

The Future of Infant and Young Children's Food: Food Supply/Manufacturing and Human Health Challenges in the 21st Century

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Abstract

Infant food and weaning practices are highly debated with lots of unanswered questions. It is becoming more apparent that early-life feeding may have an effect on the long-term health of humans, particularly for noncommunicable diseases such as obesity and allergic diseases. It is important to understand how environmental influences in early life can affect the development of the immune system and metabolic profiling. In terms of nutrition and diet, one should consider the role of the total/whole diet, as well as particular nutrients in the development of noncommunicable diseases. Providing the appropriate nutrition for infants during the weaning age needs to address factors such as the microbial load of the food, nutrient composition, presence/absence of allergens and appropriate textures. These factors are of importance irrespective of whether the food is homemade or produced commercially, and need to take environmental factors and food resources into account.

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Health Challenges

Obesity

There has been a marked increase in obesity rates over the past 20 years. Obesity and overweight affect more than 1.5 billion adults and account for 0.7–2.8% of health care costs in both the developed and developing world [1, 2].

The cost of obesity and overweight to the UK economy was estimated at GBP 15.8 billion per year in 2007, including GBP 4.2 billion in costs to the NHS [3]. In 1993, 13% of men and 16% of women were obese compared to 24% of men and 26% of women in 2011 [4]. There has also been an increase in the incidence of childhood and adolescent obesity worldwide, an important predictor of adulthood obesity, morbidity and mortality [5–7]. In the USA, a third of children were classified as either overweight or obese in 2012. The average weight of a child has risen by more than 5 kg within three decades. This varies from an increase of 2 kg in children under 8 years of age to an increase of more than 8 kg in some adolescent age groups [8]. A survey in English schoolchildren found that 19.2 and 33.9% of 4-/5- and 10-/11-year-old children, respectively, are obese or overweight [9]. However, despite an increase in obesity-related hospital admissions in children, the obesity rates of reception age children in the UK have stayed stable, albeit at a high rate of about 22%.

Maternal overweight [10–15] is associated with subsequent obesity in offspring, highlighting the importance of early-life factors in the development of obesity. In addition, increased birth weight has been associated with childhood and adolescent obesity. Data from the Isle of Wight have recently indicated [16] that an early persistent obesity was seen in obese infants but also in ‘normal-weight’ infants who went on to become obese teenagers/adults, i.e. some obese infants became obese adults but normal-weight infants could also become obese adults. Most importantly, this weight trajectory, also indicating the risk for developing asthma by 18 years of age, was set by 4 years. Maternal overweight before pregnancy and smoking during pregnancy were associated with increased risk in this group. The data, therefore, indicate that there are factors in early life that could lead to a ‘normal-weight’ infant developing into an overweight/obese infant that can persist into adulthood.

Early-Life Dietary Factors Affecting Obesity

There is some evidence indicating the microbiota is affected in obese individuals, and most importantly that microbiota as early as 3 months of age could be related to obesity at 10 years of age. This has been summarized in a review by Clarke et al. [17] (table 1). Diet, however, also affects the gut microbiota (e.g. a low fat diet is characterized by higher levels of Bacteroidetes and lower levels of Firmicutes). Weight reduction does not seem to affect gut bacteria [18] and it is therefore still unclear at this stage if the difference in gut bacteria is primarily related to body weight or diet. Early food exposure and introduction of solid food can also affect obesity outcomes, by affecting taste and food preferences to some extent.

Table 1. Gut bacteria in obesity (adapted from Clarke et al. [17])

Obese adults vs. lean adults (some conflicting data from papers)
Lower or higher levels of Bacteroidetes
Lower or higher levels of Firmicutes
Lower levels of bifidobacteria
(Some papers stating no difference)
Obese children vs. lean children
Higher levels of <i>S. aureus</i>
Lower levels of bifidobacteria
Lower levels of <i>Faecalibacterium prausnitzii</i>

Allergy

Similar to the rise in obesity, we have seen a rise in allergic diseases. The WAO White Book on allergy states that ‘the prevalence of allergic diseases worldwide is rising dramatically in both developed and developing countries. These diseases include asthma; rhinitis; anaphylaxis; drug, food, and insect allergy; eczema; and urticaria (hives), and angioedema. This increase is especially problematic in children, who are bearing the greatest burden of the rising trend, which has occurred over the last two decades. In spite of this increase, even in the developed world, services for patients with allergic diseases are fragmented and far from ideal. Very few countries have comprehensive services in this field of medicine’ [19]. In the USA, the overall economic cost of food allergy is estimated at USD 24.8 billion annually (USD 4,184 per year per child). This includes direct medical costs such as clinician visits, costs borne by the family (lost labor productivity due to caregiver needing time off work) and the cost of specialized foods [20]. In the UK, allergy accounts for 6% of GP consultations and 10% of the prescribing budget [21]. The direct costs of allergy to the NHS budget is GBP 1 billion per annum. This further emphasizes the need for preventing allergic diseases.

