

Early Origins of Overeating: Tracking Between Early Food Habits and Later Eating Patterns

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Abstract This review considers papers published in the last decade in relation to tracking between early food habits (here, habits acquired before 10 years) and later eating patterns. This review analyzes first how later eating patterns may be associated with the mode of milk feeding (formula vs. breast feeding; type of formula) and with the way complementary feeding is conducted (timing and type/variety of foods offered). Beyond the first year, this review focuses on the tracking of food preferences, food variety, portion size, dietary intake and eating traits. Most studies revealed moderate but significant associations between mode of milk feeding and complementary feeding practices and later eating patterns. When the baseline period is beyond 1 year, a moderate level of tracking is also observed for most eating behaviors reported (food preferences; food variety; dietary intake; eating traits), revealing a consistency over time in eating behavior; however eating behavior is likely to evolve when children grow older.

Keywords Tracking · Eating behavior · Food habits · Prospective studies · Food preference · Food variety · Energy intake · Dietary intake · Eating in the absence of hunger ·

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Introduction

The importance of early nutritional status on the health of the adult has been recognized more than 20 years ago [1]. Early nutrition is dependent on the early feeding practices adopted by parents and thus on food habits acquired by children. Food habits formed early are likely to track later in childhood and to form the basis of the eating patterns of the adult. The aim of the present review is to summarize findings from studies published in the last decade concerning associations between early food habits and later eating patterns. This review focuses on the child's food habits, excluding the association between parental diets or feeding practices and children's food habits; and focuses on *early* habits, here defined as habits observed during the first 10 years of life. The literature search was conducted in the PubMed and WOS databases using combinations of keyword [(energy intake / portion size / caloric compensation / eating in the absence of hunger / food variety / food preference / intake / food habits / eating habit / eating patterns) combined with (child) and (prospective / long-term / cohort / longitudinal / predict / tracking)], and was complemented by a hand search. This review focuses on publications from the last decade, except when key older references were concerned.

The analysis of the tracking of early eating habits may be analyzed in two ways: the *tracking* per se may be evaluated, i.e., the association between high level of a given eating habit for a given child in childhood and later on in life, in other words the correlations within a group of individuals between early and later eating patterns; and the *evolution* in the eating habit, i.e., the comparison of the average level of a given habit at

different time points. This paper mainly focuses on tracking and thus reports primarily studies in which eating habits were measured at several time points in the same children and in which tracking was assessed, but may also refer to articles reporting data from longitudinal studies in which only evolution was evaluated.

Association between Milk Feeding Practices and Later Eating Patterns

Milk feeding practices are in a vast majority of cases dependent on the mother's choice to breastfeed or not and thus cannot be viewed as a child's food habit; however, the importance of milk feeding mode in the building of eating habits has been increasingly recognized in the last decade and justifies scrutiny.

Feeding mode may be associated with a differential acceptance of food at the beginning of complementary feeding: breastfeeding leads to a higher acceptance of a new food at weaning when acceptance is evaluated during the first days of the weaning period [2]. However, this association is not observed when acceptance is evaluated after 2 weeks of complementary feeding [3] or when acceptance of new foods is averaged over a two-month period (Lange C, Visalli M, Jacob S, et al. Maternal feeding practices during the first year and their impact on infants' acceptance of complementary food, in review). The positive impact of breastfeeding on further food acceptance may be mediated by flavor exposure in the milk context [3, 4].

Taste experience in the milk feeding context may modify further food preferences. The longer the breastfeeding duration, the higher the acceptance of a umami-tasting solution at 6 months [5]. Exposure to hydrolyzed-protein formulas is associated to a different taste preference pattern later, up to the age of 5 years [6, 7].

