented lower odds of having the daily recommendation of FV. After adjusting for the child's characteristics (Table 2, model 3), the father's working status ceased to be significant, but maternal education remained positively associated with children's FV intake. Children who accomplished the daily FV recommendation at 7 years of age were four times more likely to maintain this food pattern at 10 years (Table 2, model 3). The consumption of sweet foods at age 7 reduced by 37% the odds of achieving the FV daily recommendation at 10 years.

Regarding the sweet foods' consumption, when the model was adjusted for household structure (Table 2, model 2), every one-year increase in maternal education and higher family income were linked to a decrease of 4% and 30%, respectively, in the odds of consuming sweet foods at 10 years of age. Being obese and having FV at least 5 times per day at 7 years old decreased by 42% and 24%, respectively, the odds of consuming sweet foods at age 10 (Table 2, model 3). Contrarily, children with a high consumption of energy-dense foods at 7 years presented higher odds of consuming sweet foods and soft drinks at least one time per day at 10 years.

Overall, maternal age and education and paternal education are inversely associated with consumption of soft drinks at 10 years (Table 3, model 2). Moreover, having a higher family income decreased 46% the odds of children consuming soft drinks at 10 years. When adjusted for model 3, only maternal age and education remained inversely associated with soft drinks' consumption at 10 years. Children who were obese at 7 years were less likely to have a high intake of soft drinks at 10 years.

A higher paternal education association was associated with lower consumption of salty snacks at 10 years (Table 3, model 2). A family income of more than 1500 euros per month was associated with a decrease in the odds of consuming salty snacks at 10 years (OR=0.629, 95%CI: 0.496-0.798. Table 3, model 2). When children's characteristics were added, the paternal education association ceased to be significant, but the family income association remained. Children who consumed salty snacks at 7 years had almost four times the odds of consuming salty snacks at 10 years weekly (Table 3, model 3). A higher consumption of soft drinks and sweet foods at 7 years was positively associated with the salty snacks' weekly intake at 10 years (Table 3, model 3).

Discussion

The current study shows that the household framework, mother, and father characteristics, and eating habits practices at 7 years influence later children's eating habits. The decrease in compliance with the recommendations for FV from 7 to 10 years old is similar to a previous American report that demonstrated that around 40% of children from 6 to 11 years consume less than a portion of fruit per day (4). Furthermore,

the IAN-AF 2015-2016 stated that 72% of Portuguese children consume less than 400g of FV per day (6). More recently, the COSI study concluded that only half of the Portuguese children from 6 to 8 years consumed FV daily (8). Thus, promoting FV intake early in life can be an important strategy to promote FV consumption later during childhood and adolescence.

Even though there was a general decrease in FV consumption from 7 to 10 years, children who were used to consuming FV at 7 years were more likely to maintain the same pattern a few years later. A North American investigation described that children who have had a varied diet, including FV, at 9 months ate more vegetables at 6 years than those who had low variety meals, stating that healthy eating practices early in life can predict good eating habits during childhood (32). Similarly, Portuguese children with a higher daily intake of FV at 4 years tend to maintain the same healthy eating pattern at 7 years old (33).

Higher maternal education level was positively associated with the consumption of FV at 10 years. Previously, in a cluster-randomized controlled trial, children from mothers who received nutrition sessions for 15 months and had at least a university degree consumed more 30 g per day of vegetables than the offspring from mothers without dietitian counselling and with lower education levels (34). A national dietary survey also stated that the higher the maternal education, the higher the children's FV consumption (35). Oppositely, every one-year increase in maternal education decreased the odds of consuming sweet foods and soft drinks in childhood. Our results align with a prospective cohort study that showed that Spanish children from mothers with low education levels are more prone to consume sweets several times per day than those from higher educated mothers (36). The same association was also found in a Portuguese prospective cohort study, where higher maternal years of education were inversely associated with the consumption of energy-dense food among 4 years old children (37). Similarly, another prospective cohort study also stated that lower maternal education is related to increased pre-school children's intake of energy-dense foods and higher adherence to a snacking pattern (38).

Maternal age was inversely associated with children's soft drink consumption at 10 years of age in the present study. Previously, higher maternal age was significantly linked to a reduced soft drink intake among Portuguese toddlers (13). Children from young mothers are more likely to present a higher risk of maintaining a sugar-sweetened beverage consumption pattern (39). It was also observed that 5-year-old children from older mothers had lower snack consumption (-5.56 g/day (95 % CI=0.70-10.41), compared to those from young mothers in a cluster-randomized controlled trial (34).

An increase in the father's level of education was associated with lower consumption of salty snacks and soft drinks. The results of the present study are consistent with other studies that showed that children from fathers with low educational levels were more likely to consume daily sugar-sweetened beverages (40) and

to prefer less healthy foods than those of fathers with higher years of education (41). Oppositely, 10-17-year-old children whose fathers had 7 or more years of education presented higher consumption of salty snacks in a national cross-sectional study (35). Similarly, Australian children from fathers with university degree tended to consume more energy from energy-dense food and beverages at snacks than those of fathers without university education in a cross-sectional study (42). These differences between our study and other research might be explained due to population variation.

Children of unemployed fathers presented lower odds of having at least five times FV per day. This result is also similar to a cross-sectional investigation where children from 2 to 5 years of unemployed fathers had lower intake of FV s compared to those of full-employed fathers (43). Contrarily, a cross-sectional study concluded that Australian children from unemployed fathers consumed lower proportion of energy-send food as snacks (42).

A family income of more than 1500 euros per month was positively significantly associated with consumption of FV but inversely related to the consumption of energy-dense foods at 10 years of age. In a previous study, the higher the Family Affluence Scale, which includes family income, the higher the odds of children's following the daily recommendation of FV (44). Portuguese children from families with monthly wages of 1500 euros or more have higher odds of exhibiting healthier dietary patterns, including soup and vegetables on the plate (38). A national study described a positive association between high socioeconomic status and consumption of FV among children from 3 to 9 years old (35).

Findings between family income and food intake described that higher income is associated with lower energy-dense food consumption among children (13, 45). These associations could be explained because children from low-income families are more vulnerable to unhealthy foods due to parents' low educational level, reduced access to healthy food varieties, and cheaper meal availability (14). Lower family income can make it difficult for children to access a healthy diet, reducing FV intake and increasing the consumption of foods high in cholesterol, saturated fat, added sugar and sodium (46).

Living with siblings helped increase the odds of meeting the FV daily consumption recommendation at 10 years compared to only children. On the contrary, a Portuguese cross-sectional study described that having older siblings is linked with higher frequency consumption of energy-dense foods by 2-year aged children compared to those without siblings. It is believed that this happens because older children can bring home some foods, such as snacks and sweetened beverages (13). Moreover, a systematic review concluded that having siblings can negatively impact children's eating habits (47). These differences in the results may be explained by the influence of the sibling on the child's eating habits can vary according to the number and age of siblings, and by the characteristics of the relationship between them (24, 48).

On the one hand, a FV consumption of at least five times per day at 7 years decreased the sweet foods consumption a few years later. Similarly, an American randomized controlled trial study stated that an increase in the consumption of FV was successfully related to a reduction in the consumption of energy-dense foods among children from 9 to 11 years old (49). On the other hand, the daily consumption of sweet foods at 7 years of age was associated with a reduction in the probability of achieving the FV daily recommendation at 10 years. A cross-sectional study suggested that Saudi children who consumed sugar-sweetened carbonated beverages and total sugar more frequently tended to increase these food preferences with age, besides presenting a decrease in the FV weekly intake (50).

Children who consumed more energy-dense foods at 7 years of age had higher chances of maintaining the same dietary pattern three years later. These results are equivalent to another Portuguese prospective cohort study that endorsed that children's consumption of energy-dense foods at 2 years was linked to poor diet quality at 4 years of age (51). Moreover, children's daily consumption of sweet foods and soft drinks at 4 years was also associated with an increase in the daily consumption of the same food groups at 7 years (10).

Around half of the children, at both ages, consume salty snacks on a weekly basis which is considerable but lower when compared to the COSI study, where 18% of children consume salty snacks at least once per week (8). These differences seen among the two Portuguese studies may be explained by the 6-year period interval between the studies, and the second study being carried out at a national level. In contrast, the current study was carried out only within the population of the municipality of Porto.

