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The Montreal Children's Hospital Feeding Scale: Relationships with parental report of child eating behaviours and observed feeding interactions

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3 **THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE: RELATIONSHIPS**
4 **WITH PARENTAL REPORT OF CHILD EATING BEHAVIOURS AND OBSERVED**
5 **FEEDING INTERACTIONS.**
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29 **SHORT TITLE: THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE**
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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 &

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

102

103 There are a number of existing measures of feeding disorders for preschool children (Sanchez et al.,
104 2015) but measures are often long, specific to only one type of feeding problem, or require clinician
105 administration. One measure, the Montreal Children's Hospital Feeding Scale (MCHFS) has been
106 developed to be a brief, easily administered parental report measure of feeding problems, covering
107 these types and causes of feeding problems. Items included in the measure are designed to assess
108 the biopsychosocial and interactional nature of feeding problems, thus identifying parental concerns
109 about feeding and growth, child appetite and eating behaviour (potentially indicative of oral motor
110 problems or physiological issues underpinning feeding) as well as evaluating impact on relationship
111 functioning. Generating a single score, it is applicable from 6 months to 6 years and has been used
112 to quantify clinical infant feeding problems and examine the prevalence of feeding problems in a
113 number of cultural settings including Canada (Ramsay et al., 2011), the Netherlands (Van Dijk et
114 al., 2011) and Thailand (Benjasuwantep, Rattanamongkolgul & Ramsay, 2015). It has been used to
115 identify feeding problems in clinical samples (e.g. toddlers who spent 4 days or more in neonatal
116 intensive care; premature infants and toddlers; Hoogewerf et al., 2017; Nieuwenhuis et al, 2016;
117 Van Dijk et al., 2016). However, there has been little examination of its potential for use in a non-
118 clinical research setting. We know little about how the MCHFS relates to other factors that are well-
119 established predictors of feeding problems, including lower birth weight, infant gender, income
120 (Cano et al., 2015), age of introduction to complementary foods (Blissett et al., 2012; Coulthard
121 Harris & Emmett, 2009; Shim, Kim & Mathai, 2011), or breastfeeding history (Galloway, Lee &
122 Birch, 2003; Emond et al., 2007; Farrow & Blissett, 2006b; Maier et al., 2008; Shim, Kim &
123 Mathai, 2011). A further question that has yet to be answered is the overlap between feeding
124 problems measured by the MCHFS and more general eating behaviour traits. It is well established
125 that there are significant individual differences in children's broad eating behaviour traits of food
126 approach and food avoidance that have a significant genetic component (Kontinen et al., 2015;
127 Smith et al., 2017). These traits are widely measured by the Child Eating Behaviour Questionnaire
128 (CEBQ; Wardle et al., 2001). Therefore, we aimed to examine the relationship between the single
129 feeding problem score yielded by the MCHFS and the subscale scores of the CEBQ.

130

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

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

146
147 Finally, it is also vital to examine observations of parent- child interaction at a mealtime in addition
148 to parental reports of feeding and eating behaviour. One pilot study has evaluated the relationship
149 between the Dutch version of the MCHFS and observations of mealtimes with 29 prematurely born
150 9-18 month olds (Van Dijk et al., 2016). In this study, MCHFS scores were related to observed food
151 refusal and feeding autonomy but did not relate to parental negative affect or mealtime instructions.
152 Further work is needed to examine relationships with observed feeding interactions in a larger, non-
153 premature sample. Whilst parents are often relatively accurate at describing their feeding practices
154 and their children's eating, it is also the case that there are some sub-groups of parents for whom
155 their self report does not reflect their observed behaviour (Bergmeier et al., 2015; Farrow, Blissett
156 & Haycraft, 2011). Therefore, we examined the relationship between MCHFS scores and
157 observations of parent-infant interaction at mealtimes.

