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Samantha Rogers, Maria Ramsay, Jackie Blissett

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THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE: RELATIONSHIPS WITH PARENTAL REPORT OF CHILD EATING BEHAVIOURS AND OBSERVED FEEDING INTERACTIONS.

Samantha Rogers[a].
Maria Ramsay[b].
Jackie Blissett[c].

Work conducted whilst Rogers and Blissett were at the School of Psychology, University of Birmingham, Edgbaston, B15 2TT, UK.

[a]Centre for Research in Primary & Community Care, University of Hertfordshire, UK
[b]Department of Psychology, Montreal Children's Hospital and Departments of Psychology and Pediatrics, McGill University, Montreal, Canada.
[c]Department of Psychology, School of Life and Health Sciences, Aston University, Birmingham, UK.

Please direct correspondence to Professor J Blissett: j.blissett1@aston.ac.uk
Tel +44 (0)121 204 3784.
Aston University, Aston Triangle, Birmingham B4 7ET United Kingdom.

SHORT TITLE: **THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE**

ABSTRACT

Feeding problems are common, with implications for nutrition, growth and family stress, placing burden on primary care services. The Montreal Children's Hospital Feeding Scale (MCHFS) is a quick and reliable measure of feeding problems for clinical settings, but there is little examination of its relationship to commonly used research measures of parental feeding practice, child eating behaviour and observations of parent-infant interaction at mealtimes. We examined the relationships between the MCHFS, demographics and early feeding history, weight across the first year, parental report of feeding practices and child eating behaviours, and observations of maternal-infant feeding interaction at 1 year. The MCHFS, Comprehensive Feeding Practices Questionnaire (CFPQ) and Child Eating Behaviour Questionnaire (CEBQ) were completed by 69 mothers when their infants were 1-year-old (37 male, 32 female). Infant weight was measured at 1 week, 1 month, 6 months and 1 year. Mothers were observed feeding their infants at 1 year. The MCHFS was reliable (Cronbach's alpha=.90) and showed significant overlap with other measures of feeding and eating. Potential feeding problems were identified in 10 of the children (14%) reflecting similar rates in other community samples. Higher MCHFS scores were associated with lower birthweight and weight across the first year, greater satiety responsiveness, fussiness and slowness in eating, lower enjoyment of food and food responsiveness, and less observed infant food acceptance. Parents of infants with more feeding problems reported less encouragement of balance and variety in their children's diets. Conclusion: MCHFS showed good criterion validity with other parental report measures of eating and observations of mealtime interactions. MCHFS may be a useful tool for researching feeding problems in community samples.

Keywords: Infant Feeding Behaviour, Feeding and Eating Disorders of Childhood, Surveys & Questionnaires, Parent.

Abbreviations: MCHFS: Montreal Children's Hospital Feeding Scale, UK: United Kingdom.

INTRODUCTION

Feeding problems in children are common (Mascola, Bryson & Agras, 2010), with potential effects on growth and weight gain (Dubois et al., 2007; Wright et al., 2007). Children who are picky eaters, or who show food neophobia (rejection of foods that are new to the child, or foods presented in a novel manner), eat fewer fruits and vegetables (Galloway, Lee & Birch 2003; Galloway et al., 2005; Howard et al., 2012), have lower dietary variety (Carruth et al., 1998) and lower weight percentiles (Carruth et al., 2004). Children with feeding problems show less frequent sucking with shorter sucking bursts in the neonatal period, resulting in less intake (Jacobi et al., 2003; Ramsay & Gisel, 1996) and continue to eat more slowly in toddler years (Reau et al., 1996). In addition to potential impact on physical wellbeing and development, there is a relationship between feeding problems and parental stress and sense of competence (Aviram et al., 2015) emotional wellbeing (Farrow & Blissett, 2006a) and parent-child interactions (Farrow & Blissett, 2006b). At 2 years of age, 50% of parents report their child to be a picky eater (Carruth et al., 2004), and 46% of children are picky eaters at some point between 1.5 and 6 years (Cano et al., 2015). Feeding issues such as fussy/picky eating are relatively stable traits (Mascola, Bryson & Agras, 2010), though a substantial proportion of children show reductions in picky eating by 6 years, with a smaller percentage still demonstrating picky eating at 6 years and beyond (Cano et al., 2015). Researching the causes and correlates of feeding problems is essential if we are to inform interventions and prevention programs that successfully change children's eating behaviour (e.g. Hendrie et al., 2017; Holley, Farrow & Haycraft, 2016).