Being obese at 7 years was inversely associated with sweets and soft drinks consumption at 10 years. Parents' misperception about their children's eating consumption might partly explain this result. These could also be seen in a North American cross-sectional study where even though most of the 3-18 years aged children and adolescents did not meet the FV recommendations, around 44-65% of parents overestimated their diet and still believed their children had a healthy diet (52). Other explanations for these differences may be that parents or caregivers cannot be aware of all the food children consume during the day and the parent's desire for their children to correspond to social norms (51). Moreover, parents could be more aware of their children's weight, impacting dietary habit changes and reducing sweets and soft drinks intake between the second and third follow-up (53, 54).

In the current study, children's physical activity practices decreased by 18.4% from 7 to 10 years, similar to the COSI study that stated that only 57.1% of Portuguese children between 6-8 years old practiced physical activity (8). It has been shown an insufficient level of physical activity among children worldwide and a decrease in physical activity with the children's aging (55). In Portugal, only 60% of children from 6 to 9 years practice 60 minutes of moderate to vigorous physical activities daily (6). Studies have elucidated

that higher physical exercise levels are significantly associated with better consumption of FV and lower energy-dense food intake (56, 57).

This study must consider some strengths and limitations that require further discussion. The major strength of this study is the longitudinal model, based on a considerable sample size with a high percentage of participation. Moreover, this study aspects acknowledge a considered time progression of the multiple exposures related to children's eating habits, providing a better control of confounding factors. Dietary consumption assessment via FFQ (28) could be a limitation since it does not contemplate details about the food quantity. However, since our objective was to detail the frequency of food consumption by children, the validated and calibrated FFQ was suitable for the study. The FFQ used in the interview could be biased since parents may not remember all types and frequency of food the children had during the 6 months prior to the interview. Furthermore, parents may not be aware of what their children ate while out of home or under caregivers' care, which could lead to an over or underestimation. Nonetheless, this sample may not consider this bias because many school-aged children consume most of their daily energy at home (58, 59). The FFQ could also be biased due to parent's social desirability, leading to errors regarding their children's food consumption. Selection bias can also be considered a limitation in the study since fathers were underrepresented in the birth cohort. Lastly, fathers who participated in the study were older and had higher level of education compared to those fathers from the remained cohort study, which could limit the understanding of father's influencers on children's eating habits.

Conclusion

The current study suggests that parents' characteristics, siblings, and family income at 7 years are significantly associated with children's food consumption at 10 years, namely, FV and energy-dense foods. Our results reinforce that consuming FV at younger ages is also important to promoting children's healthy eating habits and reducing energy-dense food intake, thus helping to prevent obesity and chronic diseases later in life.

In the present study, the father's education and working status were associated with children's eating habits. Moreover, it was also possible to observe that maternal educational level and age significantly influenced children's eating habits, with an increase in the consumption of FV and a reduction of energy-dense food intake at 10 years, inferring that the mother's influences may be stronger than the fathers.

It is important to highlight that fathers' presence in studies is still insufficient and limits the understanding of their total influences on children's eating habits, reducing effective interventions to improve children's food consumption and prevent and combat childhood obesity. Therefore, this study also underlines the

urgency to increase fathers' participation in future children's eating habits investigations since they can also have a substantial role in the development of early healthy eating habits.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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Author contributions:

Karla Leal was responsible for study design, data interpretation and wrote the first version of the manuscript. Marta Costa was responsible for the statistical analysis and data interpretation. Sofia Vilela was responsible for study design, supervision, and data interpretation. All authors read and provided critical feedback on the manuscript before approving.

References

1. Rauber F, Hoffman DJ, Vitolo MR. Diet quality from pre-school to school age in Brazilian children: a 4-year follow-up in a randomised control study. Br J Nutr. 2014;111(3):499-505.
2. (UNICEF) UNCsF. The state of the world´s children 2019: Children, food and nutrition - Growing well in a changing world. New York, USA; 2019.
3. Boyle MA, Holben D.H. Community Nutrition In Action: An Entrepreneurial Appoach. Belmont (CA): CENGAGE Learning; 2009. 752 p.
4. Wambogo EA AN, Ahluwalia N, Ogden, CL. Fruit and vegetable consumption among children and adolescents in the United States, 2015–2018. Hyattsville: Centers for Disease Control and Prevention, Statistics NCfH; 2020 November, 2020.
5. World Health Organization. Regional Office for E. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. International report. Volume 2. Key data. Copenhagen: World Health Organization. Regional Office for Europe; 2020 2020.
6. Lopes C TD, Oliveira A, Severo M, Alarcão V, Guiomar S, Mota, J TP, Rodrigues S, Lobato L, Magalhães V, Correia D, Carvalho C, Pizarro A, Marques, A VS, Oliveira L, Nicola P, Soares S, Ramos E. Inquérito Alimentar Nacional e de Atividade Física,IAN-AF 2015-2016. Porto: Universidade do Porto; 2017.
7. Organization WH. Healthy diet 2020 [Available from: https://www.who.int/news-room/fact-sheets/detail/healthy-diet.
8. Ana Rito SMJBMJG. Childhood Obesity Surveillance Iniciative - Cosi Portugal 2019. Lisboa: Direção Geral da Saúde, Jorge INdSDR; 2019.
9. and RHB, Corwyn RF. Socioeconomic Status and Child Development. Annual Review of Psychology. 2002;53(1):371-99.
10. da Costa MP, Durao C, Lopes C, Vilela S. Adherence to a healthy eating index from pre-school to school age and its associations with sociodemographic and early life factors. Br J Nutr. 2019;122(2):220-30.
11. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors Influencing Children's Eating Behaviours. Nutrients. 2018;10(6).
12. Hu H, Yang C, Tan F, Zhao X, Du X, Liang J, et al. Parental Influence in Forming Preschool Children's Eating Behaviors-A Cross-Sectional Survey in Chongqing, China. Healthcare (Basel). 2019;7(4).
13. Vilela S, Oliveira A, Pinto E, Moreira P, Barros H, Lopes C. The influence of socioeconomic factors and family context on energy-dense food consumption among 2-year-old children. Eur J Clin Nutr. 2015;69(1):47-54.
14. Yannakoulia M, Lykou A, Kastorini CM, Saranti Papasaranti E, Petralias A, Veloudaki A, et al. Socio-economic and lifestyle parameters associated with diet quality of children and adolescents using classification and regression tree analysis: the DIATROFI study. Public Health Nutrition. 2016;19(2):339-47.
15. Baek YJ, Paik HY, Shim JE. Association between family structure and food group intake in children. Nutr Res Pract. 2014;8(4):463-8.
16. Stewart SD, Menning CL. Family structure, nonresident father involvement, and adolescent eating patterns. J Adolesc Health. 2009;45(2):193-201.
17. Duriancik DM, Goff CR. Children of single-parent households are at a higher risk of obesity: A systematic review. J Child Health Care. 2019;23(3):358-69.

