Engaging fathers to improve physical activity and nutrition and in their pre-school aged children: The 'Healthy Youngsters, Healthy Dads' feasibility trial

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ABSTRACT

Background

Few lifestyle programs for young children have targeted fathers. This study examined the feasibility of a lifestyle intervention for fathers and their pre-school-aged children.

Method

Twenty-four father/pre-school child dyads were recruited from Newcastle, Australia into a single-arm, feasibility trial (baseline and 3-months post-baseline assessments). The 9-session program aimed to improve physical activity and dietary habits of fathers and children. *A priori* feasibility benchmarks targeted recruitment (15 dyads), eligibility rate (>60%), attendance (80%), retention (≥85%) and program acceptability (≥4 out of 5). Acceptability of data collection procedures, research team program/resource management, home-program compliance and preliminary intervention outcomes were also assessed.

Results

Feasibility benchmarks were surpassed for recruitment (24 dyads), eligibility rate (61.5%), attendance (89%), retention (100%), and program acceptability (4.6 out of 5). Data collection procedures were acceptable. Challenges included mothers reporting their own dietary intake rather than their child's, children moving during body-composition measurement and re-setting pedometers. Resource and program management were excellent. Most families met home-program requirements (83%). Preliminary intervention outcomes were encouraging for fathers and children.

Conclusion

Program feasibility was demonstrated by excellent recruitment, attendance, acceptability, retention, program administration and promising preliminary intervention outcomes. A few data collection difficulties were identified. A larger-scale efficacy trial is warranted.

INTRODUCTION

The prevalence of overweight and obesity among children is a global health concern [1,2]. In Australia, 25% of children aged 2 to 4 years are considered overweight or obese, which increases their lifetime risk of many chronic conditions [3]. Unhealthy lifestyle behavior patterns are now common early in life [4,5] increasing children's risk of developing obesity [6] and related co-morbidities [7] later in life. Targeting health behaviors in early childhood is critical for obesity prevention [8]. Despite this, a Cochrane review of 153 childhood obesity prevention trials identified only 39 (25%) interventions which targeted children aged 0 to 5 years [9]. In studies that have targeted children aged 0 to 5 years, systematic reviews indicate that early childhood obesity interventions have only been modestly successful [9] with combined physical activity and dietary interventions demonstrating greater effectiveness than physical activity-only and diet-only interventions [9,10]. These reviews recommended further interventions in community and home-based settings since most are conducted in pre-school settings [9,10]. . One of the criticisms of these early childhood interventions has been that parental components are minimal [9]. This is a concern as parents' beliefs, behaviors, and parenting practices have a large impact on children's physical activity, screen time and dietary behaviors [11,12]. Another criticism of these programs is a lack of engagement of fathers. Despite a sociocultural shift whereby a greater proportion of fathers are primary caregivers for pre-school aged children, [13] a review of pediatric obesity treatment and prevention programs identified that fathers accounted for just 6% of parents who attended the programs [14]. This is a limitation of parenting programs as fathers' health behaviors and weight status are associated with childhood health behaviors and obesity [15,16].

To the authors' knowledge, very few programs have specifically targeted fathers and their preschool-aged children in a lifestyle intervention [13,14]. Thus, the aim of the current study was to assess the feasibility of a novel program designed to improve the physical activity and

dietary behaviors of preschool-aged children and their fathers. Specifically, program feasibility was evaluated with reference to 1) recruitment capability; 2) data collection procedures; 3) acceptability and suitability of the intervention program; and 4) program and resource management; and 5) the preliminary efficacy of the program on intervention outcomes.

METHODS

Study Design

This study was a nine-week single-arm, pre-post feasibility trial. Assessments were conducted at baseline and 3 months post-baseline.

Sample size and participants:

As this was a feasibility trial, no sample size calculations were conducted. A recruitment goal of 15 eligible father-child dyads was considered suitable as an optimal number for program delivery. Participants were recruited from Newcastle in New South Wales, Australia over 3 months between November 2017 and January 2018. Recruitment strategies included a university media release featured in local news outlets (newspaper, television news and radio), social media (Facebook and Twitter), distribution of flyers to local early childcare centres and emails to previous university programs participants.

Fathers were eligible if they i) were a biological father/stepfather/male guardian of a child aged 3-5 years, ii) lived with the child at least 50% of the week, and iii) were able to attend assessments and program sessions. Fathers who indicated existing health conditions in a pre-exercise screening survey required a doctor's clearance to enrol. Eligible children were of pre-school age (3-5 years) and not attending primary school.

Eligible father-child dyads were invited to baseline assessments at the University.

Prior to program enrolment, child assent was obtained, and fathers provided written, informed consent for themselves and their child.

Institutional ethics approval was obtained and the trial was prospectively registered (ACTRN12615000022561).

The Healthy Youngsters, Healthy Dads Intervention:

The Healthy Youngsters, Healthy Dads (HYHD) program was designed to educate and motivate fathers and their children to improve their physical activity and dietary behaviors. The structure and content were informed and adapted from our previous extensive formative research with fathers and primary-school aged children [17-19].

Briefly, the intervention, delivered at the University by members of the research team, included: i) a five-hour *dads-only workshop* focussing on evidence-based parenting skills to optimise family physical activity and dietary behaviours; ii) eight, weekly *sessions for fathers and children* with a weekly theme (e.g., physical activity; vegetables) including a 20-minute educational component delivered using an interactive, engaging PowerPoint presentation and a 55-minute practical component incorporating three major elements: rough and tumble play (i.e., play wrestling games), fundamental movement skills (FMS) (sport skill games) and fitness (active games promoting aerobic and muscular fitness); and iii) a *home-based program* including a handbook outlining a range of engaging, age-appropriate activities (e.g., make dad a "veggie man" snack) relating to the weekly theme as well as goal-setting and step-count monitoring, for the fathers and their children to complete at home together. Mothers and non-enrolled siblings were invited to attend in week 5 and were encouraged to participate in the home-based program. A detailed description of the intervention is shown in Table 1.

A key alteration from our previous parent-child programs to suit the younger age group included keeping fathers and children together for educational sessions [20]. This allowed fathers to help their children understand the content and assist with behavioral management. Core constructs from self-determination (i.e., autonomy, competence, relatedness) [21] and social cognitive (e.g., self-efficacy, goals, social support) [22] theories were used to increase participants' perceived capabilities and autonomous motivation for behavior change. Fathers were encouraged to role-model positive behaviors and become physical activity advocates for the benefit of their children, and vice versa ("reciprocal reinforcement") [20]. This operationalized the linked concepts of relatedness (i.e., desire to connect and care for others) and social support. Multiple options were provided for program activities and home tasks to increase the participants' sense of autonomy (i.e., choice and control). Activities were designed to promote participants' perceived competence (i.e., behavioral mastery) and self-efficacy by allowing them to experience success, regardless of age, fitness, or skill level.

