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The psychological impact of diagnostic food challenges to confirm the resolution of peanut or tree nut allergy

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Abstract

Background Twenty percent of children outgrow peanut allergy and 10% outgrow tree nut allergy. Resolution can be confirmed by a food challenge. Little is known about the psychosocial impact of the challenge. We aimed to investigate effects of a food challenge on anxiety, stress and quality of life (QoL) in children and their mothers on the day of a food challenge to peanuts or nuts, and in the months following the challenge.

Methods One hundred and three families participated. Forty children undergoing food challenges to assess resolution of allergy, and their mothers, completed validated questionnaires to measure generic and food specific quality of life, stress and anxiety prior to challenge, on the day of investigation and 3–6 months later. Sixty-three children with no clinical indication to challenge (i.e. in the opinion of the allergist had persistent allergy) acted as comparison group completing questionnaires 3–6 months apart.

Results Mothers reported raised anxiety on the day of challenge ($P = 0.007$), but children were less anxious. The children ($P = 0.01$) and mothers ($P = 0.01$) had improved food-related, but not general, QoL 3–6 months following challenge. Children reported lower anxiety levels following the challenge ($P = 0.02$), but anxiety remained unchanged in mothers. The improvements in maternal and children's QoL and anxiety levels were irrespective of the challenge outcome and despite co-existing food allergies in 50% of children.

Conclusions Mothers experienced increased anxiety on the day of food challenge, unlike the children, perhaps reflecting the differences in their perceived risks. Food challenges are associated with improved food-related QoL in the following months even in those with a positive challenge.

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Introduction

There is no cure or preventative treatment for food allergy, and management is restricted to avoidance of the implicated food via elimination diets, and emergency treatment of symptoms caused by accidental ingestion. Although morbidity is low and mortality exceedingly rare, the anxiety associated with accidentally provoking a potentially fatal allergic reaction has significant implications for the quality of life (QoL) of children and their parents [1].

Resolution of allergy to peanuts and tree nuts occurs in approximately 20% and 10% of children respectively

[2, 3]. If a patient has had no exposures or reactions in the past few years to these foods they should be investigated for evidence that their allergy has resolved, using skin prick tests (SPTs) and specific IgE measurements to guide the need for an oral food challenge (OFC) [4]. Resolution of food allergy should always be confirmed by OFC under medical supervision, before introduction of the food into the child's diet.

A recent report has confirmed that the parents' quality of life measures improved following not only negative, but more surprisingly following positive food challenges [5]. Similarly, parents of egg allergic children showed reduced parental concerns following a

food challenge [6], and state anxiety was significantly lower in parents of children with suspected peanut or hazelnut allergy after challenge, in both studies, regardless of the outcome of the challenge [7].

Our study explores the psychological effects of having a food challenge further by studying both the parent and child with a current diagnosis of peanut or tree nut allergy, using disease specific and generic questionnaires to assess QoL, stress and anxiety on the day of a food challenge and in the time preceding and following the OFC. The main aim of the study was to investigate the affect of OFC on children and their mothers. The decision to investigate mothers rather than fathers was based on our previous observation that mothers of food allergic children are affected more than fathers [8]. The primary hypothesis was that QoL improves for children and their mothers following a negative or positive OFC, relative to pre-challenge scores. We additionally examined the impact of anxiety and stress on the day of OFC and in the months following the procedure.

Methods

This was a case control, multiple measures study comparing QoL and anxiety in children who underwent OFC to peanut or tree nuts with patients who were not challenged. The study was given ethical approval by Portsmouth Local Research Ethics Committee (LREC 07/H0501/175).

Participants

Children and their mothers were recruited from the paediatric allergy clinic at Southampton University Hospitals NHS Trust (SUHT). Inclusion criteria were age 6–16 years with a previous diagnosis of peanut or tree nut allergy made by a paediatric allergist on the basis of history plus a positive SPT and/or specific IgE to peanuts or tree nuts [9]. This was a pragmatic study and decisions to challenge or not challenge a patient were made on clinical grounds. It is our practice to perform SPT in clinic to investigate for evidence of resolution of allergy, on patients who have not had a recent SPT or a clinical reaction within the past year. A reduction in the wheal diameter prompts measurement of specific IgE [4]. Venesection is generally not performed if the SPT wheal is considered large, or if there is a decision not to challenge the child for other reasons. A clinical decision as to whether an OFC is indicated is based on history (e.g. time since last reaction) SPT and specific IgE level. The allergy specialists at SUHT do not use specific cut-off levels for decision making, but are guided by prior experience within our clinic population. oral food challenges were all open challenges. A comparison group of children and mothers was

recruited where the child had persistent significant SPT wheals or specific IgE, which in the experience of the allergist indicated persistent allergy (Non-challenged Group). Participants were excluded, if there were other major chronic illnesses in the family, with the exception of asthma, eczema and hay fever. No family declined a clinically indicated OFC in this study.

