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Research review

Picky/fussy eating in children: Review of definitions, assessment, prevalence and dietary intakes

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ABSTRACT

Picky eating (also known as fussy, faddy or choosy eating) is usually classified as part of a spectrum of feeding difficulties. It is characterised by an unwillingness to eat familiar foods or to try new foods, as well as strong food preferences. The consequences may include poor dietary variety during early childhood. This, in turn, can lead to concern about the nutrient composition of the diet and thus possible adverse health-related outcomes. There is no single widely accepted definition of picky eating, and therefore there is little consensus on an appropriate assessment measure and a wide range of estimates of prevalence. In this review we first examine common definitions of picky eating used in research studies, and identify the methods that have been used to assess picky eating. These methods include the use of subscales in validated questionnaires, such as the Children's Eating Behaviour Questionnaire and the Child Feeding Questionnaire as well as study-specific question(s). Second, we review data on the prevalence of picky eating in published studies. For comparison we present prevalence data from the UK Avon Longitudinal Study of Parents and Children (ALSPAC) in children at four time points (24, 38, 54 and 65 months of age) using a study-specific question. Finally, published data on the effects of picky eating on dietary intakes (both variety and nutrient composition) are reviewed, and the need for more health-related data and longitudinal data is discussed.

Contents

List of abbreviations: ALSPAC, Avon Longitudinal Study of Parents and Children; CEBQ, Children's Eating Behaviour Questionnaire; CFQ, Child Feeding Questionnaire; RNI, Reference Nutrient Intake.

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1. Introduction

Picky eating, also known as fussy, faddy or choosy eating, is sometimes seen as being on the spectrum of 'feeding difficulties', where picky eating is the most common form at one end, with severe eating disorders at the other (McCormick & Markowitz, 2013). Others, however, view picky eating as having characteristics that are completely distinct from feeding disorders (Kerzner et al., 2015). Food preferences and suspicion of new foods in infancy may have had evolutionary benefits in reducing the risk of consuming toxins, but in the modern world these behaviours can provide a barrier to the acceptance of some food items. Picky eating and food neophobia (reluctance to eat or avoidance of new foods) can prevent an increase in dietary variety, and this lack of variety can lead to concern about the nutrient composition of some children's diets (Carruth et al., 1998; Jacobi, Agras, Bryson, & Hammer, 2003; Northstone & Emmett, 2013).

The development of picky eating may be affected by factors such as pressure to eat, personality factors, and parental practices/feeding styles, including parental control and social influences (Jani Mehta, Mallan, Mihrshahi, Mandalika, & Daniels, 2014; Moroshko & Brennan, 2013), as well as specific factors, such as the absence of exclusive breastfeeding, the introduction of complementary foods before 6 months (Shim, Kim, Mathai, & Team, 2011), and the late introduction of chewy foods (Northstone, Emmett, Nethersole, & ALSPAC Study Team, 2001). Picky eating appears to affect girls and boys equally (Moroshko & Brennan, 2013), but the presence of siblings seems to be protective against the development of picky eating, as does greater maternal age (Hafstad, Abebe, Torgersen, & von Soest, 2013). Maternal healthy eating behaviour has been associated with lower child food fussiness (Gregory, Paxton, & Brozovic, 2010). Although some studies report a higher intake of energy (Finistrella et al., 2012) or energy-dense foods such as savoury snacks and sweets (Tharner, Jansen, Kiefte-de Jong, Moll, & van der Ende, 2014) among children who are picky eaters, most report that picky eating is likely to lead to a reduction in overall food consumption and a distortion of the nutrient composition of the diet through lack of variety [reduced energy intake (Cardona Cano et al., 2015; Carruth, Ziegler, Gordon, & Barr, 2004; Jacobi et al., 2003; Volger et al., 2013); lower intake of fruits and vegetables (Dubois, Farmer, Girard, & Peterson, 2007; Galloway, Fiorito, Lee, & Birch, 2005; Haszard, Skidmore, Williams, & Taylor, 2014; Horodynski, Stommel, Brophy-Herb, Xie, & Weatherspoon, 2010; Jacobi et al., 2003; Tharner et al., 2014); lower intake of vitamins and minerals (Cardona Cano et al., 2015; Carruth et al., 2004; Galloway et al., 2005); and lower intakes of whole grain products and dietary fibre (Galloway et al., 2005)]. This can lead to a higher risk of being underweight and having poor growth (Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Ekstein, Laniado, & Glick, 2010; Jansen et al., 2012; Kwok, Ho, Chow, So, & Leung, 2013; Sleddens, Kremers, & Thijs, 2008; Viana, Sinde, & Saxton, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009), or of being overweight (Finistrella et al., 2012), or of developing eating disorders (Marchi & Cohen, 1990). Caregiver stress and effects on family relationships are likely (Goh & Jacob, 2012).

There is no single widely accepted definition of picky eating, although most definitions include an element of restricted intake of familiar foods, sometimes with a further degree of food neophobia (Dovey, Staples, Gibson, & Halford, 2008). This is further complicated by the use of a variety of terminology, including picky eating, fussy eating, choosy eating and faddy eating. As a result of this, several different measures have been developed to assess picky eating, ranging from a single item question to more complex multi-item sub-scales in larger questionnaires. In this review, we first examine the range of definitions and assessment measures used in current research and assess how these can affect the prevalence of picky eating. For comparison we report on the prevalence obtained using a study-specific measure of picky eating in a longitudinal cohort of children from the UK (the Avon Longitudinal Study of Parents and Children, ALSPAC) and investigate the changes in prevalence of picky eating found when using the same measure in the cohort at four ages between 2 and 5.4 years. Last, we review the current literature relating picky eating to dietary intake.

2. Definition, assessment method and prevalence

2.1. Identification of studies on picky eating

Literature searches were made with PubMed, Google Scholar, Web of Science, Medline and Embase using the keywords 'picky eating', 'picky eater', 'picky', 'fussy eating', 'fussy eater', 'fussy', 'fussiness', 'choosy', 'choosiness', 'neophobia', 'slow eating' and 'slow eater' in June 2015. Further studies were identified by checking the reference lists of papers identified in the searches. From these searches, 65 papers and abstracts were found that described studies in which the authors used questionnaires to identify picky eating in groups of children, published from 1990 to 2015 (see Table 1).

