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Abstract

Background- Effective treatment of childhood obesity requires a multi-factorial approach and should target factors impacting on a child's environment.

Objective -To explore the impact of three treatment programs on parental child-feeding practices at 6, 12 and 24 months post-program.

Subjects/ Intervention Overweight children (n=159) aged 5-7 years, recruited to the Hunter Illawarra Kids Challenge Using Parent Support (HICUPS) RCT with three treatment arms; a dietary modification program, a physical activity skill development program or a combination of both programs.

Main outcome measures- The Child Feeding Questionnaire (CFQ), a validated 31-item questionnaire measuring child-feeding practices, completed by parents.

Statistical analysis - Linear mixed models were used to assess change over time and to determine differences by intervention group.

Results -A significant decrease ($p<0.01$) in CFQ domain scores were reported and sustained at 24 months for all groups, in the domain of pressure to eat (mean $\pm$ SEM, 1.8 ± 0.06 , 1.6 ± 0.06) with increases in degree of monitoring (4.0 ± 0.07 , 4.2 ± 0.06). The domain of restriction showed significant decreases in dietary intervention groups only (baseline 3.9 ± 0.05 , 24 months 3.7 ± 0.06), the domain scores for concern were found to be strongly, associated with child BMI z-score ($r=0.73$, $p<0.001$) at baseline only.

Conclusions - This study provides evidence that specific child-feeding domains are modifiable in the context of a targeted obesity intervention and further that changes can be sustained over time.

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83 HIKCUPS study: National Centre for Clinical Trials (NCT): 00107692

84 clinicaltrials.gov Identifier: NCT00107692 <http://clinicaltrials.gov/ct2/home>

85

86 **Introduction**

87 Effective treatment of childhood obesity requires a multi-factorial approach (1) and should
88 target factors impacting on a child's environment, beyond diet and physical activity. An
89 improved understanding of factors that influence both child and parental behavior and how
90 modifiable these are, is needed and should be considered when developing child obesity
91 interventions. One such factor is parental child-feeding practices. In this context, child-
92 feeding practices represent the caregivers' approach to maintaining or modifying children's
93 behaviors with respect to eating (2). Parental child-feeding practices are commonly
94 measured in domains, including level of parental restriction on a child's food intake, degree
95 of monitoring of food intake and parental pressure exerted to consume or not consume
96 foods. Previous research suggests that less controlling parental feeding practices are
97 associated with higher intakes of fruits, vegetables and dairy and lower intakes of energy
98 dense foods (3, 4). However, the actual specific relationship between child feeding
99 practices and child body weight is poorly described. The majority of existing studies are
100 cross sectional and remain equivocal on the association, with longitudinal data scarce (2, 5-
101 7). Interventions for the treatment of childhood obesity that utilize parents as the agents of
102 change to improve children's dietary intakes are likely to impact on a parents child-feeding
103 practices (8). This in turn may lead to improved outcomes from obesity treatment and
104 provide a specific avenue to target in future interventions.

105 Despite recommendations that interventions should be directed towards parental child-
106 feeding practices (4), there is a paucity of data on how or if parent feeding practices can be
107 modified. The majority of existing studies to date have been cross-sectional and have not
108 addressed changes secondary to treatment (9). Only one study was identified that included
109 overweight children followed up long-term (10), which found that the domains of parental

restriction and degree of monitoring can be changed . The smaller number of shorter follow up intervention studies have demonstrated significant decreases in levels of restriction, control (11, 12) and monitoring (10) secondary to parent focussed nutrition interventions found the domain changes were correlated with improved child weight status (10). Longitudinal studies, mainly conducted in young children, indicate that there is some degree of stability of parental child-feeding styles over time (13) (9). Targeting modification of parental child-feeding appears to be a logical strategy as parents have been identified as key agents of change within child obesity treatment (14).

The primary aim of the HIKCUPS RCT was to determine the efficacy of three treatment programs for childhood obesity with a secondary aim in this paper to explore the impact of the interventions on parental child-feeding practices and to compare differences between intervention groups at 6, 12 and 24 months follow-up.

