# The 'Healthy Dads, Healthy Kids' randomized controlled trial: Efficacy of a healthy lifestyle program for overweight fathers and their children

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## ABSTRACT

Objective: To evaluate the feasibility and efficacy of the 'Healthy Dads, Healthy Kids' (HDHK) program which was designed to help overweight fathers lose weight and role model positive health behaviors to their children.

Design: Randomized controlled trial

Participants: Fifty-three overweight/obese men (mean [sd] age = 40.6 [7.1] years; BMI = 33.2 [3.9]) and their primary school-aged children (n =71, 54% boys; mean [sd] age = 8.2 [2.0] years) were randomly assigned (family unit) to either (i) HDHK program (n = 26 fathers, n = 39 children) or (ii) a wait-list control group (n = 27 fathers, n = 32 children).

Intervention: Fathers in the 3-month program attended eight face-to-face education sessions. Children attended three of these sessions.

Outcomes: Primary outcome was fathers' weight. Fathers and their children were assessed at baseline, 3- and 6-month follow-up for weight, waist circumference, BMI, blood pressure, resting heart rate, objectively measured physical activity and self-reported dietary intake.

Results: Intention-to-treat analysis revealed significant between group differences at 6 months for weight loss ($P$ <.001), with HDHK fathers losing more weight (-7.6kg; 95% CI -9.2, -6.0; $d$ = .54) than control group fathers (0.0kg; 95% CI -1.4, 1.6). Significant treatment effects ($P$ < .05) were also found for waist circumference ($d$ = .62), BMI ($d$ = .53), blood pressure ($d$ = .92), resting heart rate ($d$ = .60) and physical activity ($d$ = .92) but not for dietary intake. In children, significant treatment effects ($P$ < .05) were found for physical activity ($d$ = .74), resting heart rate ($d$ = .51) and dietary intake ($d$ = .84).

Conclusion: The HDHK program resulted in significant weight loss and improved health-related outcomes in fathers and improved eating and physical activity among children. Targeting fathers is a novel and efficacious approach to improving health behaviours in their children.

Keywords: weight loss, men, obesity, children, fathers, intervention

Trial Registration: Australian New Zealand Clinical Trials Registry No: ACTRN12609000855224

# INTRODUCTION

It is well established that obesity is associated with a range of adverse physiological and psychological health consequences (1). In Australia, two thirds of men are overweight or obese, and these statistics are similar in many developed countries (2). Yet men are less likely to attempt weight loss than women (3) and are notoriously difficult to recruit to weight loss programs (4). In addition to the health consequences of being obese as an adult male, those who are fathers also place their child at increased risk for obesity. Whitaker et al. (5) found that obese children with an obese father were nearly three times more likely to remain obese as an adult compared with those children whose father was not obese. Obesity in fathers has also been found to be associated with a four-fold increase in the risk of obesity for both sons and daughters at 18 years of age, which further increases children's risk of various lifestyle diseases in adulthood (6).

It is well established that parents have a critical influence on the development of positive health behaviors in children (7). Parents influence the food and physical activity home environment through their own behaviors, attitudes, modeling, parenting styles and child feeding practices (8, 9). Studies have shown that parental eating and feeding behaviors influence the eating habits of their children (10, 11) and physically active parents more are likely to have physically active children (12). While there is some consensus in the literature that lifestyle interventions for children should involve parents as key agents of change, systematic reviews highlight the uncertainty around optimal strategies to target and involve parents (13, 14). Therefore, a research priority is to evaluate the feasibility and efficacy of well-designed studies that target parental physical activity and dietary behaviors to influence both the parent and the child.

However, family-based interventions have mostly engaged mothers (13). Fathers have not been exclusively targeted and their influence on children's physical activity and eating behaviour is commonly overlooked. A number of studies have demonstrated the relationship between mothers' health and behaviors and their children's well-being but the specific influence of fathers on their children has only recently been examined (15). Wake et al. (16) demonstrated that it was the parenting styles and behaviors of fathers, and not mothers, that predicted preschool children's overweight status. Similarly, Stein et al. found that fathers' parenting style predicted better maintenance of weight loss in obese children (17). Although a body of evidence is accumulating relating to the role of the father in a child's development, there is a paucity of experimental research on the impact of fathers on children's physical activity and dietary habits (15).

The primary aim of this RCT was to evaluate the feasibility and efficacy of a program that targeted overweight/obese fathers to lose weight, and in turn act as role models to promote positive physical activity and eating behaviors for their children. We hypothesized that health outcomes and behaviors of both fathers and children would improve in the intervention group when compared to a wait-list control group at 6-month follow-up. The design, conduct and reporting of this study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (18).

## METHODS

### *Participants*

Overweight or obese (BMI between 25 and 40kg/m$^2$) men with a child aged between 5 and 12 years of age (i.e. primary school age) were recruited from the local community via media releases, school newsletters and paid advertisements in local newspapers in August/September 2008. Men were screened for eligibility via telephone. Ineligibility criteria included a history of major medical problems such as heart disease in the last five years, diabetes, orthopaedic or joint problems that would be a barrier to physical activity, recent weight loss of ≥4.5kg, or taking medications that might affect body weight. Fathers with a child with extreme obesity (BMI z-score > 4) were also excluded. All fathers needed to have Internet access and were asked to not participate in other weight loss programs during the study. Fathers completed a pre-exercise risk assessment screening questionnaire (19) and provided written informed consent, as well as child assent. Ethics approval was obtained from the University of Newcastle Human Research Ethics Committee.