Feasibility measures

The following *a priori* benchmarks were used to determine program feasibility. These were similar to previous feasibility trials including families [23-25].

Recruitment capability was considered feasible if the recruitment goal of 15 eligible father-child dyads could be achieved with an eligibility rate ≥60% (proportion of those who were eligible among those who completed the eligibility survey) [25].

Acceptability of data collection procedures was assessed as the ease/difficulty of measuring each outcome (e.g., child step counts, body composition, fundamental movement skills) and the success or otherwise of strategies to engage the children in the assessments (e.g., the use of a stamp collector card at each assessment station). After each assessment, researchers involved with data collection (n = 15) provided verbal feedback regarding their perceived

acceptability of data collection procedures which was documented by the research program manager.

Resource and program management was considered feasible if the research team had the resources required to conduct the intervention according to the proposed plan and approved ethical standards (i.e., expertise/skills, administrative capacity, equipment) and was subjectively assessed using evaluation of program management documentation and a debrief by the research team [26].

Attendance was assessed using the proportion of enrolled fathers who attended the father-only workshop and the average attendance rate at weekly father-and-youngster sessions, each with an 80% attendance rate benchmark [23].

Retention of dyads at the post-program assessments was assessed using the proportion completing all post-program assessments with the benchmark set at ≥85% [23-25].

Compliance with the home-based program was assessed by collecting home-program handbooks at the end of the last session and recording the number of home tasks completed by the fathers and their child. No benchmark was set for this item.

Program acceptability was assessed using a post-program process evaluation survey assessing participants' enjoyment, the usefulness of the program and satisfaction with program facilitators. Responses (on a 5-point Likert scale where strongly disagree=1 and strongly agree=5) to all questions were averaged and the benchmark for overall program acceptability was set at a mean score ≥4 out of 5 [24].

Preliminary intervention efficacy measures

Assessments were held in January 2018 (baseline) and April 2018 (3 months post-baseline) at the University of Newcastle, Australia. A detailed description of preliminary intervention efficacy measures and methods of data collection are shown in Supplementary Table 1. In

summary, data were collected for the following: *fathers' and children's* sociodemographic characteristics, pedometer step-count, co-physical activity (Youth Media Campaign Longitudinal Survey (adapted) [27]), screen-time (Adolescent Sedentary Activity Questionnaire (adapted) [28]), anthropometric measurements (e.g., weight, height, body fat mass), dietary intake (Australian Eating Survey (AES) adult [29] and (ACAES) child and adolescent [30,31] versions); *fathers'* moderate-to-vigorous intensity physical activity (MVPA) (modified Godin Leisure Time Exercise Questionnaire [32]), parenting (Inventory of Father Involvement and Activity Support Scale (explicit role-modelling scale [33]); *children's* object Fundamental Movement Skill competency (Test of Gross Motor Development-3 (TGMD-3) [34]), executive function (Head-Toes-Knees-Shoulders task [35]) and social-emotional well-being (Devereux Early Childhood Assessment Clinical Form (Self-Control and Emotional Control problems scales) [36,37]) and *fathers' and mothers'* physical activity and dietary parenting practices (Parenting for Eating and Activity Scale (PEAS) [38]) and co-parenting (short-from Co-parenting Relationship Scale (CRS) [39]).

Statistical analysis

Analyses were performed using SPSS Statistics 25 (IBM Inc. Armonk, NY). Descriptive analyses (percentage and frequency counts) were conducted to assess recruitment, attendance, retention and program satisfaction. Efficacy outcome data are presented as mean (SD) for continuous variables and as counts (percentages) for categorical variables. Paired t-test were used to compare mean scores at pre-and post-intervention and effect sizes were calculated using Cohen's d (d=M1–M2/σ pooled). Effect sizes were interpreted as small (d=0.20), medium (d=0.50) or large (d=0.80) [40].

RESULTS

Recruitment capability

Over three months, 39 fathers expressed interest in the HYHD feasibility trial. Of these, 61.5% (n=24) met eligibility criteria (Figure 1). Most had heard about the program through a friend/family member (62%) or social media (15%). A total of 24 fathers and 24 children from Newcastle, NSW, Australia attended baseline assessments, exceeding the recruitment target of 15 and 100% were retained at post-program assessments. Fathers were, on average, aged 38.3 years (SD 5.6), had a mean BMI of 27.1 (SD 4.3), 88% had post-school qualifications and all were employed and married or in a relationship. Children were, on average, aged 4.1 years (SD 0.5), 71% were of healthy weight and 48% were female. Participants were broadly representative of families in the Hunter Region of New South Wales, Australia. Participants' baseline characteristics are shown in Supplementary Table 2 and Table 2.