Breastfeeding duration is positively associated to food variety later: it is associated to variety of free food choices by 2-to-3-year-old children [8], to healthy eating habits at 2 years [9], to food variety at 2 years [10], to fruit consumption at 6–8 years [11] and to a healthy eating patterns (consumption of meat, fruits and vegetables) at 2–8 years [12]. Exclusive breastfeeding for at least 3 months is associated with a higher consumption of vegetables at 4 years [13].

Finally, mode of milk feeding may also be associated with growth curves: breastfed babies are less likely to be overweight or obese at 4 years than formula-fed babies [9]. The type of formula may also matter in relation to growth since in an experimental study, weight gain at ages 2.5 to 7.5 months in infants fed an extensively hydrolyzed protein formula was more normative than that of infants fed cow's milk formula [14]. However, a recent epidemiological report did not show a significant impact of type of formula used and growth at 4 months [15].

Association between Complementary Feeding Practices and Later Eating Patterns

The analysis of the short-term impact of complementary feeding practices on later food acceptance was partly covered in a recent review [16••]. The impact of timing of complementary feeding and of the type or variety of foods offered at complementary feeding on further eating patterns was considered in some studies and will be detailed here. Age at complementary feeding may vary, despite the fact that the current recommendation is either to breastfeed exclusively until 6 months [17] or to start complementary feeding after 17 weeks and not later than 26 weeks [18].

Age at the beginning of complementary feeding may impact further eating patterns. Compared to infant weaned before 3 months, infants weaned between 4 and 10 months are more likely to develop healthy eating habits at 2 years, and less likely to be overweight or obese at 4 years [9]. Longitudinal data from the British ALSPAC cohort (Avon Longitudinal Study of Parents and Children) showed that introduction of solid foods with lumps between 6 and 9 months or before compared with introduction after 10 months is associated with a more varied diet at 15 months [19], and at 7 years [20]. Infants weaned later were more likely to have feeding problems at the age of 7 years [20].

The data from the ALSPAC cohort also revealed that the exposure to fruits and vegetables at 6 months was not associated with fruit and vegetable frequency of consumption respectively at 7 years when preparation of complementary foods was not taken into account [21]. However, considering food preparation revealed that exposure to home-cooked vegetables or fruits and to raw fruits at 6 months was associated with a higher frequency of consumption and a higher variety of fruits and vegetables at 7 years [21]. The impact of the early frequency of vegetable consumption may interact with age: if the introduction to home-cooked vegetables was early (before 3 months), the frequency of consumption at 6 months had no impact on vegetable consumption at 7 years; whereas if the introduction was delayed beyond ~6 months, the frequency of consumption at 6 months was positively associated to vegetable consumption at 7 years [21].

Food variety at the beginning of complementary feeding was shown to influence positively food acceptance later in the weaning period, as observed with experimental studies [2, 22, 23] or longitudinal observations from the French OPALINE cohort (Lange C, Visalli M, Jacob S, et al., in review). Fruit variety at weaning was shown to be associated to fruit consumption at 6–8 years [11]. Intake by food groups tracked moderately between 9 and 18 months [24].

Early taste preferences may guide early food preferences: this was observed in particular for some sweet, sour and umami foods which level of acceptance at the first presentation at weaning was positively associated with the infant's liking of the sweet, sour and umami taste in solution, respectively [25].

Association between Eating Habits in the Second Year on and Later Eating Patterns

To further evaluate the association between eating habits in the second year on and later eating patterns, we will delineate with more detail early eating habits by assessing tracking of food preferences, food variety, portion size, dietary intake and eating trait. The fact that the food repertoire is being built at this early period, and that most children reach a period of food neophobia around 2 years [26, 27], may alter tracking between eating habits at this age and further in childhood.

Tracking of Food Preferences

Taste preferences may guide food preferences in childhood as happens earlier in life: at 18 months, fruits, a group of sour foods, were all the more consumed than children liked sour taste [28]. Concerning salty taste, children's salt liking at preschool age is related to salty solutions acceptance or intake at 6 months [29].