What constitutes a clinical feeding problem is defined within DSM-V under the chapter feeding and eating disorders and includes pica, rumination disorder, and Avoidant Restrictive Food Intake Disorder (ARFID). Key to such diagnoses is persistent failure to meet nutritional or energy needs and interference with psychosocial functioning. Whilst some children's feeding problems fit diagnosable disorder criteria such as those for ARFID (Bryant-Waugh, 2013; Norris et al., 2014), the broader spectrum of feeding problems that are experienced by infants and their parents ranges widely in type and cause. These include poor appetite (including failure to consume sufficient milk or food which has an impact on infant growth and weight gain) (Dubois et al., 2007; Wright et al., 2007; Tannenbaum et al., 2009), sensory processing (including rejection of foods with bitter tastes, strong flavours or smells or unusual or lumpy textures) (Smith et al., 2005; Werthmann et al., 2015), experience of gastrointestinal illness (Johnson & Harris, 2004), neophobia (Dovey et al., 2008), or poor oral motor or feeding skills (e.g. difficulties with certain food textures) (Ramsay &

Gisel, 1996; Field, Garland & Williams, 2003). There is significant biopsychosocial interaction in feeding problems, with physiological factors potentially triggering problematic mealtime behaviour and difficult feeding interactions with parents (Ramsay et al., 2011).

There are a number of existing measures of feeding disorders for preschool children (Sanchez et al., 2015) but measures are often long, specific to only one type of feeding problem, or require clinician administration. One measure, the Montreal Children's Hospital Feeding Scale (MCHFS) has been developed to be a brief, easily administered parental report measure of feeding problems, covering these types and causes of feeding problems. Items included in the measure are designed to assess the biopsychosocial and interactional nature of feeding problems, thus identifying parental concerns about feeding and growth, child appetite and eating behaviour (potentially indicative of oral motor problems or physiological issues underpinning feeding) as well as evaluating impact on relationship functioning. Generating a single score, it is applicable from 6 months to 6 years and has been used to quantify clinical infant feeding problems and examine the prevalence of feeding problems in a number of cultural settings including Canada (Ramsay et al., 2011), the Netherlands (Van Dijk et al., 2011) and Thailand (Benjasuwantep, Rattanamongkolgul & Ramsay, 2015). It has been used to identify feeding problems in clinical samples (e.g. toddlers who spent 4 days or more in neonatal intensive care; premature infants and toddlers; Hoogewerf et al., 2017; Nieuwenhuis et al, 2016; Van Dijk et al., 2016). However, there has been little examination of its potential for use in a non-clinical research setting. We know little about how the MCHFS relates to other factors that are well-established predictors of feeding problems, including lower birth weight, infant gender, income (Cano et al., 2015), age of introduction to complementary foods (Blissett et al., 2012; Coulthard Harris & Emmett, 2009; Shim, Kim & Mathai, 2011), or breastfeeding history (Galloway, Lee & Birch, 2003; Emond et al., 2007; Farrow & Blissett, 2006b; Maier et al., 2008; Shim, Kim & Mathai, 2011). A further question that has yet to be answered is the overlap between feeding problems measured by the MCHFS and more general eating behaviour traits. It is well established that there are significant individual differences in children's broad eating behaviour traits of food approach and food avoidance that have a significant genetic component (Konttinen et al., 2015; Smith et al., 2017). These traits are widely measured by the Child Eating Behaviour Questionnaire (CEBQ; Wardle et al., 2001). Therefore, we aimed to examine the relationship between the single feeding problem score yielded by the MCHFS and the subscale scores of the CEBQ.

In addition to significant genetic underpinnings, there are also strong environmental determinants of feeding problems or fussy eating, particularly the feeding practices (Harris et al., 2016) that parents use. Much research has established the importance of early feeding behaviour and a high quality

food environment including exposure to a wide range of foods at complementary feeding stage for healthy feeding and eating outcomes (Hetherington et al., 2015; Barends et al. 2013; Coulthard et al., 2010). Practices such as restriction and pressure to eat can have unintended negative consequences for children's eating (Birch, Fisher, & Davison, 2003; Galloway, Fiorito, Francis, & Birch, 2006; Ogden, Cordey, Cutler, & Thomas, 2013) whereas practices such as monitoring of child food intake can have positive outcomes such as reduced non-nutritive food choices (Klesges, Stein, Eck, Isbell, & Klesges, 1991; Musher-Eizenman & Holub, 2007). It is also important to note that several studies have found parental feeding practices to be the result of child characteristics and behaviours, rather than the cause, or have found bidirectional relationships in feeding interactions (Demir et al., 2012; Harris et al., 2016; Hodges et al., 2013). Therefore, it is important to examine the relationship between the MCHFS and parental report of feeding practices early in life, when complementary feeding is becoming established.

Finally, it is also vital to examine observations of parent- child interaction at a mealtime in addition to parental reports of feeding and eating behaviour. One pilot study has evaluated the relationship between the Dutch version of the MCHFS and observations of mealtimes with 29 prematurely born 9-18 month olds (Van Dijk et al., 2016). In this study, MCHFS scores were related to observed food refusal and feeding autonomy but did not relate to parental negative affect or mealtime instructions. Further work is needed to examine relationships with observed feeding interactions in a larger, non-premature sample. Whilst parents are often relatively accurate at describing their feeding practices and their children's eating, it is also the case that there are some sub-groups of parents for whom their self report does not reflect their observed behaviour (Bergmeier et al., 2015; Farrow, Blissett & Haycraft, 2011). Therefore, we examined the relationship between MCHFS scores and observations of parent-infant interaction at mealtimes.