*Study design*

Participants were randomly allocated to one of two groups: the 'Healthy Dads, Healthy Kids' (HDHK) program or a wait-list control group. Based on 80% power to detect a significant weight loss difference between groups of 3kg, assuming SD = 5 ($P$ = 0.05, two-sided) a sample size of 18 fathers for each group was needed at 6 months. Assuming a 20% attrition rate, a total sample of 44 subjects was required. The random allocation sequence was generated by a computer-based random number-producing algorithm in block lengths of six to ensure an equal chance of allocation to each group. To ensure concealment, the sequence was generated by a statistician and given to the project manager. Randomization was completed by a researcher who was not involved in the assessment of participants and the allocation sequence was concealed when enrolling participants.

Outcome measures were obtained from all participants at baseline (October, 2008) and at 3-months (February, 2009) and 6-months (May, 2009) from baseline. Measurements were taken in the Human Performance Laboratory at the University of Newcastle (Australia) using the same instruments at each time point. Participants were blind to group allocation at baseline assessment. Once baseline assessments were completed, participants received a sealed envelope with a note advising their group allocation. Assessors were instructed to not ask questions that might reveal the participants' group allocation at follow-up assessments. Although it was our intention to blind assessors at follow up, it was not possible to keep assessors completely blinded as there were a few cases of treatment group families (and in particular, children) mentioning aspects of their program involvement or wearing their program t-shirts to follow-up assessment sessions. The wait-list control group received no information or intervention before attending the 3- and 6-month follow-up assessment sessions.

*The HDHK program*

The 3-month HDHK program involved fathers attending eight face-to-face group sessions (75 minutes each) starting in October 2008. Five group sessions were for fathers only, and were delivered by one of the male researchers (PJM) at the University of Newcastle. Three of the group sessions were practical and involved both fathers and children participating together. These were conducted at the University recreation centre and delivered by two of the male researchers (PJM and DRL), both qualified teachers with expertise in physical education. The total program contact time was 600 minutes. The program aims were to help fathers achieve their weight loss goals, become healthy role models, and promote healthy behaviors for their children. Table 1 details the specific HDHK program content, intervention strategies and alignment with theoretical constructs using the taxonomy of behavior change strategies identified by Abraham and Michie (20).

The HDHK program was based on Bandura's Social Cognitive Theory (SCT) (21) and Family Systems Theory (FST) (22) . Key SCT variables were targeted and operationalized including self-efficacy, outcome expectations, self-monitoring, goal setting, perceived facilitators and barriers to changes, role modeling and social support. FST postulates a complex theoretical framework of reciprocal relationships among family members. That is, when a parent changes his or her physical activity and dietary behaviours this will be reflected in the child's behavior (23). HDHK aimed to provide fathers with the education and skills important for long-term behavior change. The fathers were provided with evidence-based information about reducing health risks and behavior change and encouraged to model more appropriate health behaviors as key decision makers in family units. HDHK taught fathers about the importance of spending quality time with their children and used healthy eating and physical activity as the medium to engage fathers with their children.

The physical activity sessions for fathers emphasized modeling, reinforcing and providing opportunities and removing barriers for physical activity. The four major focus areas of the father/child physical activity sessions were (i) fundamental movement skills, (ii) rough and tumble play (iii) health-related fitness, and (iv) fun and active games.

The nutrition components of the sessions were developed by Accredited Practicing Dietitians (CEC & TLB) and modeled on a previous successful intervention (24). Sessions on healthy eating for families focused on various aspects of parental influence on children's dietary intake incorporating Satter's (25) 'trust' paradigm, which suggests parents should supply healthy foods and a supportive eating environment and children can decide when and how much to eat. Sessions focused on promoting a 'do as I do' and not a 'do as I say' philosophy and making small changes, building on initial success and setting up a home environment where sustainable healthy family eating patterns could be established. The dietary component focused on a covert parenting style to facilitate better dietary choices in children's intake (26).

Although mothers did not attend sessions, fathers were encouraged to enhance social support for their child's efforts and consider strategies to involve mothers. The face-to-face sessions were supplemented by resources including a physical activity handbook, a weight loss handbook for men, a program folder with session outlines and an online component. Fathers were instructed to access a publicly accessible and free website *Calorie King*$^{TM}$ (www.calorieking.com.au) and to self-monitor their weight, exercise and dietary intake during the program, a strategy successfully used in a previous study with overweight/obese men (27). Men also weighed in at the beginning of each session and recorded their body weight on a chart at the front of their program folders.

*Outcome measures*

Baseline assessments were taken 1-2 weeks before the program started. Assessors were trained by the same experienced researcher and for anthropometric measurements used the protocols prescribed by the International Society for the Advancement of Kinanthropometry (28). The primary outcome measure was change in body weight of the fathers (kg and percent change from baseline) at 6-month follow-up. Weight was measured with fathers wearing light clothing, without shoes on a digital scale to 0.1kg (model CH-150kp, A&D Mercury Pty Ltd, Australia). A similar protocol was followed to record children's weight.

*Secondary outcomes for fathers and children*

*BMI*: Height was measured to 0.1 cm using the stretch stature method and a stadiometer (VR High Speed Counter) (Harpenden/Holtain, Mentone Education Centre, Morrabin, Victoria). BMI was calculated using the standard equation (weight [kg]/height[m]$^2$). Height and weight were recorded twice and the average of the two measures reported. For children, height and weight were used to calculate BMI (kg/m$^2$) and age- and sex-adjusted standardized scores (*z*-scores) based upon the UK reference data (29) and LMS methods (30). International Obesity Task Force cut points were used to determine overweight or obesity (31).