Data collection tools

The questionnaires used in this study have previously been described [10]. In brief, children completed the Paediatric Quality of Life Inventory 4.0 (PedsQL™ 4.0), a validated generic QoL questionnaire, to explore physical, emotional, social and school functioning. We started recruiting patients shortly before a validated food-specific QoL tool was published, and the authors therefore used a self-completed non-validated questionnaire developed by Avery *et al.* which has been used in a number of previously published studies [8, 10, 11]. In this study sample, this scale showed a good level of internal consistency with a Cronbach's alpha of 0.77. Child participants also completed the Spence Child Anxiety Scale (SCAS) which is a validated self-report questionnaire used to measure anxiety in children [12], with subscales including social anxiety, separation anxiety, generalized anxiety, obsessions/compulsions and fear of physical injury.

Mothers completed a questionnaire to gather demographic information and details about their child's allergies. They also completed the Food Allergy Quality of Life Parental Burden Questionnaire (FAQL-PB) which is a disease specific questionnaire to assess the parental burden of having a child with food allergy [13], the World Health Organization generic Quality of Life scale (WHOQOL-BREF) which measures QoL for physical, psychological, social relationships and environment domains and the Perceived Stress Scale-14 (PSS-14) [14] was used to measure maternal stress levels. The State-Trait anxiety Inventory (STAI) [15] was used to measure anxiety in the past month (trait) and on the day of testing (state).

In addition, for parents of children who underwent food challenge, a questionnaire was developed to collect information from the mother 3–6 months after the OFC to investigate the impact of the OFC and its outcome. Data was sought on reintroduction of the index food following negative challenge. In an open question, the mother was given the opportunity to highlight perceived advantages and disadvantages of the OFC.

Data Collection

Informed consent and assent was obtained from mothers and children respectively. Participants completed

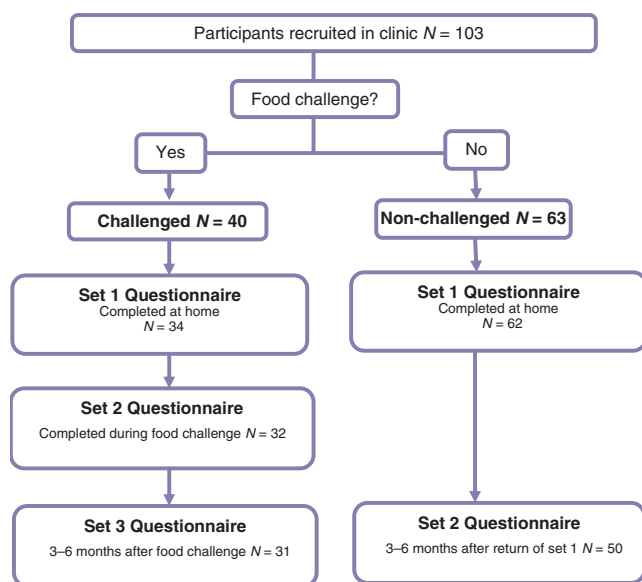


Fig. 1. Participant's pathway.

the first set (baseline) of questionnaires at home following a clinic appointment (Fig. 1). Children completed PedsQL™, the food allergy specific QoL scale by Avery et al. [11] and SCAS. Mothers were permitted to assist younger children in reading questions, but were asked not to influence their response. Mothers completed the PSS, the STAI, the WHOQOL-BREF and the FAQL-PB. The same set of questionnaires were completed by the food challenge group in the clinical setting during the OFC (the non-challenged group did not complete this set). A final set of questionnaires was completed at home 3–6 months following OFC, or in the case of the non-challenged families, 3–6 months following their clinic appointment.