2.2. Definition of picky eating

At present there is no single widely accepted definition of picky eating, and therefore little consensus on the appropriate measure of assessment.

The range of definitions of picky eating used in research settings, include, for example:

- Consumption of an inadequate variety of food through rejection of a substantial number of foods that are familiar, as well as unfamiliar; this may include an element of food neophobia, and can be extended to include rejection of specific food textures (Dovey et al., 2008).

Table 1
Measures used to assess picky eating.

Measure used to assess picky eating	Comment	Authors
Lifestyle Behaviour Checklist (West & Sanders, 2009)	Five items including refusal to eat foods and resistance or difficult behaviour around food	Haszard et al. (2014)
Children's Eating Behaviour Questionnaire (Wardle et al., 2001)	Six items identified pickiness: high fussiness/high slowness in eating/high satiety responsiveness/low food enjoyment/low food responsiveness	Bucher, Siegrist, and van der Horst (2014); Caton et al. (2014); Horst (2012); Horst, Eldridge, Deming and Reidy (2014); Haycraft, Farrow, Meyer, Powell, and Blissett (2011); Morrison et al. (2013); Jansen et al. (2012); Gregory et al. (2010); Tharner et al. (2015); Tharner et al. (2014); Hendy et al. (2010); Sleddens et al. (2008); Viana et al. (2008); Webber et al. (2009)
Child Feeding Questionnaire (Birch et al., 2001)	Three items from the Pickiness subscale (related to lack of variety/food neophobia/pickiness)	Antoniou et al. (2015); Quick et al. (2014); Moroshko and Brennan (2013); Finistrella et al. (2012); Galloway et al. (2003); Galloway et al. (2005)
Preschooler Feeding Questionnaire (Baughcum et al., 2001)	Six items on child being a picky eater (picky eating/willingness to eat new foods/has to have special food because picky/struggle to get to eat/poor appetite)	Evans et al. (2011)
Oregon Research Institute Child Eating Behavior Inventory (Archer, Rosenbaum, & Streiner, 1991)	Four items related to picky eating (food neophobia/food rejection/food preparation preferences/limited variety)	Shim et al. (2011)
	Four items identified pickiness: limited variety/food refusal/struggle for control/positive parental behaviour	Lewinsohn et al. (2005)
Modified Pelchat and Pliner Questionnaire (Pelchat & Pliner, 1986)	20 behaviour-type questions	Maslin, Dean, Arshad, and Venter (2015); Carruth et al. (1998); Carruth and Skinner (2000)
Child Behaviour Checklist (Richman & Graham, 1971)	Two eating-related items (lack of appetite and food fussiness)	Hafstad et al. (2013); Cardona Cano et al. (2015)
NOURISH questionnaire	Single item on whether child is considered to be a picky eater	Jani Mehta et al. (2014)
Toddler–Parent Mealtime Behavior Questionnaire	Five items in the picky eating subscale	Horodynski et al. (2010)
Stanford Feeding Questionnaire	Four items to assess picky eating	Micali et al. (2011)
	Single item on whether child is considered to be a picky eater	Jacobi et al. (2003); Jacobi, Schmitz, and Agras (2008)
Food Management Questionnaire	Single item on food fussiness	Calam, Waller, Cox, and Slade (1997)
Structured questionnaire on child behaviour problems	No further details available	Y. Li, Shi, Wan, Hotta, and Ushijima (2001)
Study-specific questionnaire from the Gateshead Millennium Baby Study	Item on faddy eating	Wright et al. (2007)
Eating behaviour questionnaire adapted from questions in ALSPAC questionnaires	Three items on picky eating (eating different food from rest of family/refuse to eat right food/refuse to eat)	Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda (2007); Dubois, Farmer, Girard, Peterson (2007b); Dubois et al. (2013)
Study-specific questionnaire	No further details available	Z. Y. Li et al. (2014)[a]; Jin Shi, and Jin (2009)[a]; Akamatsu Ainuki, and Yoshida (2013)[a]; Chang et al. (2013)
	Three items on portion size, food refusal and lack of interest in food	Rydell, Dahl, and Sundelin (1995)
	Single item on whether child is considered to be choosy	Golding et al. (2009)
Questionnaire items	Multi-item questionnaire	Shim, Yoon, Kim, and Pail (2013); Cerro, Zeunert, Simmer, and Daniels (2002)
	No further details reported	Kim et al. (2005)[a]
	Single item on whether child is considered to be a picky eater	Xue, Lee, et al. (2015); Xue, Zhao, et al. (2015); Goh and Jacob (2012); Orun et al. (2012); Mascola et al. (2010); Carruth et al. (2004); Reau et al. (1996)
	Single item on child's food likes and dislikes	Northstone et al. (2001); Jones et al. (2010); Northstone and Emmett (2013)

(*continued on next page*)

Table 1 (*continued*)

Measure used to assess picky eating	Comment	Authors
	Single item on the frequency of picky eating (possible responses ranged from 'Never' to 'Most mealtimes')	Dellava et al. (2012)
Clinical assessment	Clinical assessment	Chatoor et al. (2004)
	Clinical assessment plus 3-day diet recall	Alarcon et al. (2003)
Parents'/caregivers' reports	No further details reported	Kwok et al. (2013)
	Caretakers' report of picky eating habits for >1 month[b]	Ekstein et al. (2010)
	Maternal interview	Marchi and Cohen (1990)

[a] Abstract only.
[b] Defined as an unwillingness to eat familiar foods or try new foods, severe enough to interfere with daily routines to an extent that was problematic to the parent, child, or parent–child relationship.

