Relationships between feeding problems, eating behaviours and parental feeding practices in children with Down syndrome: a cross-sectional study.

Abstract

Background: Research investigating feeding problems in children with Down syndrome is scarce. This study investigated feeding problems, eating behaviours and parental feeding practices in children with Down syndrome (n=40), and typically developing (TD) children of the same age and sex (n=40).

Method: Parents of children aged 6-months to 5-years in the UK completed ~~measures~~ questionnaires assessing their child's feeding problems and eating behaviours and parental feeding practices.

Results: For children with Down syndrome, feeding problems were: significantly greater than for TD children; negatively associated with breast milk duration and appetite during exclusive milk feeding; and positively associated with drinking more slowly. For both groups, feeding problems were significantly correlated with more food avoidant eating behaviours.

Conclusions: This study provides new information about the relationships between feeding problems and eating behaviours in early development~~the early years~~. Longitudinal research is needed to further investigate these relationships, so that ~~more~~ effective support can be developed for families.

Key words

Down syndrome, feeding problems, eating behaviours

1. Introduction

Feeding problems occur commonly in childhood (Mascola et al., 2010). Children who experience early feeding and eating problems eat fewer fruits and vegetables (Howard et al., 2012; Perry et al., 2015), have poorer dietary quality and variety (Bell et al., 2018; Perry et al., 2015) and slower growth (Carruth et al., 2004). Children with Down syndrome have been reported to experience more feeding problems than typically developing (TD) children but there is a lack of research on the relationship with eating behaviours and parental feeding practices. Therefore, the focus of the present study was to explore feeding problems, eating behaviours and parental feeding practices across both milk feeding and

solid food eating in early development in children with Down syndrome compared to TD children.

Down syndrome, caused by an extra chromosome 21, is the most common genetic cause of learning disability. The number of ~~babies~~infants with Down syndrome born per year is approximately 700-800 in the UK (Wu & Morris, 2013) and 5,300 in the USA (de Graaf et al., 2015). Children with Down syndrome have anatomical and oromotor differences (Cooper-Brown et al., 2008; Field et al., 2003) that have the potential to affect milk feeding and eating solid foods, yet research investigating feeding problems in this group of children is scarce. Children with Down syndrome often have a small oral cavity, low muscle tone and issues with tongue movement; these differences can lead to problems with chewing, food capture and swallowing (Ooka et al., 2012). Medical issues such as cardiac problems, present in 40-60% of ~~babies~~infants with Down syndrome (Marder et al., 2015), can also disrupt feeding, particularly if an infant ~~baby~~ is hospitalised early in life (Mohamed et al., 2013; Pisacane et al., 2003). Although research has investigated important correlates of feeding problems in both ~~typically developing~~TD and neurodiverse children (e.g. Autism Spectrum Disorder), these relationships in children with Down syndrome are not well understood. The current study adds to the existing literature and is the first study to explore relationships between feeding problems, eating behaviours and parental feeding practices in children with Down syndrome.

The World Health Organisation recommends that ~~babies~~infants are breastfed exclusively for 6 months, at which point solid food can be introduced (WHO, 2002). Despite mothers expressing a wish to breastfeed their ~~babies~~infants, studies show that ~~babies~~infants with Down syndrome are more likely to be breastfed for shorter durations, or not at all, compared to TD ~~babies~~infants (Mohamed et al., 2013; Pisacane et al., 2003). Reasons for this include hospitalisation, issues with latching and/or swallowing, sleepiness, low milk supply, maternal frustration and depression and lack of support (Cartwright & Boath, 2018; Pisacane et al., 2003). However, ~~babies~~infants with Down syndrome who experience feeding problems can successfully breastfeed, particularly when expert support is offered (Sooben, 2012). A review of breastfeeding patterns in infants with Down syndrome revealed a huge gap in the evidence base when only seven studies (which spanned almost 30 years) were

included (Sooben, 2012). Research investigating factors associated with breastfeeding infants with Down syndrome is, therefore, seriously lacking.

The age of introduction to solid food appears to be later for children with Down syndrome than for TD children (Hopman et al., 1998; Mohamed et al., 2013). Bread, hard pieces of fruit, and meals containing vegetables, meat and/or starch are introduced to children with Down syndrome later compared to typical development (Hopman et al., 1998). Issues eating solid food that may be experienced by children with Down syndrome include chewing, swallowing, self-feeding, selectivity by texture and food rejection (Anil et al., 2019; Collins et al., 2003; Field et al., 2003; Mohamed et al., 2013; van Dijk & Lipke-Steenbeek, 2018). There is a lack of research investigating feeding problems and early eating behaviours of infants and young children with Down syndrome. Relationships between these variables, and factors associated with infant feeding decisions among parents of children with Down syndrome, are therefore not well understood.

The Montreal Children's Hospital Feeding Scale (MCHFS) (Ramsay, Martel, Porporino, & Zygmuntowicz, 2011) was developed to provide a quick and reliable measure of feeding problems for children aged 6-months to 6-years. Rogers, Ramsay and Blissett (2018) investigated the MCHFS's relationships with early feeding history, eating behaviours, and infant weight in a group of TD 1-year-olds. 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 acceptance of food during an observed mealtime. It was suggested the MCHFS would be a useful research tool for identifying groups of children at particular risk of clinically significant feeding problems.

van Dijk and Lipke-Steenbeek (2018) used the MCHFS in their study of children with Down syndrome aged 1-3 years in the Netherlands. Findings did not show a significant difference in MCHFS score between children with Down syndrome and TD children of the same age. However, results did reveal children with Down syndrome with more feeding problems exhibited more food refusal and more negative affect during an observed mealtime. From previous research, it might have been expected that children with Down syndrome would

have higher scores on the MCHFS than TD children. The authors suggested parents of children with Down syndrome may expect their children to have delays or difficulties with feeding, and therefore may not report feeding as problematic on a questionnaire.