Data analysis

Anonymized data were analysed using SPSS version 17.0 (IBM, NY, USA). Independent and paired *t*-tests were used where appropriate to analyse the differences between the challenged and non-challenged groups and to assess for change following OFC. All tests carried out were two-tailed and significance level was set as $P < 0.05$ with 95% confidence intervals (CI).

Results

Participants

We approached 176 families in clinic and 103 fulfilled the inclusion criteria and provided informed consent. All mother and child pairs completed at least one set of questionnaires (100%), but not all participants completed all questionnaires at each stage (Fig. 1).

The age range of child respondents was 6–16 years, with a mean age of 11.7 years (SD 2.99); 54 were under 13 years. Fifty-six percent of children were male. Forty participants underwent OFC. Seventeen (43%) challenges were positive indicating persistent allergy. 50% of the children who had a negative OFC had persisting allergy to another food. Sixty-three participants showed no evidence of resolution of their allergy on skin test or specific IgE, did not undergo a food challenge and therefore acted as comparisons.

The challenged group were slightly older than the non-challenged group (12.7 vs. 11.0 years; $P < 0.01$). Further comparisons of demographic data and allergic histories between the groups is summarized in Table 1. In the first set of questionnaires, completed at home in the days following the clinic appointment (baseline), the children awaiting food challenge had better food related QoL than the comparison group (Avery QoL score challenge group 46.87 (SD = 8.84), comparison group 50.80 (SD = 8.03); *t*-test $P = 0.040$), but there was no difference in anxiety scores or generic QoL. The mothers of children awaiting food challenge had lower food allergy related parental burden (FAQL-PB challenge group 47.09 (SD = 18.46) comparison group 56.90 (SD = 23.04); *t*-test $P = 0.036$), but similar anxiety, stress and general QoL score to mothers of children in the comparison group. Outcomes of OFC are summarized in Table 1.

Quality of Life, anxiety and stress measures in the child and mother on the day of oral food challenge

Children surprisingly reported lower anxiety on the day of challenge than their baseline anxiety. (SCAS; $P = 0.008$) (Table 2). The reduced anxiety was significant across all subscales (separation anxiety, social phobia and generalized anxiety) apart from fear of physical injury. There was no change in generic or food-related QoL on the day of challenge in comparison with baseline (Table 2). On the day of OFC, mothers had significantly raised state (current) anxiety scores compared with baseline ($P = 0.007$). There was no significant difference in maternal generic or food related QoL, trait-anxiety or stress levels on the day of challenge in comparison with baseline (Table 2).

Medium term effect of food challenge on quality of life, anxiety and stress measures in the child and mother

The children who underwent OFC had an improvement in allergy related QoL (Avery; $P = 0.016$) and anxiety (SCAS; $P = 0.020$), but not general QoL (PedsQL™; $P = 0.777$) in the months following the challenge compared with their baseline scores (Table 3). The allergy related QoL improved even in the patients who had a

Table 1. Demographics and allergic history of the challenged children, and the comparison, non-challenged group

	Challenged Group (<i>n</i> = 40)	Non-challenged Group (<i>n</i> = 63)	<i>P</i> -value
Age mean (SD)	12.7 (2.9)	11.03 (2.9)	0.005
Gender male (%)	25 (63)	30 (48)	0.14
Atopic disease ever (%)			
Asthma	20 (50)	44 (70)	0.13
Eczema	29 (73)	49 (78)	0.74
Hay fever	18 (45)	34 (54)	0.46
Experienced previous community reaction (%)	32 (80)	53 (84)	0.22
Previous history of anaphylaxis (breathing difficulties, wheeze, collapse, cyanosis) (%)	20 (50)	28 (44)	0.69
Previous use of adrenaline for allergic reaction (%)	5 (13)	7 (11)	0.83
Peanut allergy (%)	17 (43)	19 (30)	0.14
Tree nut allergy (%)	8 (20)	8 (13)	
Peanut and tree nut allergy (%)	15 (37)	36 (57)	
Food allergy to foods other than PN or TN (%)	19 (48)	43 (68)	0.43
Most recent SPT mm median (IQR)*	4 (0–5)	9 (8–12)	<0.001
	<i>N</i> = 36	<i>N</i> = 56	
Most recent sIgE*	1 (1–5)	27 (7–82)	0.02
	<i>N</i> = 27	<i>N</i> = 5	
Outcome of OFC	Negative 15 Mild/moderate 12 Severe 3		
Medication to treat OFC	AHist 10 AHist and HC 2 Epi plus others 3		

*For challenged participants, the SPT and sIgE result relates to the index challenge food. For non-challenged participants the largest SPT or sIgE result for peanut or tree nut is presented. Results are only presented if measured in past year.