*Waist circumference:* Waist circumference was measured at two points (i) level with the umbilicus and (ii) at the narrowest point. Each measurement was recorded with a non-extensible steel tape (KDSF10-02, KDS Corporation, Osaka, Japan). Two measures were taken and if the measures differed by more than one centimetre, a third was recorded. The average of the measures was reported and a waist *z*-score calculated for children (32).

*Blood Pressure and Resting Heart Rate (RHR):* Systolic and diastolic blood pressures were measured using a NISSEI/DS-105E digital electronic blood pressure monitor (Nihon Seimitsu Sokki Co. Ltd., Gunma, Japan) under standardized procedures. Participants were seated for at least five minutes before blood pressure and RHR was recorded. Blood pressure and RHR were measured three times and the average of the three measures was reported.

*Physical activity:* Yamax SW700 pedometers (Yamax Corporation, Kumamoto City, Japan) were used to objectively measure physical activity. Participants were asked to wear pedometers for seven consecutive days and keep to their normal routine. At baseline assessments, participants were instructed on how to attach the pedometers (at the waist on the right hand side) and asked to remove the pedometers only when sleeping, when the pedometer might get wet (e.g. swimming, showering) or during contact sports. At the end of the day participants were instructed to record their steps and reset their pedometers to zero. Once seven days of monitoring had been completed, participants were instructed to place the pedometer and record sheet in the prepaid envelope provided and return to the research team. Participants were included in all analyses if they had completed at least four weekdays of pedometer monitoring and one weekend day. Physical activity variability for the seven day monitoring period was explored using intraclass correlation coefficients (ICCs). The ICC (95% confidence intervals) for mean steps/day for fathers was .83 (.74 to .89) for seven days and for children was .79 (.70 to .86) for seven days.

*Dietary intake:* For fathers, dietary intake was measured using the Dietary Questionnaire for Epidemiological Studies (DQES) Version 2, Food Frequency Questionnaire (FFQ) from the Cancer Council Victoria (33). It provides a detailed summary of food intake (34) and was developed specifically for use in Australian adults by the Cancer Council of Victoria and both the development of the questionnaire (35) and its validation have been reported previously (36). Fathers total energy intake was calculated at each time point. For children, their mothers completed the Australian Child and Adolescent Eating Survey (ACAES), a 137-item semi-quantitative FFQ developed and validated for use with Australian children, aged 10 to 16 years (37). ACAES has also been validated for younger children aged 5-9 years for parent-reported fruit and vegetable intake using plasma carotenoid concentrations (38). Children's dietary intake was adjusted relative to body weight and kJ/kg reported. At 3- and 6-month assessments, participants and mothers were instructed to report on the previous 3-month dietary intake.

*Additional information*

*Socio-demographic information*: Age and socioeconomic status (SES) data were collected. SES was based on postal code of residence using the Index of Relative Socioeconomic Advantage and Disadvantage from the Australian Bureau of Statistics census-based Socio-Economic Indexes for Areas (SEIFA) (39).

*Process evaluation*

The feasibility of the program was evaluated using a number of metrics including recruitment (achievement of target sample size), retention (retention rates at 6-month follow-up) and attendance (at program sessions). Fathers also completed a 43-item process questionnaire to determine level of satisfaction with the program. Questions were focused on the timing of the program, self-monitoring, quality of instructors, quality of the program, impact of the program on behaviours, impact of the program on the family, use of the website, social support, and levels of overall satisfaction. A 5-point Likert scale anchored from (1) strongly disagree to (5) strongly agree was used. Adherence to self-monitoring was determined by total number of daily diet entries, total number of daily exercise entries and total number of weekly weigh-ins which were calculated from website usage data.

*Analysis*

Analyses were performed using PASW Statistics 17 (SPSS Inc. Chicago, IL). Data are presented as mean (SD) for continuous variables and counts (percentages) for categorical variables. All variables were examined to determine whether they satisfied normality criteria. Characteristics of completers versus dropouts were tested using independent *t* tests for continuous variables and chi-squared ($\chi^2$) tests for categorical variables. The significance level was set at 0.05 for all analyses. Analyses were performed separately for fathers and children and included all randomized participants. Linear mixed models were fitted with an unstructured covariance structure for all primary and secondary outcomes. Differences of means and 95% confidence intervals (CIs) were determined using the linear mixed models.

Mixed models were used to assess all outcomes for the impact of group (Intervention and control), time (treated as categorical with levels baseline, 3-months and 6-months) and the group-by-time interaction, these three terms forming the base model. This approach was preferred to using baseline scores as covariates, as the baseline scores for subjects who dropped out at 3-months and/or 6-months were retained consistent with an intention-to-treat (ITT) analysis. Mixed models are more robust to the biases of missing data, and provide better control of Type 1 and Type 2 errors than last observation carried forward (LOCF) ANOVA (40). Similarly, imputation methods such as LOCF or baseline carried forward may bias results towards the null in obesity trials where untreated overweight men are likely to increase their weight. Age, SES and sex of the child were examined as covariates to see if they contributed significantly to the models. If a covariate was significant, two-way interactions with time and treatment were also examined and all significant terms were added to the final model to adjust the results for these effects. Effect sizes were determined using Cohen's *d* (41) and calculated using mean differences and the pooled standard deviation of the group ($d = M_1 - M_2 / \sigma_{pooled}$). Effect sizes were interpreted as small ($d = .20$), medium ($d = .50$) or large ($d = .80$) (41).