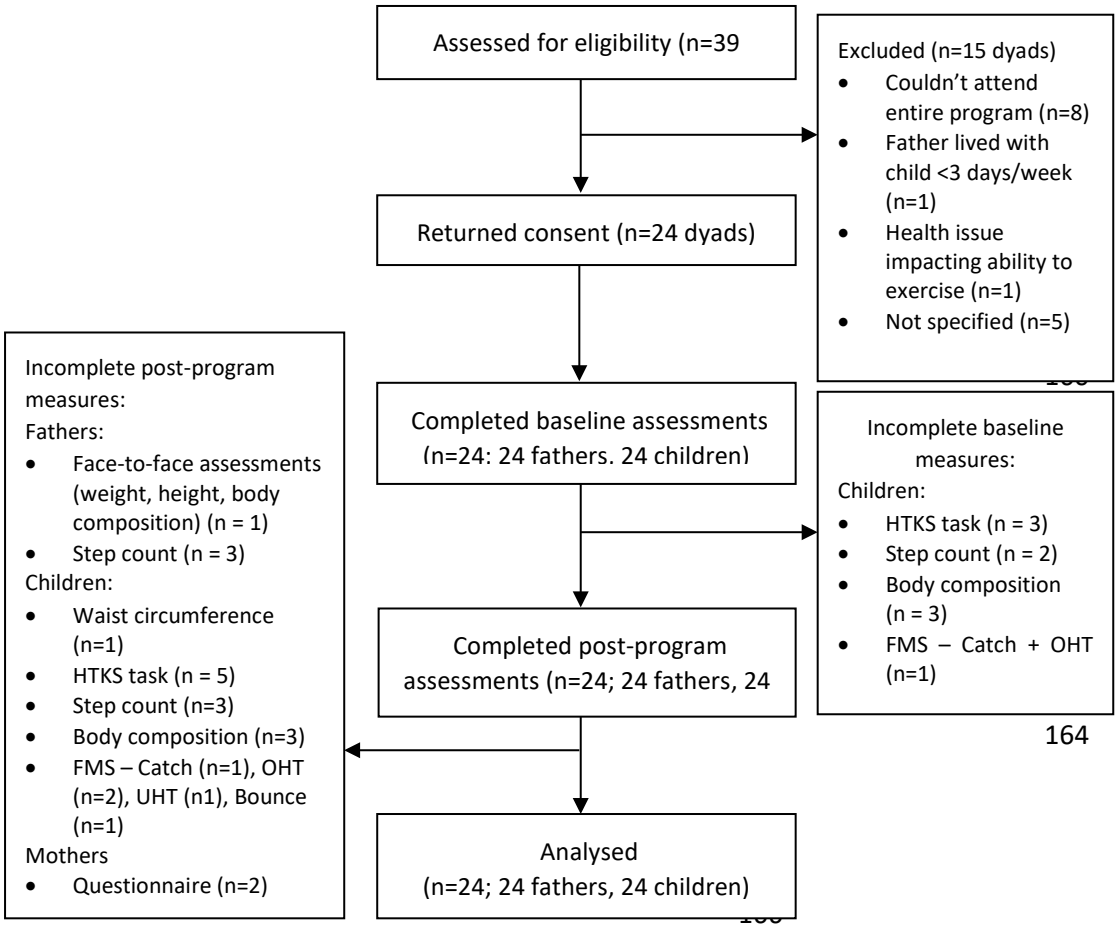

Figure 1. Participant flow through the feasibility trial

168 **Acceptability of data collection procedures**

169 Fathers and children completed all baseline and post-intervention assessments at the
170 University, except for the online AES which fathers completed at home. Mothers completed
171 online parenting questionnaires and the ACAES on behalf of their child at home given their
172 generally predominant role in food purchase, preparation and provision [41]. University-based
173 data collection procedures at each time point lasted approximately 60 minutes. All
174 participants completed all assessments at baseline and post-intervention indicating the length
175 and number of assessments were acceptable.

176 Most parents provided complete questionnaire data in a timely manner (see Figure 1). The
177 ACAES for children was completed by mothers. However, as the questions were phrased
178 "How many … do *you* eat?", approximately 46% of mothers provided their own personal
179 food recall rather than that of their participating child. This was identified due to the mother's
180 entering their own age and responses relating to alcohol intake being above zero (note: this
181 survey is validated for children aged 2 to 5 years [30]).

182 The pre-school-aged children's assessments for fundamental movement skills (TGDM-3),
183 executive function task (HTKS), step count (using pedometers) and anthropometric
184 measurements, were conducted with few concerns. However, some difficulties were
185 encountered during child assessments. For example, some children would not complete the
186 HTKS assessment without their father present in the room. As this is not part of the measure
187 protocol, these fathers were asked to sit at the back of the room and not engage with the child.
188 Body composition measurement was successful for all but three children at each assessment,
189 who were unable to stand sufficiently still or remain silent for two minutes on the body
190 composition machine. Wear-time compliance of the unsealed pedometers was a challenge for
191 some children, with some fathers reporting their child pressed the 'reset' button (n=2 at
192 baseline and n=3 at post-program). Strategies used to engage the children in assessments (e.g.

193 stamp collector card at each assessment station, daily sticker rewards for wearing
194 pedometers) were effective. While recognising that the ACAES survey would require more
195 detailed instructions for mothers and specific trouble-shooting strategies may at times be
196 required for individual child assessments, the majority of data were collected successfully
197 with relative ease. Therefore these procedures were found acceptable by research staff.

198 **Resources and management of the program**

199 Before the study began, a range of important project management tasks were completed
200 across several domains including: *participant recruitment* involving development of a
201 structured, multi-component campaign to target families (e.g., media releases, targeted
202 workplace emails, posters for local childcare centres); establishment of an *appropriate*
203 *location* with audio-visual equipment and large practical space for FMS assessments;
204 determining *suitable program timing* for participants (e.g., outside work-hours for fathers, not
205 too late for pre-schoolers); obtaining required *resources* such as data collection tools (e.g.,
206 bioelectrical impendence analyser, pedometers), program equipment (e.g., bats and balls) and
207 trained program delivery staff. All components were successfully undertaken according to
208 the proposed plan and approved ethical standards, thereby establishing the capacity to
209 implement the intervention.

210 **Attendance, retention and home-task compliance**

211 Attendance and retention rates exceeded the 80% target. In total, 100% (n=24) of fathers
212 attended the dads-only workshop and average attendance rate of father-child dyads across the
213 program was 88% (n=20). Retention was 100% (n=24) (Figure 1). On average, families
214 completed a very high proportion (83%) of the weekly home-program, with the proportion of
215 fathers fulfilling at least the minimum expectations for weekly home task of: Home challenge

= 91%; Sport Skills = 82%; Record step count = 65%; Co-physical activity with child = 88%; Review SMART goals = 91%; Dad task = 81%.

Program acceptability

Overall, participants provided very positive feedback on all program aspects. On a scale of 1 (poor) to 5 (excellent), fathers reported mean (SD) program quality satisfaction score of 4.6 (0.4) and satisfaction of facilitator quality was 4.9 (0.2). Program content quality was measured on a scale of 1 (not valuable) to 5 (very valuable), fathers reported a mean (SD) score of 4.4 (0.5). Program resources were also highly rated, scoring 4.3 (0.4) on a scale of 1 (strongly disagree) to 5 (strongly agree).

Participants were able to provide open-ended feedback about their experience of the program. The majority (n=20) provided positive feedback specifically around the valuable physical activity and nutrition education and activities, and the opportunity to spend one-on-one time with their children (Supplementary Table 3). Two participants suggested that the dads-only workshop take place during the week after work to avoid taking away from family time on the weekend and two participants recommended that Saturday mornings would be more suitable for the 8-weekly group sessions than Sundays, which are often considered a family day.