Methods

Obesity intervention study details

The Hunter Illawarra Kids Challenge Using Parent Support (HIKCUPS) randomized controlled trial (RCT) recruited families from the Hunter (population approximately 550 000) and Illawarra (population approximately 380 000) regions, NSW, Australia. The full methodological details of the HIKCUPS study have been previously published (15). Briefly, the HIKCUPS RCT recruited overweight and obese children and their families between April 2005 and April 2006. Participants were randomly allocated by blinded researchers to one of three intervention arms, using the bias coin method of allocation, using a computer-based random number-producing algorithm. This method ensures equal chance of allocation to each group: (1) a parent-centered family lifestyle and dietary modification program called PRAISE, (Positive Reinforcement and Incentives for Smart Eating); (2) a physical activity skill development program for children known as SHARK (Skills Honing and Active Recreation for Kids); and (3) a group of parents and children who received both programs (COMBINED). Interventions were undertaken in a community setting.

A detailed description of the dietary modification program, which used parents as the exclusive agents of change has been published (16). The dietary program involved 10 two-hour weekly parent group sessions with telephone follow-up, once per month for three months. The PRAISE dietary program was run by Accredited Practising Dietitians and was aimed at the parent only, with parents having responsibility for attending sessions and implementing changes to family eating habits. Two rules were reinforced throughout the program: 1) parents had to assume responsibility for food provision and decide what foods

were served and when; 2) the child could decide how much of the food was to be consumed, with no pressure to consume unwanted foods. Eating meals at a dinner table was promoted. Total avoidance and overt restriction of foods high in sugar and/or fat was discouraged. However, parents were encouraged to moderate their child's exposure to these types of foods by reducing the amounts available in the home and negotiating a limited number of 'extra' foods per week with parents encouraged to adhere to this limit. Parents were recommended not to force their children to eat but to provide repeated opportunities to try new or different foods, particularly those that are healthful and may be disliked by the child, such as vegetables. Parents were discouraged from using food as a reward and instead to use other types of age appropriate positive reinforcement and rewards to support behavior change including stickers, point systems, special outings and verbal praise. Families were assessed at baseline, prior to commencement of the study, 6, 12 and 24 months post-baseline.

The SHARK physical activity skill development program was designed for children only. The program focused on increasing the child's actual and perceived competence in performing fundamental movement skills, and improving the level of social support provided to children in their physical activity endeavors. Weekly homework was set and designed to be carried out at home with parents and siblings.

Participants and recruitment

Children and their families were recruited to the HIKCUPS study predominantly through school newsletters. Inclusion criteria included: aged five to nine years, overweight or obese according to International Obesity Task Force definitions, based on BMI z score (17), not taking medications that affect weight status, pre pubertal, and with a parent or caregiver willing to attend group education sessions. As previously reported, 505 children were

assessed for eligibility by telephone interview for the HIKCUPS study with 319 eligible with 205 parents providing consent (64% consent rate) (15). The parents of the 165 children who took part in the HIKCUPS study are the participants for the current study.

Ethical approval was obtained from the University of Newcastle Human Research Ethics Committee for both phases of the study. The University of Wollongong Human Research Ethics Committee also approved the HIKCUPS study. Parental written consent for child participation was obtained for all children.

Assessment of feeding behavior

The CFQ is a 31-item validated questionnaire, designed for completion by parents of children aged 2 to 11 years (18) (19, 20). The range of responses for each question is on a 1-5 point Likert scale with responses ranging from ‘disagree’ (=1) to ‘agree’ (=5) or ‘never’ (=1) to ‘always’ (=5). The CFQ measures parental beliefs and attitudes regarding child-feeding practices across seven domains. *Perceived parent overweight* is a 4-item scale that measures parents perception of their own weight at various life stages including childhood, adolescence, early adulthood, and currently. *Perceived child overweight* is a 6-item scale which measures the parent’s perception of their child’s weight at various life stages including the first year of life, as a toddler through to child’s weight at 6th to 8th grade at school. As these are age-based questions, perceived child weight factor was determined by the answers to the two age appropriate items only (questions 8-10). *Perceived feeding responsibility* is a 3-item scale measuring how responsible a parent feels for feeding their child. *Concern about child overweight* is a 3-item sub scale that reflects the degree to which the parent is concerned their child is or will become overweight. *Restriction* is an 8-item

scale that measures the parents' attempts to control their child's eating by restricting access to likable foods. It concerns the restriction of both the type and amount of food. *Pressure to eat* is a 4-item scale that measures the degree to which a parent encourages the child to eat by behaviors such as insisting that the child eat everything on their plate. *Monitoring* is a 3-item scale that examines the degree to which a parent keeps track of their child's consumption of energy dense snack foods. Mean scores for each of the seven feeding domains were calculated for all children at each time period. The Child Feeding Questionnaire (CFQ) (18) was completed by parents under instruction from a trained research assistant.