Parental feeding beliefs and practices are important correlates of feeding problems in the general population (Demir et al., 2012; Harris et al., 2016). In typical development, controlling feeding practices (e.g. pressure-to-eat and restriction of energy dense foods) are associated with a range of unhealthy eating behaviours, e.g. decreased fruit and vegetable consumption and self-regulation of energy intake, and increased fussiness, snacking and BMI (Birch & Fisher, 2000; Carper et al., 2000; Fisher & Birch, 2000; Gregory et al., 2011; Holley et al., 2015). Other parental feeding practices, e.g. monitoring, can lead to positive child outcomes, including making healthier food choices (Klesges et al., 1991; Musher-Eizenman & Holub, 2007). O'Neill et al. (2005) investigated parental feeding practices and their relationship with weight in children with Down syndrome and their TD siblings. Parents reported higher levels of concern, responsibility and restriction, and lower levels of pressure for children with Down syndrome than for their TD siblings. However, children with Down syndrome had higher BMIs than their TD siblings and when this was controlled for, along with other demographic factors, the only significant difference that remained between the groups was for responsibility.

More recently, Polfuss et al. (2017) explored the associations between parental feeding behaviours and child weight status in three groups of children with additional needs: Down syndrome, ASD and Spina Bifida. Overall, levels of monitoring and restriction were higher for children who were obese or overweight, whereas levels of pressure were higher for children who were underweight or normal weight. Within the group of children who were classed as obese, levels of monitoring were higher for the group with Down syndrome compared to the other groups. There is, therefore, some evidence to suggest that parents of children with Down syndrome may use more controlling feeding practices, and this is likely to be related to the child's weight. O'Neill et al. (2005) and Polfuss et al. (2017) used the Child Feeding Questionnaire to assess parental feeding practices, which focuses on controlling feeding practices. ~~In~~ For children with Down syndrome, research has not used measures

that assess other potentially important, including more positive, parental feeding practices, and has not explored the relationship between them and feeding problems.

1.1 Aims and hypotheses ~~Research Questions~~

Despite children with Down syndrome being more likely to experience feeding issues, there is relatively little research exploring the relationships between feeding issues, eating behaviours and parental feeding practices. These relationships in ~~T~~the early years are crucial in establishing healthy eating patterns and weight, and understanding more about this in children with Down syndrome~~.~~ ~~-~~may contribute to the provision of effective support. Therefore, this study aimed to explore feeding problems in young children with Down syndrome (aged 6-months to 5-years) and related eating behaviours and parental feeding practices, compared to TD children. Based on the existing literature, it was predicted that children with Down syndrome would have more feeding problems, be breastfed for shorter durations, and be introduced to solid food later compared to a group of age- and sex-matched TD children. It was also predicted that higher levels of feeding problems would be associated with higher levels of food avoidant eating behaviours e.g. fussiness, slowness in eating. Previous research has focused on controlling feeding practices, and this study aimed to expand on this by using the Comprehensive Feeding Practices Questionnaire, which incorporates a broader range of feeding practices.

2. Method

2.1 Participants

Parents were eligible to participate if they lived in the UK and had a child aged 6-months to 5-years, who either had Down syndrome or who did not have diagnosis of a developmental disorder that may affect eating. Forty-one responses were received from caregivers of children with Down syndrome; however, one participant was excluded due to missing data. Forty children with Down syndrome, 18 females and 22 males, aged between 7- and 63-months (*M*[*SD*] = 30.3[15.7]) were included.

Seventy-nine parents of TD children also completed the study. Of these, 40 children were pairwise matched with children with Down syndrome of the same sex (18 females, 22

males) and within 6-months-of-age (*M*[*SD*] = 30.5[16.0]). In total, the data from 80 parents (76 mothers and 4 fathers) aged between 24- and 48-years (*M*[*SD*] = 36.1[5.6] years) were analysed. Participants were recruited, online and in person, through local charities, support groups and social media. Table 1 shows the demographic characteristics of the sample.

2.2 Measures

Demographic information for child and caregiver were collected (Table 1) before participants reported early feeding practices (e.g. duration of breast- and/or formula feeding, age of introduction to solids). Participants then completed the following standardised measures, each of which assessed distinctly different child or parent behaviours:

Baby Eating Behaviour Questionnaire (BEBQ) (Llewellyn et al., 2011)

The BEBQ is an 18-item questionnaire which measures infant appetite within the period of exclusive milk-feeding; it can be completed concurrently or retrospectively. One single general appetite item and four subscales were calculated: enjoyment of food (4 items, e.g. My baby loved milk), food responsiveness (6 items, e.g. My baby frequently wanted more milk than I provided), slowness in eating (4 items, e.g. My baby fed slowly) and satiety responsiveness (3 items, e.g. My baby got full up easily). Participants responded to items on a 5-point Likert scale ranging from 1 (never) to 5 (always); higher scores demonstrated greater expression of the given eating behaviour. Llewellyn et al. (2011) demonstrated the BEBQ has good internal consistency (Cronbach's alpha ranged from .73 to .81). Reliability of each scale for the current study was established using Cronbach's alpha values (Table 2).