Preliminary intervention outcomes

Several outcome measures demonstrated improvements (Table 2). Medium-to-large effects were found for children's daily step counts (d=1.0), screen-time (d=0.8), FMS (d=1.0), executive functioning (d=0.6) and vegetable intake (d=0.5), and social-emotional wellbeing (reduced emotional control problems, d=0.5; improved self-control, d=0.6) as well as fathers' one-on-one co-physical activity (d=1.0), screen-time (d=1.4), role modelling for physical activity (d=0.5) and diet (d=0.8). Medium-to-large effects were also found for fathers', but

not mothers', physical activity and dietary parenting practices (fathers: control, *d*=1.38; praise, *d*=0.9; limit setting, *d*=0.6; monitoring, *d*=0.6), screen-use for entertaining child (fathers: *d*=0.7) and mothers' dinner-time practices (*d*=0.5).

There was a small effect on children's weight (*d*=0.2), BMIz (*d*=0.1) and body fat mass (*d*=0.3), which all increased, as well as father's daily step count (*d*=0.4), anthropometric outcomes (weight, waist, BMI and body fat mass all *d*=0.1) and mothers' co-parenting (*d*=0.3).

Minimal effects were found for children's waist circumference and other dietary intake measures and fathers' MVPA, dietary intake, father-child relationship, co-parenting or family mealtime practices.

DISCUSSION

This study assessed the feasibility of a novel lifestyle behavior change intervention for fathers and their pre-school-aged children. The results indicate the program met or exceeded all *a priori* benchmarks set for recruitment, attendance, retention and program satisfaction and demonstrated acceptable home program compliance, data collection procedures, resourcing and management of the program. Additionally, there were promising preliminary findings relating to intervention effects on both fathers' and pre-school-aged children's physical activity and dietary outcomes and fathers' parenting practices.

Despite fathers infrequently participating in parenting interventions [14], there was high interest among fathers (39 father-child dyads expressing an interest) to join the program. The use of recruitment materials utilising key "hooks" to entice fathers to enrol such as the use of words like "quality time", "fun", "sports skills" and "University-based" may have factored in the level of interest.

Overall, attendance was excellent with both the dads-only workshop (100%) and the average of weekly group sessions (88%) surpassing the attendance benchmarks. However, only 58% of participants attended the session held during the Easter holiday period. This is an important consideration for future family-based programs to ensure participants receive the maximum dose of the intervention. Retention was exceptional with 100% returning to be measured at the post-program follow-up.

These high attendance and retention rates are similar to a father and primary school-aged daughter activity program (attendance=89%, retention=93% fathers, 89% daughters [18]) and higher than several other mother-child ('Soul Mates': attendance= 67%, retention=76% [25]; 'KAN-DO': attendance=46%, retention=68% [42]; 'MADE4LIFE': attendance=82%, retention=93% [23]), father-child ('Healthy Dads, Healthy Kids'(HDHK) RCT: attendance=81%, retention=83% [17]; and HDHK Community RCT: attendance=71%, retention=81% [19]) and parent-preschool-aged child ('MEND 2-4': attendance=82%, retention=86% [43]) obesity prevention interventions.

The high attendance and retention rates demonstrated in this study may be a manifestation of the restrictive eligibility criteria which required participants to be available for all HYHD sessions and assessments. They may also be result of the high satisfaction with the program reported by participants which may have subsequently led to the high levels of weekly program engagement and an inclination to attend assessments.

Data collection procedures were generally successful. Given the strong retention, the requirement to complete assessments at the university did not appear to be unduly burdensome. Despite this, a few limitations associated with data collection were identified. Completion of the ACAES [31] by mothers on behalf of their children was particularly problematic. Almost half of mothers reported their own dietary behavior (n=11), despite multiple email and phone-call reminders that they should report on their participating child's

dietary intake. Any future studies will need to ensure surveys are worded in such a way that parents know they are reporting on their child's dietary intake and not their own (e.g., "How many pieces of fruit does *your child* eat?").

Pedometer wear-time compliance was generally good however occasionally problematic. For example, some children removed them, some forgot to replace pedometers after removing for a nap, and a couple of children reset their pedometer before the end of the day. For pragmatic and budget purposes, physical activity was measured using pedometers rather than more expensive accelerometers. However, the use of hip-worn pedometry has been found to be a reliable tool to assess general physical activity accumulation among pre-school children [44,45]. Further guidance and support for parents on specific strategies to maximise wear-time in children may improve compliance. Additionally, future research should consider the use of accelerometers to provide measures of physical activity intensity and duration although wear time issues might also pertain to accelerometers in this age-group.

Although a few problems were also encountered collecting fundamental movement skills (FMS) (TGDM-3) (e.g. refusal due to being upset/emotional or inattention to assessor instructions), executive function (HTKS) (e.g., refusal to complete measure without father in the room) and anthropometric assessments (e.g. inability to remain still on the bio-impedance machine). However, overall data collection was largely successful considering the very young age of child participants. Strategies to assist child compliance during assessments (e.g. stamp collector card at each assessment station) were generally effective and should be applied in future trials.

The program received highly positive feedback from participants in all aspects, achieving a score of 4.6 out of 5 points for overall program satisfaction. The very high participant satisfaction demonstrates the appeal and acceptability of the program. Several factors may have influenced this high level of satisfaction. The program structure and content were based

313 on rigorous formative research with fathers and their primary school aged children which
314 have already achieved high program satisfaction levels [17,18]. Additionally, careful
315 consideration was given to developing program content which encompassed the unique
316 values and preferences of the target sample and the incorporation of these elements across
317 four core program components (content, format, facilitator, pedagogy) [20].

318 To determine the potential efficacy of the intervention, anthropometric and behavioral
319 outcomes were collected. This feasibility study was not powered to detect changes in these
320 outcomes and analysed pre- and post-intervention measures without a control group.
321 However, promising results emerged with improvements in fathers' and children's step
322 counts and screen-time, children's dietary intake, executive function and social-emotional
323 well-being and fathers' anthropometric characteristics, co-physical activity and a number of
324 parenting practices. This indicates that program evaluation could progress to a randomized
325 controlled trial to determine efficacy.

326 Study strengths include the successful targeting and recruitment of fathers and their pre-
327 school-aged children into a program designed to improve their physical activity and dietary
328 behaviors and the diverse spread across socioeconomic status among participants. In addition
329 to the limitations associated with data collection discussed above, the instrument measuring
330 screen-time is validated for those aged 11-15 year but not pre-school aged children or adults.
331 Also, although not the primary focus of this feasibility study, the encouraging preliminary
332 efficacy of the intervention must be considered cautiously given the small sample and lack of
333 controls [46]. Furthermore, the delivery of the program by highly skilled facilitators may reduce
334 the generalizability of the results for effectiveness (e.g., community) trials.