18. Walsh AD, Cameron AJ, Hesketh KD, Crawford D, Campbell KJ. Associations between dietary intakes of first-time fathers and their 20-month-old children are moderated by fathers' BMI, education and age. British Journal of Nutrition. 2015;114(6):988-94.
19. Litchford A, Savoie Roskos MR, Wengreen H. Influence of fathers on the feeding practices and behaviors of children: A systematic review. Appetite. 2020;147:104558.
20. Morgan PJ, Young MD. The Influence of Fathers on Children's Physical Activity and Dietary Behaviors: Insights, Recommendations and Future Directions. The Obesity Epidemic: Causes and Consequences. 2017;6(3):324-33.
21. Davison KK, Gicevic S, Aftosmes-Tobio A, Ganter C, Simon CL, Newlan S, et al. Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. Am J Public Health. 2016;106(11):e14-e21.
22. Winpenny EM, Corder KL, Jones A, Ambrosini GL, White M, van Sluijs EMF. Changes in diet from age 10 to 14 years and prospective associations with school lunch choice. Appetite. 2017;116:259-67.
23. Harris C, Flexeder C, Thiering E, Buyken A, Berdel D, Koletzko S, et al. Changes in dietary intake during puberty and their determinants: results from the GINIplus birth cohort study. BMC Public Health. 2015;15:841.
24. Ragelienė T, Grønhøj A. The influence of peers′ and siblings′ on children's and adolescents′ healthy eating behavior. A systematic literature review. Appetite. 2020;148:104592.
25. Chung A, Vieira D, Donley T, Tan N, Jean-Louis G, Kiely Gouley K, et al. Adolescent Peer Influence on Eating Behaviors via Social Media: Scoping Review. J Med Internet Res. 2021;23(6):e19697.
26. Larsen PS, Kamper-Jorgensen M, Adamson A, Barros H, Bonde JP, Brescianini S, et al. Pregnancy and birth cohort resources in europe: a large opportunity for aetiological child health research. Paediatr Perinat Epidemiol. 2013;27(4):393-414.
27. Cade J, Thompson R, Burley V, Warm D. Development, validation and utilisation of food-frequency questionnaires - a review. Public Health Nutr. 2002;5(4):567-87.
28. Vilela S, Severo M, Moreira T, Ramos E, Lopes C. Evaluation of a short food frequency questionnaire for dietary intake assessment among children. Eur J Clin Nutr. 2019;73(5):679-91.
29. World Health Organization. Regional Office for E. Food and nutrition policy for schools : a tool for the development of school nutrition programmes in the European Region. Copenhagen : WHO Regional Office for Europe; 2006.
30. Júnior F, F, Ismael. Padronização de medidas antropométricas e avaliação da composição corporal. In: Paulo CRdEFdRS, editor. São Paulo, Brazil2018.
31. Organization WH. Child growth standards [Available from: https://www.who.int/tools/child-growth-standards/standards.
32. Rose CM, Birch LL, Savage JS. Dietary patterns in infancy are associated with child diet and weight outcomes at 6 years. Int J Obes (Lond). 2017;41(5):783-8.
33. Vilea M, Ana Sofia. Tracking the acquisition of eating habits in children and its effects on behaviours related to appetite and on adiposity. Porto, Portugal: Faculdade de Medicina da Universidade do Porto; 2018.
34. Delisle Nyström C, Cameron AJ, Campbell KJ, Hesketh KD. Variation in outcomes of the Melbourne Infant, Feeding, Activity and Nutrition Trial (INFANT) according to maternal education and age 2 and 3·5 years post-intervention. Public Health Nutr. 2021;24(6):1460-8.
35. Vilela S, Muresan I, Correia D, Severo M, Lopes C. The role of socio-economic factors in food consumption of Portuguese children and adolescents: results from the National Food, Nutrition and Physical Activity Survey 2015-2016. Br J Nutr. 2020;124(6):591-601.
36. Cárdenas-Fuentes G, Homs C, Ramírez-Contreras C, Juton C, Casas-Esteve R, Grau M, et al. Prospective association of maternal educational level with child's physical activity, screen time, and diet quality. Nutrients. 2021;14(1).

37. Durao C, Severo M, Oliveira A, Moreira P, Guerra A, Barros H, et al. Evaluating the effect of energy-dense foods consumption on preschool children's body mass index: a prospective analysis from 2 to 4 years of age. European Journal of Nutrition. 2015;54(5):835-43.
38. Durao C, Severo M, Oliveira A, Moreira P, Guerra A, Barros H, et al. Association of maternal characteristics and behaviours with 4-year-old children's dietary patterns. Matern Child Nutr. 2017;13(2).
39. Lopez-Gonzalez D, Avila-Rosano F, Montiel-Ojeda D, Ortiz-Obregon M, Reyes-Delpech P, Diaz-Escobar L, et al. Maternal Factors and Their Association with Patterns of Beverage Intake in Mexican Children and Adolescents. Children (Basel). 2021;8(5).
40. Ramírez-Vélez R, Fuerte-Celis JC, Martínez-Torres J, Correa-Bautista JE. Prevalence and associated factors of sugar-sweetened beverages intake among schoolchildren aged 9 to 17 years from Bogotá, Colombia: the FUPRECOL Study. Nutr Hosp. 2017;34(2):422-30.
41. De Lira-Garcia C, Bacardi-Gascon M, Jimenez-Cruz A. Preferences of healthy and unhealthy foods among 3 to 4 year old children in Mexico. Asia Pac J Clin Nutr. 2012;21(1):57-63.
42. Mauch CE, Wycherley TP, Bell LK, Laws RA, Byrne R, Golley RK. Parental work hours and household income as determinants of unhealthy food and beverage intake in young Australian children. Public Health Nutrition. 2022:1-12.
43. Alsharairi NA, Somerset S. Parental work status and children's dietary consumption: Australian evidence. International Journal of Consumer Studies. 2018;42(5):522-32.
44. Yannakoulia M, Lykou A, Kastorini CM, Saranti Papasaranti E, Petralias A, Veloudaki A, et al. Socio-economic and lifestyle parameters associated with diet quality of children and adolescents using classification and regression tree analysis: the DIATROFI study. Public Health Nutr. 2016;19(2):339-47.
45. Kant AK, Graubard BI. Family income and education were related with 30-year time trends in dietary and meal behaviors of American children and adolescents. J Nutr. 2013;143(5):690-700.
46. Mohd Shariff Z, Lin KG, Sariman S, Lee HS, Siew CY, Mohd Yusof BN, et al. The relationship between household income and dietary intakes of 1-10 year old urban Malaysian. Nutr Res Pract. 2015;9(3):278-87.
47. Ragelienė T, Grønhøj A. The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. (1095-8304 (Electronic)).
48. Potter C, Gibson EL, Ferriday D, Griggs RL, Coxon C, Crossman M, et al. Associations between number of siblings, birth order, eating rate and adiposity in children and adults. Clin Obes. 2021;11(3):e12438-e.
49. Thompson D, Ferry RJ, Jr., Cullen KW, Liu Y. Improvement in Fruit and Vegetable Consumption Associated with More Favorable Energy Density and Nutrient and Food Group Intake, but not Kilocalories. J Acad Nutr Diet. 2016;116(9):1443-9.
50. Collison KS, Zaidi Mz Fau - Subhani SN, Subhani Sn Fau - Al-Rubeaan K, Al-Rubeaan K Fau - Shoukri M, Shoukri M Fau - Al-Mohanna FA, Al-Mohanna FA. Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. (1471-2458 (Electronic)).
51. Vilela S, Oliveira A, Ramos E, Moreira P, Barros H, Lopes C. Association between energy-dense food consumption at 2 years of age and diet quality at 4 years of age. Br J Nutr. 2014;111(7):1275-82.
52. Eliason J, Acciai F, DeWeese RS, Vega-López S, Ohri-Vachaspati P. Children's Consumption Patterns and Their Parent's Perception of a Healthy Diet. Nutrients. 2020;12(8):2322.
53. Ogden J. The Psychology of Eating: From Healthy to Disordered Behavior. 2nd ed. United Kingdom - UK: Wiley-Blackwell; 2010. 400 p.
54. McCambridge J, Witton J, Elbourne DR. Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. J Clin Epidemiol. 2014;67(3):267-77.
55. Aubert S, Brazo-Sayavera J, Gonzalez SA, Janssen I, Manyanga T, Oyeyemi AL, et al. Global prevalence of physical activity for children and adolescents; inconsistencies, research gaps, and recommendations: a narrative review. Int J Behav Nutr Phys Act. 2021;18(1):81.

56. Manz K, Mensink GBM, Finger JD, Haftenberger M, Brettschneider A-K, Lage Barbosa C, et al. Associations between Physical Activity and Food Intake among Children and Adolescents: Results of KiGGS Wave 2. Nutrients. 2019;11(5):1060.
57. Paulina Kiebuła KT, Joanna Furman, Beata Łabuz-Roszak. Association between eating habits and physical activity in primary school students. Wiadomości Lekarskie. 2020;10(73):2120-6.
58. Moreira T, Severo M, Oliveira A, Ramos E, Rodrigues S, Lopes C. Eating out of home and dietary adequacy in preschool children. Br J Nutr. 2015;114(2):297-305.
59. Prado BG, Hinnig PdF, Tanaka LF, Latorre MdRDdO. Qualidade da dieta de escolares de 7 a 10 anos do município de São Paulo: associação com o número e os locais de refeições. Revista de Nutrição. 2015;28:607-18.

Table 1. Sociodemographic characteristics, family household, and children and parents' characteristics.