- Restricted intake of food, especially of vegetables, and strong food preferences, leading parents to provide a different meal from the rest of the family (Mascola, Bryson, & Agras, 2010).
- Unwillingness to eat familiar foods or try new foods, severe enough to interfere with daily routines to an extent that is problematic to the parent, child, or parent–child relationship (Lumeng, 2005, cited in Ekstein et al., 2010).
- Consumption of an insufficient amount or inadequate variety of food through rejection of food items (Hafstad et al., 2013).
- Limited number of food items in the diet, unwillingness to try new foods, limited intake of vegetables and some other food groups, strong food preferences (likes/dislikes), and special preparation of foods required (Horst, 2012; Horst et al., 2014).

Other studies have developed definitions of aspects of picky eating from analysis of responses to questions on eating behaviour. For example, Northstone and Emmett (2013) used a questionnaire item that was part of a series of questions on feeding. Using a focus group approach for parental definition of picky eating, Boquin et al. developed four categories of picky eating in which the overarching characteristics were unwillingness to try new foods and consuming a limited type and amount of foods (Boquin, Moskowitz, Donovan, & Lee, 2014). Tharner et al. used a latent profile approach with data from the Child Eating Behaviour Questionnaire (CEBQ) (Wardle, Guthrie, Sanderson, & Rapoport, 2001) to identify a fussy eating profile comprising high food fussiness, slowness on eating and high satiety responsiveness, combined with low enjoyment of food and food responsiveness (Tharner et al., 2014). Some studies have identified slow eating as a feature of picky eating (e.g. Mascola et al., 2010; Reau, Senturia, Lebailly, & Christoffel, 1996). 'Flags' for identification of picky eaters are: child eats only preferred food, drinks most of his/her energy intake, uses distractions when eating, eats food camouflaged in other foods or liquids, and has lengthy mealtimes (McCormick & Markowitz, 2013).

It is important that an understanding of the definitions used in studies is reached in order to enable comparison of studies. This is necessary to facilitate the identification of children at risk and to identify any adverse health outcomes that may be associated with being a 'picky eater'. A consensus around a definition would enable the development of interventions to avert poor health outcomes. We support the definition of Lumeng (2005) cited in Ekstein et al. (2010) as it includes elements of lack of dietary variety, neophobia and persistent behaviour: 'unwillingness to eat familiar foods or try new foods, severe enough to interfere with daily routines to an extent that is problematic to the parent, child, or parent–child relationship'.

2.3. Assessment methods used in research studies

The methods used to identify picky eating in research studies fall into two broad categories (see Table 1): the use of item(s) from existing validated questionnaires (with a range of different questionnaires being used) and the use of a study-specific question(s). The investigation usually involves the mother as the primary caregiver. The items range in complexity from a simple single question (e.g. 'Is your child a picky eater?' (Mascola et al., 2010)) to multi-item questionnaires in which individual items are more complex (e.g. 'My child is interested in tasting foods s/he hasn't tasted before' (from the Fussiness subscale of the CEBQ)). Study-specific question(s) can be specially designed for the particular study cohort and can provide more flexibility than pre-existing questionnaire items. Such questions provide an opportunity to obtain a range of information about varied aspects of feeding behaviour, although they can be more difficult to analyse. The CEBQ has become popular recently (for example: Morrison, Power, Nicklas, and Hughes (2013); Tharner et al. (2014)). Other questionnaires such as the Lifestyle Behaviour Checklist (West & Sanders, 2009) (e.g. Haszard et al. (2014)) and the Child Behaviour Checklist (Richman & Graham, 1971) (e.g. Cardona Cano et al., 2015; Hafstad et al., 2013) are also in recent use, as are study-specific measures (e.g. Jani Mehta et al., 2014; Horst et al., 2014).

Responses are usually on a Likert scale with between three and seven points. Analysis of the scoring scales has involved various strategies for categorisation, using mean or median score, or dividing responses into subcategories for scoring. Even the method of analysis of the same scale varies (e.g. CEBQ analysed by latent profile analysis (Tharner et al., 2014), standard deviation scores of scale scores (Jansen et al., 2012), mean score (Hendy, Williams, Riegel, & Paul, 2010)).

2.4. Age of initial picky eating

Some studies have included children below the age of 1 year and provided prevalence figures for picky eating for this age group. This is a time when infants are first learning about food tastes and textures: at this age the child is too young to experience neophobia and thus any parental concept of picky eating is unlikely to be a true reflection of picky eating as defined in this review. These studies (or parts of studies) have therefore been excluded from consideration of the prevalence and consequences of picky eating.

2.5. Reported prevalence of picky eating

Estimates of the prevalence of picky eating range widely from 5.6% in 4-year-olds in the Netherlands (Tharner et al., 2014) to 50% in 2-year-olds in the USA (Carruth et al., 2004) (Table 2). A prevalence of 59% was reported in 7–12-year-old Chinese children, but the category was inflated by the inclusion of children who were 'somewhat picky' as well as those who were 'always picky' (Xue, Lee, et al., 2015). The variations in the definition of picky eating and the differences in methods of assessment used leads to this wide range of prevalence, which can differ even within a study. This problem is illustrated in the study of Goh and Jacob (2012): the question 'Do you think your child is a picky eater?' elicited a response of 25.1% for 'Always a picky eater'. When the caregivers of

Table 2
Prevalence of picky eating.