335

336

Conclusion

The HYHD program was the first intervention designed to engage fathers and their pre-school-aged children to improve their physical activity and dietary behaviors. The feasibility of this program was demonstrated with excellent recruitment, acceptability, retention, capacity to administer the program and promising preliminary intervention outcomes. After addressing a small number of data collection difficulties, a randomised controlled efficacy trial appears warranted.

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Author Disclosure Statement

No competing financial interests exist.

Adherence to Ethical Standards

All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

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Table 1. Description of intervention components in the 'Healthy Youngsters, Healthy Dads' program

Intervention component	Overview	Detail	Behavior change techniques	Targeted theoretical mediators
'Dads-only' workshop	• 5-hours • Delivered by a male researcher with physical education qualifications. • Held one week prior to the weekly father-and-child sessions.	Topics covered: • Optimising health in the early years • The unique and powerful influence of fathers • Positive parenting strategies • Physical activity parenting • Nutrition and parenting practices • Screen-time parenting • Weight management for dads	• Social support (practical, emotional) • Increase positive emotions • Instructions on how to perform the behavior • Information about consequences (health, social and environmental, emotional) • Demonstration of the behavior • Graded tasks • Credible source	• Social support/ relatedness (SCT/SDT) • Autonomy (SDT) • Self-efficacy/ perceived competence (SCT/SDT) • Outcome expectations (SCT) • Goals (SCT)
Weekly group sessions for fathers and children	• 8 x weekly 75-minute sessions (20-minute *Education session* plus 55-minute *Practical session).* • Mothers/partners and siblings invited to attend week 5 session. • Delivered by one male and one female researcher with physical education qualifications.	*Education session:* • Icebreakers and overview of weekly focus which alternated between physical activity (e.g. rough and tumble play, sport skills) and healthy eating (e.g. vegetables, fruit). *Practical session* • Designed to increase pre-school-aged children's motivation and skills to engage in		

		physical activity fun and active father-child games. • Each session targeted rough and tumble play (15 min), sport skills (i.e., FMS) (15 min), and aerobic and muscular fitness (15 min). • Seven sports skills targeted (2/week): catch, kick, one-handed strike, two-handed strike, bounce, overhand throw and underhand throw.	• Identification of self as role model • Framing/reframing • Verbal persuasion about capability	
Home-based program	• Activity folder containing a range of engaging activities, challenges and sport skills. • One Yamax SW200 *pedometer* to assist with monitoring step counts. • Sticker chart to earn the animal sticker of the week (e.g. Charlie the Chimpanzee) for one home challenge and bonus stickers for completing more than one activity (e.g. apple, basketball).	Fathers asked to use activity folder each week and record completed home tasks: • Home challenges based on weekly theme (e.g., sock wrestle) • Sports skill games (e.g., capture the target) • Step count monitoring (using pedometer) • Co-physical activity (≥ 10-minute bouts) • SMART goals relating to physical activity, healthy eating, screen time and parenting • Dad task (e.g. eat dinner at the table)	• Material incentive • Instructions on how to perform the behavior • Graded tasks • Prompts/cues • Increase positive emotions • Goal setting • Action planning • Self-monitoring	• Goals (SCT) • Social support/ relatedness (SCT/SDT) • Autonomy • Self-efficacy /perceived competence (SCT/ SDT)

523 Abbreviations: SCT = social cognitive theory; SDT = self-determination theory; FMS= fundamental movement skills; SMART = Specific, Measurable, Achievable, Relevant, Timely.

Table 2. Changes in outcomes between baseline and post-intervention for study participants

Outcome	Baseline Mean (SD)	Post-intervention Mean (SD)	Mean difference (SD)	95% CI	t (df)	Cohen's d
Fathers						
Steps/day	8,932 (3,782)	10,463 (4,738)	1,531 (2,346)	463, 2,599	2.99 (20) **	0.4
MVPA (min/week)	252 (607)	558 (1,992)	306 (2,123)	-590, 1,202	0.71 (23)	0.2
Co-physical activity 1-on-1 (days/week)	1.5 (1.5)	3.1 (1.8)	1.6 (1.5)	1.0, 2.3	5.36 (23)***	1.0
Screen time of father (mins/day)	107 (53)	43 (37)	-64 (42)	-82, -47	-7.54 (23)***	1.4
Waist circumference (cm)	94.3 (11.4)	93.4 (11.7)	-0.9 (2.2)	-1.9, -0.0	-2.17 (22)*	0.1
Weight (kg)	85.9 (12.4)	85.1 (12.8)	-0.8 (1.3)	-1.3, -0.2	-2.96 (22) **	0.1
BMI	27.1 (4.4)	26.8 (4.6)	-0.3 (0.4)	-0.4, -0.1	-2.88 (22)**	0.1
Body fat mass (%)	21.5 (8.2)	20.6 (8.5)	-0.9 (2.0)	-1.7, 0.0	-2.07 (22)	0.1
Dietary intake						
Energy (kJ/day)	10,443 (2,377)	9,583 (2,277)	-860 (2,272)	-1,843, 122	-1.82 (22)	0.4
Vegetable (ARFS score)	13.4 (5.2)	14.4 (4.7)	1.0 (3.0)	-0.4, 2.3	1.52 (22)	0.2
Fruit (ARFS score)	5.7 (2.4)	5.7 (2.5)	0.0 (2.1)	-0.9, 0.9	0.10 (22)	0.0
Role modelling - Physical activity	2.9 (0.6)	3.2 (0.5)	0.3 (0.4)	0.1, 0.5	3.55 (23)**	0.5
Role modelling - Diet	3.1 (0.6)	3.5 (0.4)	0.4 (0.5)	0.2, 0.6	4.62 (23)***	0.8
Father-child relationship - Personal relationships	4.1 (0.5)	4.1 (0.6)	0.0 (0.4)	-0.1, 0.2	1.0 (23)	0.0