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

The CEBQ is a 35-item parent-report questionnaire that assesses individual eating styles of children. Unlike the BEBQ, which is designed for use with infants exclusively fed milk, the CEBQ is designed to be used with children who have been introduced to solid food, but it is not a measure of feeding problems. Four subscales measure food approach behaviours: enjoyment of food, food responsiveness, desire to drink and emotional overeating; four subscales measure food avoidant behaviours: food fussiness, satiety responsiveness, slowness in eating and emotional undereating. Participants rated how often their child currently exhibits each behaviour on a 5-point Likert scale ranging from 1 (never) to 5

(always), with greater representation of the given behaviour indicated through higher scores. Development of the questionnaire demonstrated good internal reliability coefficients (Cronbach's alpha) for all subscales (Wardle et al., 2001), and has been validated against behavioural measures of eating (Carnell & Wardle, 2007). The CEBQ has shown good reliability with infants (S. L. Rogers & Blissett, 2017; Schneider-Worthington et al., 2020). Cronbach's alpha values for the current study are shown in Table 2.

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

The MCHFS was designed as a specific measure of feeding problems. It is a 14-item ~~parent-report~~ scale that can be completed by parents of~~assessing feeding problems in~~ children aged ~~from~~ 6-months to 6-years~~-of-age~~. A total score is calculated as a measure of overall feeding problems, which considers feeding domains and parental concerns about feeding. Items included assess the biopsychosocial and interactional nature of feeding problems. Participants rated the items based on the current frequency (e.g. most of the time to never) or difficulty level (e.g. very difficult to easy) of the behaviour or parental concern on a 7-point Likert scale. Total scores range from 14 to 98, with higher scores indicating greater feeding problems and concern. The clinical cut-off for feeding problems is 45 (or above) (Ramsay et al., 2011). Ramsay et al. (2011) found moderate-to-good internal consistency for this scale (Cronbach alpha ranging from .48 to .87). The MCHFS demonstrated very good reliability in the current study (Table 2).

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

The CFPQ is a 49-item self-report measure of feeding practices that can be completed by caregivers of young children. Whilst it was originally designed for use with children from 2-years, it has been previously used with children as young as 1 year (Rogers et al., 2018) and 1.5 years (Rodgers et al., 2013). In the current study the CFPQ was completed by parents of children aged over 1.5-years. Twelve subscales measure dimensions of feeding practices, including: monitoring, emotional regulation, child control, encourage balance and variety, environment, involvement, pressure, restriction for weight control, food as reward, restriction for health, teaching about nutrition and modelling. Items are ranked in frequency or agreement with the item from 1 (never or disagree) to 5 (always or agree); higher scores indicate greater prevalence of the feeding practice. Musher-Eizenman & Holub (2007) found

moderate to high internal consistency for the subscales scores (Cronbach's alpha ranged from .58 to .81). Cronbach's alpha values for the current study are shown in Table 2.

2.3 Procedure

Ethical approval was obtained from [insert details on acceptance for publication]. The study was advertised through local charities, social media, online forums, playgroups and support groups for families with children with Down syndrome, including play and speech and language therapy group sessions. UK-based ~~O~~organisations advertised the research through social media platforms, newsletters and in-person. We aimed to recruit as many participants as possible through these routes. Participants completed measures administered at local groups, by post or online using Qualtrics. The questionnaires took approximately 25-minutes to complete. Upon completion, participants were debriefed and given contact details of organisations who could help if they wanted to discuss or research issues around feeding.

2.4 Analysis

The analysis aimed to ~~Independent t-tests were conducted to~~ compare differences in weight, and parental report of early feeding behaviours, feeding problems, eating behaviours and feeding practices between children with Down syndrome and TD children. To evaluate group difference while controlling for repeated testing, we conducted independent t-tests. However, as this was an exploratory study and the sample size was relatively low (as it was determined pragmatically by the availability of the DS group, N=40), we also evaluated study power post-hoc. Where the study power is larger than 1-beta=0.8 a high level of confidence can be placed in observed group differences. Where the study power 1-beta is between .6 and .8 less confidence is placed in the observed group difference. Where power 1-beta is less than .6 observed group differences are treated with caution. Our interpretation of the analysis was informed by ~~(~~Onwuegbuzie and ~~&~~ Leech~~,~~ (2004)and is based on a synthesis of the t-tests, study power and whether the confidence interval of the difference excluded zero.

Two-tailed Pearson's correlations were then conducted to identify the necessity to control for factors previously related to feeding problems (child age, current weight and birthweight, respondent age and BMI, breastfeeding duration and age introduced to solid food) ~~covariates for further~~in subsequent analyses. A series of one-tailed and two-tailed

partial correlations (controlling for maternal age, maternal BMI and child birthweight) were run to analyse the MCHFS's relationships with the BEBQ, CEBQ and CFPQ. Missing data is noted in the results section and was omitted from analyses.