Early-Life Dietary Factors Affecting Allergy Outcomes

The role of the microbiota in the development of allergic disease has been researched for some time, with data indicating differences between the gut bacteria of allergic and nonallergic infants (table 2) [22]. This may be due to a decline in microbial exposure during early infancy, which in turn could be affected by environmental factors such as diet or early-life nutrition.

Food diversity in early life may also affect allergy outcomes. In 2013, Nwaru et al. [23] indicated that by 12 months of age, less food diversity was associated with increased risk of any asthma, atopic asthma, wheeze and allergic rhinitis. Despite some controversy and debate, micronutrients such as vitamins A, E, C

Table 2. Differences in bacterial load of infants with and without allergic disease [20]

<i>Allergic vs. healthy infants</i>
Less enterococci in the 1st month
Less bifidobacteria in the 1st year
Higher counts of clostridia at 3 months
Higher counts of <i>S. aureus</i> at 6 months
Lower counts of Bacteroidetes at 12 months

and D, selenium and zinc may also affect allergy outcomes, as discussed in a review by Nurmatov et al. [24] in 2011. Finally, in 2013, Grimshaw et al. [25] indicated that a diet low in commercial baby foods was associated with less food allergy in the infant.

The Infant Diet

Infant foods and the weaning diet (also referred to as introduction of solid foods) have been at the forefront of dialogues in the scientific world and media over the past few decades. Answers to questions such as the most appropriate age of introduction of solid or allergenic foods, should breastfeeding continue alongside solid food introduction, what are the crucial times for introduction of different textures, and should organic or nonorganic foods be used have been sought.

Central to all of these points is the use of homemade versus commercially available infant foods. The UK has seen an increase in baby food sales from GBP 303 million in 1995 to GBP 872 million in 2013 [26]. This is reflected in particular in the increase in sales of organic baby food. Worldwide, the baby food industry is worth USD 50 billion and is growing at a rate of 7% per year. These commercially prepared foods clearly constitute a large proportion of the infant diet, and should take into account factors that may play a role in the development of noncommunicable diseases. It is well known that association does not always equal causation. Black and Sharpe [27] published a paper looking at the association between fat intake and increase in allergic diseases in 1997. This association has never been proven in randomized controlled trials, and it will be interesting to see if there is any merit in the association seen between increase in sales of commercial baby foods and food allergy (using food-related anaphylaxis as a proxy; fig. 1). It is thought that gut microbiota has an effect on the development of allergic disease, and that certain foods and nutrients may also play a role in the prevention of allergic disease, e.g. fish/fish oil, vitamins A, E, C and

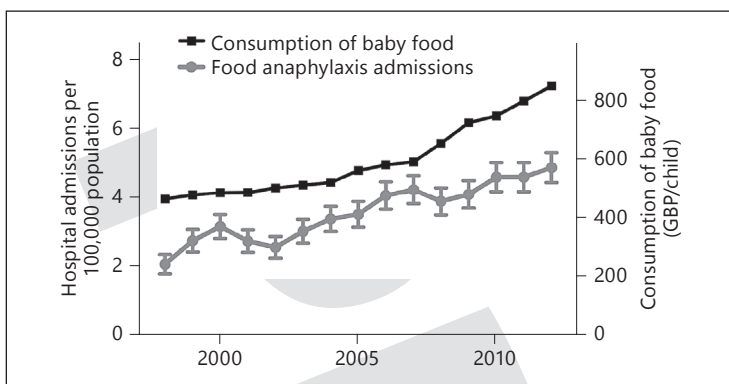


Fig. 1. Sales of commercial baby food in the UK versus admissions in food-related anaphylaxis [adapted from ref. 31].

D, selenium and zinc. Recent studies also indicate that a home-prepared [28] and more diverse diet leads to less allergic disease [29].

There are a number of ways in which the future of commercial baby foods can be improved to address the knowledge we have about possible preventative measures of allergic disease: the importance of microbes; nutrients that may play a role in the development of the immune system, and the importance of providing (some) homemade foods. The microbial load of commercially prepared baby food is negligible as food safety measures need to fulfill F_0 requirements. F_0 is a term used in the canning industry to denote the minimum process required to destroy *Clostridium botulinum* spores, which are the most deadly of all bacteria, dependent on the material being processed. However, when home-cooked food is provided to infants, up to 65% of the daily microbial load may be provided by fresh fruits and vegetables. As only a finite number of foods are included in baby foods, an increase in consumption of commercial infant foods (with corresponding decrease in consumption of home-cooked foods) may affect the diversity of foods introduced during the weaning period and ultimately affect allergy outcomes. Finally, the importance of nutrients such as antioxidants and other nutrients also require consideration when discussing commercial baby food production. It is known that sterilization can reduce the vitamin C content by up to 50% and the vitamin B₁ content by up to 30% [30].