There is significant burden of feeding problems on families and on primary care services given that feeding problems are estimated to affect 14-50% of preschool children and 7-27% of older children (e.g. Benjasuwantep, Chaithirayanon, & Eiamudomkan, 2013; Bernard-Bonnin, 2006; Norris, Spettigue & Katzman, 2016). Furthermore, clinically diagnosable disorders such as ARFID show a point prevalence of 3.2% of 8-12 year olds; Kurz et al., 2015). Given this, as well as the implications for child nutrition, there is a need for a measure that can quickly identify feeding problems that is reliable and valid for use in research and clinical practice. Therefore, this study's aims were to examine the MCHFS's relationships with demographics and early feeding history, infant weight and weight gain, parental report of feeding practices and eating behaviour traits, and observed feeding and eating behaviour at 1 year.

METHODS

Participants and Procedure

The study protocol received full ethical approval from Birmingham East, North, and Solihull Research Ethics Committee, United Kingdom (reference number 10/H1206/67). Research and development approval was granted by Birmingham Women's National Health Service Foundation Trust (reference number 10/BWH/NO95).

Mothers were recruited on the postnatal low-risk wards at Birmingham Women's Hospital. They were visited or contacted at 1 week, 1 month, 3 months, 6 months and 12 months postnatally. Demographics were collected at baseline, infant weight measures were taken at all time points, and at 1 year, questionnaire and observation measures were reported.

After informed consent, as part of a longitudinal study of infant feeding and weight gain, 69 mothers of 1-year-old infants (37 male, 32 female) in the Midlands, UK completed a series of questionnaires during home visits in which they were observed feeding their infant complementary foods during a typical mealtime.

Table 1 shows the demographic characteristics of the sample. Women were mostly White British, well-educated and low levels of dependence on state benefits. Gestational age, birthweight and Apgar scores at 1 minute and 5 minutes indicate healthy birth outcomes. Infants were breastfed for a mean of around 6 months and were introduced to complementary foods at an average of around 4.7 months.

Table 1: Descriptive demographic statistics of the sample

N= 69	**N (%) / Mean (SD)**
Ethnicity N (%)	
White British	39 (56.5)
White Irish/other	8 (11.6)
Asian Pakistani	10 (14.5)
Black Caribbean	4 (5.8)
Asian Indian	3 (4.3)
Mixed	3 (4.3)

Black African	1 (1.4)
Black other	1 (1.4)
Education N (%)	
Left school between 13-16 years	4 (5.8)
Further Secondary education (16-18 years)	10 (14.5)
Secretarial/Technical qualification	9 (13)
University course not completed	5 (7.2)
Professional Qualification but no degree	6 (8.7)
Degree	26 (37.7)
Further degree	9 (13)
Maternal Pre-pregnancy BMI	23.6 (3.2)
Maternal BMI (1 week postnatal)	26.7 (3.7)
Weekly Household Income	
£250 or below	16 (23.2)
£350 or below	10 (14.4)
Above £350	42 (61)
Dependent on state benefits N (%)	9 (13)
Mean birth weight (SD)	3540 (388)
Mean Gestation in weeks (SD)	39.6 (1.0)
Apgar score mean (SD)	
1 minute	8.8 (.8)
5 minutes	9.5 (.5)
Breastfeeding duration (days) Mean (SD)	191 (156)
Age infant introduced to solids (days)	143 (23)
1 year infant weight SDS	.05 (1.2)

Measures:

Demographics and Additional Information

A demographic questionnaire was administered at baseline describing age, pre-pregnancy weight, ethnic background, household income, educational level and infant date of birth and birthweight. At each visit, mothers reported whether infants were being breast or formula-fed, the duration and exclusivity of feeding method and age of introduction of complementary foods. At 1 week, 1 month, 6 months and 12 months, infants were weighed naked with electronic scales. Mothers were also weighed at 1 week postnatally. Demographic and additional variables were collected because of their potential association with infant weight gain (Oken, Levitan & Gillman, 2008; Wijlaars,

Johnson, van Jaarsveld & Wardle, 2011), feeding practices (Taveras et al., 2004; Woo, Dolan, Morrow, Geraghty & Goodman, 2008) and feeding problems (Crapnell et al., 2013).

At 12 months, mothers completed a series of validated questionnaires:

Montreal Children's Hospital Scale (*MCHFS* Ramsay et al., 2011)

The MCHFS is a brief 14 item parental report tool designed to quickly identify feeding problems in children from 6 months to 6 years of age. It has excellent construct validity and test-retest reliability in Canadian samples (Ramsay et al., 2011), has a reliable and valid French translation, and has also been translated and used in the Netherlands (Van Dijk et al., 2011) and Thailand (Benjasuwantep et al. 2015). Parents respond to each item using a 7 point Likert scale with various anchors depending on type of question (e.g. very difficult to easy, not worried to very worried, never hungry to good appetite, most of the time to never, etc.). The full measure can be seen in Ramsay et al., (2011). Items ask about parents' perception and worries about mealtimes and their children's eating and growth, appetite, duration of meals, child's mealtime behaviour, chewing/sucking, gagging/spitting or vomiting, holding of food in the mouth, use of distraction or force to eat, and how feeding influences relationships. Cronbach's alpha for the MCHFS was high (.90). Examination of potential improvement in alpha on the basis of removal of specific items did not identify any items that would improve the measure's reliability for this sample. Therefore, all items were retained within the scale.