3. Results

3.1 Descriptive statistics

The mean MCHFS score for the children with Down syndrome (39.39 [SD 14.07]) was significantly higher than the TD group (29.90 [SD 9.31]), $t(78) = 3.56$, $p = .001$ (also see Table 2), with high power (0.94) indicating high confidence in this finding. Twelve children with Down syndrome (30%) scored above the clinical cut-off (45 or more) on the MCHFS, compared to one TD child (2.5%). Children with Down syndrome weighed significantly less at birth (2.983~~.0~~kg [SD 0.61]) than TD children (3.32kg [SD 0.81]), $t(76) = -2.10$, $p = .039$, although the power is relatively low. However, there was no significant difference in current weight between children with Down syndrome (12.596~~6~~kg [SD 3.92]) and TD children (14.71kg [SD 5.73]), $t(49) = -1.58$, $p = .121$. There were relatively high levels of missing data for current weight with 32 parents of children with Down syndrome providing this information and 19 parents of TD children.

3.2 Covariates

For both groups combined, two-tailed Pearson's correlations revealed that MCHFS total score was negatively associated with child birthweight ($r = -.27$, $p = .017$) and respondent BMI ($r = -.31$, $p = .009$), and positively associated with respondent age ($r = .24$, $p = .031$), i.e. more feeding problems were associated with lower child birthweight, lower respondent BMI and higher respondent age. ~~.~~These variables were therefore controlled in further analyses. MCHFS total score was not associated with current child age ($r = .09$, $p = .445$), child's current weight ($r = -.10$, $p = .507$), breast milk duration ($r = -.16$, $p = .172$) or age introduced to solid food ($r = .001$, $p = .991$).

3.3 Infant feeding and eating behaviours

Thirty-four (85%) children with Down syndrome had received breast milk (direct from the breast or via bottle, for any duration), compared to 35 (88%) TD children. Children with Down syndrome did not significantly differ in the duration they received breast milk

(directly from the breast or via bottle) (M 34.54 weeks, SD 33.02) compared to TD children (M 42.96 weeks, SD 44.32), $t(77) = -.96$, $p = .342$. All children had been introduced to solids foods, ~~H~~however, children with Down syndrome (M 26.92 weeks, SD 7.42) were introduced to solid food significantly later than TD children (M 23.86 weeks, SD 4.19), $t(77) = 2.26$, $p = .027$ (power = 0.60).

There was a significant difference on the BEBQ subscale for general appetite, $t(76) = -2.06$, $p = .043$, with TD children showing higher levels than children with Down syndrome, however there was relatively low power, indicating a lack of confidence in this finding ~~There were no significant differences, at the Bonferroni-corrected level of .002, between children with Down syndrome and TD children on any of the BEBQ subscales~~ (Table 2).

Partial correlations were conducted to investigate relationships between MCHFS score and infant feeding (two-tailed) and eating behaviours (one-tailed). Table 3 shows that, in children with Down syndrome, MCHFS score was negatively associated with breast milk duration and BEBQ general appetite, and positively associated with BEBQ slowness in eating. MCHFS score was not related to age of introduction to solid food or other BEBQ subscales in children with Down syndrome. There were no significant relationships between the MCHFS and infant feeding and eating behaviours in TD children.

3.4 Children's eating behaviours

TD children scored significantly higher on the CEBQ subscale of emotional overeating than children with Down syndrome, $t(74) = -2.03$, $p = .046$, but the power was relatively low. There were no other significant differences ~~, at the Bonferroni-corrected level of .002, between children with Down syndrome and TD children~~ on any ~~of the~~other CEBQ subscale~~s~~ (Table 2). One-tailed partial correlations were conducted to investigate relationships between MCHFS score and children's eating behaviours. Table 4 shows that, in children with Down syndrome, MCHFS score was negatively associated with CEBQ food responsiveness and enjoyment of food, and positively associated with satiety responsiveness, slowness in eating, emotional undereating and food fussiness. The same relationships were also significant in TD children, with the exception of food responsiveness.

3.5 Parental feeding practices

Fifty-six parents completed the CFPQ. The mean scores for Involvement (t(54) = -3.18, p = .002), Emotional Regulation (t(54) = -2.80, p = .007) and Teaching About Nutrition (t(52) = -2.96, p = .005) ~~was~~ were significantly lower for the parents of children with Down syndrome than for parents of TD children and the mean score for Monitoring (t(54) = 2.16, p = .036) was significantly higher for the parents of children with Down syndrome. The power for differences regarding Involvement and Teaching About Nutrition was high but the power for Monitoring was low and the power for Emotional Regulation was medium (Table 2)~~).~~ ~~There were no significant differences, at the Bonferroni-corrected level of .002, between children with Down syndrome and TD children on the remaining CFPQ subscales.~~ Two-tailed partial correlations were conducted to investigate relationships between MCHFS score and parental feeding practices. Table 5 shows that despite some of the relationships being of moderate strength, particularly in the group of children with Down syndrome, no correlations were significant.

4. Discussion

Children with Down syndrome were reported to experience significantly more feeding problems when compared to a group of age- and sex-matched TD children, as assessed by the MCHFS. Relationships with eating behaviours and parental feeding practices were examined, adding to the existing research base. For the group of children with Down syndrome, feeding problems were negatively associated with general appetite and positively associated with slowness in eating during the period of exclusive milk feeding, and negatively associated with breast milk duration. For both groups, feeding problems were significantly correlated with more food avoidant eating behaviours. There were no significant relationships between feeding problems and parental feeding practices.