## RESULTS

*Participant flow*

Figure 1 illustrates the flow of participants through the trial. A total of 107 men responded to the HDHK recruitment materials with most participants recruited in response to notices placed in school newsletters. Seventy men were eligible for the study but 17 men were not randomized as no consent was received. In total, 53 overweight or obese fathers and their children (n = 71) attended baseline assessments and were randomized by family unit, resulting in an overall recruitment rate of 50%. In terms of retention, measurements were obtained for 83% of the sample at 3- and 6-months (n = 44). There was no difference in retention between the HDHK and control groups at 3- ($\chi^2 = 1.1$, df = 1, $P = .30$) or 6-months ($\chi^2 = 3.1$, df = 1, $P = .08$). All randomized participants with baseline data (n = 53 fathers, n = 71 children) were analysed for outcomes at 3- and 6-months. There were no significant differences ($P > .05$) in baseline characteristics between those lost to follow-up and those retained at 6-months for weight or any of the secondary outcomes for fathers or children.

*Baseline data*

Table 2 presents the baseline characteristics of the fathers. Fathers' mean (SD) age was 40.6 years (7.1) and mean BMI was 33.2 (3.9). Mean weight and waist circumference were 105.9kg (13.5) and 111.2cm (10.0), respectively with 77.4% of the sample considered obese (BMI>30). Table 3 presents baseline characteristics of the children (53.5% boys). Mean (SD) age for the children was 8.2 (2.0) years and mean BMI *z*-score was 0.7(1.2) with 19.7% and 9.9% of the sample overweight or obese, respectively. There were no baseline differences between men randomized to the HDHK or control groups; however, it appeared that children in the control group were more likely to be overweight/obese.

*Change in primary outcome for fathers*

Figure 2 shows the mean change in absolute body weight by treatment group. There was a significant treatment effect for change in weight at 3- and 6-month follow-up ($P < .001$; $d = .54$) (see Table 4 also). Weight loss as a percentage of baseline weight was also calculated at 3- and 6-months and there was a significant difference in percentage weight loss between groups ($P < .001$). Mean percentage weight loss in the HDHK group was 6.4% at 3 months and 7.4% at 6 months. Mean percentage weight loss in the control group was 0.3% at 3 months and 0.2% at 6 months. At 6 months, 85% of men in the HDHK group had lost more than 5% of their baseline weight.

*Change in secondary outcomes for fathers*

Significant treatment effects were found from baseline to 3 and 6 months for waist circumference (umbilicus) ($P < .001$); waist circumference (narrowest point) ($P < .001$); BMI ($P < .001$); systolic ($P = .01$) and diastolic ($P = .04$) blood pressure; resting heart rate ($P = .01$); and mean steps/day ($P = .002$). Medium-to-large effect sizes (range from d = .53 - .92) were found for all secondary outcomes. While there was a significant time effect for kJ intake ($P < .001$), no group-by-time effect was found ($P > .05$).

*Change in outcomes for children*

Results for outcome variables for children are displayed in Table 5. There were significant group-by-time differences for mean steps/day ($P < .001$; $d = .74$), resting heart rate ($P = .01$; $d = .51$) and kJ/kg ($P = .01$, $d = .74$) at 3- and 6-months. There were no significant between group differences for blood pressure ($P > .05$). Anthropometric data are also provided in Table 5. No significant group differences were found for waist $z$-score or BMI $z$-score (both $P > .05$).

*Process evaluation*

We were able to recruit our target sample size and retain 83% of participants at 6-month follow-up. Participants attended 81% of the HDHK sessions. A detailed account of the process evaluation scores are presented in Table 6. Fathers believed the timing and structure of the program was appropriate, and that the quality of the program, instructors, and resources was high. Fathers also perceived that the program affected their lifestyles, and the behavior of other family members. The overall satisfaction score was very high. In terms of adherence to self-monitoring, the mean (SD) number of diet and exercise entries to the Calorie King$^{TM}$ website by HDHK group participants was 46 (65) and 31(49) respectively with an average of 14 (12) weight check-ins over the 3-month period. Significant correlations were found between percent weight loss at 6 months and number of days of diet intake entries ($r$ = .62, $P$ = .004), number of daily exercise entries ($r$ = .74, $P$ < .001) and number of weekly weight check-ins ($r$ = .55 $P$ = .012).

## DISCUSSION

Approximately 85% of fathers in the 'Healthy Dads, Healthy Kids' (HDHK) group achieved a clinically important (42) sustained weight loss of >5% of their body weight. HDHK also resulted in a significant treatment effect in mens' waist circumference, blood pressure, resting heart rate and physical activity with medium-to-large intervention effect sizes. Importantly, fathers maintained improvements from 3- to 6-months, despite no contact between researchers and participants. The weight loss findings are greater than many studies in men reported in the literature (27, 43). The web-based self-monitoring of diet, exercise and weight were strongly related to weight loss, which supports previous studies that have identified the importance of these behaviors to weight loss (44), and compliance rates with the self-monitoring were similar to other weight loss studies (45). In addition, children in the HDHK group also significantly improved their physical activity levels, reduced their resting heart rate and decreased their kilojoule intake relative to the control group, with improvements also maintained at 6-month follow-up.

Research has demonstrated that parents shape children's lifestyle behavioral patterns by their own behaviors (i.e. role modelling) and by activity and eating-related parenting practices (8), although only a small number of studies have examined paternal influences separately. The significant improvements in health-related outcomes and physical activity for fathers may be attributed to the fact that fathers were instructed and encouraged to role model these healthy behaviors for their children and this is likely to have acted as an additional source of motivation. Similarly, children were also taught to role model and encourage their fathers to adopt healthy behaviours. According to Bandura (46), this reciprocal reinforcement between family members is particularly important when changing and sustaining new behaviors. That is, both fathers and children mutually reinforced healthier behaviors.

