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Tracking diet variety in childhood and its association with eating behaviours related to appetite: The generation XXI birth cohort

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ABSTRACT

Research on the influence of early eating habits on eating behaviours related to appetite using a prospective approach is scarce, especially in children. The aim of this study was to explore the relationship between changes in diet variety from 4 to 7 years of age and appetitive traits measured at 7 years of age. Participants are from the population-based birth cohort Generation XXI (2005–2006). The present analysis included 4537 children with complete data on a food frequency questionnaire (FFQ) at both ages, and on the Children's Eating Behaviour Questionnaire at 7y. A healthy diet variety index (HDVI) was calculated at both ages using data from the FFQ. To assess tracking of diet variety, tertiles of HDVI scores were calculated and then re-categorized as 'maintain: low', 'maintain: high', 'increase' and 'decrease'. Although the HDVI score decreased from 4 to 7y ($p < .001$), it showed a high stability, a positive predictive value, and a fair agreement. Increasing diet variety, compared to maintaining a low variety, was inversely associated with the 'Desire to Drink' ($\beta = -0.090$, 95%CI: 0.174; −0.006) and 'Satiety Responsiveness' ($\beta = -0.119$, 95%CI: 0.184; −0.054) subdimensions and positively with 'Enjoyment of Food' ($\beta = 0.098$, 95%CI: 0.023; 0.172) and 'Emotional Overeating' ($\beta = 0.073$, 95%CI: 0.006; 0.139). Those classified as either increase or maintain a high diet variety, in comparison with maintaining a low variety, had lower scores of 'Food Fussiness'. In conclusion, diet variety decreased from 4 to 7y with a fair tracking. Children with a higher diet variety were less fussy, had a lower desire to drink and a higher general interest in food.

1. Introduction

Eating behaviour patterns acquired during childhood and adolescence are likely to track into adulthood (Mikkila, Rasanen, Raitakari, Pietinen, & Viikari, 2004, 2005). Diet tracking might be represented by the maintenance of eating habits, nutrient intake or food intake over time. Poor eating habits established in early life are likely to remain stable, therefore establishing healthy eating habits early on is essential. Dietary tracking has been demonstrated in adults and between adolescence and adulthood period, while few studies have tracked diet during childhood (Northstone & Emmett, 2008). It has been shown that the introduction of a variety of foods as early as the beginning of the complementary feeding, positively influences the variety of the diet later on (Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). Variety of the free food choices between 2 and 3 years has been associated with the variety of food consumed up to the age of 22 years (Nicklaus, Boggio, Chabanet, & Issanchou, 2005). Several paediatric diet quality indices, including assessment of the food variety, have been administered in both developed and developing countries and studied in relation to health-related outcomes (Marshall, Burrows, & Collins, 2014). However, the tracking of the overall food variety throughout childhood, using the same validated instrument, is lacking in the literature.

An earlier study has proposed that other aspects of eating behaviour, such those related to appetite, also track throughout childhood (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008). The authors highlighted that some changes in the magnitude of appetitive traits can, however, occur as the result of

Abbreviations: HDVI, Healthy Diet Variety Index.

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interaction with child's food environment (Mallan, Fildes, Magarey, & Daniels, 2016; de Barse et al., 2017). One aspect previously explored was the decrease of food fussiness behaviour with an increase of diet variety offered to children (Mallan et al., 2016; de Barse et al., 2017).

Recommendations (WHO, 1996) to increase the diet variety in order to achieve a higher quality diet are included in most European national dietary guidelines, including Portugal (WHO European Region, 2003). The term 'diet variety' indicates the number of different foods or food groups consumed over a given reference period. Increasing the variety of nutrient-dense foods, within and across food groups, is thought to ensure adequate intake of essential nutrients and to improve health outcomes (Conklin, Monsivais, Khaw, & Wareham, 2016; Foote, Murphy, Wilkens, Basiotis, & Carlson, 2004; Murphy et al., 2006; Steyn, Nel, Nantel, Kennedy, & Labadarios, 2006; Vadiveloo, Parkeh, & Mattei, 2015). The World Health Organization (WHO) recommends the consumption of a varied diet originated mainly from plants, rather than animals (WHO, 1996). Eating a variety of foods is crucial to achieving optimal nutritional status and complete coverage of essential nutrients. It is also a key factor to tackle chronic micronutrient deficiencies, also known as hidden hunger (Burchi, Fanzo, & Frison, 2011).

A greater variety of healthy foods has been also associated with a lower prevalence of overweight or obesity (Vadiveloo, Dixon, & Parekh, 2013). However, intake of a variety of less healthy foods, such as energy-dense foods, has been positively associated with adiposity (Vadiveloo et al., 2013). It is not known whether exposure to a higher food variety environment might stimulate appetite and increase food consumption, leading to excess energy intake and an unhealthy body weight gain. Short-term controlled feeding studies consistently show that the variety of food offered during a meal increases energy intake, and limiting variety across days tends to reduce food consumption (Brondel et al., 2009; Raynor & Epstein, 2001). The stimulating effect of a high diet variety on appetite might be attributable to lower sensory-specific satiation for multiple components of a meal, to delayed satiation or by making the eating occasion more enjoyable (Brondel et al., 2009). These short-term studies are limited by the tendency to offer highly palatable, energy-dense foods. When low energy-dense foods are offered, for example, fruits and vegetables (FV), the variety effect seems to stimulate intake in both children (Roe, Meengs, Birch, & Rolls, 2013) and adults (Meengs, Roe, & Rolls, 2012a).