Child Eating Behaviour Questionnaire (CEBQ, Wardle et al., 2001).

The CEBQ, a well validated 35 item measure of food approach (enjoyment of food, food responsiveness and desire to drink) and food avoidance (satiety responsiveness, slowness in eating, food fussiness) behaviour, was administered at 1 year. The CEBQ was included to examine the criterion validity of MCHFS. At the time of data collection, the toddler version of the CEBQ was not available. Therefore, the original CEBQ was modified to ensure appropriateness for 12-month-old infants. The emotional over- and under-eating subscales were removed, leaving 23 items. Mothers responded to the statements describing their child's eating behaviour using a five-point rating scale ('never' to 'always'). The edited measure showed good reliability in this sample (See Table 3).

The Feeding Interaction Scale (FIS, Wolke et al., 1987*)*

The FIS is a clinically valid measure, which was used to rate observed mother-infant interactions during a normal mealtime at 12 months. Mothers were asked to feed their infants solid food as they

normally would during a midday or evening meal. The choice of food offered to the infant was determined by the mother. Mothers were not given further instructions. Each mealtime was video recorded by the researcher but the researcher was absent from the room during the mealtime. The researcher observed the recorded mealtime and rated the infant and maternal behaviour on a rating scale (See Table 2). We rated three maternal and two infant subscales of the FIS, selected for their likelihood of reflecting how difficult or stressful mothers found the mealtime, objective measures of infant food acceptance/rejection, and the infant emotional reaction to the mealtime. A sample (17%) of the videos were rated by two observers and intra-class correlations were calculated to examine inter-rater reliability. All correlations were greater than .76, suggesting strong agreement between raters.

Table 2: Feeding Interaction Scale variables, definitions and scoring.

FIS variable	Description of observed behaviour	Scoring
Maternal expressed positive emotion	Verbal statements or physical expressions of positive emotion	1 (none) to 5 (very much)
Maternal expressed negative emotion	Negative verbal statements and non-verbal cues such as tone of voice	1 (very much) to 5 (none)
Maternal sensitivity	Sensitivity relating to: positioning of infant; comments and feedback on infant behaviour, hunger and eating stimulation; cue sensitivity; timing of offered food and termination of mealtime	1 (highly insensitive) to 9 (highly sensitive)
Infant food acceptance/rejection	Degree to which infant accepts or rejects food offered directly by the mother	1 (active rejection and resistance) to 5 (infant accepts food throughout the session, no rejection)
Infant emotional tone	How unhappy the infant is during the mealtime	1 (very unhappy, fussy for most of the session) to 9 (very happy throughout mealtime)

The Comprehensive Feeding Practices Questionnaire (CFPQ, Musher-Eizenman & Holub, 2007*)*
The CFPQ is a widely used reliable and valid 49 item self-report measure of 12 parental feeding practices (Musher-Eizenman & Holub, 2007). Feeding practices measured by this instrument are child control of eating, use of food for emotion regulation, encouragement of balance and variety, quality of food environment, use of food as a reward, modelling, monitoring, pressure to eat, restriction for health, restriction for weight control and teaching about nutrition. The original measure also includes a subscale called 'involvement' which concerns parental involvement of children in activities such as cooking, food choice and shopping, which was not appropriate for this age group. Whilst designed for use with children from 2 years, the CFPQ has been previously used with toddlers from 1.5 years (Rodgers et al., 2013). Parents reported the frequency of their use of each feeding practice using a 5-point Likert scale from 1 (Never/Disagree) to 5 (Always/Agree). Subscales of use of food for emotion regulation, use of food as reward, modelling, monitoring, restriction for weight control and teaching about nutrition showed good to acceptable reliability in this sample. The remaining subscales had questionable reliability (alpha between .5 and .6). One subscale (restriction for health) had unacceptable reliability in this sample.

Data Analysis:

Means, standard deviations and frequency data were calculated and the scale reliabilities were established using Cronbach's alpha. The percentage of children who scored above the recommended cut-off for clinical feeding problems (score of 45 or above) was calculated. Gender differences in MCHFS scores were examined using independent sample t-tests. Pearson's two-tailed correlation coefficients with bootstrap (1000 samples) 95% confidence intervals were calculated between MCHFS scores and demographics and other background information. Two-tailed Pearson's correlation coefficients with bootstrap 95% confidence intervals were then calculated between MCHFS scores, CEBQ scale scores, FIS scale scores, and CFPQ scores. All correlation calculations were carried out with pairwise deletion for missing data to preserve power. We also used independent samples t-tests to examine potential differences in demographics and additional variables, CEBQ, CFPQ and FIS scores, between children who were scored above and below a 'cut off' score of 45 on the MCHFS, indicating potentially significant feeding problems. Alpha was set at $p<.05$. Post hoc power analyses demonstrated that the study had power of .71 to detect effect sizes of .3; power of .93 to detect effect sizes of .4, and power of .99 to detect effect sizes at .5 or more.

RESULTS

Descriptive Statistics.

