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Research report

Associations between commercial complementary food consumption and fruit and vegetable intake in children. Results of the DONALD study ☆

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ABSTRACT

Objectives: Fruit and vegetable (FV) consumption is influenced by individual taste and food preferences that are developed early in life. Thus, the sensory properties of foods given during complementary feeding may shape later food acceptance and dietary intake. However, those experiences differ with respect to the preparation method of complementary food (CF), that is, homemade and commercial CF. The aim of this study therefore was to examine the association between the infant's consumption of commercial CF and FV intake and variety during infancy, preschool and school age. *Methods:* In total, 281 children of the DONALD Study with 3-day weighed dietary records at 0.5 and 0.75 (infancy), 3 and 4 (preschool age), 6 and 7 years of age (school age) were included in this analysis. Percentage of commercial CF (%cCF) was averaged at 0.5 and 0.75 years. Individual FV intake (g/day) and FV variety scores were calculated and averaged separately for all three age groups. Multivariate linear regression was used to analyse associations between %cCF and FV intake and variety. Models were adjusted for early life and socioeconomic factors. *Results:* For boys, higher %cCF was associated with lower vegetable intake in infancy ($p < 0.0001$) and preschool age ($p = 0.036$) as well as lower total FV intake in preschool and school age ($p < 0.009$). For girls, higher %cCF was associated with lower vegetable intake ($p < 0.0001$) in infancy. FV variety scores showed no clear associations with %cCF in girls and boys. *Conclusion:* The results of the DONALD Study suggest that the preparation method of CF is associated with FV consumption in infancy and at least for boys also in preschool and school age.

Introduction

Although it is well known that a high intake of fruits and vegetables (FV) especially in addition to a high variety reduces the risk of different chronic diseases and cancer (Boeing et al., 2012; World Cancer Research Fund (WCRF) & American Institute for Cancer Research (AICR), 2007), intake is far below recommendations in adults (Mensink et al., 2013) as well as in children (Hilbig et al., 2011; Mensink et al., 2007). Some of the major determinants of a high FV consumption are individual preferences and liking (Krolner et al., 2011; Rasmussen et al., 2006). Given that taste preferences that were built in infancy and childhood track into adulthood (Nicklaus, 2009; Nicklaus et al., 2005), it is important to set the foundations for favourable dietary preferences as early as possible.

Emerging research indicates that the sensory properties of different foods given early in life can shape later taste preferences and food choices (Mennella, 2014). The exposure to different flavour experiences begins as early as in the womb. Flavours of the maternal diet, e.g. garlic or carrot, are transmitted to the foetus via amniotic fluid and later to the infant via breast milk (Mennella & Trabulsi, 2012; Ventura & Worobey, 2013). Breastfed children tend to have a higher vegetable consumption as well as a higher FV (and overall food) variety in childhood (Burnier, Dubois, & Girard, 2011; Scott, Chih, & Oddy, 2012) compared to formula fed infants.

Abbreviations: FV, fruit and vegetable; CF, complementary food; %cCF, percentage of commercial complementary food; DONALD Study, Dortmund Nutritional and Anthropometric Longitudinally Designed Study; FrS, fruit variety score; VegS, vegetable variety score; FrVegS, fruit and vegetable variety score; ALSPAC, Avon Longitudinal Study of Parents and Children.

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With the introduction of complementary food (CF) the spectrum of different flavours and textures increases further. Infants learn to accept unfamiliar foods more easily through repeated exposure and early dietary variety (Maier et al., 2007, 2008; Mennella, 2014; Mennella et al., 2008; Nicklaus, 2011; Remy et al., 2013). However, sensory properties of commercial CF are likely to differ from those of homemade CF by (1) differences in flavour or texture experiences (Birch et al., 1998; Blossfeld et al., 2006; Coulthard, Harris, & Emmett, 2010), (2) multiple combinations of flavours diluting the taste of individual FV (Caton, Ahern, & Hetherington, 2011), (3) a lower exposure to FV (Maier et al., 2007; Mesch et al., 2014) or (4) a combination of all these factors mentioned above.

For this reason, German recommendations on infant feeding state that given their respective advantages and disadvantages, both homemade and commercial CF are equally acceptable alternatives for infant feeding. However, parents are encouraged to not only rely on commercial products as homemade CF provides a broader range of different flavours and textures (Koletzko et al., 2013).