TN, tree nut; PN, peanut; IQR, interquartile range; AHist, antihistamine; HC, hydrocortisone; Epi, epinephrine.

positive OFC (Avery pre-challenge 48.45 (SD = 9.62), post-challenge 44.63 (SD = 5.40); mean difference 3.818 (SD = 5.437); *t*-test *P* = 0.042) and those children who had ongoing allergies to other foods (Avery pre-challenge 49.00 (SD = 9.723), post-challenge 45.45 (SD = 6.02); mean difference 3.583 (SD = 5.299); *t*-test *P* = 0.039). This was in contrast to the children in the non-challenged group who had no change in their measures of allergy related QoL, general QoL or general anxiety scores as measured soon after their clinic appointment, and 3–6 months later (Table 3). For a health related QoL scale, the minimal clinically important difference (MCID) is the difference in patient function that is perceived as beneficial and would change the patient's management [16]. The MCID (based on standard error of measurement for the scale [17]) for Avery is 3.65, A mean improvement of score of 2.89, 3–6 months following challenge is therefore approaching MCID, and for patients who had a positive OFC is greater than the MCID.

Mothers whose children underwent a food challenge had a reduction in food allergy related parental burden, but anxiety and stress scores did not change significantly following the challenge compared with baseline (Table 3). The improvement in food related parental

burden occurred even if the OFC was positive (FAQL-PB pre-challenge 49.53 (SD = 17.79), post-challenge 43.61 (SD = 15.22); mean difference 5.92 (SD = 8.807) *t*-test *P* = 0.032) or if the child had on-going allergies to other foods (FAQL-PB pre-challenge 53.28 (SD = 15.29) post-challenge 45.78 (SD = 18.234); mean difference 7.500 (SD = 10.46); *t*-test *P* = 0.019). This was in contrast to the mothers of children who did not have a challenge, who reported no improvement in food related QoL or parental burden (Table 3).

Differences for the mother and child following food challenge

Following a negative food challenge, mothers were invited to provide 'free text' feedback about the changes that had occurred in the 3–6 months since the challenge. Thirteen of fourteen children had got introduced to the peanut or tree nut that they had been tested to into their diet, although only four were eating the whole peanut or tree nut, the remainder eating it as an ingredient in food. Most mothers expressed that they felt more relaxed or didn't need to worry (Table 4). One parent commented on the improved experience when shopping, and another when eating

Table 2. Comparison of the mother's and children's anxiety and stress scores on the day of challenge with those at baseline (paired *t*-test). Paired data was available for *n* = 29 mothers and children

	Scales (possible range of scores for scale)	Pre-challenge, mean (SD)	Day of challenge, mean (SD)	Mean paired difference, (95% CI)	<i>P</i> value
Child	(Avery)	47.83 (8.02)	46.29 (7.56)	1.54 (−0.18 to 3.26)	0.077
	Allergy-specific QoL (↓ = ☺) (25–100)				
	(SCAS)	22.64 (15.53)	16.60 (11.36)	6.04 (1.72 to 10.36)	0.008*
	Total anxiety score (↓ = ☺) (0–114)				
Mother	(PedsQL™)	79.50 (10.07)	78.90 (11.19)	0.60 (−1.90 to 3.10)	0.627
	Total generic QoL (↑ = ☺) (0–100)				
	(FAQL-PB)	49.77 (16.41)	48.00 (16.52)	1.76 (−2.15 to 5.69)	0.361
	Allergy-specific QoL (↓ = ☺) (17–119)				
	(STAI)				
	(↓ = ☺)				
	State-anxiety (20–80)	30.96 (7.30)	36.32 (10.61)	−5.36 (−9.11 to −1.61)	0.007**
	Trait-anxiety (20–80)	34.88 (7.79)	34.58 (8.90)	0.30 (−1.14 to 1.75)	0.665
	(PSS)	21.00 (5.36)	19.88 (7.71)	1.12 (−0.63 to 2.86)	0.197
	Maternal Stress (↓ = ☺) (0–56)				
	(WHOQOL-Bref)	71.96 (12.83)	71.794 (13.19)	0.16 (−2.75 to 3.07)	0.911
	Psyc domain QoL (↑ = ☺) (0–100)				

For significant results the effect sizes (Cohen's *d*) were:

*SCAS 0.44;

**State STAI −0.59.

(↓ = ☺) lower score associated with better QoL or less anxiety; (↑ = ☺) higher score associated with better QoL or less anxiety.

out. No parent reported disadvantages following a negative challenge.