Table 3: Minimum, Maximum, Mean and SD of MCHFS, CEBQ, CFPQ and FIS at 1 year.

	Minimum	Maximum	Mean	Standard Deviation	Cronbach's alpha
MCHFS Score	14	66	29.8	13.1	.90
CEBQ Satiety Responsiveness	1.0	4.8	2.6	.7	.74
CEBQ Enjoyment of food	2.0	5.0	4.3	.7	.83
CEBQ Food Responsiveness	1.0	5.0	2.5	1.0	.85
CEBQ Slowness to eat	1.0	4.8	2.5	.8	.74
CEBQ Fussiness	1.0	4.4	2.2	.7	.84
CEBQ Desire to drink	1.0	5.0	2.4	1.1	.88
FIS Maternal Frequency of Positive Expressed Emotion	1.0	3.7	2.5	.7	N/A
FIS Maternal Frequency of Negative Expressed Emotion	3.5	5.0	4.9	.3	N/A
FIS Maternal Sensitivity rating	4.0	7.1	6.1	.7	N/A
FIS Infant food acceptance/rejection	2.0	5.0	3.7	.8	N/A
FIS Infant emotional tone	3.5	7.5	5.8	.8	N/A
CFPQ child control	1.0	4.4	2.3	.7	.50
CFPQ emotion regulation	1.0	3.3	1.8	.6	.70
CFPQ encourage balance and variety	2.8	5.0	4.6	.5	.53
CFPQ food environment	2.0	5.0	4.1	.7	.52
CFPQ food as reward	1.0	5.0	2.1	1.0	.75
CFPQ modelling	1.5	5.0	4.0	1.0	.84
CFPQ monitoring	1.0	5.0	4.3	.8	.86
CFPQ pressure	1.0	4.5	2.7	.8	.59
CFPQ restriction for health	1.0	5.0	3.1	.8	.47
CFPQ restriction for weight control	1.1	3.6	2.2	.6	.70
CFPQ teaching about nutrition	1.0	5.0	3.5	1.1	.67

Table 3 demonstrates that this sample's MCHFS scores reflect Canadian community sample scores (Ramsay et al., 2011). The range of MCHFS and CEBQ scores demonstrates that there are children at the extremes of food approach and avoidance behaviour in the sample. Mealtimes were observed to have some positive maternal expressed emotion, little negative expressed emotion, moderately high maternal sensitivity, moderately high infant food acceptance, and moderately positive infant emotional tone. CFPQ scores reflect that parents reported a wide range of use of feeding practices, with mean scores suggesting high levels of encouraging balance and variety, healthy food environment, parental modelling and monitoring of children's food intake, along with low levels of use of food for emotion regulation and pressure to eat.

Gender differences:

There were no significant gender differences in MCHFS (male mean 32.3, SD 15.4, vs. female mean 26.9, SD 9.2, t=1.75, p=.085).

Correlations of MCHFS with demographics:

Table 4. Pearson's correlation coefficients (r) with bootstrapped 95% confidence intervals between MCHFS scores and demographic and descriptive variables.

	MCHFS		
	r	p	95% CI
Weeks Gestation	-.17	.16	[-.36, .01]
Birthweight SDS	-.41	<.001	[-.60, -.18]
Infant Weight SDS at 1 week	-.47	<.001	[-.60, -.17]
Infant Weight SDS at 1 month	-.46	<.001	[-.63, -.27]
Infant Weight SDS at 6 months	-.34	.004	[-.61, -.24]
Infant Weight SDS at 1 year	-.34	.004	[-.51, -.14]
Infant Growth (Weight change SDS from 1 month to 12 months)	-.023	.43	[-.27, .21]
Apgar score at 1 minute	-.06	.65	[-.23, .15]
Apgar score	-.05	.66	[-.27, .18]

at 5 minutes			
Breastfeeding duration	.04	.73	[-.22, .35]
Age infant introduced to complementary foods	.24	.05	[-.01, .43]
Maternal age	.06	.63	[-.17, .27]
Maternal Pre-pregnancy BMI	-.06	.63	[-.30, .20]
Maternal BMI (1 week postnatal)	.04	.76	[-.19, .26]
Household Income	.04	.74	[-.20, .26]
Maternal education	-.02	.85	[-.26, .23]

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Table 4 shows that MCHFS scores were not related to gestation, Apgar scores, maternal age, maternal BMI, income or education. Higher MCHFS score was related to lower birthweight, and lower infant weight throughout the first year, but it was not associated with slower or poorer growth per se (i.e. indicated by a smaller change in weight SDS score across the first year). Higher MCHFS score was also significantly correlated with later introduction to complementary foods, but the confidence interval ranged from -.01 to .43, suggesting that this relationship is unlikely to be reliable.

Correlations of MCHFS with CEBQ, CFPQ and FIS:

Table 5: 2-tailed Pearson Correlation coefficients and bootstrapped 95% confidence intervals for relationships between MCHFS, the CEBQ & FIS.