Focus Group Results

Another very important factor to take into consideration is maternal/paternal experience of weaning and how they want the weaning message to be conveyed to them. This may not be important in terms of food production, but most baby food

manufacturers also provide information to parents of young infants. We conducted 4 × 2.5 h focus group discussions with mothers of babies 4–7 months old. Babies had either commenced weaning solids already or were about to start weaning solids. The sample of mothers was split into groups by awareness/experience of allergies, social class and whether they were a first- or second-time mother.

Three groups emerged from the analysis. These were ‘practical’, ‘balanced’ and ‘anxious’. Those in the ‘practical’ group were confident about weaning. They were often second-time mums who perceived prepared baby food as good (if not better) than homemade baby food. Mothers in the ‘balanced’ group had a balanced approach to weaning. They perceived homemade baby foods as ultimately the optimal choice, but conceded that it was not always practical to prepare and feed homemade foods. These mothers tended to examine food labels closely to determine the ingredient content. Those in the ‘anxious’ group tended to be either first-time mums with limited knowledge or second-time mums who had heard negative stories about weaning. As a result, this group often sought advice and guidance from experts. They also perceived homemade baby food as optimal, but some thought baby food has potential to be ‘safer’. Despite these three distinct typologies, all three groups had an underlying common perspective, viewing the goal of weaning as enjoyment of food and have development of a broad palate. They did not want the weaning message to be too directive, medical or pharmaceutical, and wanted the weaning message to center around ‘pure’, ‘simple’ and ‘healthy’.

With regard to timing of weaning, there were two patterns. Second-time mothers tended to be ‘baby led’, using cues such as changes in sleep pattern, finishing milk quickly, being more irritable and watching others in the family eat. In contrast, ‘advice-led’ mothers sought advice from health care professionals, the internet, books, their own mothers or friends. Those in the higher social class were more likely to seek advice from health care professionals. Besides timing of weaning, the process of weaning (e.g. risk of choking) and what food to give were other sources of worry. For the majority of mothers these concerns were very short lived. Once weaning had started concerns over when and how were almost instantly overcome. However, concerns over what to feed and how quickly to introduce new flavors and foods into the diet were more variable between mothers.

Generally, mothers commenced the weaning process with excitement and good intention of cooking homemade foods. However, even those who did a lot of home cooking reported that preparing fruit purees could be ‘hassle’. It was felt that prepared baby foods were composed of simple, safe ingredients. Indeed they were viewed by some to be superior to homemade foods especially if they were organic, prepared by better cooks and used better ingredients.

The choice of what prepared baby food to use was driven by three key factors: 'taste', 'goodness' and 'the truth'. 'Taste' was characterized mainly by the description of the ingredients and recipes. 'Goodness' helped mothers decide whether the product was healthy. Finally, mothers were keen to know the 'truth' about prepared baby foods (i.e. what exactly was contained in the food and what was hidden). Specifically, they were keen to discover whether the products contained milk, eggs, gluten and nuts, in addition to preservatives, coloring and salt. Interestingly, there was very little spontaneous mention of food allergies. When probed, mothers in the 'balanced' and 'anxious' groups showed some concerns, but the vast majority thought that food allergies are very individual and that exposure to a variety of foods early in the weaning process was important to identify any issues.

Conclusion

There is no doubt that the weaning diet will affect later health outcomes alongside maternal eating practices during pregnancy and breastfeeding as well as early milk (breast milk or formula) consumption. This poses the opportunity for families cooking homemade foods and industry producing commercial baby foods to provide infant foods in order to (perhaps) stem the tide of noncommunicable diseases such as allergy and obesity. Therefore, in the future, the introduction of food to infants should focus on three main factors:

- (1) Parental cooking skills to provide freshly cooked, homemade food
- (2) The possible bacterial content of commercial (sterilized vs. pasteurized) versus home-made foods
- (3) The particular nutrient content of baby foods and diversity of the infant diet.

This will have to be provided with the backdrop of current dwindling world resources, focusing specifically on the availability and sustainable production of fish and meat, better food distribution and less food waste at home.

Disclosure Statement

Kate Maslin and Carina Venter has no conflict of interest regarding this chapter. Carina Venter has acted as a consultant of provide lectures for Danone, Mead Johnson and Nestle in the past.

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