Adiposity

Children's weight was measured by blinded trained research assistants to the nearest 100g wearing light clothing using Tanita HD646 scales (Tanita Corporation of America Inc, Illinois, USA). Height was measured to the nearest 0.1 cm using the stretch stature method and PE87 portable stadiometers (Mentone Educational Centre, Victoria, Australia). BMI z-score was calculated for all children from both groups by a computer program using the LMS method based on UK reference data (21).

Statistical analysis

Linear mixed models which use a direct likelihood estimation procedure were generated to determine differences by intervention group and change over time. The effects were time (baseline, 6, 12 and 24 months), intervention group (diet, physical activity, combined), and the interaction between them with age added as a co-variant. No imputation of missing values was carried out for subjects, the study and subjects were analyzed in their allocated,

randomization group. Statistical significance was set at $p < 0.05$. Linear regression was undertaken to determine associations between variables. Statistical analysis was completed using SPSS version 15 (SPSS Inc, Chicago, IL, USA).

Results

Baseline characteristics

The total study sample included 159 children at baseline (58% girls). Baseline characteristics of participants are summarized in **Table 1**.

Parents' child-feeding practices

Child-feeding data were available for 159 children at baseline, 110 at 6 months, 97 at 12 months and 87 at 24 months (55% retention at 24 months). Dropouts at all time periods did not differ at baseline from those who were followed up in regards to sex, BMI z-score or parent child feeding practices ($p > 0.05$). Mean scores for each of the feeding domains by intervention group are presented in **Table 2** with mean changes over time for all children shown in **Table 3**.

Effect of dietary intervention

There were significant differences over time in the mean scores for all treatment groups (Table 3) with a decrease at 6 months post-intervention in the domains of concern, pressure to eat and an increase in the mean score of monitoring. These changes were all sustained at 12 and 24 months, except for concern which rebounded to baseline levels at 12 months.

A significant linear interaction for group by time was observed for the CFQ domain of parent restriction ($p < 0.001$) shown in **Figure 1**. Significant reductions for parent restriction

were observed for parents who received the PRAISE dietary modification program only (PRAISE and combined), and not parents in the SHARK (physical activity) group at 6 months only. The reduction in restriction at 6 months for the dietary groups was maintained at 12 and 24 months. Of the eight items which constitute the restriction domain the group-by-time interaction was significant for a reduction in scores ($p<0.05$) relating to the both questions on offering children ‘favorite foods’ or ‘sweets’ as a reward in exchange for good behavior.

Regression analysis

At baseline, parent child-feeding domain scores for concern were found to be strongly, associated with child BMI z-score ($r=0.73$, $p<0.001$). A significant, but weak association was found between change in child adiposity (BMI z-score) and change in mean score for parental concern about child weight ($r=0.25$, $p=0.008$) baseline to 6 months. No associations were detected between any parent child-feeding domains and changes in adiposity from baseline to 12 or baseline to 24 months.

Discussion

This is only the second study to report parental child-feeding practices in the context of an obesity intervention with long-term follow-up. It provides insights as to which aspects of parent child-feeding are modifiable and potentially could be targeted within child obesity interventions.

This study explored how three obesity treatment arms impacted on parent child-feeding practices. While no differences were found between the three intervention arms for the parental child-feeding domains of pressure and monitoring, these domain scores did change over the 6 month intervention period and the changes sustained to 24 months. However, the domain of restriction was only significantly reduced in the two groups receiving the parental dietary intervention program. A significant reduction was seen in the mean scores baseline to 6 months, with no further reductions shown between follow up time points (6-12 or 12 or 24 months), changes at 6 months were sustained up to 24month post program. No significant change was seen in the SHARK physical activity group for this domain at any point from baseline measures. Eight questions contribute to the scoring domain of restriction. The group-by-time interaction found in this study was predominantly driven by significant decreases in scores relating to the questions on offering children ‘favorite foods’ or ‘sweets’ as a reward in exchange for good behavior, an action that was strongly discouraged in the dietary intervention program.