	Evaluation			
	Baseline	**7 years**	**10 years**	**p-value**
Girls, n (%)	1432 (52.1)	-	-	
Maternal age (years), mean (SD)	30.0 (4.8)	-	-	
Paternal age (years), mean (SD)	31.9 (5.3)	-	-	
Maternal educational level (years), mean (SD)	11.9 (4.3)	-	-	
Paternal educational level (years), mean (SD)	10.6 (4.2)	-	-	
Family income (euros/month), n (%)				
≤1000		601 (22.3)	589 (22.1)	
1001-1500		758 (28.1)	759 (28.4)	
≥ 1501		1342 (49.7)	1322 (50.2)	
Mother's working status, n (%)				
Employed		2197 (80.7)	-	
Unemployed		526 (19.3)	-	
Father's working status, n (%)				
Employed		2259 (90.5)	-	
Unemployed		238 (9.5)	-	
Father's BMI, mean (SD)		27.5 (4.1)	-	
Mother's BMI, mean (SD)		26.6 (5.1)	-	
Family structure, n (%)				
Live with both parents		2351 (85.7)	-	
Live only with mother		353 (12.9)	-	
Live only with father		21 (0.8)	-	
Live with none of them		17 (0.6)	-	
Live with siblings, n (%)		1747 (64.0)	-	
Child's practice of physical activity, n (%)		2366 (86.4)	1871 (68.0)	<0.001
Child's BMI, n (%)				
Underweight/Normal weight		901 (48.4)	661 (49.1)	<0.001
Overweight		597 (32.1)	544 (40.4)	
Obesity		362 (19.5)	140 (10.4)	

BMI, body mass index; SD, standard deviation

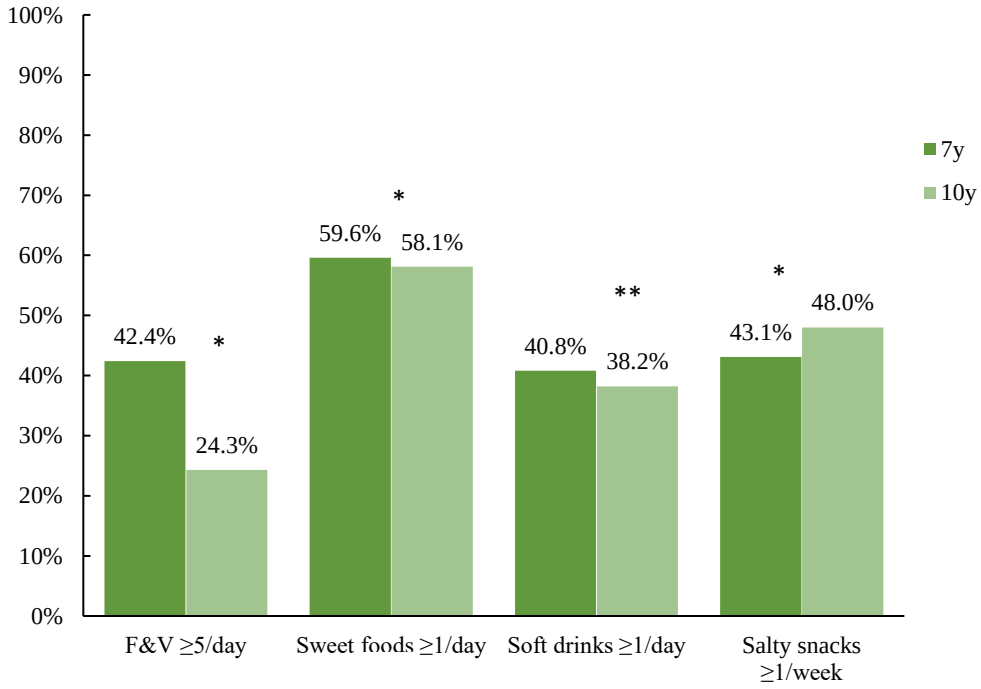

Fig. 1 - Proportion of children consuming fruits and vegetables at least five times a day, sweet foods, and soft drinks at least once a day, and salty snacks at least once a week at 7 and 10 years of age (y). *p<0.001 ** p<0.05

Table 2. Associations between parent and children's characteristic and fruits and vegetables, and sweet foods consumption at 10 years of age (β-Coefficients and 95% confidence intervals)

	Fruits and vegetables at 10y (≥5 /day)			**Sweet foods at 10y (≥1/day)**		
	Model 1 β (95%CI)	Model 2 β (95%CI)	Model 3 β (95%CI)	Model 1 β (95%CI)	Model 2 β (95%CI)	Model 3 β (95%CI)
Sociodemographic factors						
Maternal age (years)	**1.034 (1.007; 1.062)**	1.029 (0.999; 1.060)	1.024 (0.986; 1.064)	0.979 (0.957; 1.001)	0.976 (0.953; 1.000)	0.977 (0.946; 1.008)
Maternal education (years)	**1.105 (1.074; 1.137)**	**1.114 (1.081; 1.149)**	**1.107 (1.063; 1.152)**	**0.972 (0.949; 0.995)**	**0.969 (0.945; 0.994)**	0.990 (0.958; 1.023)
Paternal age (years)	0.976 (0.953; 1.000)	0.981 (0.959; 1.007)	0.977 (0.944; 1.011)	**1.026 (1.005; 1.046)**	1.020 (0.998; 1.043)	1.015 (0.988; 1.044)
Paternal education (years)	**1.035 (1.007; 1.064)**	1.029 (1.000; 1.059)	1.003 (0.965; 1.042)	0.982 (0.959; 1.006)	0.980 (0.956; 1.005)	0.985 (0.953; 1.018)
Household structure						
Family income at 7y						
≤1000	-	Ref.	Ref.	-	Ref.	Ref.
1001-1500	-	1.147 [a] (0.828; 1.590)	0.809 [b] (0.536; 1.220)	-	1.041 [a] (0.806; 1.344)	1.045 [b] (0.754; 1.448)
≥ 1501	-	**2.007 [a] (1.484; 2.713)**	1.284 [b] (0.872; 1.892)	-	**0.702 [a] (0.551; 0.895)**	0.772 [b] (0.564; 1.058)
Maternal working status						
Employed	-	Ref.	Ref.	-	Ref.	Ref.
Unemployed	-	1.050 (0. 808; 1.364)	1.156 (0.827; 1.617)	-	0.950 (0.767; 1.176)	0.903 (0.687; 1.186)
Paternal working status						
Employed	-	Ref.	Ref.	-	Ref.	Ref.
Unemployed	-	**0.611 (0.415; 0.900)**	0.703 (0.436; 1.133)	-	1.001 (0.756; 1.325)	0.944 (0.662; 1.347)
Live with siblings						
No	-	Ref.	Ref.	-	Ref.	Ref.
Yes	-	**1.323 (1.074; 1.630)**	1.237 (0.945; 1.619)	-	0.931 (0.783; 1.108)	0.974 (0.778; 1.218)
Live with both parents						
No	-	Ref.	Ref.	-	Ref.	Ref.

Yes	-	1.149 (0.762; 1.733)	1.648 (0.922; 2.946)	-	1.074 (0.766; 1.508)	1.206 (0.744; 1.879)
Child's Characteristics						
Physical activity at 7y						
No	-	-	Ref.	-	-	Ref.
Yes	-	-	1.029 (0.700; 1.513)	-	-	1.132 (0.831; 1.540)
Children BMI at 7y						
Under/normal weight	-	-	Ref.	-	-	Ref.
Overweight	-	-	1.107 (0.837; 1.464)	-	-	0.882 (0.694; 1.122)
Obesity	-	-	1.103 (0.787; 1.548)	-	-	**0.54 (0.411; 0.721)**
FV at 7y (≥5/day)	-	-	**4.264 (3.301; 5.508)**	-	-	**0.768 (0.618; 0.954)**
Sweet foods at 7y (≥1/day)	-	-	**0.633 (0.513; 0.856)**	-	-	**3.195 (2.572; 3.969)**
Soft drinks at 7y (≥1/day)	-	-	0.827 (0.627; 1.091)	-	-	**1.294 (1.031; 1.623)**
Salty snacks at 7y (≥1/week)	-	-	0.872 (0.671; 1.133)	-	-	**1.642 (1.322; 2.040)**

Significant associations are shown in bold. CI, confidence interval. Children's sex was adjusted for all the models.
Model 1 included maternal and paternal age and education variables.
Model 2 included the previous variables adjusted for parent's working status, live with both parents, and live with siblings.
Model 3 comprehended the variables from model 2 and was further adjusted for child's physical activity and BMI, 'FV' at 7 y, 'Sweet foods' at 7 y, 'Soft drinks' at 7 y, and 'Salty snacks' at 7 y.
[a] Adjusted for parent's age, parent's working status, live with both parents and live with siblings.
[b] Adjusted for parent's age, parent's working status, live with both parents, live with siblings, physical activity, 'FV' at 7 y, 'Sweet foods' at 7 y, 'Soft drinks' at 7 y, and 'Salty snacks' at 7 y.