	MCHFS		
	r	p	95% CI
CEBQ Satiety Responsiveness	.67	<.001	[.50, .78]
CEBQ Enjoyment of food	-.65	<.001	[-.79, -.48]
CEBQ Food Responsiveness	-.44	<.001	[-.61, -.25]
CEBQ Slowness to eat	.48	<.001	[.30, .64]
CEBQ Fussiness	.56	<.001	[.38, .70]
CEBQ Desire to drink	.04	.73	[-.20, .28]
FIS Maternal Frequency of Positive Expressed Emotion	.10	.48	[-.14, .32]
FIS Maternal Frequency of Negative Expressed Emotion	-.26	.05	[-.58, .16]
FIS Maternal Sensitivity rating	.04	.76	[-.24, .26]
FIS Infant food acceptance/rejection	-.34	.02	[-.63, -.03]
Infant emotional tone	-.25	.07	[-.48, -.01]
CFPQ child control	.28	.02	[-.01, .54]
CFPQ emotion regulation	.27	.03	[-.01, .15]
CFPQ encourage balance and variety	-.32	<.01	[-.58, -.08]
CFPQ food environment	-.17	.18	[-.39, .07]
CFPQ food as reward	.26	.04	[-.03, .49]
CFPQ modelling	-.04	.75	[-.35, .22]
CFPQ monitoring	-.18	.15	[-.39. .02]
CFPQ pressure	.23	.06	[-.09, .52]

CFPQ restriction for health	-.09	.49	[-.37, .20]
CFPQ restriction for weight control	.-.04	.75	[-.24, .17]
CFPQ teaching about nutrition	-.02	.88	[-.32, .24]

CEBQ

There were significant correlations between MCHFS scores and maternal reports of children's food approach and avoidance behaviour at 1 year (Table 5). MCHFS was significantly correlated in the expected direction with all CEBQ measures except desire to drink.

FIS

MCHFS was positively correlated with more observed negative maternal expressed emotion during the mealtime, but the 95% confidence interval for this relationship was wide and passed through zero. Higher MCHFS score was associated with lower observed infant food acceptance at a mealtime. There were no significant relationships between number of reported feeding problems and maternal expression of positive emotion, maternal sensitivity or infant emotional tone.

CFPQ

MCHFS was significantly negatively correlated with parental report of encouragement of balance and variety. MCHFS score was significantly correlated with parental reports of more child control of mealtimes, greater use of food for emotion regulation and greater use of food as a reward but for all of these correlations, 95% confidence intervals were wide, passing through zero. There was no significant correlation between number of feeding problems reported by parents and their report of healthy food environment, use of modelling, monitoring, pressure, restriction or teaching about nutrition.

Comparison of children above and below MCHFS 'cut off'

Ten out of 69 participants (14.5%) reached an MCHFS score of 45 or above, indicating potentially clinically significant feeding problems. Supplementary Table 1 presents the differences in variables between those children above and below this cut off point. Children who scored above 45 on the MCHFS had significantly lower birth weight, were relatively lighter at 1 week, 1 month and 12 months, were rated by their mothers as more in control of mealtimes, had higher ratings of satiety responsiveness, slowness in eating and food fussiness, as well as lower ratings of enjoyment of food and food responsiveness. They were also observed to have lower levels of food acceptance and higher rejection as well as lower emotional tone during the observed feeding interaction.

DISCUSSION

This study aimed to examine the MCHFS's relationships with demographics and early feeding history, parental report of feeding practices and eating behaviour traits, and observed feeding and eating behaviour at 1 year. Good reliability of the MCHFS at 1 year was demonstrated in this UK community sample. MCHFS scores were related to birth-weight and infant weight across the first year of life. Good criterion validity of the MCHFS was demonstrated, with higher MCHFS scores being associated with lower food approach and higher food avoidance, as well as observed infant mealtime behaviour. Overall, the findings suggest that the MCHFS measure is a useful research tool for brief quantification of the scale of children's feeding problems, which demonstrates relationships with other parental report and observational measures of children's eating.

The range of scores yielded by the MCHFS in this non-clinical community sample demonstrates its capacity to be sensitive to the wide range of feeding problems experienced by families. Primary care practitioners can be guided by mean scores to make inferences about the severity of the feeding problems reported by parents and the necessity for further clinical investigation. In Thai samples, a score of 40 yielded acceptable sensitivity and specificity in identification of children with clinical feeding problems (Benjasuwantep et al., 2015). In a Canadian sample, the clinical cut off of 45 (mean +1SD of non-clinical sample) yielded excellent sensitivity and specificity in identification of 6 month to 6 year old children with and without clinical feeding problems (Ramsay et al., 2011). In this sample, 14% of parents reported problems on the MCHFS that reached this cut off. This also suggests that the MCHFS would be a useful research tool for identifying groups of children at particular risk of clinically significant feeding problems.

Infants who had lower birthweight and lower weight at throughout the first year were more likely to have feeding problems at 1 year, despite the fact that this sample did not include low birth weight or premature infants. Notably, MCHFS scores were not associated with poorer growth per se: those infants with lower SDS weight gain scores across the first year were not more likely to have more feeding problems. Rather, babies born lighter, and who were therefore lighter through the first year, had higher MCHFS scores. Furthermore, whilst infants with high MCHFS scores at 1 year had been introduced to complementary foods slightly later than infants with fewer feeding problems, the confidence interval for this analysis suggested that it was not likely to be an important and consistent correlate of MCHFS score. Because of other work which has suggested that later introduction of complementary food (over 7 months of age) is associated with poorer feeding outcomes (Northstone, Emmett & Nethersole, 2001; Oliveira et al., 2015), further work is necessary on the likely reciprocal relationship between the timing of introduction to solid food and feeding problems.