158
159 There is significant burden of feeding problems on families and on primary care services given that
160 feeding problems are estimated to affect 14-50% of preschool children and 7-27% of older children
161 (e.g. Benjasuwantep, Chaithirayanon, & Eiamudomkan, 2013; Bernard-Bonnin, 2006; Norris,
162 Spettigue & Katzman, 2016). Furthermore, clinically diagnosable disorders such as ARFID show a
163 point prevalence of 3.2% of 8-12 year olds; Kurz et al., 2015). Given this, as well as the
164 implications for child nutrition, there is a need for a measure that can quickly identify feeding
165 problems that is reliable and valid for use in research and clinical practice. Therefore, this study's
166 aims were to examine the MCHFS's relationships with demographics and early feeding history,
167 infant weight and weight gain, parental report of feeding practices and eating behaviour traits, and
168 observed feeding and eating behaviour at 1 year.

169

170

METHODS

171 Participants and Procedure

172

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

177

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

182

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

187

188 Table 1 shows the demographic characteristics of the sample. Women were mostly White British,
189 well-educated and low levels of dependence on state benefits. Gestational age, birthweight and
190 Apgar scores at 1 minute and 5 minutes indicate healthy birth outcomes. Infants were breastfed for
191 a mean of around 6 months and were introduced to complementary foods at an average of around
192 4.7 months.

193

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)

194

195 Measures:

196 *Demographics and Additional Information*

197 A demographic questionnaire was administered at baseline describing age, pre-pregnancy weight,
198 ethnic background, household income, educational level and infant date of birth and birthweight.

199 At each visit, mothers reported whether infants were being breast or formula-fed, the duration and
200 exclusivity of feeding method and age of introduction of complementary foods. At 1 week, 1
201 month, 6 months and 12 months, infants were weighed naked with electronic scales. Mothers were
202 also weighed at 1 week postnatally. Demographic and additional variables were collected because
203 of their potential association with infant weight gain (Oken, Levitan & Gillman, 2008; Wijlaars,

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

206
207 At 12 months, mothers completed a series of validated questionnaires:

208
209 *Montreal Children's Hospital Scale (MCHFS* Ramsay et al., 2011)

210 The MCHFS is a brief 14 item parental report tool designed to quickly identify feeding problems in
211 children from 6 months to 6 years of age. It has excellent construct validity and test-retest reliability
212 in Canadian samples (Ramsay et al., 2011), has a reliable and valid French translation, and has also
213 been translated and used in the Netherlands (Van Dijk et al., 2011) and Thailand (Benjasuwantep et
214 al. 2015). Parents respond to each item using a 7 point Likert scale with various anchors depending
215 on type of question (e.g. very difficult to easy, not worried to very worried, never hungry to good
216 appetite, most of the time to never, etc.). The full measure can be seen in Ramsay et al., (2011).

217 Items ask about parents' perception and worries about mealtimes and their children's eating and
218 growth, appetite, duration of meals, child's mealtime behaviour, chewing/sucking, gagging/spitting
219 or vomiting, holding of food in the mouth, use of distraction or force to eat, and how feeding
220 influences relationships. Cronbach's alpha for the MCHFS was high (.90). Examination of potential
221 improvement in alpha on the basis of removal of specific items did not identify any items that
222 would improve the measure's reliability for this sample. Therefore, all items were retained within
223 the scale.

224
225 *Child Eating Behaviour Questionnaire (CEBQ,* Wardle et al., 2001).

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

235
236 *The Feeding Interaction Scale (FIS,* Wolke et al., 1987)

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

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

249

250

251 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)

252

253

254 *The Comprehensive Feeding Practices Questionnaire (CFPQ, Musher-Eizenman & Holub, 2007)*

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

269

270 Data Analysis:

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

286

287

288

289 *Descriptive Statistics.*

290 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

291

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

301

302 *Gender differences:*

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

305

306 *Correlations of MCHFS with demographics:*

307

308 Table 4. Pearson's correlation coefficients (r) with bootstrapped 95% confidence intervals between
 309 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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312 Table 4 shows that MCHFS scores were not related to gestation, Apgar scores, maternal age,
 313 maternal BMI, income or education. Higher MCHFS score was related to lower birthweight, and
 314 lower infant weight throughout the first year, but it was not associated with slower or poorer growth
 315 per se (i.e. indicated by a smaller change in weight SDS score across the first year). Higher MCHFS
 316 score was also significantly correlated with later introduction to complementary foods, but the
 317 confidence interval ranged from -.01 to .43, suggesting that this relationship is unlikely to be
 318 reliable.