Twelve children with Down syndrome scored above the MCHFS clinical cut-off for feeding problems, compared to one TD child. The MCHFS scores of TD children reflect those of other community samples in the UK (Rogers et al., 2018). Anil et al. (Anil et al., 2019) found children with Down syndrome aged 2-7-years had more physical, functional and emotional problems with feeding than TD children of the same age, including swallowing, oromotor function and transitioning to varied textured food. Collins et al. (Collins et al., 2003) found

that parents reported more issues at mealtimes for their children with a developmental disorder, including Down syndrome, than their TD children. Our findings are in-line with these studies, although are in contrast with those of Van-Dijk and Lipke-Steenbeek (van Dijk & Lipke-Steenbeek, 2018) who found no significant difference between children with Down syndrome and TD children on the MCHFS ~~but did find some significant differences on observed measures of feeding~~. The authors suggested that parents of children with Down syndrome may have expected feeding problems but not perceived these to be as severe as parents of TD children. A subgroup of parents of children with Down syndrome who took part in the present study also participated in semi-structured interviews where the majority of parents felt their child had feeding issues (Authors, in prep), so differences in parents' perceptions may underlie the different results of studies. It is also worth noting that Van-Dijk and Lipke-Steenbeek (van Dijk & Lipke-Steenbeek, 2018) also had a narrower age band of children (1-3-years) compared to the current study (6-months-5-years).

According to parental report of infant feeding, the number of parents who fed their children breast milk (either directly from the breast or via bottle) for any length of time were comparable in both groups (34 parents of children with Down syndrome and 35 parents of TD children). The duration that children received breast milk did not differ significantly between groups. Other studies have shown that ~~babies~~infants with Down syndrome are more likely to be breastfed for shorter durations or not at all (Mohamed et al., 2013; Pisacane et al., 2003), and this may be due to illness and admission to the neonatal unit, difficulty suckling, maternal feelings of frustration and depression, and perception that their milk supply was insufficient (Pisacane et al., 2003). Results of the current study ~~revealed~~ added to this literature by showing that children with Down syndrome who were reported to have more feeding problems received breast milk for significantly shorter durations (or not at all). Some mothers of infants with Down syndrome have reported receiving a lack of skilled support and a dismissal of their wish to breastfeed (Cartwright & Boath, 2018; Sooben, 2012). Given this, and the benefits of breastfeeding, it is essential that up-to-date training and support is provided to key healthcare professionals, such as midwives, so they promote and proactively support breastfeeding as an option for children with Down syndrome. ~~Given the desire to breastfeed, unmet needs for support, benefits of breast milk and lack of research (Cartwright & Boath, 2018; Sooben, 2012), more evidence is required to~~

~~better understand how to improve practice and support parents who wish to breastfeed their babiesinfants with Down syndrome.~~

In the current study, parents of children with Down syndrome reported introducing solid food significantly later than parents of TD children. This finding had medium power but it is worth noting that similar results have been found by ~~ese results support~~ Hopman et al. (1998), who suggested children with Down syndrome may be introduced to solids later due to delayed oral-motor development, or because their parents may delay introduction in response to their child's more general developmental delay. Introducing solid food can be a stressful and anxiety-provoking time for any parent (Brown, 2017; First Steps Nutrition Trust, 2015). Parents of children with intellectual or developmental disabilities may experience greater stress, compared to parents of TD children, due to having a heightened sense of responsibility in caring, poorer health and worrying about the future (Hayes & Watson, 2013; Murphy et al., 2007; Norton & Drew, 1994). Taking this into account alongside the fact that children with Down syndrome have oromotor and structural differences that predispose them to potential feeding problems (Cooper-Brown et al., 2008), future research should investigate parental experience of introducing solid food to children with Down syndrome in more detail.

To our knowledge, the current study was the first to investigate parental report of eating behaviours of children with Down syndrome during the period of exclusive milk feeding using the BEBQ, and after the introduction of solid food using the CEBQ, and to examine how these relate to feeding problems. TD children were reported to have higher appetites during milk feeding and higher levels of emotional overeating during solid food eating by their parents. Although these differences were significant, the power for both was relatively low, indicating that further research is needed to confirm this. ~~Parents of children with Down syndrome did not report significantly different eating behaviours during the period of exclusive milk feeding, or solid food eating, compared to parents of TD children. However,~~ Cchildren with Down syndrome who were reported to have more feeding problems on the MCHFS were perceived by their parents to have a significantly smaller appetite and to drink more slowly during the period of exclusive milk feeding. Lewis and Kritzinger (Lewis & Kritzinger, 2004) found that heart defects and low muscle tone were associated with

exhaustion before completing a feed. It is possible that the ~~babies~~infants with Down syndrome in our sample were perceived to have a smaller appetite as feeding was exhausting them and therefore feeds were slower and shorter. Feeding problems were not related to age of introduction to solid food or other BEBQ subscales in children with Down syndrome.

There were no significant associations between feeding problems and infant feeding and eating behaviours during the period of exclusive milk feeding in TD children. This was unexpected; Ramsay and Gisel (1996) found that among a group of healthy infants (mean age 6-weeks), 41% experienced some milk feeding problems. However, the same research team later found that inefficient sucking in the neonatal period did not predict later feeding problems. It was concluded that feeding difficulties may appear and resolve at different stages (Ramsay, Gisel, McCusker, Bellavance & Platt, 2002). We suggest, therefore, that although healthy infants may experience issues with feeding and eating, difficulties experienced by TD children may be less severe, and perhaps appear later, than those experienced by children with Down syndrome, who have anatomical and oromotor differences.