Father-child relationship - Disciplinary warmth	4.0 (0.5)	4.2 (0.5)	0.2 (0.4)	-0.0, 0.3	1.57 (23)	0.4
Physical activity and dietary parenting practices						
Limit setting	4.2 (0.8)	4.6 (0.4)	0.4 (0.6)	0.0, 0.6	2.42 (23)*	0.6
Monitoring	4.0 (0.6)	4.3 (0.4)	0.3 (0.5)	0.1, 0.6	3.13 (23)**	0.6
Disciplining	3.5 (1.1)	3.9 (1.1)	0.4 (1.3	-0.3, 1.0	1.27 (18)	0.4
Control	2.9 (0.6)	2.0 (0.7)	-0.9 (0.7)	-1.1, -0.6	-6.29 (23)***	1.4
Praise	3.9 (0.8)	4.5 (0.5)	0.6 (0.7)	0.3, 0.9	4.43 (23)***	0.9
Co-parenting	3.7 (0.4)	3.7 (0.4)	0.0 (0.4)	-0.2, 0.1	-0.84 (23)	0.0
Screen use for entertainment (child)	2.0 (0.7)	1.6 (0.5)	-0.4 (0.6)	-0.6, -0.1	-2.80 (23)*	0.7
Family mealtime practices - Breakfast	3.2 (2.2)	3.0 (1.7)	-0.2 (2.0)	-1.1, 0.6	-0.61 (23)	0.1
Family mealtime practices - Lunch	2.3 (1.3)	1.9 (1.1)	-0.4 (1.9)	-1.3, 0.4	-1.07 (23)	0.3
Family mealtime practices - Dinner	4.9 (2.0)	4.8 (1.8)	-0.1 (1.6)	-0.8, 0.6	-0.25 (23)	0.1
Children						
Steps/day (unadjusted)	8,044 (2,620)	10,948 (2,991)	2,904 (2,844)	1,574, 4,236	4.57 (19)***	1.0
Screen time of child (mins/day)	79 (41)	51 (31)	-28 (41)	-46.2, -9.7	-3.19 (21)**	0.8
Object control score (TGMD-3)	9.0 (5.1)	17.1 (9.3)	8.1 (6.0)	5.4, 10.9	6.17 (20)***	1.1
BMI-z score	0.3 (1.5)	0.5 (1.4)	0.2 (0.3)	0.1, 0.3	3.26 (22)**	0.1
Body fat mass (%)	18.2 (10.5)	21.1 (8.8)	2.9 (5.6)	0.1, 5.6	2.24 (18)*	0.3
Dietary intake						

Energy (kJ/day)	5,902 (2,676)	6,405 (3,605)	503 (3,124)	-1,385, 2,390	0.58 (12)	0.2
Non-Core (kJ/day)	1,800 (1,117)	1,766 (1,124)	-34 (748)	-508, 440	-0.16 (12)	0.0
Vegetable (ARFS score)	9.5 (3.0)	11.2 (3.5)	1.7 (2.1)	0.3, 3.0	2.745 (11)*	0.5
Fruit (ARFS score)	7.0 (1.9)	7.1 (1.4)	0.1 (1.6)	-0.9, 1.1	0.18 (11)	0.1
Executive function (HTKS)	15.2 (11.8)	23.2 (13.5)	8.0 (9.2)	3.4, 12.6	3.69 (17)**	0.6
Emotional control (father report)	14.1 (4.9)	11.9 (3.4)	-2.2 (4.7)	-4.1, -0.2	-2.28 (23)*	0.5
Self-control (father report)	18.4 (3.4)	20.5 (3.9)	2.1 (2.7)	1.0, 3.3	3.96 (23)**	0.6
Mothers						
Physical activity and dietary parenting practices						
Limit setting	4.5 (0.4)	4.7 (0.3)	0.1 (0.4)	-0.1, 0.3	1.44 (21)	0.6
Monitoring	4.3 (0.5)	4.2 (0.5)	-0.1 (0.4)	-0.3, 0.1	-0.97 (21)	0.2
Disciplining	3.9 (0.9)	3.4 (1.2)	-0.5 (0.8)	-0.9, 0.0	-2.05 (12)	0.5
Control	2.6 (0.7)	2.4 (0.9)	-0.2 (0.8)	-0.5, 0.2	-0.85 (21)	0.3
Co-parenting	3.6 (0.6)	3.4 (0.7)	-0.2 (0.4)	-0.4, -0.0	-2.61 (21)*	0.3
Screen use for entertainment (child)	0.6 (0.4)	0.5 (0.4)	-0.1 (0.4)	-0.3, 0.0	-1.92 (21)	0.3
Family mealtime practices - Breakfast	4.0 (2.3)	4.0 (2.0)	0.0 (2.1)	-0.9, 1.0	0.10 (21)	0.0
Family mealtime practices - Lunch	3.2 (2.0)	3.0 (1.7)	-0.2 (2.3)	-1.2, 0.9	-0.28 (21)	0.1
Family mealtime practices - Dinner	5.4 (1.6)	4.4 (2.4)	-1.0 (2.0)	-1.9, -0.1	-2.40 (21)	0.5

Abbreviations: BMI = body mass index (kg/m^2); MVPA = Moderate-to-vigorous intensity physical activity; ARFS = Australian Recommended Food Score; TGMD-3 = Test of Gross Motor Development-3; HTKS = head-toes-knees-shoulders task, maximum score = 40; *p<0.005; **p<0.01; ***p<0.001

526

Supplementary Table 1. Intervention Measures

Measure	Description
Fathers and children	
Socio-demographic characteristics	• Child and father's age. • Father's employment status, education level, country of birth, ethnicity and marital status
Physical Activity (steps/day)	• One week of pedometry using Yamax SW200 pedometers (Yamax Corporation, Kumamoto City, Japan). Validated in pre-school-aged children [1,2] and adults [3]. • Asked to wear all waking hours (except when it could get wet or damaged) and to record steps on a log sheet for seven consecutive days. • Daily step count averages were included in the final analysis if they had completed at least 4 days of pedometry. • Post intervention assessments were completed in the week after the final session. • Participants were given a pedometer log sheet to log non-wear time activities such as swimming and bike riding, including their intensities. • Children were provided with stickers as a motivation to wear their monitors.
Father-child co-physical activity	• Adapted item from the validated Youth Media Campaign Longitudinal Survey [4]. • Fathers reported on days per week they were physically active with their child one-on-one and with one or more family member.
Father-child relationship	• Personal Relationships and Disciplinary Warmth subscales of the reliable Parent-Child Relationships Questionnaire [5,6].