The HDHK program is the first study to exclusively target overweight fathers to improve their weight profile, physical activity and dietary behaviours in order to positively influence the physical activity and eating behaviors of their children. This study represents an important contribution to the field of family interventions as it has demonstrated behavioral changes in children following weight loss in overweight fathers. To date, studies of family-based lifestyle interventions have mainly targeted parents and/or mothers of obese children. When both children and parents have been targeted, weight loss outcomes for children usually improve (47, 48). Results have been equivocal for programs that have also targeted parental and child weight loss (13). Importantly, relative to previous family-based interventions, the HDHK program was relatively low dose with many published studies detailing interventions with a substantially greater number of sessions and total contact time compared to HDHK (13).

The HDHK program was unique in that it was designed to engage fathers as key agents of behavior change in their families. We hypothesised that in losing weight, fathers would be more likely to role model positive health behaviors and create healthier home environments for their children. While there was no significant intervention effect for dietary intake for fathers, men in the HDHK group still decreased their dietary intake by more than 3 000kJ per day and given the large standard deviation for fathers kJ intake this is likely to have been underpowered to detect a significant group effect for this secondary outcome. This was equal to an effect size of *d* = .69.

The increased physical activity levels and lower resting heart rate, represented by medium-to-large effect sizes, seen in children indicate the effectiveness of the strategies used to improve physical activity and fitness levels. The interactive sessions focused on teaching fathers and children the importance of physical activity to improve physical fitness, fundamental motor skills, rough and tumble play and fun and active games. Fathers were encouraged to spend time each day with their children engaged in physical activities that targeted these components. For example, sessions focused on the development and practice of object control fundamental motor skills, given the established importance of these types of basic sports skills to future physical activity participation (49) and fitness (50). The development of physical fitness through vigorous intensity active play at home was also encouraged as recent evidence has shown the independent health benefits of both cardiorespiratory and muscular fitness (51, 52), which may explain the improvements in resting heart rates of both fathers and children.

Recent reviews have demonstrated that parental modelling of physical activity is associated with child physical activity (53) and that parental exercise is associated with children's sports participation and fitness (54). But there is limited evidence for the effectiveness of family-based interventions to increase physical activity among children (55, 56). Of only six studies that included direct contact with parents to increase child physical activity, findings were mixed and generally studies have been of poor quality, not used objective measures of physical activity, and been equivocal about the best way to engage parents (56).

We also found a significant treatment effect for dietary intake for children which supports research showing modelling of healthy eating by parents influence children's dietary intake (10). The reduction in kJ / kg for children reported by mothers at 6-month follow-up, particularly the magnitude relative to the control group, provides support that families in the program have modified their eating habits in a sustainable way. This is important and reporting by the mothers is likely to have reduced reporting bias relative to having fathers report for their children. This provides further evidence that the fathers have effectively facilitated transfer of dietary information to the family environment to a level that has impacted positively on their children's intake. We did not find a significant treatment effect for children's anthropometric data but this is not surprising as 80% of the intervention group were a healthy weight at baseline.

The feasibility of the HDHK program was also demonstrated as we were able to successfully recruit fathers and retain them in the program. Furthermore, the high attendance levels and high levels of overall satisfaction relating to structure, content and instruction suggest that the HDHK program is a feasible and efficacious approach to weight loss among overweight fathers. A lifestyle program that can recruit and engage men, and achieve clinically important weight loss and improved health behaviors of children at the same time may be a more cost effective approach than separate interventions.

The idea that children's health can be promoted through engaging fathers is not yet a strongly held view in public health policy, health promotion, medicine or family service (15), which tend to focus on mother's involvement as critical; this approach is described as 'mothercentric' (15). There is evidence of the positive influence of father engagement on children's social, behavioural and psychological outcomes (57), and our findings provide further support for health-related interventions that target fathers. There is an urgent need for strategies to reduce obesity in men and improve the lifestyle behaviors of children. The HDHK program worked exclusively with fathers and targeted overall family changes, highlighting the generalizability of this approach with children of varying ages and weight profiles.

Our study addressed many of the weaknesses identified in the literature (13, 55, 58), and its strengths included: a randomized design, high retention rate, intention-to-treat analysis, theoretically-based framework, and follow-up assessments three months after the immediate post-intervention assessment. There were some study limitations which need to be noted. The physical activity assessment may contribute to some reactivity, as both groups of participants were required to monitor and record their physical activity in a log book over a period of one week. However, the majority of weight loss interventions use self-report measures of physical activity, which are more susceptible to social desirability bias and the evidence for reactivity is inconclusive (59). Use of the FFQ as a dietary assessment tool may be associated with a reporting bias, which would manifest as systematic rather than random error and additionally there could be a training effect which could mask some of the between groups changes.

Future research could explore the capacity of father-focused programs to engage mothers and examine any change in maternal health-related behaviours to further our understanding of the broader familial influences of such programs. Further, while SES was examined as a covariate, only data on area-level SES were collected and other more sensitive measures such as education level and income could be examined in future studies. Finally, the intervention was delivered by highly qualified staff with expertise in physical education. There is a need to test the HDHK program in larger effectiveness trials to determine the impact of the program delivered by trained community-based facilitators and with longer-term follow-up.

*Conclusion*

A program targeting overweight fathers was effective in achieving statistically and clinically important weight loss in men that was sustained up to 6 months. The HDHK program also increased physical activity-related outcomes and decreased total energy intake in children in response to paternal role modelling. Future family-based programs should consider how best to include and engage fathers and mothers in obesity treatment and prevention interventions to optimise the effectiveness of programs in reducing obesity-related risk factors long term.