It could have been anticipated that the parent dietary intervention groups would have had greater improvements compared to the child-only physical activity program. However this is not what was found and suggest that all parents enrolling in the RCT were motivated and ready to make lifestyle changes, regardless of allocation to treatment group. The lack of group differences could also be explained by parents in the physical activity only program

284 having learnt skills for facilitating changes in child physical activity and were able to adapt
285 these to dietary change and child-feeding practices more generally. Although not assessed
286 as part of this study, there may have been a general shift in parenting style for all groups. It
287 is also possible that differences in parent child-feeding practices were not detected due to
288 inadequate power as the primary outcome was change in child BMI z-score.

289 The decrease in the restriction domain score in the current study for the diet interventions
290 groups only is similar to the post-intervention reduction, as measured by the CFQ in a small
291 US study in overweight parents of young children (n= 43, nine months-three years) of
292 varying weight categories (11). These parents reported significant reductions following a
293 16-week obesity prevention plus parenting program. Another US study involving parents of
294 older children (n=26, 10 to 12 years) who participated in a 10 week nutrition intervention to
295 enhance fruit consumption also demonstrated significant decreases in scores for controlling
296 feeding practices (restriction, monitoring and pressure) as measured by the CFQ compared
297 to a control group (12). A more recent study which compared two dietary approaches for
298 overweight children either targeting increased healthy eating or reducing energy dense
299 foods also showed decreases in mean restriction scores. Reductions were seen for both
300 groups but a greater degree was reported for the healthy eating group (10). These studies
301 support our findings that dietary interventions can change the mean score of parenting
302 domain of restriction. Our research differs from previous studies in that we had a control
303 measure of a physical activity only group who received no formal nutrition education and
304 no significant change was shown in the restriction domain by this group over time.

305 The literature to date is inconclusive in regards to associations between restriction and
306 weight status (22). The decreases in the restriction scale found here over time could be
307 interpreted as a shift from overt restriction to covert restriction, mediated by the reduction

in purchasing and availability of energy dense, nutrient poor foods and these have been previously reported (16) . Generally, it is anticipated that foods purchased by parents will be consumed by their children and that if parents reduce their purchases of energy dense, nutrient poor foods then there is less need to be overtly restrictive. The restriction domain of the CFQ largely assesses overt restriction by the question, ‘If I do not guide or regulate my child’s eating she would eat too many junk foods’ and ideally this limitation could be addressed in future studies to allow quantification of both covert and overt restriction.

The HIKCUPS group as a whole had high levels of parental restriction when compared to previous results at baseline and increased restriction has been shown to be associated with an increased risk of further weight gain (23, 24).

Levels of concern for child overweight significantly reduced at six months and returned to baseline levels at 12 and 24 months. This could be attributed to the satisfaction that parents had in completing the treatment program initially and the relative change in weight or shape of the children initially (25), but with the removal of professional support and some adiposity rebound, parents may have lost confidence with their prior success with parental concern rebounding at 12 and 24 months. Higher baseline scores for the concern domain are noted for this sample of overweight children when compared to previous reports (6, 26, 27). With limited comparable studies it is difficult to ascertain if concern for child’s weight is a cause or reaction to weight gain. Given that parents involved in HIKCUPS volunteered and were recruited for a child obesity treatment program, it is plausible that higher scores in the concern domain were secondary to child weight gain. These results provide the basis for future research to assess the impact of longer-term professional support in changing and sustaining positive parent child-feeding practices.