Children with Down syndrome who were reported to have more feeding problems were perceived by their parents to enjoy solid food less and be less responsive to solid food; they were also perceived to be fussier, more satiety responsive, eat more slowly, and were more likely to under-eat in response to anger/sadness. The same relationships were also significant in TD children, with the exception of food responsiveness. These relationships suggest that greater food avoidance traits depict risk for feeding problems in both children with Down syndrome and TD children. Previous research has indicated children with Down syndrome exhibit more food avoidant behaviours, such as food selectivity and refusal, and display more negative affect during a mealtime when compared to children with other developmental or intellectual disabilities and TD children (Bandini et al., 2019; Field et al., 2003; Mohamed et al., 2013; ~~van Dijk & Lipke-Steenbeek, 2018~~). T~~, and t~~he present study extends this by linking greater levels of similar food avoidant behaviours, as well as lower levels of food approach~~these~~ behaviours, with feeding problems. Discussing eating behaviours with parents may help healthcare professionals identify children with Down

syndrome with feeding problems and the type of support they may need. There is also a need to understand mechanisms involved in the relationship between feeding problems and more food avoidant behaviours in children with Down syndrome so more effective support can be offered to parents. It is particularly important to know whether these mechanisms are similar to TD children, as this would have an impact on the type of support needed by families.

Parents of children with Down syndrome in the current study reported involving their child less in grocery shopping, meal planning and preparation, less often teaching their child about nutrition, less often using food for emotional regulation, and monitoring food intake more than parents of TD children. There were no significant relationships between feeding problems and parental feeding practices in both groups, although some of the relationships, particularly for children with Down syndrome, were of moderate strength. Previous research has found that parents of TD infants with more feeding problems reported encouraging balance and variety in their children's diets less often (Rogers et al., 2018). Parents of children with Down syndrome in the current study reported involving their child in grocery shopping, meal planning and preparation and teaching their child about nutrition significantly less ~~often~~ than parents of TD children, and the power was high for these results indicating that these are reliable findings. Parents of children with Down syndrome reported using food for emotional regulation less, but the power was medium indicating that further research is needed. There was also a significant difference regarding monitoring as parents of children with Down syndrome reported monitoring food intake more than parents of TD children, however the difference was relatively small, with low power, indicating low reliability for this finding. ~~The findings of the current study do not support~~ It is worth nothing that previous research~~, which~~ has found that controlling feeding practices may be more common in parents of children with Down syndrome, though the use of greater control during feeding in these studies could have been related to child weight (O'Neill et al., 2005; Polfuss et al., 2017).

There are relatively high levels of overweight and obesity in children and young people with Down syndrome, with evidence to suggest that rates increase after the age of 2 years (Amo-

Setién et al., 2020; Bertapelli et al., 2016; Suarez-Villadat et al., 2019). There was no difference in current weight between children with Down syndrome and TD~~typically developing~~ children in our study, and children with Down syndrome ~~in our study~~ weighed significantly less at birth than TD children, although the power for this difference was low indicating caution when interpreting this. A lack of certainty is in line with Morris et al's~~.~~ (~~Morris et al.,~~ 2015) analysis of birth weight of~~in~~ infants with Down syndrome, which demonstrated the difference between infants with Down syndrome and TD infants varies according to gestation. ~~and although their current weight was also lower, the difference was not significant.~~ Shloim et al (~~Shloim et al.,~~ 2015) highlighted that parental feeding practices are responsive and parents adapt their feeding practices according to their child's individual characteristics and eating behaviours. Therefore, it may be that parental feeding practices in children with Down syndrome, and their relationship to feeding problems, change as children become older and are more able to feed themselves, or if their BMI increases.

Young children without Down syndrome and with congenital heart disease have been found to experience delayed growth, more feeding difficulties and more oromotor function difficulties compared to TD children (Barbosa et al., 2020; Chen et al., 2004; Maurer et al., 2011). Between 40 and 60% of children with Down syndrome experience congenital heart disease (Marder et al., 2015). Although beyond the scope of the present study, it may be that within the population of children with Down syndrome, those with congenital heart disease are more likely to experience feeding difficulties, so further research in this area is warranted.

The present study was cross-sectional and therefore causality and change over time cannot be investigated. Future longitudinal research would be valuable in exploring these issues, and potential areas of support for families. Due to relatively low prevalence rates of children with Down syndrome~~DS~~, the age range of the children in this~~e~~ study is wide and the sample size is low compared to research with TD children, potentially affecting generalisability. However, our sample size is larger than much of the previous feeding research with children with Down syndrome (Anil et al., 2019; Hopman et al., 1998; Magenis et al., 2018; Ooka et al., 2012), and therefore moves the field forwards. Our study has gathered useful and

unique information about a relatively large group of children with Down syndromes, and so to extend our findings, future research may wish to focus on more narrow age bands and explore specific feeding issues in more depth. Our study was primarily designed to capture parent report of different aspects of feeding and eating, and as the study could be shared and completed online, participants were geographically disparate. This limited the potential to carry out home visits and collect objective measures of height and weight and mealtime observations. There were relatively high levels of missing data for child's current weight, particularly for the TD group, and visits by the researcher would minimise this missing data. Furthermore, to fully understand feeding problems in children with Down syndrome, other factors need to be considered. Given that motor development, including self-feeding skills, is typically delayed (Frank & Esbensen, 2015), and issues with sensory processing have been reported (Bruni et al., 2010; Will et al., 2019) in children with Down syndrome, these factors would be a valuable avenue for future research to explore.