Nevertheless, recent data show that commercial CF dominates complementary feeding in Germany (Foterek, Hilbig, & Alexy, 2014). The overall vegetable variety in German commercial CF is rather low with a total of 16 different vegetables available in retail (compared to 26 different vegetables used in homemade CF) and 60% of commercial CF meals containing carrot as main vegetable (Mesch et al., 2014). Thus, exposure to a broad taste range of different FV across meals during complementary feeding and with this the chance to develop favourable food preferences seems to be rather limited. Moreover, commercial CF contains on average more different vegetables per meal than homemade CF (2.2 vs. 1.6, Mesch et al., 2014) which may impede learning about the particular flavour of single vegetables (Caton et al., 2011).

Therefore, we hypothesized that the extent of total commercial CF consumption and not only the preparation type of FV could affect preference for FV in infancy and beyond. The objective of this study was to examine the short-term and long-term association between the consumption of commercial CF in infancy and FV intake as well as FV variety during infancy, preschool and school age.

Materials and methods

Study population

The current analysis is based on data from the DONALD (DOrtmund Nutritional and Anthropometric Longitudinally Designed) Study, an ongoing open cohort study. Details of the study design have been published elsewhere (Kroke et al., 2004). Briefly, since 1985, detailed information concerning diet, growth, development, and metabolism has been collected in healthy subjects between infancy and early adulthood. Every year, infants are newly recruited and first examined at the age of three months. Each child returns for three more visits in the first year, two in the second, and then annually until young adulthood. The non-invasive assessments include 3-day weighed dietary records, interviews on lifestyle, anthropometric measurements, and a medical examination. The study was approved by the Ethics Committee of the University of Bonn and all examinations are performed with parental written consent.

The inclusion criterion for this analysis was the availability of three pairs of plausible 3-day weighed dietary records at 0.5 and 0.75 (infancy), 3 and 4 (preschool age), 6 and 7 (school age) years of age. Participants who were still fully breast- or formula-fed by the age of 0.5 years were excluded from this analysis (n = 42). Thus, 281 children born between 1985 and 2005 were included in the study sample.

Nutritional assessment

Dietary intake was assessed by 3-day weighed dietary records. The parents of each child were instructed to weigh and record all foods and beverages consumed by their child using electronic food scales (±1g) on three consecutive days. The participants chose the day of the beginning of dietary recording within a given period of time. Also foods and beverages consumed during any type of child care were recorded. Recipes (ingredients and preparation) of homemade CF as well as a detailed description including type and brand of commercial CF were also requested. If exact weighing was not possible, semi-quantitative recording with household measures (e.g. number of glasses, cups, and spoons) was allowed. A trained dietitian visited the family at home and checked the record for accuracy and completeness.

Subsequently, any recorded food or drink was entered into the continuously updated in-house food composition database LEBTAB, which incorporates information from standard nutrient tables. For commercial food products, e.g. commercial CF, energy and nutrient content was estimated using recipe simulation based on the labelled ingredients and nutrients (Sichert-Hellert et al., 2007). Dietary supplements and pharmaceuticals were recorded, too, but excluded from this analysis. Data on total daily energy intake (kcal/d) and food intakes (g/d) were derived for each participant from the mean of the three days of recording.

Infant feeding

CF was defined as all semi-solid, pureed or mashed foods fed with a spoon during complementary feeding. Snack foods intended for infants and toddlers (e.g. biscuits or cereal bars) were not included in the definition of CF due to their solid texture. Commercial CF was defined as all industrially processed, pre-packaged foods (from jars or packets). Homemade CF was defined as all home-prepared semi-solid, pureed or mashed foods made from scratch. If homemade CF was mixed with commercial CF products within a meal (e.g. homemade vegetable puree in combination with a commercial baby-meat jar), the complete meal was categorized according to the preparation method of its fruit or vegetable component. Commercial CF consumption (g/day) was summed up for every record at 0.5 and 0.75 years of age and calculated as percentage of total CF (%cCF) based on weight; subsequently both percentages were averaged for every participant to represent the habitual extent of commercial CF consumption during infancy.

Fruit and vegetable intake and variety

Individual FV intake was calculated as the sum of all recorded FV (including fresh, dried, frozen, and canned products). Nuts, seeds, and herbs were excluded. The FV proportion of composite foods with at least 50% FV content based on weight (e.g. coleslaw, soups) and 100% FV juices were also included in the calculation of FV intake.

To describe FV variety, three variety scores were calculated (Jeurnink et al., 2012). The individual number of different fruits and vegetables respectively, eaten at least once in a 3-day diet record were counted (FrS, VegS) and also summed up for a total score (FrVegS). According to Daniels et al. (2009) only FV with an amount of above 10g were considered for the variety score calculation. In contrast to the calculation of FV amounts, FV juices were excluded from the variety score calculation. To represent FV intake and variety in infancy, preschool, and school age, FV amounts as well as FV variety scores were averaged at 0.5 and 0.75, 3 and 4, 6 and 7 years respectively, for every participant.