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## CONFLICT OF INTEREST

The author(s) declare that they have no competing interests.

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**Table 1: HDHK program content and alignment with theoretical constructs**

| Session no. | Session focus | Session detail | Behavior change techniques | SCT construct |
|---|---|---|---|---|
| 1 | 'Weight loss for men' *(Dads)* | * Program rationale<br>* Importance of fathers and their influence on children<br>* Energy balance and weight loss<br>* 9 Weight loss tips for men<br>* Website use for eating and activity diaries | * Provide information about behavior health link<br>* Prompt self-monitoring of behaviors<br>* Prompt specific goal setting<br>* Information on consequences<br>* Prompt intention formation<br>* Provide instruction | * Outcome expectations<br>* Social support<br>* Self-efficacy<br>* Intentions |
| 2 | 'Raising active children in an inactive world' *(Dads)* | * Obesogenic environments<br>* PA levels, trends and benefits<br>* PA recommendations<br>* PA goals for Dads<br>* Ideas for fitness/activity at home | * Provide information about behavior health link<br>* Model or demonstrate the behavior<br>* Prompt specific goal setting<br>* Barrier identification<br>* Prompt self-monitoring of PA<br>* Plan social support or social change | * Outcome expectations<br>* Self-efficacy<br>* Social support |
| 3 | 'Ready to rumble with Dad' *(Dads & Kids)* | * Rough and Tumble Play<br>* Fun Fitness circuits<br>* Fun and active games | * Model or demonstrate the behavior<br>* General encouragement<br>* Provide instruction<br>* Graded tasks | * Self-efficacy<br>* Social support |
| 4 | 'Healthy eating for families – Dads matter' *(Dads)* | * Healthy eating benefits<br>* Food based guidelines<br>* Role of fathers in healthy home eating environments<br>* Authoritative feeding practices<br>* Reading food labels | * Provide instruction<br>* Prompt identification as a role model<br>* Prompt review of goals<br>* Prompt barrier identification<br>* Plan social support or social change | * Outcome expectations<br>* Self-efficacy<br>* Intentions<br>* Social support |
| 5 | 'Sustaining healthy eating at home' *(Dads)* | * Planning meals<br>* Australian Guide to Healthy Eating<br>* Recommended daily intakes<br>* Why we eat food?<br>* Support and strategies for successful dietary changes and relapse prevention | * Provide information about behavior health link<br>* Prompt review of behavioral goals<br>* Relapse prevention<br>* Problem solving | * Social support<br>* Self-efficacy<br>* Outcome expectations |
| 6 | 'Fitness, fun and fundamental movement skills' *(Dads & Kids)* | * FMS skills circuit<br>* Rough and Tumble activities<br>* Partner fitness challenges | * Model or demonstrate the behavior<br>* Prompt identification as a role model<br>* General encouragement | * Social support<br>* Self-efficacy |
| 7 | 'Playing strong' *(Dads & Kids)* | * The benefits of strength training<br>* Strength training exercises<br>* Rough and tumble activities<br>* Ball and game skills | * Provide information about behavior health link<br>* Model or demonstrate the behavior<br>* Prompt identification as a role model<br>* General encouragement | * Outcome expectations<br>* Social support<br>* Self-efficacy |
| 8 | 'Games show and Healthy BBQ' *(Dads)* | * Program revision<br>* Group based trivia competition with practical challenges to reinforce PA messages (fitness, FMS etc.) | * Model or demonstrate the behavior<br>* Prompt review of behavioral goals<br>* Problem solving<br>* Post-program goal setting | * Self-efficacy<br>* Intentions<br>* Social support |

Abbreviations: SCT – Social Cognitive Theory; FMS – fundamental movement skill; WL – weight loss; PA – physical activity

**Table 2: Baseline characteristics of men randomized to the intervention and control groups**

| Characteristics | Control ($n$ = 26) | | HDHK program ($n$ = 27) | | Total ($N$ = 53) | |
|---|---|---|---|---|---|---|
| | Mean | (SD) | Mean | (SD) | Mean | (SD) |
| Age (years) | 40.3 | 7.5 | 40.9 | 6.7 | 40.6 | 7.1 |
| *SES*[a], *n (%)* | | | | | | |
| 1-2 (lowest) | 0 | 0.0 | 1 | 3.7 | 1 | 1.9 |
| 3-4 | 1 | 3.8 | 4 | 14.8 | 5 | 9.4 |
| 5-6 | 12 | 46.2 | 10 | 37.0 | 22 | 41.5 |
| 7-8 | 10 | 38.5 | 9 | 33.3 | 19 | 35.8 |
| 9-10 (highest) | 3 | 11.5 | 3 | 11.1 | 6 | 11.3 |
| Weight (kg) | 105.0 | 13.4 | 106.7 | 13.7 | 105.9 | 13.5 |
| Height (m) | 1.78 | 0.07 | 1.79 | 0.06 | 1.79 | 0.06 |
| BMI (kg/$m^{2}$) | 33.1 | 4.1 | 33.3 | 3.7 | 33.2 | 3.9 |
| *BMI Category* | | | | | | |
| Overweight, *n* (%) | 7 | 26.9% | 5 | 18.5% | 12 | 22.6% |
| Obese, *n* (%) | 19 | 73.1% | 22 | 81.5% | 41 | 77.4% |
| Waist (Umb) (cm) | 111.1 | 9.7 | 111.2 | 10.5 | 111.2 | 10.0 |
| Waist (Narrow) (cm) | 104.4 | 7.8 | 104.7 | 8.9 | 104.5 | 8.3 |
| Systolic blood pressure (mmHg) | 134 | 16 | 134 | 11 | 134 | 13 |
| Diastolic blood pressure (mmHg) | 87 | 11 | 88 | 8 | 87 | 10 |
| Resting heart rate (BPM) | 78 | 11 | 75 | 10 | 76 | 10 |
| Physical activity (steps/day)[b] | 8028 | 2559 | 8521 | 2745 | 8285 | 2643 |
| Dietary intake (kJ/day)[c] | 12759 | 4132 | 11792 | 3587 | 12256 | 3849 |

Abbreviations: HDHK = Healthy Dads, Healthy Kids; BMI = Body Mass Index; SES = socioeconomic status; Umb = umbilicus measurement; BPM = beats per minute; kJ = kilojoules.