Authors	Country	Age (years)	Prevalence (%)	Assessment method
Xue, Lee, et al. (2015)	China	7–12	59.3	Single item
Xue, Zhao, et al. (2015)	China	3–7	54.0	Single item
Cardona Cano et al. (2015)	The Netherlands	1.5	26.5	CBCL – 2 items
		3	27.6	
		6	13.2	
Haszard et al. (2014)	New Zealand	4–8 (overweight)	36.5	LBC – 5 items
Jani Mehta et al. (2014)	Australia[a]	1–5	34.1	Single item
Z. Y. Li et al. (2014)[b]	China	25–36 months	36.2	Study-specific questionnaire
Tharner et al. (2014)	The Netherlands	4	5.6	CEBQ – latent profile approach – 6 items
Horst et al. (2014)	USA	3–4	15.6	Several items
Dubois et al. (2013)		2.5	9.4	Single item
		9	10.7	
Akamatsu et al. (2013)[b]	Japan	1.5	12.7–38.7	Several items
Hafstad et al. (2013)	Norway	1.5–4.5	22–35	Two items
Finistrella et al. (2012)	Italy	1	20	CFQ – 3 items
Orun et al. (2012)	Turkey	12–27 months	Overall 39	Single item
		12–24 months	34.8	
		25–38 months	38.7	
		49–72 months	38.0	
Goh and Jacob (2012)	Singapore	1–10	40.8	Single item
Micali et al. (2011)	Denmark	5–7	7.3	SFQ – factor analysis – 4 items
Mascola et al. (2010)	USA	3–11	13–22	Single item
Jin et al. (2009)[b]	China	1–6	39.7	Study-specific questionnaire
Jacobi et al. (2008)	Germany	11.7–12.7	19 (girls)	Single item
			18 (boys)	
Dubois, Farmer, Girard, Peterson, et al. (2007)	Canada	Preschoolers	14–17	Three items
Wright et al. (2007)	UK	1.5	8.3	Single item
Carruth et al. (2004)	USA	24 months	50	Single item
Jacobi et al. (2003)	USA	3–4	21	SFQ – 4 items
Cerro et al. (2002)	New Zealand	31 months[c]	20	Study-specific questionnaire
Y. Li et al. (2001)	China	2–6	17	No further details available
Reau et al. (1996)	USA	13–27	36	Single item
Rydell et al. (1995)	Sweden	6.1–11.0	30	Three items
Marchi and Cohen (1990)	USA	1–10	29	Four items
		9–18	28	
		11–21	27	

CEBL, Child Behaviour Checklist; CEBQ, Children's Eating Behaviour Questionnaire; CFQ, Child Feeding Questionnaire; LBC, Lifestyle Behaviour Checklist; SFQ, Stanford Feeding Questionnaire.
[a] Mothers were Indian immigrants.
[b] Abstract only.
[c] Corrected age (children were born preterm).

these children were provided with a list of typical behaviours, the reported prevalence changed to 49.6%. Furthermore, the number of participants included in some of the studies reporting prevalence has been low (e.g. Jacobi et al., 2003; Mascola et al., 2010, n = 135 and 110 respectively), which may limit the reliability of the results.

When including only data on children aged ≥1 year, the prevalence of picky eating seems to be unrelated to the child's age, the number of questionnaire items, the type of questionnaire or the country of the study (Table 2). Similarly, there is no consensus in the change in prevalence over time. Some authors have found changes in the prevalence with age: Mascola et al. (2010) found an increase from age 2 years to a peak at age 6 years, when the prevalence plateaued; Hafstad et al. (2013) found the highest prevalence at age 3.5 years in a study spanning the age range of 1.5–3.5 years old, and Cardona Cano et al. (2015) found the prevalence to be highest at age 3 years compared with age 1.5 and 6 years. Others, however, have reported no change in the prevalence of picky eating with age: Marchi and Cohen (1990) found the prevalence to be stable in a 10-year study with a starting age ranging from 1 to 11 years old, as did Orun, Erdil, Cetinkaya, Tufan, and Yalcin (2012) between 12 and 72 months and Dubois, Farmer, Girard, Peterson, et al. (2007) in children age 2.5–4.5 years.

2.6. Picky eating in different cultures and countries

Picky eating has generally been studied in populations from developed countries, predominantly the USA, but this narrowness has been criticised as disregarding the effect of the mother's cultural background on feeding practices (Jani Mehta et al., 2014). However, Indian immigrants into Australia showed similar associations to those in European origin populations, namely that pressure-feeding and perceptions of pickiness were positively related (Jani Mehta et al., 2014). In addition, the prevalence of picky eating in these immigrants and in a Turkish population was similar to that in developed countries (Jani Mehta et al., 2014; Orun et al., 2012). Despite these findings, the number of studies investigating picky eating in developing countries is limited and further work is needed to confirm these results.

3. Picky eating in the ALSPAC cohort

For comparison we present prevalence data from the UK ALSPAC cohort in children at four time points (24, 38, 54 and 65 months of age) using a study-specific question. ALSPAC is a longitudinal population-based study investigating environmental and genetic influences on the health, behaviour and development of children. In brief, all pregnant women in the former Avon Health Authority with an expected delivery date between April 1991 and December 1992 were eligible for the study; 14,541 pregnant women were initially enrolled, resulting in a cohort of 14,062 live births with 13,988 alive at 1 year of age (Boyd et al., 2013). The social and demographic characteristics of the cohort, collected by self-

Table 3
Prevalence of picky eating at each time point in the ALSPAC cohort (all singleton cases).

Age (months)	Response to question[a]		
	No	Yes quite choosy	Yes very choosy
24	6039 (59.6%)	3113 (30.7%)	982 (9.7%)
38	4448 (45.2%)	3948 (40.1%)	1448 (14.7%)
54	4247 (45.2%)	3811 (40.6%)	1329 (14.2%)
65	4160 (48.0%)	3492 (40.2%)	1018 (11.8%)

Values are n (%).
[a] Question was: Does your child have definite likes and dislikes as far as food is concerned?

completion postal questionnaires, were similar to those found in UK national census surveys (Fraser et al., 2013). Further details of ALSPAC are available at www.bris.ac.uk/alspac and the study website contains details of all the data that are available through a fully searchable data dictionary (http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary). Ethics approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

3.1. Defining picky eating in the ALSPAC cohort

Primary caregivers (usually mothers) received postal self-completion questionnaires asking about their child at different ages throughout childhood. The questionnaires are available from the study website (http://www.bristol.ac.uk/alspac/researchers/resources-available/data-details/questionnaires/). A single question was used to assess picky eating. It is similar to those used in several recent studies (Goh & Jacob, 2012; Jani Mehta et al., 2014; Mascola et al., 2010; Orun et al., 2012) and was asked at four time points up to age 5 years (24, 38, 54 and 65 months).