Conclusions

There are a range of consequences associated with feeding problems, and eating behaviours are relatively stable and track through the life course (Ashcroft et al., 2008; Lien et al., 2001). The present study has provided evidence for early feeding problems in children with Down syndrome, and related eating behaviours. It is essential that healthcare professionals have the specific skills and knowledge required to manage the unique drinking and eating needs of infants with Down syndrome. When working with children with Down syndrome, it is important for healthcare professionals to ask parents about different eating behaviours, both in exclusive milk feeding and solid food eating, so issues can be identified and targeted support can be provided. It is crucial to understand the complex relationships between feeding problems and wider eating behaviours in children with Down syndrome, particularly in early development, so that more effective support can be developed that addresses the unmet needs of children and families.

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Tables

Table 1

Descriptive demographic information

Demographic information	Group with Down syndrome N (%)/Mean (SD)	TD group N (%)/Mean (SD)
Respondent ethnicity - N (%)		
White British	26 (65)	34 (85)
White Irish/other	6 (15)	4 (10)

Asian Indian	3 (7.5)	0
Asian Pakistani	1 (2.5)	0
Asian other	0	1 (2.5)
Black African	1 (2.5)	0
Mixed	2 (5)	0
Other	1 (2.5)	0
Missing data	0	1 (2.5)
Respondent education - N (%)		
Left school between 13 and 16 years	3 (7.5)	3 (7.5)
Further secondary education (16-18 years)	4 (10)	2 (5)
Secretarial/technical qualification	2 (5)	0
Teacher training	0	1 (2.5)
University course not completed	1 (2.5)	1 (2.5)
Professional qualification without degree	1 (2.5)	1 (2.5)
Degree	12 (30)	17 (42.5)
Further degree	15 (37.5)	13 (32.5)
Missing data	2 (5)	2 (5)
Weekly household income - N (%)		
£150 or below	2 (5)	0
£151-250	3 (7.5)	2 (5)
£251-350	5 (12.5)	3 (7.5)
££350 and above	30(75)	33 (82.5)
Dependent on state benefits	3 (7.5)	1 (2.5)
Missing data	0	2 (5)
Respondent BMI - Mean (SD)	23.8 (5.5)	26.0 (5.3)
Total number of participants	40	40

Table 2

N, Mean, SD, *t* and *p* values (two-tailed) of feeding and weight background questions, MCHFS, BEBQ, CEBQ, and CFPQ

Measure		N		Mean (SD)		Difference between the means (pooled SD)	95% confidence interval of the group difference		Power (1-beta)	*t*	*p*	Cronbach's alpha	
		DS	TD	DS	TD		Lower	Upper				DS	TD
Weight	Birth weight (kg)	39	39	2.98 (0.61)	3.32 (0.81)	-0.34 (0.72)	-0.50	-0.18	0.54	2.10	.039*		
	Current weight (kg)	32	19	12.59 (3.92)	14.71 (5.73)	-2.12 (4.67)	-3.46	-0.78	0.28	-1.58	.121		

Breast milk duration (weeks)		39	40	34.54 (33.02)	42.96 (44.32)	-8.42 (39.15)	-17.30	0.47	0.16	-0.96	.342		
Age of introduction of solid foods		39	40	26.92 (7.42)	23.86 (4.19)	3.06 (6.01)	1.70	4.42	0.60	2.26	.027*		
MCHFS	Total score	40	40	39.39 (14.07)	29.90 (9.31)	9.49 (11.93)	6.80	12.18	0.94	3.56	.001*	.84	.81
BEBQ	Food Responsiveness	38	40	2.33 (0.72)	2.64 (0.77)	-0.31 (0.75)	-0.48	-0.14	0.44	-1.86	.067	.79	.85
	Enjoyment of Food	38	40	4.02 (0.84)	4.30 (0.62)	-0.28 (0.74)	-0.45	-0.11	0.38	-1.71	.091	.81	.80
	Satiety Responsiveness	37	40	2.44 (0.71)	2.23 (0.72)	0.21 (0.72)	0.05	0.37	0.25	1.28	.206	.52	.77
	Slowness in Eating	39	40	3.04 (1.06)	2.77 (0.69)	0.27 (0.89)	0.07	0.47	0.25	1.32	.190	.87	.57
	General Appetite	38	40	3.39 (1.20)	3.93 (1.07)	-0.54 (1.14)	-0.80	-0.28	0.54	-2.06	.043*	N/A	N/A
CEBQ	Food Responsiveness	36	40	2.52 (1.00)	2.87 (0.85)	-0.35 (0.92)	-0.56	-0.14	0.36	-1.65	.103	.87	.82
	Emotional Overeating	36	40	1.69 (0.52)	1.95 (0.60)	-0.26 (0.56)	-0.39	-0.13	0.52	-2.03	.046*	.59	.70