Seventeen mothers provided 'free text' information following a positive challenge to explain the advantages and disadvantages they perceived surrounding the OFC. More provided positive comments regarding the OFC than negative ones, despite the fact that it had confirmed that their child had ongoing allergy (Table 4). Most of the positive comments related to feeling more informed about their child's allergy by having the allergen confirmed. One mother felt that it had been beneficial for her child to have experienced the symptoms of an allergic reaction whilst under medical supervision, and another felt that it was reassuring to know that her child had reacted to a large dose. One mother reported that she no longer felt that her child's allergy was 'perverse.' The most common disadvantage that they reported for the challenge was the disappointment that it confirmed ongoing allergy. Only one parent reflected on the challenge itself, saying that the reaction had scared both her and her son. It is notable that this is despite three patients having severe reactions requiring treatment with adrenaline.

Discussion

This is the first study to demonstrate the psychological benefits for peanut and tree nut allergic children and their mothers conferred by a food challenge. Importantly the study demonstrates a spectrum of measurable psychological benefits for patients and their mothers, even if the OFC result was positive.

We recruited children with an existing diagnosis of peanut or tree nut when they attended our specialist allergy clinic for review. This pragmatic study investigated the psychological impact of *clinically indicated* OFCs and we therefore used our normal decision making processes rather than defining criteria for proceeding to OFC as might be done for a clinical trial. At the time that the participants completed their first set of questionnaires, participants would have been informed whether their SPT indicated possible resolution of their allergy, and would have been aware whether they would be likely to have an OFC. This might explain the better food allergy related QoL reported by mothers and children in the group awaiting OFC. The slightly older age of the challenged group might also contribute to

Table 3. Comparison of the quality of life and anxiety scores in children and their mothers before, and 3–6 months following a food challenge (paired *t*-tests). The comparison group did not have a food challenge, but completed questionnaires on two occasions 3–6 months apart

Scales	Challenge group (<i>N</i> = 31)			Non-challenged group (<i>N</i> = 50)		
	'Immediately' post-clinic, pre-challenge, mean (SD)	Post-challenge 3–6 months, mean (SD)	Mean Paired Difference, (95% CI)	<i>P</i> value	'Immediately' post-clinic, Mean (SD)	3–6 months post-clinic, Mean (SD)
Child						
Allergy-specific QoL (↓ = ☹)	47.17 (8.45)	44.28 (5.35)	2.89 (0.62 to 5.16)	0.016*	51.05 (7.4)	50.12 (8.76)
(SCAS)	22.95 (14.01)	17.27 (10.11)	5.68 (1.00 to 10.36)	0.020**	22.00 (13.10)	20.12 (13.33)
Total anxiety score (↓ = ☹)						
(PedsQL™)	77.70 (9.7)	77.71 (10.10)	−0.54 (−4.48 to 3.39)	0.777	78.72 (12.20)	79.60 (11.40)
Total generic QoL (↑ = ☺)						
(FAQL-PB)	47.05 (15.49)	41.18 (15.96)	5.86 (1.57 to 10.15)	0.010***	57.69 (21.38)	55.46 (20.70)
Mother						
Allergy-specific QoL (↓ = ☹)						
(STAI)						
Anxiety score (↓ = ☹)						
State-anxiety	33.80 (8.86)	34.70 (10.40)	−0.87 (−4.10 to 2.36)	0.582	32.57 (10.09)	33.11 (8.93)
Trait-anxiety	36.91 (9.53)	36.91 (9.78)	0.00 (−1.74 to 1.74)	1.000	36.87 (9.95)	36.95 (11.81)
(PSS)	21.77 (6.09)	21.72 (6.60)	0.05 (−1.10 to 1.19)	0.935	20.98 (6.25)	21.69 (7.39)
Maternal Stress (↓ = ☹)						
(WHOQOL-Bref)	69.38 (13.5)	69.03 (15.69)	2.36 (−0.758 to 5.47)	0.131	67.31 (13.20)	68.28 (16.77)
Psych domain QoL (↑ = ☺)						

For significant results in the challenged group, the effect sizes (Cohen's *d*) were:

*Avery 0.41;

**SCAS 0.46;

***FAQL-PB 0.37.

(↓ = ☹) lower score associated with better QoL or less anxiety; (↑ = ☺) higher score associated with better QoL or less anxiety.