Q. Does your child have definite likes and dislikes as far as food is concerned?
A. No/Yes, quite choosy/Yes, very choosy

The main advantage of this question is that it does not rely on a parental/caregiver interpretation of the term 'picky eating', or on parental/caregiver interpretation of time (slow eating). Furthermore, although it was administered as part of a multi-item questionnaire in the context of the ALSPAC study, the question could easily and quickly be administered in a variety of contexts, the answer is readily interpreted without complex statistical analyses, and the question has clinical relevance since it is similar to what might naturally be asked of a parent by a healthcare provider such as a doctor, nurse or dietitian.

The responses for singleton cases were scored 0, 1 or 2. The overall prevalence of picky eating was calculated from the number of cases that reported 'Yes, very choosy' at ≥2 time points. Early onset picky eating was defined as the first report of picky eating ('Yes, very choosy') being at 24 or 38 months; late onset picky eating was defined as the first report of picky eating ('Yes, very choosy') being at 54 or 65 months. Persistent picky eating was defined as score 2 ('Yes, very choosy') at the first and/or second time points, then score 2 at both the third and fourth time points.

3.2. Prevalence of picky eating in the ALSPAC cohort

The prevalence of picky eating at each age was between 9.7% and 14.7% (Table 3). The peak age for reporting picky eating was 38 months (see Table 2 for comparative data). 256 children (3.5%) were reported to be picky at all four time points while 1929 (26.0%) were never reported to be a picky eater. Early onset picky eating was more frequent than late onset and persistent picky eating occurred in 8% of the children (Table 4).

Picky eating at the peak age of prevalence (38 months) was associated with greater maternal age, maternal smoking, higher maternal social class, lower pre-pregnancy body mass index, higher maternal educational attainment, lower parity, and the infant being male and of a lighter birth weight (Table 5).

4. Picky eating and dietary intake

4.1. Early feeding

Picky eating has been shown to be associated with a reduced duration of breast-feeding and early introduction of complementary foods. One study found a positive association between breast-feeding for less than 6 months and picky eating in 7-year-old girls (Galloway, Lee, & Birch, 2003). A study investigating the effect of infant feeding practices on picky eating in 2–3-year-old children, by Shim et al. (2011) found that exclusive breast-feeding for 6 months and the introduction of complementary foods after 6 months of age reduced the odds of picky eating in early childhood. In contrast, Finistrella et al. (2012) found no difference in neophobia or pickiness scores between children who were breast-fed or formula-fed, or a mixture of both. They also noted that there was no association of weaning age with the scores. From a different perspective, children later classified as picky eaters have been shown to have a different sucking pattern at age 2 and 4 weeks, with fewer sucks per session (Jacobi et al., 2003).

4.2. Food groups

Several studies have identified associations of picky eating with intakes of particular food groups. A strong association was found between the mother's liked and disliked food items and those of the child, as well as the frequency of consumption of those items

Table 4
Timing of incident picky eating and subsequent categorisation in the ALSPAC cohort.

Incident PE at (age, months)	Still a PE at (age, months)			
	24	38	54	65
24	763 (100%) (10.3% of total)	508 (66.6%) (6.8% of total)	417 (54.6%) (5.6% of total)	338 (44.2%) (4.6% of total)
38	–	635 (100%) (8.6% of total)	296 (46.6%) (4.0% of total)	251 (39.5%) (3.4% of total)
54	–	–	362 (100%) (4.9% of total)	142 (39.2%) (1.9% of total)
68	–	–	–	161 (100%) (2.2% of total)

n = 7420 complete cases (singletons only).
Picky eating defined as 'Yes, very choosy'.

Table 5
Demographics of children with picky eating age 38 months in ALSPAC (all singleton cases).

	Picky eating			P value
	No	Yes quite	Yes very	
Maternal age (years)[b]				
<25	896 (20.1%)	695 (17.6%)	239 (16.5%)	<0.001
25–35	3250 (73.1%)	2940 (74.5%)	1075 (74.2%)	
>35	302 (6.8%)	313 (7.9%)	134 (9.3%)	
Prepregnancy BMI (kg/m^2)[a]	23.1 ± 3.9	22.8 ± 3.6	22.6 ± 3.6	<0.001
Maternal education[b]				
None/CSE/Vocational	1221 (28.5%)	885 (23.2%)	331 (23.7%)	<0.001
O- or A-level	2575 (60.0%)	2306 (60.3%)	827 (59.3%)	
Degree	493 (11.2%)	631 (16.5%)	237 (17.0%)	
Parity[b]				
0	1820 (43.0%)	1800 (47.7%)	691 (50.1%)	<0.001
≥1	2408 (57.0%)	1974 (52.3%)	688 (49.9%)	
Mother smoked[b]				
No	3565 (82.1%)	3285 (84.9%)	1156 (81.9%)	<0.001
Yes	776 (17.9%)	583 (15.1%)	255 (18.1%)	
Social class[b]				
I and II	1286 (36.3%)	1378 (42.3%)	467 (39.8%)	<0.001
III	1837 (51.9%)	1556 (47.7%)	580 (49.4%)	
IV and V	416 (11.8%)	325 (10.0%)	126 (10.7%)	
Child's sex[b]				
Male	2292 (51.5%)	1991 (50.4%)	790 (54.6%)	0.027
Female	2156 (48.5%)	1957 (49.6%)	658 (45.4%)	
Birth weight (g)[a]	3454 ± 537	3436 ± 534	3379 ± 514	<0.001
Gestational age (weeks)[a]	39.5 ± 1.9	39.5 ± 1.8	39.5 ± 1.7	0.830
Preterm birth (<37 weeks)[b]				
Yes	214 (4.8%)	179 (4.5%)	72 (5.0%)	0.744
No	4233 (95.2%)	3769 (95.5%)	1376 (95.0%)	
Low birth weight (<2500 g)[b]				
Yes	215 (4.8.%)	196 (5.0%)	81 (5.6%)	0.510
No	4233 (95.2%)	3752 (95.0%)	1367 (94.0%)	

BMI, body mass index; CSE, Certificate of School Education.
[a] ANOVA.
[b] Chi-square test.