Feeding problems measured by the MCHFS were associated with other parental report measures of child food approach (food responsiveness and enjoyment of food) and avoidance behaviours (satiety responsiveness, slowness in eating, fussiness) suggesting good criterion validity. Whilst the CEBQ is conceptualized as a measure of eating behaviour traits and the MCHFS is designed to be a measure that identifies feeding problems, it is clear that there is significant overlap between these measures. The magnitudes of the correlation coefficients between these measures were relatively high (between -.44 to .67), confirming that lower food approach behaviour and higher food avoidance traits both confer risk for feeding problems. However, these two measures are not measuring exactly the same construct: the MCHFS captures other aspects of feeding problems not summarized by the CEBQ (e.g. influence of feeding problems on family relationships, oral motor aspects of feeding problems, etc.).

This study also demonstrated that feeding problems measured by the MCHFS showed some significant relationship with observed infant behaviour at a mealtime at one year. In particular, infants who were rated as having more feeding problems were observed to show greater food rejection at the mealtime. Interestingly, there were no significant relationships between parental report of feeding problems and observations of maternal emotional expression or sensitivity in mealtime interactions. This reflects a similar pattern of relationships between the MCHFS and observations of infant but not parent behaviour in a previous pilot study (Van Dijk et al., 2016). These observational findings are important because it suggests that the MCHFS retains objectivity and is not simply a measure of parental anxiety about infant feeding. Using the MCHFS, parents are reliable reporters of their children's feeding problems; their responses reflect independent observations of infant's food acceptance at mealtimes. However, it must be noted that many of the FIS items had a relatively restricted range of responses (reflecting fairly emotionally neutral, relatively sensitive maternal-infant interactions). Therefore, there may be different patterns of association between MCHFS scores and mealtime behaviour in clinical samples.

Similarly, there were few significant relationships between reports of feeding problems and feeding practice. The only relationship that is likely to be important, given that the other relationships had wide confidence intervals, is that parents who reported more feeding problems also reported lower encouragement of dietary balance and variety. Even so, the reliability of this subscale was questionable, casting some uncertainty over this relationship, too. Furthermore, it is not possible to determine from these data whether feeding problems result in less parental effort to encourage variety (for example, because of persistent rejection of new foods, or fruits and vegetables, by fussy

eaters, parents begin to offer a more narrow range of foods) or whether less encouragement of balance and variety in the diet contributes to the development of feeding problems, but there is potential for both of these mechanisms to be at work. This is a potentially fruitful area upon which to focus research examining feeding problem intervention development.

Comparison of infants who were scored above the proposed MCHFS cut off score of 45 to those scoring below the cut off reflected the findings from correlational analyses. In addition, infants who scored above the cut off were also reported by their parents to have more control over mealtimes than children under the cut off, and these infants were also observed to have lower emotional tone (i.e. more negative affect) during the observed mealtime. Using the MCHFS cut off of 45 will therefore identify those children who have significantly poorer appetite, are more fussy, picky or selective in eating behaviour, who enjoy and accept food less, and have significantly more negative emotion expressed at mealtimes than children below this cut off, and whom, if in a clinical setting, may warrant further investigation or support. Nevertheless, for research purposes it may not be necessary or desirable to use the measure to identify presence or absence of feeding problems in a dichotomous manner. Rather, given the significant relationships between MCHFS scores, observed feeding and other measures of eating behaviour, the data support the idea that the score generated by the MCHFS can also be used as an ordinal scale of the severity of feeding problems.

There are a number of limitations to this study. The sample was affluent and well educated, and relatively homogenous in ethnicity, with healthy birth outcomes, relatively long durations of breastfeeding and timely introduction to solid food. Therefore, further work should examine whether there is social and demographic variation in MCHFS scores in broader samples. Nevertheless, within our sample we did not observe any links between MCHFS and demographic variables or gestation, Apgar scores, maternal age, or maternal BMI, suggesting independence of MCHFS scores from these covariates of infant feeding. Whilst we observed a wide range of scores, we did not include clinically diagnosed children in the study, and therefore could not examine the MCHFS's ability to differentiate between children with and without clinically diagnosed feeding problems. Similarly, this study demonstrates reliability of the MCHFS for use with typically developing children without other risk factors for feeding problems (e.g. significant prematurity, autistic spectrum disorders, disorders affecting oral motor function, etc.). Effect sizes in this study ranged from small to large. The study was adequately powered to detect large effects but there was insufficient power within this study to detect less important, medium to small effects. Nevertheless, multiple relationships between the MCHFS and the variables of interest in this study were detected suggesting that the study was adequately powered for its purpose. However there were a number of

relationships that failed to reach significance or had wide confidence intervals, suggesting that larger sample sizes may be advantageous in further work of this kind.