Weight	• Measured in light clothing, without shoes on a digital scale to 0.01 kg (model CH-150kp, A&D Mercury Pty Ltd, Australia). • Weight was recorded at least twice until two measures fell within a range of 0.1kg, averaged for the analysis.
Height	• Measured using the stretch stature method on an electronic stadiometer to 0.1 cm (model BSM370, Biospace, USA). • Height was be recorded at least twice until two measures fell within a range of 0.3cm, averaged for the analysis.
BMI	• Calculated using the standard formula, weight (kg)/height in m^2. • Children's BMI-z scores were calculated using age- and sex-adjusted standardized scores (z-scores) based upon the UK reference data [7] and LMS methods [8]. • International Obesity Task Force cut points were used to determine overweight or obesity [9].
Waist circumference (CM)	• Measured horizontally around the navel for both father and child with a non-extensible steel tape (KDSF10-02, KDS Corporation, Osaka, Japan). • Recorded at least twice until two measures fell within a range of 0.5 cm, averaged for the analysis. • A waist z-score was also calculated for children [10].
Body composition	• InBody720 bioelectrical impendence analyser, a multi-frequency bioimpedance device (Biospace Co., Ltd, Seoul, Korea) validated for use in pre-school aged children [11].
Fathers only	
Moderate-to-vigorous physical activity	• Average weekly MVPA measured using modified version of the valid and reliable Godin Leisure Time Exercise Questionnaire [12].

(MVPA)	• Participants reported average weekly bouts of moderate and vigorous physical activity and average bout length [13]. Values in each category were multiplied and summed to give an overall measure of weekly MVPA.
Physical Activity Role Modelling	• Explicit role modelling scale from the valid and reliable Activity Support Scale [14].
Screen time	• Adapted version of the Adolescent Sedentary Activity Questionnaire [15,16]. • Fathers reported the total time they spent sitting using screens (of any kind) for anything outside of work on each day in the previous week. • This adapted measure has shown good sensitivity to change in previous behavior change research [17].
Parenting responsibility	• Single item from the valid and reliable Inventory of Father Involvement [18].
Dietary intake	• Online Australian Eating Survey, a 120-item semi-quantitative Food Frequency Questionnaire (FFQ), validated in adults [19].
Children only	
Object Control Fundamental Movement Skill (FMS) Competency	• Assessed with seven object control skills described in the Test of Gross Motor Development (kicking, catching, two-handed strike at a stationary ball, one-handed strike, stationary dribble, overhand throw, and underhand throw [TGMD-3]) which is reliable and valid instrument for assessing FMS in pre-school children [20]. • After watching a live demonstration, children were filmed performing each skill twice and received a score of 0 or 1 for the presence or absence of various performance criteria (e.g., ball is caught by hands only).

	• Combined scores for both attempts across all skills represented the overall object control score.
Executive function	• Head-Toes-Knees-Shoulders task with good reliability in pre-school aged children [21]. • Children were first asked to touch their head, then to touch their toes. Children were then told that they were playing an "opposite game" in which they must touch the opposite part of the body than the experimenter said. • If a child scored 10 points or more on the first 10 items, a second series of 10 items was administered which included knees and shoulders • Maximum points a child could earn was 40.
Dietary intake (Mother proxy)	• For children, mothers completed the online Australian Child and Adolescent Eating Survey a 120-item semi-quantitative FFQ developed and validated for use with pre-school children [22,23].
Social-emotional well-being (Father proxy)	• Self-Control and Emotional Control problems scales from the Devereux Early Childhood Assessment Clinical Form father-report) a reliable and valid instrument for use in preschool children [24,25].
Screen time (Mother proxy)	• Adapted version of the Adolescent Sedentary Activity Questionnaire [15]. • Mother reported the total time their child spent sitting using screens (of any kind) on each day in the previous week. • This adapted measure has shown good sensitivity to change in previous behavior change research [17].
Fathers and mothers	
Physical activity and dietary parenting practices	• Scales from the valid and reliable Parenting for Eating and Activity Scale to assess their control, limit setting, discipline and monitoring in relation to their child's physical activity and screen time [26].

Co-parenting	• 14-item short form of the valid and reliable Co-parenting Relationship Scale measured both mothers and fathers current relationship (i.e. partner they reside with) [27].

527

Supplementary Table 1. Intervention Measures

Measure	Description
Fathers and children	
Socio-demographic characteristics	• Child and father's age. • Father's employment status, education level, country of birth, ethnicity and marital status
Physical Activity (steps/day)	• One week of pedometry using Yamax SW200 pedometers (Yamax Corporation, Kumamoto City, Japan). Validated in pre-school-aged children [1,2] and adults [3]. • Asked to wear all waking hours (except when it could get wet or damaged) and to record steps on a log sheet for seven consecutive days. • Daily step count averages were included in the final analysis if they had completed at least 4 days of pedometry. • Post intervention assessments were completed in the week after the final session. • Participants were given a pedometer log sheet to log non-wear time activities such as swimming and bike riding, including their intensities. • Children were provided with stickers as a motivation to wear their monitors.
Father-child co-physical activity	• Adapted item from the validated Youth Media Campaign Longitudinal Survey [4]. • Fathers reported on days per week they were physically active with their child one-on-one and with one or more family member.
Father-child relationship	• Personal Relationships and Disciplinary Warmth subscales of the reliable Parent-Child Relationships Questionnaire [5,6].
Weight	• Measured in light clothing, without shoes on a digital scale to 0.01 kg (model CH-150kp, A&D Mercury Pty Ltd, Australia).

	• Weight was recorded at least twice until two measures fell within a range of 0.1kg, averaged for the analysis.
Height	• Measured using the stretch stature method on an electronic stadiometer to 0.1 cm (model BSM370, Biospace, USA). • Height was be recorded at least twice until two measures fell within a range of 0.3cm, averaged for the analysis.
BMI	• Calculated using the standard formula, weight (kg)/height in m^2. • Children's BMI-z scores were calculated using age- and sex-adjusted standardized scores (z-scores) based upon the UK reference data [7] and LMS methods [8]. • International Obesity Task Force cut points were used to determine overweight or obesity [9].
Waist circumference (CM)	• Measured horizontally around the navel for both father and child with a non-extensible steel tape (KDSF10-02, KDS Corporation, Osaka, Japan). • Recorded at least twice until two measures fell within a range of 0.5 cm, averaged for the analysis. • A waist z-score was also calculated for children [10].
Body composition	• InBody720 bioelectrical impendence analyser, a multi-frequency bioimpedance device (Biospace Co., Ltd, Seoul, Korea) validated for use in pre-school aged children [11].
Fathers only	
Moderate-to-vigorous physical activity (MVPA)	• Average weekly MVPA measured using modified version of the valid and reliable Godin Leisure Time Exercise Questionnaire [12]. • Participants reported average weekly bouts of moderate and vigorous physical activity and average bout length [13]. Values in each category were multiplied and summed to give an overall measure of weekly MVPA.