	Enjoyment of Food	40	40	3.79 (0.88)	4.00 (0.65)	-0.21 (0.77)	-0.38	-0.04	0.22	-1.23	.223	.92	.90
	Desire to Drink	35	40	2.36 (1.01)	2.58 (1.00)	-0.22 (1.00)	-0.45	0.01	0.15	-0.95	.343	.87	.84
	Satiety Responsiveness	36	40	2.64 (0.68)	2.77 (0.62)	-0.13 (0.65)	-0.28	0.02	0.14	-0.87	.389	.79	.72
	Slowness in Eating	39	40	2.96 (1.04)	2.84 (0.70)	0.12 (0.88)	-0.08	0.32	0.09	0.63	.530	.90	.71
	Emotional Undereating	38	40	3.22 (0.96)	3.40 (0.87)	-0.18 (0.91)	-0.39	0.03	0.14	-0.86	.391	.79	.83
	Food Fussiness	39	40	2.72 (1.09)	2.67 (0.91)	0.05 (1.00)	-0.18	0.28	0.06	0.24	.812	.94	.89
CFPQ	Monitoring	27	29	4.44 (0.57)	4.03 (0.82)	0.41 (0.71)	0.22	0.60	0.57	2.16	.036*	.71	.89
	Emotional Regulation	27	29	1.72 (0.56)	2.18 (0.68)	-0.46 (0.63)	-0.63	-0.29	0.78	-2.80	.007*	.71	.74
	Child Control	27	29	2.30 (0.74)	2.47 (0.67)	-0.17 (0.70)	-0.36	0.02	0.14	-0.90	.371	.75	.69
	Encourage Balance and Variety	27	29	4.30 (0.67)	4.24 (0.65)	0.06 (0.66)	-0.12	0.24	0.06	0.35	.731	.66	.78
	Food Environment	27	29	3.95 (0.73)	3.90 (0.55)	0.05 (0.64)	-0.13	0.23	0.06	0.33	.741	.75	.67

Involvement	27	29	2.30 (1.02)	3.10 (0.87)	-0.8 (0.95)	-1.06	-0.54	0.87	-3.18	.002*	.71	.75
Pressure	26	29	2.88 (0.90)	2.85 (0.72)	0.03 (0.81)	-0.19	0.25	0.05	0.14	.887	.71	.67
Restriction for Weight Control	25	29	2.12 (0.63)	1.89 (0.63)	0.23 (0.63)	0.05	0.41	0.26	1.30	.199	.78	.82
Food as Reward	27	29	1.88 (0.82)	2.21 (0.93)	-0.33 (0.88)	-0.57	-0.09	0.28	-1.41	.164	.56	.87
Restriction for Health	26	29	3.10 (0.95)	3.15 (0.90)	-0.05 (0.92)	-0.30	0.20	0.05	-0.20	.841	.74	.84
Teaching About Nutrition	25	29	2.95 (0.89)	3.64 (0.84)	-0.69 (0.86)	-0.93	-0.45	0.82	-2.96	.005*	.41	.71
Modelling	25	29	3.98 (0.94)	4.05 (0.71)	-0.07 (0.82)	-0.30	0.16	0.06	-0.32	.751	.92	.84

* significant at ~~the Bonferroni-corrected level of .002~~alpha level of <.05

Table 3

Partial correlations between MCHFS score, breast milk duration, age introduced to solid food (two-tailed), and MCHFS and BEBQ (one-tailed). Covariates include: Respondent age, respondent BMI and child birthweight.

	DS		TD	
	r	*p*	*r*	*p*
Breast milk duration	-.36	.044	.04	.856
Age introduced to solid food	-.20	.270	-.16	.394
BEBQ Food Responsiveness	-.15	.209	.21	.135
BEBQ Enjoyment of Food	-.26	.081	-.29	.062
BEBQ Satiety Responsiveness	.27	.075	.21	.140
BEBQ Slowness in Eating	.43	.007	-.14	.233
BEBQ General Appetite	-.35	.026	-.20	.152

Table 4

Partial correlations (one-tailed) between MCHFS score and CEBQ. Covariates include: Respondent age, respondent BMI and child birthweight.

	DS		TD	
	r	*p*	*r*	*p*
CEBQ Food Responsiveness	-.41	.012	.03	.441
CEBQ Emotional Overeating	-.03	.439	.30	.060
CEBQ Enjoyment of Food	-.75	<.001	-.60	<.001
CEBQ Desire to Drink	-.11	.295	-.14	.232
CEBQ Satiety Responsiveness	.49	.003	.36	.030
CEBQ Slowness in Eating	.61	<.001	.57	.001
CEBQ Emotional Undereating	.35	.026	.42	.011
CEBQ Food Fussiness	.55	.001	.70	<.001

Table 5

Partial correlations (two-tailed) between MCHFS score and CFPQ. Covariates include: Respondent age, respondent BMI and child birthweight.

	DS		TD	
	r	*p*	*r*	*p*
CFPQ Monitoring	-.28	.222	-.28	.228
CFPQ Emotional Regulation	-.01	.950	.11	.651
CFPQ Child Control	.32	.161	.39	.078
CFPQ Encourage Balance and Variety	-.38	.090	-.13	.589
CFPQ Food Environment	-.42	.057	-.18	.424
CFPQ Involvement	-.24	.293	-.16	.501
CFPQ Pressure	-.06	.804	.31	.178
CFPQ Restriction for Weight Control	-.41	.069	.06	.813
CFPQ Food as Reward	.04	.873	.15	.519
CFPQ Restriction for Health	-.03	.906	.18	.433

CFPQ Teaching About Nutrition	-.16	.509	-.11	.634
CFPQ Modelling	-.04	.881	.17	.459