(Finistrella et al., 2012). A common finding is reduced intakes of fruits and vegetables in picky eaters. For example, Horodynski et al. (2010) used a food frequency questionnaire in nearly 400 US mother–toddler dyads and found that picky eaters consumed fruits and vegetables less often than non-picky eaters and that the toddlers were more likely to eat fruits and vegetables if their mothers also did so. Haszard et al. (2014) found that picky eaters ate fewer fruits and vegetables than non-picky eaters using subscales of the Children's Dietary Questionnaire (Magarey, Golley, Spurrier, Goodwin, & Ong, 2009) in a group of overweight 4–8-year-old children in New Zealand. This complemented the findings of Galloway et al. (2005) that children consumed fewer fruit and vegetable servings than recommended in the USA Food Guide Pyramid, and that picky eaters consumed significantly less than non-picky eaters (fruits 1.5 ± 1.1 vs 1.0 ± 0.94 servings per day; vegetables 1.7 ± 0.89 vs 1.3 ± 0.72 servings per day; non-picky vs picky eaters, respectively). Avoidance of vegetables in particular has been found in several studies (Cardona Cano et al., 2015; Carruth et al., 2004; Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Z. Y. Li et al., 2014; Tharner et al., 2014), and has been noted to occur particularly in male rather than female picky eaters (Jacobi et al., 2003; Jones, Steer, Rogers, & Emmett, 2010). Based on twin studies, fussiness about vegetables appears to be a heritable trait, as do food refusal and fussiness about food in older children (9 years of age) (Dubois et al., 2013). This may be related to genetic taste predisposition and an innate tendency to reject bitter tastes (Golding et al., 2009).

With regard to broader food groups, Finistrella et al. (2012) used a food frequency questionnaire to measure the intake of 14 main food groups (e.g. milk and yogurt, cheese, eggs, vegetables, etc.) in 2–6-year-old picky eaters in Italy, but did not report any detailed findings. Tharner et al. (2014) used a food frequency questionnaire in 14-month-old Dutch children enrolled in the Generation R study to identify food groups that were associated with picky eating: children later identified as picky eaters at age 4 years had eaten fewer whole grain products, fewer vegetables, less fish/seafood and less meat at age 14 months than those not later identified as picky eaters. Intakes of savoury snacks and confectionary had been higher in picky eaters, although there was no difference in total energy intake, suggesting that these items were being substituted for more 'healthy' foods. These differences could reflect early signs of picky eating or could be implicated in causing picky eating at the later age. In a further study from the same cohort but using a different measure of picky eating, Cardona Cano et al. (2015) broadly replicated the findings of Tharner et al. but found lower energy intakes in picky eaters than non-picky eaters at age 14 months. In a study in which 24 h food intake was measured in US children at ages 3.5 and 5.5 years old, picky eaters ate a mean of one less food item that non-picky eaters, but there were no differences in the consumption of two food groups (fruits, sweets) (Jacobi et al., 2003); Carruth et al. (2004) used a single 24-h recall for a younger age group of children (4–24 months old) also in the USA, and found no major differences in consumption of major food groups between picky eaters and non-picky eaters, including milk and milk products. However, picky eaters consumed less unsweetened and more sweetened ready-to-eat cereal than non-picky eaters at 15–24 months. At age 15–24 months within the fruits group, bananas were popular with picky eaters; within the vegetable group, a greater percentage of picky eaters ate French fries, and a lower percentage ate mashed potato; within the meat group, picky eaters ate mixed dishes (e.g. spaghetti, lasagne, ravioli) less frequently than non-picky eaters. Children who were picky eaters were more

likely to eat one serving or less of meat or meat alternatives than children who were not picky eaters in a study of Canadian children aged 2.5–4.5 years (24-h recall) (Dubois, Farmer, Girard, & Peterson, 2007). Highlighting the importance of including a group of non-picky eaters as a comparison group, Galloway et al. (2005) found that intakes in both picky eaters and non-picky eaters fell below the recommended number of daily servings of grains and meat (US Food Guide Pyramid), but there were no significant differences between the groups. Intakes of dairy foods were above the recommended number of servings for both groups, and there was no significant difference between them.

4.3. Dietary diversity, dietary quality and dietary patterns

It has consistently been found that picky eaters have less variety in their diets than non-picky eaters. Children who were picky eaters consumed fewer food items than non-picky eaters (Cardona Cano et al., 2015; Jacobi et al., 2003; Z. Y. Li et al., 2014; Northstone & Emmett, 2013). Carruth et al. (1998) used food intakes in US toddlers aged 24–26 months old (2-day food record plus a 24-h recall on two occasions) to assess dietary variety and diversity scores: both scores were significantly lower for picky eaters than non-picky eaters. Using 3-day food records in US teenagers (13 years old) with type 1 diabetes, who are at particular risk of poor health outcomes, Quick et al. (2014) investigated a nutrient-rich food index and a healthy eating index, used as measures of dietary quality: both were both inversely associated with pickiness, as was dietary variety (measured as the variability in foods chosen from across 20 food groups). Volger et al. (2013) used 3-day food records to study diet in 153 picky eating pre-schoolers in China and Hong Kong: they did not include a comparison group of non-picky eaters and so compared their findings with the Hong Kong Food Pyramid recommendations. Participants had a dietary pattern that included less than the recommended amount for all food groups (including vegetables, dairy products, meats and alternatives, and fruits), but more sweets and fat.

Food neophobia, which is considered to be a component of picky eating behaviour (Dovey et al., 2008), has itself been associated with reduced dietary variety, and reduced intakes of fruits, vegetables and protein-rich foods such as meat and fish (L. Cooke, Carnell, & Wardle, 2006; L. Cooke, Wardle, & Gibson, 2003; L. J. Cooke et al., 2004; Falciglia, Couch, Gribble, Pabst, & Frank, 2000).