Physical Activity Role Modelling	• Explicit role modelling scale from the valid and reliable Activity Support Scale [14].
Screen time	• Adapted version of the Adolescent Sedentary Activity Questionnaire [15,16]. • Fathers reported the total time they spent sitting using screens (of any kind) for anything outside of work on each day in the previous week. • This adapted measure has shown good sensitivity to change in previous behavior change research [17].
Parenting responsibility	• Single item from the valid and reliable Inventory of Father Involvement [18].
Dietary intake	• Online Australian Eating Survey, a 120-item semi-quantitative Food Frequency Questionnaire (FFQ), validated in adults [19].
Children only	
Object Control Fundamental Movement Skill (FMS) Competency	• Assessed with seven object control skills described in the Test of Gross Motor Development (kicking, catching, two-handed strike at a stationary ball, one-handed strike, stationary dribble, overhand throw, and underhand throw [TGMD-3]) which is reliable and valid instrument for assessing FMS in pre-school children [20]. • After watching a live demonstration, children were filmed performing each skill twice and received a score of 0 or 1 for the presence or absence of various performance criteria (e.g., ball is caught by hands only). • Combined scores for both attempts across all skills represented the overall object control score.
Executive function	• Head-Toes-Knees-Shoulders task with good reliability in pre-school aged children [21]. • Children were first asked to touch their head, then to touch their toes. Children were then told that they were playing an “opposite game” in

	which they must touch the opposite part of the body than the experimenter said. • If a child scored 10 points or more on the first 10 items, a second series of 10 items was administered which included knees and shoulders • Maximum points a child could earn was 40.
Dietary intake (Mother proxy)	• For children, mothers completed the online Australian Child and Adolescent Eating Survey a 120-item semi-quantitative FFQ developed and validated for use with pre-school children [22,23].
Social-emotional well-being (Father proxy)	• Self-Control and Emotional Control problems scales from the Devereux Early Childhood Assessment Clinical Form father-report) a reliable and valid instrument for use in preschool children [24,25].
Screen time (Mother proxy)	• Adapted version of the Adolescent Sedentary Activity Questionnaire [15]. • Mother reported the total time their child spent sitting using screens (of any kind) on each day in the previous week. • This adapted measure has shown good sensitivity to change in previous behavior change research [17].
Fathers and mothers	
Physical activity and dietary parenting practices	• Scales from the valid and reliable Parenting for Eating and Activity Scale to assess their control, limit setting, discipline and monitoring in relation to their child's physical activity and screen time [26].
Co-parenting	• 14-item short form of the valid and reliable Co-parenting Relationship Scale measured both mothers and fathers current relationship (i.e. partner they reside with) [27].

Abbreviations: BMI = body mass index (kg/m2); LMS = Least Mean Square; MVPA = moderate-to-vigorous physical activity; FFQ = food frequency questionnaire; TGMD-3 = Test of Gross Motor Development-3

Supplementary Table 2. Baseline characteristics of fathers and children

Fathers (n = 24)	**M (SD), n (%)**
Age (years), M (SD)	38.3 (5.6)
Height (cm), M (SD)	178.4 (6.4)
BMI Category, n (%)	
Healthy weight	7 (29)
Overweight/obese	17 (71)
Education level, n (%)	
School certificate (year 10 or equivalent)	1 (4)
Higher school certificate (Year 12 or equivalent)	2 (8)
Post-school qualifications[a]	21 (88)
Employment Status, n (%)	
Full-time	21 (88)
Part-time	3 (12)
Born in Australia[b], n (%)	21 (88)
SES[c], n (%)	
1 (most disadvantaged)	1 (4)
2	6 (24)
3	11 (44)
4	5 (20)
5 (most advantaged)	1 (4)
Relationship status, n (%)	
In a relationship	1 (4)
Married/de facto	23 (96)
Children (n = 24)	**M (SD), n (%)**
Age (years), M (SD)	4.1 (0.5)
Female, n (%)	11 (48)

Weight (kg), M (SD)	17.6 (3.6)
Height (c), M (SD)	104.0 (6.1)
BMI (kg m ^{2}), M (SD)	16.3 (0.3)
BMI z-score, M (SD)	0.23 (1.5)
BMI z-score category, n (%)	
Thin (<-2.0)	2 (8.3)
Healthy weight (-2.0 to 1.0)	17 (70.8)
Risk of overweight (>1.0)	4 (16.7)
Overweight (>2.0)	0 (0.0)
Obese (>3.0)	1 (4.2)

Abbreviations: M = mean; SD = standard deviation; BMI = body mass index (kg/m^2); SES = socio-economic status.
Notes: a. Post-school qualifications include: Trade / Apprenticeship, Certificate / Diploma, University Degree, Higher University Degree; b. Malaysia (n=1), Indonesia (n=1), New Zealand (n=1); c. Socioeconomic status by population quintile for SEIFA Index of Relative Socioeconomic Advantage and Disadvantage.

Supplementary Table 3. Participant quotes in response to the questions "What did you like about the HYHD program?" and "What was the best impact of the HYHD program?"
One-on-one Time
Ability to spend 1-on-1 time with my youngster.
Having one on one time with my youngster. Tough to get this with a young, large family.
We have 3 kids so it can be difficult to get quality 1 on 1 time with them. This program allowed me to get that and provides activities that ensure that will be ongoing
Always fun for both youngster and I, long term benefits for entire family, positive approach to being healthy.
Opportunity to spend quality time with my daughter and develop fundamental movement skills in a fun environment.
Parenting Skills
I have benefited from many of the parenting skills learned as well as adding a number of activities to enhance our fun times and play. Everyone loved getting involved with the home activities.
Learning new techniques to provide better outcomes for myself and my kids.
Made me take a step back and look at all the areas of being a parent and how/where I can improve; gave me and my son a fun/bond each week.
Physical Activity/Healthy Lifestyle Skills
I enjoyed all aspects of the HYHD program. Being involved with my daughter in such a hands on way was really rewarding and enjoyable. All sessions were professional and engaging. I enjoyed the weekly messages and activities focused on the fundamental movement skills.
The realization that you can have fun doing exercise with the kids without them really knowing and it can be done without taking up a lot of time.
Spending time with my daughter, having fun with my daughter, playing sport/activities outside/during the week as part of the program.

The exposure to the importance of choices early in life for children both foods and lifestyle. Making activities fun and enjoyable for children and parents to share was invaluable.
The best impact from the program was the delivery and reinforcement of the key health issues (veggies, fruit, water etc), as well as the focus on fundamental movement skills which resulted in my daughter engagement and improvement in these skills.

Abbreviations: HYHD = Healthy Youngsters Healthy Dads

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