In an American longitudinal cohort, food preferences at 2–3 years appeared to be related to food preference at 4 and 8 years, especially when specific food groups were reported as liked [30]. In a French longitudinal cohort, food choices at 2–3 years were significantly but moderately related to food preference up to the age of 22 years, especially for cheeses and meat products; and for vegetables only in girls [31]. Tracking of liking of meat products was altered at adolescence in girls [31]. Vegetable preference increased with age; animal foods decreased with age only in girls; preference for starchy foods and cheeses slightly decreased between 3 and 22 years [31]. Data from a longitudinal cohort of American girls (NEEDS cohort) showed that likes and dislikes of snack foods tracked between 5 and 11 years; snacks which were not much liked at 5 were more liked at 11 years [32]. In the same cohort, the stability of the preference-intake association for snack foods was evaluated in a longitudinal way and revealed a strong association between preference and intake, which may decline in girls with higher dietary restraint, weight concern and percent body fat [33]. This suggests that when children grow older tracking of food preferences may be altered by their concerns about weight status, and by their attempts to restrict specific foods which may vary within a population.

Tracking of Food Variety

As mentioned in the section about the tracking of food habits from complementary feeding onward, the introduction of a variety of foods as early as the beginning of complementary feeding promotes the variety of the diet later on.

Longitudinal observation of free food choices at a French kindergarten canteen revealed that the variety of food choices decreased between 2 years and 2.5 years and then remained constant until the age of 3 years, while at the same time energy intake increased [8]. Variety of the free food choices between 2 and 3 years was associated with the variety of foods consumed up to the age of 22 years [34]; this was true for the variety of foods consumed in general and for the variety of vegetables, meat products (only until the age of 16 years) and dairy products, but not for starchy foods, and mixed dishes. In an American cohort, the variety of fruits in school-aged children was predicted by the variety of fruits consumed at 2 years, but this relation was not observed for vegetables [11].

Tracking of Portion Size

Few authors have looked at the tracking of portion size in children. One study reported changes in portion size (amount of food eaten at a given eating occasion) in children: between 2 and 5 years, the majority of food portions were stable, and portions decreased for raw carrots and chicken; between 6 and 11 years, the majority of food portions were stable, some portions decreased (for pizza, chicken and margarine) and the portion of corn flakes increased [35]. Tracking of individual portion size is not reported in this study.

Tracking of Dietary Intake by Food Group

Tracking of energy intake and dietary intake by food groups was covered by a recent review [36••], and the following section will mainly focus on recent papers not considered in this recent review [37–42].

Table 1 summarizes the main information gathered from these studies. When tracking in dietary intake by food groups is studied, it is generally significant [40–42]. Dietary intake is likely to evolve when children grow older: the intake of milk as a beverage decreases [37, 39], while the intake of snacks increases [38].

Other studies investigated the tracking of eating patterns between adolescence and adulthood but will not be reported in more detail since they fall beyond the scope of this review, however, tracking during this period of dietary intake [43–47], or dieting and eating disorders [48, 49] has been investigated.

Tracking of Eating Traits

Eating traits include a cluster of behaviors which influence food intake. For example a trait of concern to parents is their child's picky eating, "characterized by the toddler or child

Table 1 Main results from longitudinal studies which evaluated the tracking and/or the evolution of eating habits across childhood