4.4. Nutrient intakes

Few studies have investigated the effect of picky eating on nutrient intakes, and not all have included a comparison group of non-picky eaters. Galloway et al. (2005) used three 24-h diet recalls to assess the dietary intakes of 9-year-old US female picky and non-picky eaters. Overall energy intake was adequate in both groups, and there were no differences in protein, fat or carbohydrate intake as a percentage of energy between picky and non-picky eaters. Intakes of vitamin E, calcium and magnesium were below recommended US intakes (Institute of Medicine, 2000) in both groups, but intakes of vitamin E and folate were significantly lower in the picky group than the non-picky group. Similarly, Carruth et al. (1998) found that intakes of calcium, zinc, vitamin D and vitamin E were below US recommended intakes in both picky and non-picky eaters, but that there were no significant differences between the two groups (24–26 months old; 2-day food record plus a 24-h recall on two occasions). In a later study, Carruth et al. (2004) used a single 24-h recall for a younger age group (4–24 months old) of picky eaters also in the USA, although they reported detailed nutrient intakes only for children aged <1 year old. Jacobi et al. (2003), using a 24-h food intake measurement at age 3.5 and 5.5 years and found that female picky eaters had a decreased energy intake at 5.5 years compared with 3.5 years, in contrast to male picky eaters and all non-picky eaters in whom energy intake increased. Dubois, Farmer, Girard, and Peterson (2007) also found a lower energy intake in children who were picky eaters compared with non-picky eaters (6.48 vs 6.80 MJ, respectively); this difference was reflected in lower energy intakes from protein and fat in analyses that were adjusted for sex and other variables (2.5–4.5-year-olds; 24-h recall).

Studies without a comparison group of non-picky eaters have to rely solely on comparison with reference or recommended nutrient intakes (RNI). Country-specific guidelines are not always available. Volger et al. (2013) found that intake of several nutrients were below the Chinese RNI: calcium (63% of RNI), iron (63% of RNI), zinc (52% of RNI), and vitamins A (82% of RNI), C (58% of RNI) and D (37% of RNI). Similarly, Kim et al. (2005) reported that intakes of thiamine, niacin and vitamin E in picky eaters aged 12–24 months were <75% of Korean recommended dietary allowances, whereas vitamin A intakes exceeded the recommendation (120%). A study designed to validate a food frequency questionnaire against a 3-day food record for 29 picky eaters in Hong Kong aged 2–5 years old (Kwok et al., 2013) is more difficult to interpret. Using the data from the reference 3-day food record and comparing them with UK reference nutrient intakes (Department of Health, 1991) intakes of most vitamins and minerals were adequate. Intake of energy also appeared to be adequate (reported mean intake for 2–5-year-olds 4.5 MJ/day, range 3.8–5.3 MJ/day; cf. UK estimated average requirement for 2–5-year-olds 3.9–6.2 MJ/day (Scientific Advisory Committee on Nutrition, 2011). Comparison of nutrient and energy intakes with UK reference data may not be appropriate because of the possible smaller body size of indigenous Hong Kong residents. Similarly, it may not be appropriate to make comparisons of the calcium contents of the diets of children from Hong Kong, where large intakes of dairy-based foods are not usual, with UK reference intakes.

4.5. Dietary fibre

Constipation has been found to be associated bidirectionally with higher food fussiness at age 4 years (Tharner et al., 2014). Dietary fibre intake was not reported in that study, nor in a study finding an association between a clinical history of constipation and picky eating (Chang et al., 2013). In the USA Galloway et al. (2005) found that intake of dietary fibre was significantly lower in 9-year-old female picky eaters than non-picky eaters (11.2 ± 3.3 vs 12.7 ± 3.6 g/day for picky vs non-picky), but intakes in both groups were substantially below the US recommended adequate intake for this age group of 26 g/day (Institute of Medicine, 2005). Intake of dietary fibre has also been found to be inadequate in preschool children who were picky eaters in Hong Kong: Volger et al. (2013) found an intake of 7.3 g/day, while Kwok et al. (2013) reported an intake of 9.1 (range 5.6–11.3) g/day. The mean intakes of the picky eaters were insufficient according to the US guideline (adequate intake 19 g/day for children ages 1–3 years) (Institute of Medicine, 2005) and draft UK guideline (15 g/day for children aged 2–5 years) (Scientific Advisory Committee on Nutrition, 2014). Findings of a reduced intake of whole grain and of vegetables (Cardona Cano et al., 2015; Galloway et al., 2005; Haszard et al., 2014) in picky eaters are also likely to result in a lower fibre intake.

5. Discussion

We have reviewed the literature for picky eating including articles published from 1990 to 2015 with an initial emphasis on the definition of picky eating and the methods that researchers have

used to identify picky eating. The majority of studies on picky eating are cross-sectional, and therefore do not provide any opportunity to study the prevalence of picky eating with time or the development of health-related outcomes, such as growth, in the longer term. The complexity of picky eating is reflected in the heterogeneity of assessment methods and the lack of clarity on a definition of picky eating. It will remain difficult to compare the prevalence of picky eating across studies and identify adverse outcomes until there is agreement on the definition of picky eating and then on a specific method of assessment. The range of assessment tools, and the different characteristics and sizes of the studies, contribute to a wide range of values for the prevalence of picky eating. There are few longitudinal data on the prevalence of picky eating, and those that exist are conflicting. There is little known about whether picky eating is sustained once established, or about its possible relationship with eating disorders later in life.

ALSPAC is a longitudinal population-based study that has covered diet extensively and collected questionnaire data from parents about feeding their children, allowing the identification of children who are picky eaters. The ALSPAC cohort therefore provides an important opportunity to study the longitudinal prevalence of picky eating and its effect on diet, both as nutrients and food groups, as well as the effect of possible differences in dietary intakes on health-related outcomes, which has been lacking in previous studies. Using ALSPAC questionnaires, we have identified picky eating at four ages in childhood, explored the demographics of picky eating in the cohort and assessed the longitudinal prevalence and incident onset for comparison with the studies identified from the literature. ALSPAC used an unambiguous question about child choosiness that is similar to ones used in several recent studies (Goh & Jacob, 2012; Jani Mehta et al., 2014; Mascola et al., 2010; Orun et al., 2012; Wright, Parkinson, Shipton, & Drewett, 2007), although it did not cover the full range of 'picky eating' traits as defined in some other studies (e.g. Jansen et al. (2012); Tharner et al. (2015); Horst (2012)). A strength of this measure is that the question did not invite the parents to define picky eating for themselves.