Table 3. Associations between parent and children's characteristic and soft drinks and salty snacks consumption at 10 years of age (β-Coefficients and 95% confidence intervals)

	Soft drinks at 10y (≥1 /day)			**Salty snacks at 10y (≥1/week)**		
	Model 1 β (95%CI)	Model 2 β (95%CI)	Model 3 β (95%CI)	Model 1 β (95%CI)	Model 2 β (95%CI)	Model 3 β (95%CI)
Sociodemographic factors						
Maternal age (years)	**0.943** **(0.921; 0.965)**	**0,946** **(0.922; 0.970)**	**0.955** **(0.924; 0.988)**	0.998 (0.977; 1.020)	1.005 (0.981; 1.029)	1.012 (0.981; 1.043)
Maternal education (years)	**0.928** **(0.905; 0.951)**	**0.924** **(0.900; 0.949)**	**0.942** **(0.910; 0.975)**	1.000 (0.977; 1.024)	0.996 (0.972; 1.022)	1.009 (0.977; 1.043)
Paternal age (years)	1.013 (0.992; 1.034)	1.007 (0.985; 1.030)	1.017 (0.988; 1.048)	1.005 (0.986; 1.025)	1.004 (0.983; 1.026)	1.004 (0.977; 1.031)
Paternal education (years)	**0.959** **(0.935; 0.984)**	**0.958** **(0.932; 0.984)**	0.973 (0.939; 1.009)	**0.974** **(0.952; 0.998)**	**0.970** **(0.946; 0.994)**	0.984 (0.953; 1.017)
Household structure						
Family income at 7y						
≤1000	-	Ref.	Ref.	-	Ref.	Ref.
1001-1500	-	0.853 [a] (0.664; 1.096)	1.087 [b] (0.778; 1.520)	-	0.825 [a] (0.644; 1.056)	0.789 [b] (0.574; 1.085)
≥ 1501	-	**0.544** [a] **(0.426; 0.694)**	0.750 [b] (0.539; 1.042**)**	-	**0.629** [a] **(0.496; 0.798)**	**0.688** [b] **(0.504; 0.938)**
Maternal working status						
Employed	-	Ref.	Ref.	-	Ref.	Ref.
Unemployed	-	0.995 (0.799; 1.238)	1.074 (0.807; 1.429)	-	1.090 (0.084; 1.343)	1.079 (0.824; 1.412)
Paternal working status						
Employed	-	Ref.	Ref.	-	Ref.	Ref.
Unemployed	-	1.043 (0.784; 1.389)	1.184 (0.818; 1.712)	-	0.931 (0.708; 1.225)	0.900 (0.636; 1.274)
Live with siblings						
No	-	Ref.	Ref.	-	Ref.	Ref.
Yes	-	0.843 (0.704; 1.008)	0.911 (0.719; 1.156)	-	0.997 (0.841; 1.182)	1.013 (0.812; 1.264)
Live with both parents						
No	-	Ref.	Ref.	-	Ref.	Ref.

Yes	-	1.167 (0.814; 1.673)	1.198 (0.741; 1.935)	-	1.076 (0.769; 1.504)	1.205 (0.774; 1.874)
Child's Characteristics						
Physical activity at 7y						
No	-	-	Ref.	-	-	Ref.
Yes	-	-	1.157 (0.831; 1.609)	-	-	0.894 (0.659; 1.213)
Children BMI at 7y						
Under/normal weight	-	-	Ref.	-	-	Ref.
Overweight	-	-	0.931 (0.719; 1.206)	-	-	0.844 (0.666; 1.070)
Obesity	-	-	**0.718 (0.530; 0.972)**	-	-	0.788 (0.596; 1.043)
FV at 7y (≥5/day)	-	-	0.862 (0.681; 1.091)	-	-	0.879 (0.708; 1.091)
Sweet foods at 7y (≥1/day)	-	-	**1.612 (1.266; 2.052)**	-	-	**1.395 (1.120; 1.737)**
Soft drinks at 7y (≥1/day)	-	-	**4.463 (3.547; 5.616)**	-	-	**1.368 (1.095; 1.707)**
Salty snacks at 7y (≥1/week)	-	-	**1.381 (1.098; 1.738)**	-	-	**3.434 (2.777; 4.246)**

Significant associations are shown in bold. CI, confidence interval. Children's sex was adjusted for all the models.
Model 1 included maternal and paternal age and education variables.
Model 2 included the previous variables adjusted for parent's working status, live with both parents, and live with siblings.
Model 3 comprehended the variables from model 2 and was further adjusted for child's physical activity and BMI, 'FV' at 7 y, 'Sweet foods' at 7 y, 'Soft drinks' at 7 y, and 'Salty snacks' at 7 y.
[a] Adjusted for parent's age, parent's working status, live with both parents and live with siblings.
[b] Adjusted for parent's age, parent's working status, live with both parents, live with siblings, physical activity, 'FV' at 7 y, 'Sweet foods' at 7 y, 'Soft drinks' at 7 y, and 'Salty snacks' at 7 y.

Conclusions

Parents' characteristics, living with siblings, and family income at 7 years of age influence children's food consumption of fruits and vegetables and energy-dense foods at 10 years of age. Paternal educational level was associated with a decrease in children's weekly salty snacks and daily soft drinks consumption while children of unemployed fathers were less likely to meet the fruits and vegetables daily recommendations. Moreover, children from higher educated mothers were also more likely to meet the fruits and vegetables daily recommendation and additionally presented a decrease in sweet foods and soft drinks consumption at 10 years. Higher maternal age was associated with a reduction of energy-dense food intake at 10 years.

Higher family income increased the odds of children meeting the daily fruit and vegetables recommendations while decreasing the odds of eating salty snacks and sweet foods weekly and daily intake, respectively.

Even though that was a general reduction in fruit and vegetable intake from 7 to 10 years, children who used to consume the recommended portions of fruits and vegetables daily at 7 years are more likely to maintain this eating pattern in addition to present a reduction in soft drinks intake at 10 years of age. This healthy food pattern can be considered positive and a preventive factor for children's unhealthy eating habits over the years.

Social media, siblings, and peers can influence positively or negatively children's and preadolescents' eating habits. Therefore, it is valuable to promote well-designed studies approaching the association of children and preadolescents' social connections and their impacts on eating habits, thus contributing for future intervention programs to promote healthy eating habits in these groups.

Studies focusing on the association of fathers' sociodemographic characteristics, namely age, education level and employment status, and children's eating patterns are still scarce and urgent. Therefore, it is important to develop research that prioritizes the larger participation of fathers, thus improving the knowledge of their total influences on children's eating habits. This will contribute to the development of future effective public policies and interventions including the fathers on the promotion of healthy eating habits among children and preadolescents.