Authors ^a	Year	Cohort	Country	Age ^b		N	Intake outcomes	Results
				From	To			
Alexy et al. [37]	2003	DONALD	Germany	1 y	13 y	914	Dairy foods (formula, milk, yogurt, cheese); fat, calcium	Total dairy food intake increased only until 9 y; milk beverages intake increased while fluid milk intake decreased; yogurt and cheese intake increased between 4 and 13 y
Alexy et al. [38]	2008	DONALD	Germany	3 y	18 y	554	% of daily intake of convenience foods and prepared savory products	Convenience food intake increased. % of children who ate convenience foods increased
Fiorito et al. [39]	2006	NEEDS	USA	5 y	11 y	151 girls	Cheese, milk as beverage, yogurt, dairy dessert	Intake of milk as beverage decreased, intake of cheese, yogurt and dairy products did not change
Pearson et al. [42]	2011		Australia	6 y	11 y	121	Vegetables, energy-dense sweet snacks, energy-dense savory snacks	For intake of each food category a high level of tracking was observed
Gregory et al. [41]	2011	The Child and Family Health Study	Australia	1 y	2 y	60	Fruits, vegetables, sweets	For each food group, the consumption frequency at 2 y was predicted by the consumption frequency at 1 y
Fremaux et al. [40]	2011	EarlyBird Diabetes Study	UK	5 y	13 y	342	Healthy foods; Unhealthy foods & beverages	Dietary patterns were moderately consistent over time. Individual choices were consistent year-on-year. The quality of diet diminished over time in 29 % of the children and improved in only 14 %

^a Only studies not quoted by Madriga et al. [36••] 2012 were considered here.

^b Only studies in which the age at baseline was below 10 years were considered here

eating a limited amount of food, restricting intake particularly of vegetables, being unwilling to try new foods, and having strong food preferences often leading parents to provide their child a meal different from the rest of the family” [50]. This trait was shown to be fairly stable from 2 to 11 years and may reflect an individual eating style [50]. Level of food fussiness, a trait close to picky eating, defined as “being highly selective about the range of foods that are accepted”, was evaluated at the ages of 4 and 11 years and was shown to track significantly in a cohort of English twins [51]. Other eating traits measured by the Child Eating Behaviour Questionnaire were also characterized in this cohort and were shown to track significantly: satiety responsiveness, slowness in eating, food responsiveness, enjoyment of food, emotional overeating; with a lower tracking for emotional undereating [51]. Some traits decreased over time between 2 and 11 years (satiety responsiveness, slowness in eating, food fussiness, and emotional undereating) while other traits increased (food responsiveness, enjoyment of food and emotional overeating) [51].

Another trait which is more related to overeating, eating in the absence of hunger was characterized by a behavioral assessment of children’s drive to eat when they have just eaten [52]. The level of eating in the absence of hunger was studied longitudinally from 5 to 9 years in the American NEEDS cohort of girls: it tracked significantly from 5 to 7 years [53] and increased significantly from 5 to 9 years [52]. Another eating trait, inhibitory control, was also characterized in the same cohort [54]. Tracking of this trait was not reported, it was shown that lower level of inhibitory control at the age of 7 years significantly predicted greater weight gain and higher BMI up to the age of 15 years [54].

This analysis reveals that eating traits related to undereating (e.g., picky eating) or overeating (e.g., food responsiveness, eating in the absence of hunger) emerge early in the development and show stability at the individual level, even if they are likely to evolve with age, and thus can be considered as stable personality traits. For further understanding of the association between eating traits and weight gain in childhood, a recent review may be consulted [55•].

Conclusions

This review highlights the association of breastfeeding with healthy eating patterns further on in childhood. It also reveals that complementary feeding practices (timing, variety of foods offered) are also likely to be associated with healthy eating habits (e.g., fruit and vegetable consumption) later on in development. In the available literature concerning tracking of eating habits after the first year, the majority of studies report moderate tracking from early childhood on, suggesting that certain aspects of eating behavior are fairly stable for a given individual during childhood. The average

level of a given eating habit is more likely to evolve with age, especially when the baseline measurement is early in life, because the diet is largely modified qualitatively after the beginning of complementary feeding, when milk intake decreases and other foods are progressively introduced to the child’s diet. Altogether, the available results are in broad agreement with the evidence showing strong tracking of body mass index during development in childhood [56•].

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Conflict of Interest Sophie Nicklaus declares that she has no conflict of interest.

Eloïse Rémy declares that she has no conflict of interest.

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- Of importance
- Of major importance

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