The majority of previous studies have investigated the effects of food variety on appetite using short-term controlled feeding studies, however, to date no published research has investigated the association in children between tracking of diet variety and eating behaviours related to appetite, using a prospective approach. Therefore, we aimed to prospectively assess the effect of changes in diet variety from 4 to 7 years on eating behaviours related to appetite at 7 years of age.

2. Material and methods

2.1. Study design and participants

Participants were from the population-based birth cohort Generation XXI, assembled in the five-level III public maternity units in the Porto Metropolitan Area (Northern Portugal), during 2005/2006 (Larsen et al., 2013). At enrolment, these maternity units were responsible for 91.6% of the deliveries in the whole catchment population. Of the invited mothers, 91.4% accepted to participate at baseline (n = 8647 children). Data on demographic and social conditions, lifestyles, medical history and anthropometrics were collected by trained interviewers within 72 h after delivery. When the children were 4 and 7 years of age, an evaluation of the entire cohort occurred, achieving a participation rate of 86% and 81%, respectively. In baseline and follow-up evaluations, information was collected in face-to-face interviews, and for those families that were not able to participate in-person, the evaluation was performed by telephone using a shorter version of the questionnaire (20% and 15% at 4 and 7 years of age, respectively).

The present analysis included 4748 children with complete data using a food frequency questionnaire (FFQ) (Durao et al., 2015) at 4 and 7 years of age, and complete information on the Children's Eating Behaviour Questionnaire (CEBQ) (Wardle, Guthrie, Sanderson, & Rapoport, 2001), at 7 years of age. We excluded twins (n = 183) and children with congenital anomalies or diseases that might influence dietary intake (cerebral palsy, celiac disease, food allergy, food intolerance, and phenylketonuria; n = 28), resulting in a sample of 4537 children. Comparing the children included in the analysis with the remaining cohort, we found no statistical differences regarding sex children. However, mothers of children included in the study at baseline were slightly older (mean (SD): 29.8 (5.25) vs. 28.1 (5.82) years, $p < .001$) and more educated (mean (SD): 11.2 (4.27) vs. 9.6 (4.10) years, $p < .001$). The prevalence of obesity in our sample was also higher (68% vs. 67%, $p = .009$).

2.2. Data collection

2.2.1. Dietary intake

The children's dietary intake was evaluated through an FFQ that queried frequency of intake for 35 and 38 food items at 4 and 7 years of age, respectively, that was previously tested. As previously described (Durao et al., 2015), for each food item, parents or another caregiver were asked how many times on average his/her child had consumed that food during the previous 6 months.

For each food item, the selected frequency response option (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\once a month, or never) was converted into daily frequency (e.g. 5–6 times per week was converted into a mean of 5.5 times per week, meaning 5.5/7d = 0.78 times per day). Five food groups were defined: starchy foods (3 original food items: rice, pasta, potatoes, bread and semi-sweet type biscuits); fruits (only one food item); vegetables (3 original food items: vegetable soup and vegetable on plate); meat, fish and alternatives (5 original food items: meat, sausage, ham, fish and eggs); and dairy products (5 original food items at 4y and 4 food items at 7y: yoghurt, cheese and milk).

In a subsample of 2482 children at 4 years and 3511 at 7 years, FFQ data was compared with 3-day food diaries. For food groups eaten more often, fair-to-moderate agreement was obtained. Significant positive intraclass correlation coefficients (ICC) were found for vegetable soup [(ICC = 0.54, 95%CI: 0.51; 0.56) at 4 years and (ICC = 0.54, 95%CI: 0.52; 0.56) at 7 years], fruit [(ICC = 0.42, 95%CI: 0.39; 0.45) at 4 years and (ICC = 0.46, 95%CI: 0.43; 0.48) at 7 years], milk [(ICC = 0.46, 95%CI: 0.43; 0.49) at 4 years and (ICC = 0.50, 95% CI: 0.47; 0.52) at 7 years], yoghurt [(ICC = 0.48, 95%CI: 0.45; 0.51) at 4 years and (ICC = 0.49, 95%CI: 0.47; 0.52) at 7 years], sweets [(ICC = 0.23, 95%CI: 0.19; 0.26) at 4 years and (ICC = 0.22, 95%CI: 0.19; 0.25) at 7 years] and salty snacks [(ICC = 0.19, 95%CI: 0.16; 0.23) at 4 years and (ICC = 0.10, 95%CI: 0.07; 0.13) at 7 years].

2.2.2. Diet variety index

A healthy diet variety index (HDVI) (Jones et al., 2015), based on the Food Variety Index for Toddlers by Cox et al. (Cox, Skinner, Carruth, Moran, & Houck, 1997), was calculated at 4 and 7 years using data from the FFQ. This was done by considering variety within and among the five food groups previously described, and