References

1. Rauber F, Hoffman DJ, Vitolo MR. Diet quality from pre-school to school age in Brazilian children: a 4-year follow-up in a randomised control study. Br J Nutr. 2014;111(3):499-505.
2. Ventura AK, Phelan S, Silva Garcia K. Maternal Diet During Pregnancy and Lactation and Child Food Preferences, Dietary Patterns, and Weight Outcomes: a Review of Recent Research. Curr Nutr Rep. 2021;10(4):413-26.
3. Maier-Nöth A. Early Development of Food Preferences and Healthy Eating Habits in Infants and Young Children. Nestle Nutr Inst Workshop Ser. 2019;91:11-20.
4. Boyle MA, Holben D.H. Community Nutrition In Action: An Entrepreneurial Appoach. Belmont (CA): CENGAGE Learning; 2009. 752 p.
5. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors Influencing Children's Eating Behaviours. Nutrients. 2018;10(6).
6. and RHB, Corwyn RF. Socioeconomic Status and Child Development. Annual Review of Psychology. 2002;53(1):371-99.
7. Winpenny EM, Corder KL, Jones A, Ambrosini GL, White M, van Sluijs EMF. Changes in diet from age 10 to 14 years and prospective associations with school lunch choice. Appetite. 2017;116:259-67.
8. Ragelienė T, Grønhøj A. The influence of peers′ and siblings′ on children's and adolescents′ healthy eating behavior. A systematic literature review. Appetite. 2020;148:104592.
9. Bruening M, Eisenberg M, MacLehose R, Nanney MS, Story M, Neumark-Sztainer D. Relationship between adolescents' and their friends' eating behaviors: breakfast, fruit, vegetable, whole-grain, and dairy intake. J Acad Nutr Diet. 2012;112(10):1608-13.
10. Chung A, Vieira D, Donley T, Tan N, Jean-Louis G, Kiely Gouley K, et al. Adolescent Peer Influence on Eating Behaviors via Social Media: Scoping Review. J Med Internet Res. 2021;23(6):e19697.
11. Rohlfs Domínguez P. A minireview of effects of maternal diet during pregnancy on postnatal vegetable consumption: Implications for future research (a new hypothesis) and recommendations. Crit Rev Food Sci Nutr. 2018;58(13):2229-38.
12. Johnson SL. Developmental and Environmental Influences on Young Children's Vegetable Preferences and Consumption. Adv Nutr. 2016;7(1):220S-31S.
13. Fonseca PCA, Ribeiro SAV, Andreoli CS, de Carvalho CA, Pessoa MC, de Novaes JF, et al. Association of exclusive breastfeeding duration with consumption of ultra-processed foods, fruit and vegetables in Brazilian children. Eur J Nutr. 2019;58(7):2887-94.
14. Colombo L, Crippa BL, Consonni D, Bettinelli ME, Agosti V, Mangino G, et al. Breastfeeding Determinants in Healthy Term Newborns. Nutrients. 2018;10(1).
15. Sarki M, Parlesak A, Robertson A. Comparison of national cross-sectional breast-feeding surveys by maternal education in Europe (2006-2016). Public Health Nutr. 2019;22(5):848-61.
16. Sandes ARN, C.; Figueira, R.; Gouveia, S.; Valente, S.; Martins, S.; Correia, E.; Rocha, L.; Silva, J. Aleitamento materno: Prevalência e Factores Condicionantes. Acta Médica Portuguesa. 2007;20(3):193-200.
17. Fisher J LJ, Miller L, Smethers A, Lott M. EvidenceBased Recommendations and Best Practices for Promoting Healthy Eating Behaviors in Children 2 to 8 Years Executive Summary. Durham, NC: Robert Wood Johnson Foundation; 2021.
18. Newby PK. Are dietary intakes and eating behaviors related to childhood obesity? A comprehensive review of the evidence. J Law Med Ethics. 2007;35(1):35-60.
19. Boeing H, Bechthold A, Bub A, Ellinger S, Haller D, Kroke A, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. European Journal of Nutrition. 2012;51(6):637-63.

20. Vilela S, Magalhães V, Severo M, Oliveira A, Torres D, Lopes C. Effect of the food processing degree on cardiometabolic health outcomes: A prospective approach in childhood. Clinical Nutrition. 2022;41(10):2235-43.
21. Rose CM, Birch LL, Savage JS. Dietary patterns in infancy are associated with child diet and weight outcomes at 6 years. Int J Obes (Lond). 2017;41(5):783-8.
22. Vilea M, Ana Sofia. Tracking the acquisition of eating habits in children and its effects on behaviours related to appetite and on adiposity. Porto, Portugal: Faculdade de Medicina da Universidade do Porto; 2018.
23. Thompson D, Ferry RJ, Jr., Cullen KW, Liu Y. Improvement in Fruit and Vegetable Consumption Associated with More Favorable Energy Density and Nutrient and Food Group Intake, but not Kilocalories. J Acad Nutr Diet. 2016;116(9):1443-9.
24. Ng CM, Satvinder K, Koo HC, Yap RWK, Mukhtar F. Influences of psychosocial factors and home food availability on healthy meal preparation. Maternal & child nutrition. 2020;16 Suppl 3(Suppl 3):e13054-e.
25. Folkvord F, Naderer B, Coates A, Boyland E. Promoting Fruit and Vegetable Consumption for Childhood Obesity Prevention. Nutrients. 2021;14(1):157.
26. De Bock F, Breitenstein L Fau - Fischer JE, Fischer JE. Positive impact of a pre-school-based nutritional intervention on children's fruit and vegetable intake: results of a cluster-randomized trial. (1475-2727 (Electronic)).
27. Mérida Rios L, Márquez Serrano M, Jiménez Aguilar A, Barboza Chacón L, Rueda Neria CM, Arenas Monreal L. Promoting fruit, vegetable and simple water consumption among mothers and teachers of preschool children: An Intervention Mapping initiative. (1873-7870 (Electronic)).
28. Wambogo EA AN, Ahluwalia N, Ogden, CL. Fruit and vegetable consumption among children and adolescents in the United States, 2015–2018. Hyattsville: Centers for Disease Control and Prevention, Statistics NCfH; 2020 November, 2020.
29. World Health Organization. Regional Office for E. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. International report. Volume 2. Key data. Copenhagen: World Health Organization. Regional Office for Europe; 2020 2020.
30. Lopes C TD, Oliveira A, Severo M, Alarcão V, Guiomar S, Mota, J TP, Rodrigues S, Lobato L, Magalhães V, Correia D, Carvalho C, Pizarro A, Marques, A VS, Oliveira L, Nicola P, Soares S, Ramos E. Inquérito Alimentar Nacional e de Atividade Física,IAN-AF 2015-2016. Porto: Universidade do Porto; 2017.
31. Ana Rito SMJBMJG. Childhood Obesity Surveillance Iniciative - Cosi Portugal 2019. Lisboa: Direção Geral da Saúde, Jorge INdSDR; 2019.
32. Poti JM, Braga B, Qin B. Ultra-processed Food Intake and Obesity: What Really Matters for Health-Processing or Nutrient Content? Current obesity reports. 2017;6(4):420-31.
33. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018;21(1):5-17.
34. Costa CS, Rauber F, Leffa PS, Sangalli CN, Campagnolo PDB, Vitolo MR. Ultra-processed food consumption and its effects on anthropometric and glucose profile: A longitudinal study during childhood. Nutr Metab Cardiovasc Dis. 2019;29(2):177-84.
35. Collison KS, Zaidi MZ, Subhani SN, Al-Rubeaan K, Shoukri M, Al-Mohanna FA. Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. BMC Public Health. 2010;10:234.
36. Vedovato GM, Vilela S, Severo M, Rodrigues S, Lopes C, Oliveira A. Ultra-processed food consumption, appetitive traits and BMI in children: a prospective study. Br J Nutr. 2021;125(12):1427-36.
37. Prevention USDoHaHS-CfDCa. Sugar-sweetened Beverage Consumption Among US children, 2011-2014. Hyattsville, MD; 2017. Contract No.: 271.