Level of monitoring increased over time illustrating that this skill was sustained by parents long-term. This differs from Epstein's (10) findings which demonstrated an increase in monitoring (0.4 ± 0.6) at 6 months post-program which diminished by 24 months in both the increase healthy eating and reduce energy dense foods groups. This is also different to the effect of a 10-week intervention targeting increased fruit consumption (12) where monitoring scores decreased. Healthy food behaviors, including fruit consumption were targeted in the PRAISE program, in addition to reducing unhealthy eating behaviors. Monitoring is a difficult parenting practice to interpret and there is some debate as to whether it a positive or negative attribute. It has been suggested that a decrease in monitoring could be indicative of parents becoming less involved in directly controlling their child's eating behavior (10). In contrast, making parents aware of what their children are eating, by asking them to monitor their intake, may make them more aware and covertly facilitate better choices. Our results suggest that parents can increase their surveillance of what their child's food intake. The changes in parent child-feeding practices reported by parents participating in the HIKCUPS intervention were consistent with desirable changes in weight and dietary outcomes (16).

A significant relationship was found between change in child adiposity and the feeding domain of concern from baseline to 6 months. However no further relationships were found between changes in any domain scores and child adiposity at 12 or 24 month follow up. Epstein and colleagues have shown that reductions in restriction and parental concern were associated with a change in BMI z-score in children 8-12 years at 24 months (10). Our results support these findings. While, the changes in parent child-feeding practices could have been influenced by increasing child age over the study, adding age as a covariant into the statistical analyses did not change the results. Our results seem plausible given the age

range of the children, and the likely dependence on parents for most, if not all of food intake. Longitudinal studies of changes in parental feeding style with age are rare. To date, it is not clear how, or to what extent parents' child-feeding practices change as children get older, or whether high or low degrees of specific feeding domains 'track' over time. From the limited evidence available, there is some degree of stability of parental feeding styles in younger children. A study in children 3-5years (9) and another in children 5-7 years (13) reported that no dimension of parent child-feeding style, as measured by the CFQ, changed significantly over the two years.

Limitations of the study include that the families were mainly Anglo-Saxon heritage and of moderate socioeconomic status (SES) from NSW, Australia. Therefore, the results may not be applicable to low SES or ethnically diverse populations. The HIKCUPS study had a low retention rate after two years, although an intention-to-treat analysis was performed. Finally, the HIKCUPS study may have been underpowered to detect changes in secondary outcomes. Strengths include use of a validated instrument for measuring child-feeding practices, assessment and reporting of feeding practices with follow-up of children after an obesity intervention in the longer-term, at 24 months.

Conclusions

This study provides evidence that specific child-feeding domains are modifiable in the context of a targeted obesity intervention. Further, that the changes in parenting domains can be sustained over time. A better understanding of parent child-feeding practices may enhance the effectiveness of interventions for child obesity and future studies should include measurement of these.

379 **Author contribution:** TLB, JMW and CEC all contributed to the design of the study and
380 contributed to data acquisition and manuscript review. TLB was responsible for data
381 analysis. TLB wrote original draft and incorporated comments and feedbacks from all
382 authors.

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Table 1. Baseline characteristics of children (n=159) participating in an obesity treatment randomized controlled trial

Sex	HIKCUPS ^a		
	Male	Female	Total
Number	67	92	159
Height (m)	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1
Weight (kg) **	48.4 ± 9.7	45.6 ± 11.4	46.8 ± 10.8
BMI (ht.m ⁻²) **	25.1 ± 3.5	24.6 ± 3.9	24.8 ± 3.7
BMI z-score **	3.1 ± 0.8	2.8 ± 0.8	2.9 ± 0.8
Age (yrs) **	8.3 ± 1.3	7.8 ± 1.5	8.0 ± 1.5

Data is mean ± SD. **p<0.05 ^aHIKCUPS – Hunter Illawarra Kids Challenge Using Parents Support.