[a] Socioeconomic status by population decile for SEIFA Index of Relative Socio-economic Advantage and Disadvantage

[b] n = 25 (Control); n = 27 (Intervention); N = 52 (Total)

[c] n = 24 (Control); n = 26 (Intervention); N = 50 (Total)

**Table 3: Baseline characteristics of children randomized to the intervention and control groups**

| Characteristics | Control ($n$ = 32) | | HDHK program ($n$ = 39) | | Total ($N$ = 71) | |
|---|---|---|---|---|---|---|
| | Mean | (SD) | Mean | (SD) | Mean | (SD) |
| Age (years) | 7.9 | 1.9 | 8.4 | 2.1 | 8.2 | 2.0 |
| Sex, n(%) | Male | 56.3% | Male | 51.3% | Male | 53.5% |
| Weight (kg) | 34.9 | 14.8 | 33.0 | 12.9 | 33.8 | 13.7 |
| Height (m) | 1.32 | 0.14 | 1.34 | 0.14 | 1.33 | 0.14 |
| BMI (kg/m$^2$) | 19.1 | 4.5 | 17.6 | 3.3 | 18.3 | 3.9 |
| BMI $z$-score | 1.0 | 1.3 | 0.3 | 1.0 | 0.7 | 1.2 |
| *BMI Category* | | | | | | |
| Healthy weight, $n$ (%) | 19 | 59.4 | 31 | 79.5 | 50 | 70.4 |
| Overweight, $n$ (%) | 7 | 21.9 | 7 | 17.9 | 14 | 19.7 |
| Obese, $n$ (%) | 6 | 18.8 | 1 | 2.6 | 7 | 9.9 |
| Waist (Umb) (cm) | 64.8 | 14.1 | 61.4 | 13.1 | 62.9 | 13.6 |
| Waist (Narrow) (cm) | 60.7 | 11.0 | 57.7 | 9.5 | 59.1 | 10.2 |
| Waist $z$-score | .8 | 1.5 | .1 | 1.4 | 0.5 | 1.5 |
| Systolic blood pressure (mmHg) | 103 | 10 | 100 | 8 | 102 | 9 |
| Diastolic blood pressure (mmHg) | 64 | 9 | 64 | 9 | 64 | 9 |
| Resting heart rate (BPM) | 85 | 11 | 85 | 9 | 85 | 10 |
| Physical activity (steps/day)[a] | 11084 | 3184 | 11171 | 2719 | 11132 | 2915 |
| Dietary intake (kJ/kg/day)[b*] | 312 | 131 | 363 | 140 | 339 | 137 |

Abbreviations: HDHK = Healthy Dads, Healthy Kids; BMI = Body Mass Index; SES = socioeconomic status; UM = umbilicus measurement; BPM = beats per minute; kJ = kilojoules; kg = kilograms; g = grams.

[a] n = 31 (Control); n = 38 (Intervention); N = 69 (Total)

[b] n = 25 (Control); n = 27 (Intervention); N = 52 (Total)

* reported by mothers (for eldest child if more than one child enrolled)

**Table 4: Changes in outcome variables for fathers by treatment group from baseline to 3- and 6-months and differences in outcomes among the treatment groups at 3- and 6-months (ITT analysis) (n=53)***

| Outcome | Mth | Treatment group: Mean change from Baseline (95% CI)[†] — Control (n = 26) | HDHK program (n = 27) | Mean difference between groups (95% CI)[§] | Group * Time *P* | Effect Size (Cohen's *d*) |
|---|---|---|---|---|---|---|
| Weight (kg)* | 3 | -0.4 (-1.9, 1.1) | -6.7 (-8.2, -5.1) | | | |
| | 6 | 0.0 (-1.4, 1.6) | -7.6 (-9.2, -6.0) | 7.6 (5.4, 9.9) | <.001 | .54 |
| Waist (Umb) (cm)* | 3 | -0.5 (-2.3, 1.4) | -6.2 (-8.2, -4.3) | | | |
| | 6 | -0.7 (-2.4, 1.1) | -7.5 (-9.4, -5.7) | 6.9 (4.3, 9.5) | <.001 | .62 |
| Waist (Narrow) (cm) | 3 | 1.0 (-0.6, 2.6) | -4.4 (-6.0, -2.7) | | | |
| | 6 | 1.2 (-0.5, 2.8) | -5.5 (-7.3, -3.7) | 6.6 (4.2, 9.1) | <.001 | .67 |
| BMI (kg/$m^2$)* | 3 | 0.0 (-0.5, 0.5) | -1.8 (-2.4, -1.3) | | | |
| | 6 | 0.0 (-0.5, 0.4) | -2.3 (-2.8, -1.8) | 2.3 (1.5, 3.0) | <.001 | .53 |
| Systolic blood pressure (mmHg) | 3 | -3 (-7, 2) | -9 (-13, -4) | | | |
| | 6 | 3 (-2, 8) | -9 (-14, -3) | 12 (4, 19) | .01 | .92 |
| Diastolic blood pressure (mmHg) | 3 | 1 (-3, 5) | -5 (-9, -1) | | | |
| | 6 | 4 (-1, 8) | -5 (-9, -0) | 8 (2, 15) | .04 | .82 |
| Resting heart rate (BPM)* | 3 | -2 (-6, 1) | -9 (-13, -6) | | | |
| | 6 | -3 (-6, 1) | -11 (-15, -7) | 8 (2, 14) | .01 | .66 |
| Physical activity (mean steps/day)[a] | 3 | -39 (-1080, 1002) | 2178 (1074, 3281) | | | |
| | 6 | -710 (-2010, 591) | 2837 (1448, 4225) | -3546 (-5449, -1643) | .002 | .91 |
| Dietary Intake (total daily kJ) | 3 | -2031 (-3514, -548) | -2857 (-4400, -1315) | | | |
| | 6 | -973 (-3212, 1266) | -3270 (-5490, -1050) | 2297 (-856, 5450) | .350 | .69 |