319

320 *Correlations of MCHFS with CEBQ, CFPQ and FIS:*

321 Table 5: 2-tailed Pearson Correlation coefficients and bootstrapped 95% confidence intervals for
 322 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]

323

324 *CEBQ*

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

328 *FIS*

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

334 *CFPQ*

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

342 *Comparison of children above and below MCHFS 'cut off'*

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

351

352

DISCUSSION

353

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

363
364 The range of scores yielded by the MCHFS in this non-clinical community sample demonstrates its
365 capacity to be sensitive to the wide range of feeding problems experienced by families. Primary
366 care practitioners can be guided by mean scores to make inferences about the severity of the feeding
367 problems reported by parents and the necessity for further clinical investigation. In Thai samples, a
368 score of 40 yielded acceptable sensitivity and specificity in identification of children with clinical
369 feeding problems (Benjasuwantep et al., 2015). In a Canadian sample, the clinical cut off of 45
370 (mean +1SD of non-clinical sample) yielded excellent sensitivity and specificity in identification of
371 6 month to 6 year old children with and without clinical feeding problems (Ramsay et al., 2011). In
372 this sample, 14% of parents reported problems on the MCHFS that reached this cut off. This also
373 suggests that the MCHFS would be a useful research tool for identifying groups of children at
374 particular risk of clinically significant feeding problems.

375
376 Infants who had lower birthweight and lower weight at throughout the first year were more likely to
377 have feeding problems at 1 year, despite the fact that this sample did not include low birth weight or
378 premature infants. Notably, MCHFS scores were not associated with poorer growth per se: those
379 infants with lower SDS weight gain scores across the first year were not more likely to have more
380 feeding problems. Rather, babies born lighter, and who were therefore lighter through the first year,
381 had higher MCHFS scores. Furthermore, whilst infants with high MCHFS scores at 1 year had been
382 introduced to complementary foods slightly later than infants with fewer feeding problems, the
383 confidence interval for this analysis suggested that it was not likely to be an important and
384 consistent correlate of MCHFS score. Because of other work which has suggested that later
385 introduction of complementary food (over 7 months of age) is associated with poorer feeding
386 outcomes (Northstone, Emmett & Nethersole, 2001; Oliveira et al., 2015), further work is necessary
387 on the likely reciprocal relationship between the timing of introduction to solid food and feeding
388 problems.

389

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

401

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

416

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

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

428

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

442 There are a number of limitations to this study. The sample was affluent and well educated, and
443 relatively homogenous in ethnicity, with healthy birth outcomes, relatively long durations of
444 breastfeeding and timely introduction to solid food. Therefore, further work should examine
445 whether there is social and demographic variation in MCHFS scores in broader samples.

446 Nevertheless, within our sample we did not observe any links between MCHFS and demographic
447 variables or gestation, Apgar scores, maternal age, or maternal BMI, suggesting independence of
448 MCHFS scores from these covariates of infant feeding. Whilst we observed a wide range of scores,
449 we did not include clinically diagnosed children in the study, and therefore could not examine the
450 MCHFS's ability to differentiate between children with and without clinically diagnosed feeding
451 problems. Similarly, this study demonstrates reliability of the MCHFS for use with typically
452 developing children without other risk factors for feeding problems (e.g. significant prematurity,
453 autistic spectrum disorders, disorders affecting oral motor function, etc.). Effect sizes in this study
454 ranged from small to large. The study was adequately powered to detect large effects but there was
455 insufficient power within this study to detect less important, medium to small effects. Nevertheless,
456 multiple relationships between the MCHFS and the variables of interest in this study were detected
457 suggesting that the study was adequately powered for its purpose. However there were a number of

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

460

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

467

468

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

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

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

482

483

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646

647

648 Supplementary Table 1

649

650 Independent samples t-tests comparing demographics, weight, CFPQ, CEBQ and FIS scores for
 651 infants scoring above or below the MCHFS cut off of 45 (n MCHFS identified feeding problems =
 652 10, n below cut off = 59).

653

	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	-3.07**
	Yes	-.60	.88	
6 months infant weight SDS	No	.28	1.13	

THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE

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	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**

THE MONTREAL CHILDREN'S HOSPITAL FEEDING SCALE

ACCEPTED MANUSCRIPT

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

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