Table 2. Comparison of parent child-feeding domain scores for overweight children (n=159) participating in the HIKCUPS obesity treatment RCT at baseline, 6, 12 and 24 month post intervention

Child-feeding domain		Baseline	6 months	12 months	24 months	Significance by time
Total Number		159	110	97	87	
Perceived feeding responsibility	PRAISE	4.2 ± 0.09	4.4 ± 0.10	4.2 ± 0.11	4.3 ± 0.12	ns
	SHARK	4.1 ± 0.08	4.2 ± 0.10	4.2 ± 0.10	4.0 ± 0.12	ns
	Combined	4.2 ± 0.08	4.2 ± 0.09	4.2 ± 0.01	4.0 ± 0.11	ns
	Total	4.2 ± 0.05	4.3 ± 0.06	4.2 ± 0.06	4.1 ± 0.07	ns
Concerns about child overweight	PRAISE	4.5 ± 0.09	4.2 ± 0.11	4.4 ± 0.11	4.3 ± 0.11	ns
	SHARK	4.3 ± 0.08	4.3 ± 0.01	4.4 ± 0.11	4.4 ± 0.11	ns
	Combined	4.5 ± 0.08	4.3 ± 0.10	4.3 ± 0.10	4.4 ± 0.09	ns
	Total	4.4 ± 0.05	4.3 ± 0.06	4.4 ± 0.06	4.4 ± 0.06	ns
Restriction	PRAISE	4.1 ± 0.09	3.6 ± 0.11	3.6 ± 0.11	3.6 ± 0.13	<0.001
	SHARK	3.8 ± 0.08	3.8 ± 0.10	3.7 ± 0.11	3.7 ± 0.11	ns
	Combined	3.9 ± 0.08	3.6 ± 0.10	3.7 ± 0.10	3.6 ± 0.11	0.003
	Total	3.9 ± 0.05	3.7 ± 0.06	3.7 ± 0.06	3.7 ± 0.06	<0.001
Pressure to eat	PRAISE	1.9 ± 0.11	1.6 ± 0.12	1.7 ± 0.11	1.6 ± 0.12	0.04
	SHARK	1.8 ± 0.10	1.7 ± 0.11	1.6 ± 0.11	1.5 ± 0.12	0.03
	Combined	1.8 ± 0.10	1.7 ± 0.10	1.5 ± 0.10	1.6 ± 0.12	0.03
	Total	1.8 ± 0.06	1.6 ± 0.06	1.6 ± 0.06	1.6 ± 0.06	<0.001
Monitoring	PRAISE	4.1 ± 0.13	4.3 ± 0.11	4.2 ± 0.10	4.3 ± 0.12	0.03
	SHARK	4.0 ± 0.11	4.2 ± 0.10	4.3 ± 0.1	4.1 ± 0.12	0.04
	Combined	3.9 ± 0.11	4.3 ± 0.10	4.3 ± 0.1	4.3 ± 0.1	0.03
	Total	4.0 ± 0.07	4.3 ± 0.06	4.2 ± 0.06	4.2 ± 0.07	0.01

Data is mean ± SEM.

Scores generated from responses to the Child Feeding Questionnaire. Scales range from one to five.

520 Table 3. Mean changes in scores of parent child-feeding domains over time for all intervention groups in the HIKCUPS obesity
 521 treatment program
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Child-feeding domain	Mean (95% CI) changes over time		
	0-6	0-12	0-24
Perceived feeding responsibility	-0.07 (-0.18, 0.05)	-0.01 (-0.14, 0.11)	0.09 (-0.05,0.22)
Concerns about child overweight	0.13 (0.02, 0.23) *	0.06 (-0.06, 0.19)	0.05 (-0.06, 0.17)
Restriction	0.25 (0.14, 0.35) *	0.24 (0.12, 0.36) *	0.26 (0.13, 0.40) *
Pressure to eat	0.20 (0.08, 0.32)**	0.24(0.11, 0.36)**	0.27 (0.12,0.42)**
Monitoring	-0.25 (-0.39, -0.11)**	-0.23 (-0.37,-0.09)**	-0.20 (-0.36,-0.05)**

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 524 Data is mean change (95% confidence interval). Analysed as per linear mixed models. Child feeding domain scores derived from
 525 the Child Feeding Questionnaire. ** p<0.01, *p <0.05 for all treatment groups
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Figure 1. Mean restriction score for children in the HIKCUPS study by treatment group over time

547 **Figure 1 legends**
548 Restriction score generated from The Child Feeding Questionnaire. Scales range from one to five.
549 No significant difference between groups at baseline ($p>0.05$)
550 Groups with different letters differ from each other at a given time point.
551 The PRAISE and Combined groups reported significant decrease from baseline to 6, baseline to 12 and baseline to 24 months
552