Abbreviations: Mth = Month; Umb = Umbilicus; BMI = body mass index; BPM = beats per minute; kJ = kilojoules

[a] *n* = 52

[†] Time differences were calculated as (3 month – baseline) and (6 month – baseline)

[§] Between group differences at 6 months

* Adjusted for age

**Table 5: Changes in outcome variables for children by treatment group from baseline to 3- and 6-months and differences in outcomes among the treatment groups at 3- and 6-months (ITT analysis)***

| Outcome | Month | Treatment group: Mean change from Baseline (95% CI)[†] Control (n = 32 ) | HDHK program (n = 39) | Mean difference between groups (95% CI)[§] | Group * Time *P* | Effect Size (Cohen's *d*) |
|---|---|---|---|---|---|---|
| BMI *z*-score | 3 | 0.0 (-0.1, 0.1) | -0.0 (-0.1, 0.1) | | | |
| | 6 | 0.1 (-0.1, 0.2) | -0.0 (-0.1, 0.1) | 0.1 (-0.1, 0.2) | .74 | .09 |
| Waist *z*-score | 3 | 0.3 (0.1, 0.5) | 0.2 (-0.0, 0.5) | | | |
| | 6 | 0.2 (-0.0, 0.4) | -0.1 (-0.3, 0.2) | 0.3 (-0.0, 0.6) | .17 | .22 |
| Systolic blood | 3 | -2 (-5, 0) | -4 (-6, -1) | | | |
| pressure (mmHg)** | 6 | -1 (-4, 1) | -4 (-7, -2) | 3 (-1, 7) | .26 | .40 |
| Diastolic blood | 3 | -4 (-7, -0) | -3 (-6, -0) | | | |
| pressure (mmHg)* | 6 | -2 (-5, 1) | -3 (-6, -0) | 1 (-3, 6) | .69 | .13 |
| Resting heart rate | 3 | 3 (-1, 7) | -4 (-8, -1) | | | |
| (BPM) | 6 | -1 (-4, 3) | -6 (-9, -3) | 5 (1, 10) | .01 | .51 |
| Physical activity | 3 | -763 (-1600, 74) | 465 (-331, 1261) | | | |
| (mean steps/day)[a] | 6 | -828 (-1700, 42) | 1499 (665, 2322) | -2327 (-3531, -1122) | <.001 | .74 |
| Dietary Intake | 3 | -18 (-55, 19) | -37 (-77, 3) | | | |
| (kJ/kg)[b] | 6 | -1 (-39, 37) | -88 (-128, -48) | 87 (32, 143) | .01 | .84 |

Abbreviations: Umb = Umbilicus; BMI = body mass index; BPM = beats per minute; kJ = kilojoules; kg = kilograms
[†] Time differences were calculated as (3 month – baseline) and (6 month – baseline)
[§] Between group differences at 6 months
[a] n = 69
* Adjusted for age; ** Adjusted for age and sex
[b] reported by mothers (for eldest child if more than one child enrolled)

**Table 6: Overall satisfaction and perceptions of impact for fathers**

| Construct (n = number of items) | Example item | Mean (SD) |
|---|---|---|
| Program structure and timing (n=3) | *'The number of sessions was appropriate'* | 4.1 (0.5) |
| Quality of instructors (n=4) | *'The instructors had a high level of knowledge'* | 4.9 (0.2) |
| Quality of program (n=3) | *'The content of the program was interesting'* | 4.6 (0.5) |
| Impact on family (n=6) | *'HDHK has impacted positively on the whole family'* | 4.0 (0.4) |
| Resources (n=2) | *'The physical activity handbook was useful'* | 4.4 (0.5) |
| Website satisfaction (n=3) | *'The website was easy to use'* | 4.2 (0.7) |
| Adherence to self-monitoring (n=5) | *'I now keep a record of my physical activity'* | 3.7 (0.7) |
| Program support (n=3) | *'HDHK program provided me with enough support to help me lose weight'* | 4.3 (0.8) |
| Overall satisfaction (n=3) | *'I enjoyed the HDHK program'* | 4.8 (0.4) |

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

**Figure 1: Participant flow through the trial and analysed for the primary outcome (Fathers' weight [kg])**

**Figure 2: Mean change in weight at 3 months and 6 months after baseline for fathers in both groups (n = 53). *P* > 0.05 for between group comparisons. Error bars represent 95% confidence intervals (intention-to-treat analysis)**