Table 4. Mothers were invited to explain what advantages or disadvantages they had perceived following the oral food challenge. The comments provided by mothers following positive or negative food challenges are provided. No mother of a child having a negative food challenge reported any disadvantages to the investigation

Comments about advantages following a negative food challenge:

Psychological benefits of having diagnosis removed:

"Not having to worry about him eating peanuts if he wants to."

"As a parent I feel much more relaxed about what she eats."

"Can relax more that they might come into contact with nuts and will be OK."

"Feel more confident about choices."

"It was great to know that he isn't allergic to almond."

"Some peace of mind as to the extent of my son's allergies."

"Do not have to worry about eating nuts any more."

"To know [son's name] doesn't have an allergy."

"Discussed allergy more openly, feel less anxiety."

Impact on life style:

"With the result she got the ability to lead a normal life. No more questioning chefs at restaurants, being able to choose foods based on look, smell or taste, not contents."

"Makes shopping easier."

Comments about advantages following a positive food challenge:

Greater clarity/information about their child's allergic status:

"Greater certainty about what he is allergic too"

"Confirming the need to avoid peanut and carry EpiPens"

"Being more definite about the need to avoid walnuts and brazil nuts"

"We were able to determine exactly what my daughter was allergic to"

"Confirming allergy to tree nuts"

"Proved exactly what he is allergic to"

"Knowing what she can eat/should avoid."

"Knowing that she is allergic to all nuts"

"He is now allergic only to peanuts so we feel less worried about the risk of anaphylaxis."

"To find out if his allergy is still present, if any changes have occurred."

"Able to now look for specific nuts rather than all nuts."

Other advantages:

"Recognising the effects of allergens in a safe environment."

"Knowing that he is not affected by small amounts of nuts"

"That his allergy is not as 'perverse' as we originally thought."

Comments about disadvantages following a positive food challenge:

Disappointment that the allergy had persisted:

"Disappointment that the child has a negative reaction to the food challenge."

"Another food substance to avoid! Greater sense of need to be careful- more of a burden."

"The disappointment of it still being positive."

"Just the disappointment."

"Knowing that she is allergic to peanuts after thinking that the problem had been resolved."

"The disappointment after believing that she may not be allergic to the nuts."

Other disadvantages:

"Experiencing different results at home to the hospital."

"Scared my poor son and myself on the day!"

"Reinforced the small amount of peanut required to trigger a reaction."

the better baseline QoL and anxiety, as these scores were associated with age in the whole study population and the association has been previously described [1].

On day of the oral food challenge

Mothers had increased anxiety on the day of OFC and those supervising OFCs should be prepared to deal with this increased parental anxiety during the visit. A food challenge is likely to cause anxiety for a number of reasons. Admission to a clinical area and waiting for the result of an investigation in itself may cause anxiety. In addition, the investigation is designed to provoke an allergic reaction, and the parents are informed of the potential for severe reactions. The procedure is likely to retrieve memories of community reactions which, for 50%, were severe. In comparison, the children reported reduced anxiety on the day of challenge, although the fear of physical harm domain remained unchanged relative to baseline. The difference between the mothers and children perhaps reflects their different perception of risk [8, 18.] A qualitative approach would be useful to gain further understanding of this unexpected finding [19].

There has been a suggestion in the literature that a degree of anxiety may be beneficial to improve vigilance and dietary compliance [11]. However, we have previously reported that anxiety did not improve adherence to allergy management plans [10]. As anxiety increases it is likely that any protective effect may disappear. It remains unknown at what level anxiety may become maladaptive for food allergy management, but very high levels of anxiety are associated with clinical disorders, such as generalized anxiety disorder, panic disorder and obsessive compulsive disorder. Exhibition of symptoms diagnostic of these disorders should be referred for therapeutic interventions, such as cognitive behavioural therapy. In contrast to this, an absence of anxiety may lead to a lack of vigilance regarding food allergy management. This is an area that warrants further investigation to ascertain levels of anxiety that would require either physician or therapeutic intervention.