Conclusion: The MCHFS is a brief, reliable parental report measure of infant feeding problems which shows significant relationships with observations of infant food acceptance and rejection. Infants with lower birthweight, lower weight throughout the first year of life, and whose parents report lower promotion of balanced and varied diet, are more likely to have feeding problems. Whilst further work with clinical samples is required, the MCHFS may be a useful tool for identifying feeding problems.

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Contributors' statements:

Dr Samantha Rogers jointly conceptualized and designed the study, collected all study data, assisted with interpretation of data, critically reviewed and revised the draft article, and approved the final article as submitted.

Dr Maria Ramsay assisted with interpretation of data and critically reviewed and revised the draft article and approved the final article as submitted.

Prof. Jackie Blissett conceptualized and designed the study, supervised data collection, analysed and interpreted the data, drafted the initial article and carried out article revisions, and approved the final article as submitted.

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Supplementary Table 1

Independent samples t-tests comparing demographics, weight, CFPQ, CEBQ and FIS scores for infants scoring above or below the MCHFS cut off of 45 (n MCHFS identified feeding problems = 10, n below cut off = 59).

	MCHFS Feeding problems at 1 year	Mean	SD	T
Weeks gestation at birth	No	39.6	1.1	.68
	Yes	39.4	.97	
Birth weight SDS	No	.43	.71	3.90***
	Yes	-.52	.72	
Maternal age (years)	No	30.0	5.8	-.16
	Yes	30.3	6.1	
1-week maternal BMI	No	26.6	3.7	-1.17
	Yes	28.1	3.7	
Apgar score at 1 minute	No	8.7	.9	-.57
	Yes	8.9	.3	
Apgar score at 5 minutes	No	9.5	.5	.09
	Yes	9.5	.5	
1 week infant weight SDS	No	-.28	.75	-3.67***
	Yes	-1.21	.71	
1 month infant weight SDS	No	.22	.76	
	Yes	-.60	.88	-3.07**
6 months infant weight SDS	No	.28	1.13	

	Yes	-.46	.93	-1.95
12 month infant weight SDS	No	.17	1.18	2.07*
	Yes	-.64	.87	
Infant growth (1 month to 1 year weight SDS change)	No	-.05	1.01	.03
	Yes	-.46	.93	
Age infant introduced to solid food (days)	No	141	23	1.57
	Yes	153	23	
Breastfeeding duration (days)	No	188	155	.31
	Yes	204	166	
Twelve Month CFPQ child control	No	11.2	3.1	-2.04*
	Yes	13.4	3.7	
Twelve Month CFPQ emotion regulation	No	5.2	1.8	-2.06
	Yes	6.5	2.3	
Twelve Month CFPQ encourage balance and variety	No	18.6	1.8	2.00
	Yes	16.7	2.9	
Twelve Month CFPQ environment	No	16.6	2.7	1.46
	Yes	15.3	2.3	
Twelve Month CFPQ food as reward	No	6.2	3.2	-.52
	Yes	6.8	2.9	
Twelve Month CFPQ modelling	No	16.3	3.9	.48
	Yes	15.6	4.7	
Twelve Month CFPQ monitoring	No	17.4	3.1	1.03
	Yes	16.3	3.1	
Twelve Month CFPQ pressure	No	10.7	3.2	-.69
	Yes	11.5	3.8	
Twelve Month CFPQ restriction for health	No	12.4	3.1	.94
	Yes	11.4	3.3	
Twelve Month CFPQ restriction for weight control	No	17.6	5.3	.90
	Yes	16.1	3.2	
Twelve Month CFPQ teaching about nutrition	No	10.8	3.1	1.37
	Yes	9.3	3.7	
Twelve month CEBQ satiety responsiveness	No	2.5	.6	-3.88***
	Yes	3.4	.8	
Twelve month CEBQ enjoyment of food	No	4.4	.6	4.17***
	Yes	3.5	.7	
Twelve month CEBQ food responsiveness	No	2.6	1.1	2.27*
	Yes	1.8	.7	
Twelve month CEBQ slowness in eating	No	2.4	.7	-2.53*
	Yes	3.0	.64	
Twelve month CEBQ food	No	2.1	.7	-2.96**

fussiness	Yes	2.8	.7	
Twelve month CEBQ desire to drink	No	2.4	1.1	.02
	Yes	2.4	1.2	
Twelve Month FIS: Maternal amount/ frequency of expressed positive emotion	No	2.5	.7	-.58
	Yes	2.7	.6	
Twelve Month FIS Food Intake: Maternal amount/frequency of negative emotion	No	4.9	.2	1.10
	Yes	4.7	.5	
Twelve Month FIS Food Intake: Maternal sensitivity	No	6.1	.7	-.33
	Yes	6.2	.6	
Twelve Month FIS Food Intake: Infant acceptance/ rejection of maternal food offerings	No	3.8	.7	3.33**
	Yes	2.9	.7	
Twelve Month FIS Food Intake: Infant Emotional Tone	No	5.9	.8	2.38*
	Yes	5.2	.7	

*p<.05 **p<.01, ***p<.001