38. Prevention USDoHaHS-CfDCa. Fast food intake among children and adolescents in the United States, 2015-2018. Hyattsville, MD; 2020. Contract No.: 375.
39. Brug J, Kremers SP, Lenthe Fv, Ball K, Crawford D. Environmental determinants of healthy eating: in need of theory and evidence: Symposium on 'Behavioural nutrition and energy balance in the young'. Proceedings of the Nutrition Society. 2008;67(3):307-16.
40. Ong JX, Ullah S, Magarey A, Miller J, Leslie E. Relationship between the home environment and fruit and vegetable consumption in children aged 6–12 years: a systematic review. Public Health Nutrition. 2017;20(3):464-80.
41. Manson AC, Johnson BJ, Zarnowiecki D, Sutherland R, Golley RK. The food and nutrient intake of 5- to 12-year-old Australian children during school hours: a secondary analysis of the 2011–2012 National Nutrition and Physical Activity Survey. Public Health Nutrition. 2021;24(18):5985-94.
42. Alcione Aguiar S. O papel das famílias e da escola na formação de hábitos alimentares saudáveis de crianças escolares. Revista Pedagógica. 2017;19(40).
43. Wäsche H, Niermann C, Bezold J, Woll A. Family health climate: a qualitative exploration of everyday family life and health. BMC Public Health. 2021;21(1):1261-.
44. Fink SK, Racine EF, Mueffelmann RE, Dean MN, Herman-Smith R. Family meals and diet quality among children and adolescents in North Carolina. J Nutr Educ Behav. 2014;46(5):418-22.
45. Avery A, Anderson C, McCullough F. Associations between children's diet quality and watching television during meal or snack consumption: A systematic review. Maternal & child nutrition. 2017;13(4):e12428.
46. Wolnicka K, Taraszewska AM, Jaczewska-Schuetz J, Jarosz M. Factors within the family environment such as parents' dietary habits and fruit and vegetable availability have the greatest influence on fruit and vegetable consumption by Polish children. Public Health Nutr. 2015;18(15):2705-11.
47. Amuta AO, Jacobs W, Idoko EE, Barry AE, McKyer EL. Influence of the Home Food Environment on Children's Fruit and Vegetable Consumption: A Study of Rural Low-Income Families. Health Promot Pract. 2015;16(5):689-98.
48. Vepsäläinen H, Korkalo L, Mikkilä V, Lehto R, Ray C, Nissinen K, et al. Dietary patterns and their associations with home food availability among Finnish pre-school children: a cross-sectional study. Public Health Nutr. 2018;21(7):1232-42.
49. Wang L, Dalton WT, 3rd, Schetzina KE, Fulton-Robinson H, Holt N, Ho AL, et al. Home food environment, dietary intake, and weight among overweight and obese children in Southern Appalachia. South Med J. 2013;106(10):550-7.
50. Organization WH. WHO guidelines on physical activity and sedentary behaviour. Geneva; 2020.
51. Zamai CA, Bankoff DP, Antonia. Atividade Física e saúde: experiências bem-sucedidas nas empresas, organizações e setor público. Jundiaí, São Paulo, Brasil: Paco Editorial; 2013.
52. Manz K, Mensink GBM, Finger JD, Haftenberger M, Brettschneider A-K, Lage Barbosa C, et al. Associations between Physical Activity and Food Intake among Children and Adolescents: Results of KiGGS Wave 2. Nutrients. 2019;11(5):1060.
53. Paulina Kiebuła KT, Joanna Furman, Beata Łabuz-Roszak. Association between eating habits and physical activity in primary school students. Wiadomości Lekarskie. 2020;10(73):2120-6.
54. Qiu C, Hou M. Association between Food Preferences, Eating Behaviors and Socio-Demographic Factors, Physical Activity among Children and Adolescents: A Cross-Sectional Study. Nutrients. 2020;12(3):640.
55. Aubert S, Brazo-Sayavera J, Gonzalez SA, Janssen I, Manyanga T, Oyeyemi AL, et al. Global prevalence of physical activity for children and adolescents; inconsistencies, research gaps, and recommendations: a narrative review. Int J Behav Nutr Phys Act. 2021;18(1):81.
56. Wyszyńska J, Ring-Dimitriou S, Thivel D, Weghuber D, Hadjipanayis A, Grossman Z, et al. Physical Activity in the Prevention of Childhood Obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics. Front Pediatr. 2020;8:535705.

57. Katzmarzyk PT, Denstel KD, Beals K, Carlson J, Crouter SE, McKenzie TL, et al. Results from the United States 2018 Report Card on Physical Activity for Children and Youth. J Phys Act Health. 2018;15(S2):S422-S4.
58. Organization WH. Physical Activity Factsheets for the 28 European Union Members States of th WHO European region. Copenhagen, Denmark: WHO Regional Office for Europe; 2018.
59. Potter C, Gibson EL, Ferriday D, Griggs RL, Coxon C, Crossman M, et al. Associations between number of siblings, birth order, eating rate and adiposity in children and adults. Clin Obes. 2021;11(3):e12438-e.
60. Ragelienė T, Grønhøj A. The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. (1095-8304 (Electronic)).
61. Rodrigues D, Muc M, Rodrigues PR, Pinto AM, Padez C. Dietary Patterns and Their Socioeconomic and Behavioral Determinants in 6- to 8-Year-Old Portuguese Children. Ecol Food Nutr. 2016;55(5):428-41.
62. Bogl LH, Mehlig K, Ahrens W, Gwozdz W, de Henauw S, Molnár D, et al. Like me, like you - relative importance of peers and siblings on children's fast food consumption and screen time but not sports club participation depends on age. Int J Behav Nutr Phys Act. 2020;17(1):50.
63. Vilela S, Oliveira A, Pinto E, Moreira P, Barros H, Lopes C. The influence of socioeconomic factors and family context on energy-dense food consumption among 2-year-old children. Eur J Clin Nutr. 2015;69(1):47-54.
64. Ruggiero CF, McHale SM, Paul IM, Savage JS. Learned Experience and Resource Dilution: Conceptualizing Sibling Influences on Parents' Feeding Practices. Int J Environ Res Public Health. 2021;18(11):5739.
65. Berge JM, Meyer C, MacLehose RF, Crichlow R, Neumark-Sztainer D. All in the family: correlations between parents' and adolescent siblings' weight and weight-related behaviors. Obesity (Silver Spring, Md). 2015;23(4):833-9.
66. Fismen A-S, Smith ORF, Samdal O, Helleve A, Haug E. Associations between family structure and adolescents' food habits. Public Health Nutrition. 2022;25(3):702-9.
67. Yannakoulia M, Papanikolaou K, Hatzopoulou I, Efstathiou E, Papoutsakis C, Dedoussis GV. Association between family divorce and children's BMI and meal patterns: the GENDAI Study. British Journal of Nutrition. 2008;16(6):1382-7.
68. Wang XTH. The Impact of Having One Parent Absent on Children' Food Consumption and Nutrition in China. Nutrients. 2019;12:1-17.
69. Mauskopf SS, O'Leary AK, Banihashemi A, Weiner M, Cookston JT. Divorce and eating behaviors: a 5-day within-subject study of preadolescent obesity risk. Child Obes. 2015;11(2):122-9.
70. Duriancik DM, Goff CR. Children of single-parent households are at a higher risk of obesity: A systematic review. J Child Health Care. 2019;23(3):358-69.
71. Levin KA, Kirby J, Currie C. Family structure and breakfast consumption of 11-15 year old boys and girls in Scotland, 1994-2010: a repeated cross-sectional study. BMC Public Health. 2012;12:228-.
72. Parikka S, Levälahti E, Martelin T, Laatikainen T. Single-parenthood and perceived income insufficiency as challenges for meal patterns in childhood. Appetite. 2018;127:10-20.
73. Biehl A, Hovengen R, Grøholt EK, Hjelmesæth J, Strand BH, Meyer HE. Parental marital status and childhood overweight and obesity in Norway: a nationally representative cross-sectional study. BMJ Open. 2014;4(6):e004502.
74. Stewart SD, Menning CL. Family structure, nonresident father involvement, and adolescent eating patterns. J Adolesc Health. 2009;45(2):193-201.
75. Yannakoulia M, Lykou A, Kastorini CM, Saranti Papasaranti E, Petralias A, Veloudaki A, et al. Socio-economic and lifestyle parameters associated with diet quality of children and adolescents using classification and regression tree analysis: the DIATROFI study. Public Health Nutr. 2016;19(2):339-47.
76. Ma Y, McRae C, Wu Y-H, Dubé L. Exploring Pathways of Socioeconomic Inequity in Vegetable Expenditure Among Consumers Participating in a Grocery Loyalty Program in Quebec, Canada, 2015-2017. Front Public Health. 2021;9:634372-.