Medium term consequences of the oral food challenge

Both children and their mothers reported improved quality of life pertaining to food allergy following the OFC, independent of the outcome of the challenge, or whether the child had ongoing coexisting food allergies. This reflects the benefits of having the allergic status clarified. This is supported by the qualitative responses that the mothers provided in the optional 'free text' response to what were the main advantages and disadvantages of the food challenge. Those whose child had a positive challenge reported disappointment

at the persistence of their allergic status, but most also commented on the advantage of having greater clarity (Table 4). The positive benefits of a negative challenge were predictable, with most mothers commenting on feeling more relaxed now that they could reintroduce the food to the diet. Only a couple of parents reflected on the lifestyle improvements when shopping or eating out. This might reflect the fact that most children had persisting allergy to other foods and requiring ongoing vigilance. The generic QoL scales and anxiety and perceived stress measurements did not change following the challenge. This highlights the importance of using disease-specific questionnaires (e.g. Avery, FAQL-PB) in food allergy studies, rather than generic questionnaires (PedsQL, WHOQOL-BREF). The impact of IgE-mediated food allergy is different to that of most chronic diseases, with the child having no regular symptoms, but with the constant risk of life-threatening reactions. The food specific questionnaires successfully detected improvements in QoL following OFC, demonstrating their potential for use in intervention studies and clinical practice.

At the start of this study, no food allergy specific quality of life questionnaire was validated in children. We, therefore, used a previously used [8, 10, 11] tool developed by Avery *et al.* Supporting the validity of the 'Avery questionnaire', it demonstrated longitudinal change and consistency in groups as expected. A multinational study has recently developed and validated [20] a questionnaire (Food Allergy QoL- Parent form FAQLQ-PF) to assess parental perception of QoL in children aged 0–12 years with food allergy. FAQLQ-PF will be an important tool for future health related QoL and food-related anxiety studies in allergic children.

Negative food challenges for patients previously diagnosed with food allergy should logically be followed by reintroduction of the food. Eigenmann *et al.* identified that not all patients will reintroduce the food, and studied the possible reasons behind such a decision [21]. In their study, 25% of respondents had not reintroduced the food following a negative food challenge and they suggest that neither the severity of initial reaction, previous anxiety of accidental reaction or prolonged avoidance diet influenced the decision regarding reintroduction of the food. It is our practice to emphasize the necessity of introducing the food as a regular part of the diet following a negative food challenge to avoid resensitization to the food [22]. Only one of our patients had not introduced the food to the diet, and reported that this was because they did not like the taste, smell or texture. They were, however, eating products that were labelled with 'may contain' warnings. A number of our patients had circumvented the problem of disliking the taste by eating nuts as an ingredient, but not in an overt form.

Clinical implications and future directions

This study clearly demonstrates improvements in food related quality of life for children with food allergy and their mothers following a food challenge. In many cases, this was despite a challenge confirming persisting allergy, or the child having ongoing allergies to other foods. This suggests that the intervention of the challenge is in itself beneficial to the family, even if they have ongoing issues surrounding food allergy. The OFC can therefore be considered as both a diagnostic and therapeutic tool. The comments made by mothers 3 months following the challenge indicate that the clarification of an ongoing allergy was beneficial, even if disappointing. Our study also confirms that with firm advice to reintroduce the food into the diet, a high introduction rate can be accomplished. Oral food challenge requires clinical resources and time; this study supports its use in specialist care confirming that OFC not only provides clinical information that influences management, but also imparts psychological benefits.

This study demonstrates the potential use of disease-specific questionnaires as an outcome measure in food allergy intervention studies and standard clinical care. The existence of a number of validated questionnaires (e.g. QoL, anxiety) enables researchers to choose tools pertinent to their study design and population. Future research should include qualitative studies to gain understanding of the elements of the OFC that render it of psychological benefit to children and their parents.

Author contributions

JSAL had the concept for the study and was responsible for the study conduct and governance. JSAL and RCK designed the study. NFI, RP and AJC recruited patients, collected data, input data into SPSS. RMK, LB, DK, MEL, GR and JSAL recruited patients and were responsible for clinical care of participants. GS retrieved and analysed additional data requested by reviewers. JSAL analysed the data and drafted the article. All authors commented on the draft documents.

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Conflict of interest

The authors declare no conflict of interest.

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