A wide range of prevalence of picky eating from 6% to 50% was reported in 24 of the 60 studies on picky eating that were identified in our review. The prevalence in ALSPAC varied with age from 10% to 15%, with the peak prevalence at 38 months. We identified only one other study in the UK that has reported on the prevalence of picky eating: Wright et al. (2007) used a study-specific questionnaire item similar to that used in ALSPAC in 455 children (aged 30 months) who were enrolled as part of the Gateshead Millennium Baby Study. They reported that 8% of the parents described their child as being definitely 'faddy' (picky), similar to ALSPAC (Table 1). We identified a further six studies in non-UK countries reporting prevalence that used a similar assessment method. Three of these studied children of a similar age to those in ALSPAC but reported higher prevalences of picky eating (Table 2; 36–50%; USA, Turkey and USA: Carruth et al. (2004); Orun et al. (2012); Reau et al. (1996), respectively). Two reported on older children (up 11 years) and again found higher prevalences than in ALSPAC (Table 2; 34–40%; Singapore and Australia [Indian immigrants]: Goh and Jacob (2012); Jani Mehta et al. (2014), respectively). The reason for these differences between studies is unclear, but it may be related to cultural differences in parental perception of picky eating between countries, perhaps combined with differences in parenting styles and eating/feeding behaviours. Only the final study of the six, in which US children aged 3–11 years were studied longitudinally, reported prevalences similar to that in ALSPAC of 13–22% at any given age (Mascola et al., 2010). With regard to the age at peak prevalence, we were able to identify picky eating at four time points in ALSPAC and showed a clear peak at 38 months old. Similar to this, two studies have reported a peak at about age 3 years (Cardona Cano et al., 2015; Hafstad et al., 2013), although the children were not followed beyond this age in one of these studies (Hafstad et al., 2013). Three further studies have found the prevalence to be stable over time (Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Marchi & Cohen, 1990; Orun et al., 2012). In ALSPAC, we were able to follow the incidence and persistence of picky eating and found that a greater proportion of children who had incident picky eating at the earliest time point (24 months) were still picky eaters at the next time point than if they were incident at a subsequent time point (Table 4). We identified only one other study that has followed incidence and persistence including children up to the age of 11 years: Mascola et al. (2010) found that prevalence increased from about 13% to 21%, whereas incidence declined from 13% to 2%, reaching a plateau at age 6 years. The authors interpreted this widening difference as evidence of the persistence of picky eating in childhood, although early onset cases seemed to recover more quickly, and more than half of the picky eaters recovered in the subsequent 2 years irrespective of age of onset. It would be of value to have further longitudinal data on children who are picky eaters, particularly with regard to factors that are associated with short or long duration of picky eating. This might have clinical applications in identifying children who are more likely to develop long-term picky eating.

We have also reviewed the literature on dietary intakes of picky eaters to evaluate whether any possible impact of picky eating on health-related outcomes is mediated by diet. Although there are a few reports of the effects of picky eating on detailed dietary intake, there are none that include longitudinal data. Studies to date raise the possibility that dietary variety is restricted in picky eaters, particularly with regard to intakes of fruits and vegetables, and that intakes of specific nutrients may be compromised. However, there are several nutrients that do not seem to have been reported on previously that are of importance in childhood nutrition, such as selenium, iodine, sodium and sugars (including free (added) sugars). Preferring drinks to food has been noted as being associated with problem eating, with excessive milk drinking being associated with reduced appetite (Wright et al., 2007). However, the possible role of the substitution of drinks for food in modifying dietary intakes in picky eaters has not been studied.

There is very little known about the health outcomes of picky eating: for example, although it has been noted that picky eaters tend to eat less dietary fibre (Galloway et al., 2005), the prevalence of constipation has been assessed in only one study (Tharner et al., 2015) and other gastrointestinal disturbances have not been studied. Similarly, although it is known that picky eaters eat fewer fruits and vegetables (Galloway et al., 2005), and therefore by inference less antioxidants, the effect on resistance to infections is unknown. The effect of picky eating on growth trajectories during childhood and adolescence is also unknown. Such information is essential in deciding whether it is important to identify picky eaters, particularly persistent picky eaters, at an early stage and whether intervention is warranted. It will be possible to identify these outcomes in the ALSPAC cohort and to study them longitudinally in a substantial number of participants, with an appropriate comparison group.

Once picky eating has been identified in a child, it may be possible to attenuate this behaviour by relatively simple interventions; this may be especially important in those in whom picky eating is persistent. Treatment strategies include not allowing the child to drink too much, especially between meals, not allowing food grazing, providing more frequent but smaller meals, ensuring more mealtime structure, having consistent feeding expectations and presenting small tastes of rejected foods on at least ten separate occasions (McCormick & Markowitz, 2013). However, such

strategies may only address short-term goals and the effectiveness of these strategies has not been fully evaluated. Selection of appropriate treatment strategies may hinge on an understanding of the long-term consequences of picky eating, and these have yet to be fully elucidated.

6. Conclusion

There is little consensus on the definition of picky eating, or on the choice of assessment tools. This has led to a wide variation in reports of the prevalence of picky eating. There are many areas of research that still need to be addressed including health-related outcomes. Furthermore, dietary intakes need to be measured systematically with an appropriate method and compared with intakes in an appropriate comparison group as well as with country-specific reference values. Longitudinal dietary data from the ALSPAC cohort will be used in future studies to investigate these associations.

Conflict of interest

KN and PME have from time to time received research funding and PME has received consultancy funding from Pfizer Nutrition Ltd, Plum Baby and Danone Baby Nutrition (Nutricia Ltd). SMW is an employee of Nestlé Nutrition, which provided funding for the research. The remaining author declares that there are no conflicts of interest.

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