77. WHO. Obesity and inequities: guidance for addressing inequities in overweight and obesity. Copenhagen, Denmark; 2014.
78. French SA, Tangney CC, Crane MM, Wang Y, Appelhans BM. Nutrition quality of food purchases varies by household income: the SHoPPER study. BMC Public Health. 2019;19(1):231.
79. Eurostat SE-. Nutritional habits statistics: Fruit and vegetable consumption statistics. 2019.
80. Kant AK, Graubard BI. Family income and education were related with 30-year time trends in dietary and meal behaviors of American children and adolescents. J Nutr. 2013;143(5):690-700.
81. Durao C, Severo M, Oliveira A, Moreira P, Guerra A, Barros H, et al. Association of maternal characteristics and behaviours with 4-year-old children's dietary patterns. Matern Child Nutr. 2017;13(2).
82. Vilela S, Muresan I, Correia D, Severo M, Lopes C. The role of socio-economic factors in food consumption of Portuguese children and adolescents: results from the National Food, Nutrition and Physical Activity Survey 2015-2016. Br J Nutr. 2020;124(6):591-601.
83. Voráčová J, Sigmund E, Sigmundová D, Kalman M. Family Affluence and the Eating Habits of 11- to 15-Year-Old Czech Adolescents: HBSC 2002 and 2014. Int J Environ Res Public Health. 2016;13(10).
84. Liu KSN, Chen JY, Ng MYC, Yeung MHY, Bedford LE, Lam CLK. How Does the Family Influence Adolescent Eating Habits in Terms of Knowledge, Attitudes and Practices? A Global Systematic Review of Qualitative Studies. Nutrients. 2021;13(11).
85. Soares MM, Juvanhol LL, Ribeiro SAV, Franceschini S, Araújo RMA. Prevalence of processed and ultra-processed food intake in Brazilian children (6-24 months) is associated with maternal consumption and breastfeeding practices. Int J Food Sci Nutr. 2021;72(7):978-88.
86. Ruiz M, Goldblatt P, Morrison J, Porta D, Forastiere F, Hryhorczuk D, et al. Impact of Low Maternal Education on Early Childhood Overweight and Obesity in Europe. Paediatr Perinat Epidemiol. 2016;30(3):274-84.
87. da Costa MP, Durão C, Lopes C, Vilela S. Adherence to a healthy eating index from pre-school to school age and its associations with sociodemographic and early life factors. Br J Nutr. 2019;122(2):220-30.
88. Delisle Nyström C, Cameron AJ, Campbell KJ, Hesketh KD. Variation in outcomes of the Melbourne Infant, Feeding, Activity and Nutrition Trial (INFANT) according to maternal education and age 2 and 3·5 years post-intervention. Public Health Nutr. 2021;24(6):1460-8.
89. Zadka K, Pałkowska-Goździk E, Rosołowska-Huszcz D. Family Factors Associated with Selected Childhood Nutrition Aspects in Central Poland. Int J Environ Res Public Health. 2019;16(4):541.
90. Rasmussen M, Krølner R, Klepp KI, Lytle L, Brug J, Bere E, et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. Int J Behav Nutr Phys Act. 2006;3:22.
91. Godinho APK, Conceição AdOd, Rodrigues EL, Siqueira IMBJ, Taconeli CA, Crispim SP, et al. Dietary patterns and associated factors of children under two years of age born prematurely. Rev Paul Pediatr. 2022;40:e2021177-e.
92. Bogea EG, Martins MLB, Carvalho WRC, Arruda SPM, Franca A, Silva A. Eating patterns among children aged 13 to 35 months and association with maternal characteristics. Cad Saude Publica. 2019;35(4):e00072618.
93. Petrauskienė A, Žaltauskė V, Albavičiūtė E. Family socioeconomic status and nutrition habits of 7–8 year old children: cross-sectional Lithuanian COSI study. Italian Journal of Pediatrics. 2015;41(1):34.
94. Mauch CE, Wycherley TP, Bell LK, Laws RA, Byrne R, Golley RK. Parental work hours and household income as determinants of unhealthy food and beverage intake in young Australian children. Public Health Nutrition. 2022:1-12.
95. Datar A, Nicosia N, Shier V. Maternal work and children's diet, activity, and obesity. Soc Sci Med. 2014;107:196-204.

96. Jarman M, Edwards K, Blissett J. Influences on the dietary intakes of preschool children: a systematic scoping review. International Journal of Behavioral Nutrition and Physical Activity. 2022;19(1):20.
97. Gwozdz Wea. Maternal employment and childhood obesity: a european perspective. 2013. p. 1-39.
98. Hamilton K, Laura. The role of family income and other factors in understanding the food and eating practices of young people in the UK: a mixed methods approach.: UCL Institute of Education; 2020.
99. Chen JL, Guo J, Esquivel JH, Chesla CA. Like Mother, Like Child: The Influences of Maternal Attitudes and Behaviors on Weight-Related Health Behaviors in Their Children. J Transcult Nurs. 2018;29(6):523-31.
100. Groele B, Głąbska D, Gutkowska K, Guzek D. Mother's Fruit Preferences and Consumption Support Similar Attitudes and Behaviors in Their Children. Int J Environ Res Public Health. 2018;15(12):2833.
101. Pei Z, Flexeder C, Fuertes E, Standl M, Berdel D, von Berg A, et al. Mother's body mass index and food intake in school-aged children: results of the GINIplus and the LISAplus studies. European journal of clinical nutrition. 2014;68(8):898-906.
102. Thompson AL. Intergenerational impact of maternal obesity and postnatal feeding practices on pediatric obesity. Nutrition Reviews. 2013;71(suppl_1):S55-S61.
103. Vollmer RL, Adamsons K, Foster JS, Mobley AR. Association of fathers' feeding practices and feeding style on preschool age children's diet quality, eating behavior and body mass index. Appetite. 2015;89:274-81.
104. Mallan KM, Nothard, M., Thorpe, K., Nicholson, J.M., Wilson, A., Scuffham, P.A. and Daniels, L.A. The role of fathers in child feeding: perceived responsibility and predictors of participation. 2014;Child Care Health Dev(40):715-22.
105. Morgan PJ, Lubans DR, Callister R, Okely AD, Burrows TL, Fletcher R, et al. The 'Healthy Dads, Healthy Kids' randomized controlled trial: efficacy of a healthy lifestyle program for overweight fathers and their children. International Journal of Obesity. 2011;35(3):436-47.
106. Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Paternal Lifestyle-Related Parenting Practices Mediate Changes in Children's Dietary and Physical Activity Behaviors: Findings From the Healthy Dads, Healthy Kids Community Randomized Controlled Trial. J Phys Act Health. 2015;12(9):1327-35.
107. Walsh AD, Cameron AJ, Crawford D, Hesketh KD, Campbell KJ. Dietary associations of fathers and their children between the ages of 20 months and 5 years. Public Health Nutr. 2016;19(11):2033-9.
108. Papamichael MM, Moschonis G, Mavrogianni C, Liatis S, Makrilakis K, Cardon G, et al. Fathers' daily intake of fruit and vegetables is positively associated with children's fruit and vegetable consumption patterns in Europe: The Feel4Diabetes Study. J Hum Nutr Diet. 2022;35(2):337-49.
109. Walsh AD, Cameron AJ, Hesketh KD, Crawford D, Campbell KJ. Associations between dietary intakes of first-time fathers and their 20-month-old children are moderated by fathers' BMI, education and age. British Journal of Nutrition. 2015;114(6):988-94.
110. Cohen AK, Rai M, Rehkopf DH, Abrams B. Educational attainment and obesity: a systematic review. Obes Rev. 2013;14(12):989-1005.
111. Lin L, Yang-Huang J, Wang H, Santos S, van Grieken A, Raat H. Social mobility by parent education and childhood overweight and obesity: a prospective cohort study. European Journal of Public Health. 2021;31(4):764-70.
112. Liu Y, Ma Y, Jiang N, Song S, Fan Q, Wen D. Interaction between Parental Education and Household Wealth on Children's Obesity Risk. Int J Environ Res Public Health. 2018;15(8):1754.
113. Matłosz P, Wyszyńska J, Asif M, Szybisty A, Aslam M, Mazur A, et al. Prevalence of Overweight, Obesity, Abdominal Obesity, and Obesity-Related Risk Factors in Polish Preschool Children: A Cross-Sectional Study. J Clin Med. 2021;10(4):790.
114. De Lira-Garcia C, Bacardi-Gascon M, Jimenez-Cruz A. Preferences of healthy and unhealthy foods among 3 to 4 year old children in Mexico. Asia Pac J Clin Nutr. 2012;21(1):57-63.

115. Ramírez-Vélez R, Fuerte-Celis JC, Martínez-Torres J, Correa-Bautista JE. Prevalence and associated factors of sugar-sweetened beverages intake among schoolchildren aged 9 to 17 years from Bogotá, Colombia: the FUPRECOL Study. Nutr Hosp. 2017;34(2):422-30.
116. Alsharairi NA, Somerset S. Parental work status and children's dietary consumption: Australian evidence. International Journal of Consumer Studies. 2018;42(5):522-32.
117. De Cosmi V, Scaglioni S, Agostoni C. Early Taste Experiences and Later Food Choices. Nutrients. 2017;9(2).
118. Morgan PJ, Young MD. The Influence of Fathers on Children's Physical Activity and Dietary Behaviors: Insights, Recommendations and Future Directions. The Obesity Epidemic: Causes and Consequences. 2017;6(3):324-33.