Sustainability of Effects of an Early Childhood Obesity Prevention Trial Over Time
A Further 3-Year Follow-up of the Healthy Beginnings Trial

Li Ming Wen, MD, MMEd, PhD; Louise A. Baur, MBBS, PhD; Judy M. Simpson, PhD; Hui Lan Xu, MBiostat, MPH; Alison J. Hayes, PhD; Louise L. Hardy, MPH(Hons), PhD; Mandy Williams, MHP; Chris Rissel, PhD

IMPORTANCE Little evidence exists on whether effects of an early obesity intervention are sustainable.

OBJECTIVE To assess the sustainability of effects of a home-based early intervention on children’s body mass index (BMI) and BMI z score at 3 years after intervention.

DESIGN, SETTING, AND PARTICIPANTS A longitudinal follow-up study of the randomized clinical Healthy Beginnings Trial was conducted with 465 participating mothers consenting to be followed up at 3 years after intervention until their children were age 5 years. This study was conducted in socially and economically disadvantaged areas of Sydney, Australia, from March 2011 to June 2014.

INTERVENTIONS No further intervention was carried out in this Healthy Beginnings Trial phase 2 follow-up study. The original intervention in phase 1 comprised 8 home visits from community nurses delivering a staged home-based intervention, with one visit in the antenatal period and 7 visits at 1, 3, 5, 9, 12, 18, and 24 months after birth.

MAIN OUTCOMES AND MEASURES Primary outcomes were children’s BMI and BMI z score. Secondary outcomes included dietary behaviors, quality of life, physical activity, and TV viewing time of children and their mothers.

RESULTS In total, 369 mothers and their children completed the follow-up study, a phase 2 completion rate of 79.4% (80.9% for the intervention group and 77.7% for the control group). The differences between the intervention and control groups at age 2 years in children’s BMI and BMI z score disappeared over time. At age 2 years, the difference (intervention minus control) in BMI (calculated as weight in kilograms divided by height in meters squared) was −0.41 (95% CI, −0.71 to −0.10; P = .009), but by age 5 years it was 0.03 (95% CI, −0.30 to 0.37). No effects of the early intervention on dietary behaviors, quality of life, physical activity, and TV viewing time were detected at age 5 years.

CONCLUSIONS AND RELEVANCE The significant effect of this early life home-visiting intervention on child BMI and BMI z score at age 2 years was not sustained at age 5 years without further intervention. Obesity prevention programs need to be continued or maintained during the early childhood years.

Published online April 20, 2015.

Research

Original Investigation

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T here is an upward trend in the prevalence of overweight or obese preschool-age children (age range, 0-5 years), from 4.2% in 1990 to 6.7% in 2010, that is occurring worldwide.¹ Obesity in young children may progress to obesity in later childhood²⁻³ and potentially into adulthood.⁴⁻⁷ It is increasingly argued that childhood obesity prevention should begin in the early years.⁸ Tackling childhood obesity now represents an important opportunity to reduce the effect of heart disease, diabetes mellitus, and other serious preventable chronic diseases in the future while immediately improving the health of children.⁹ The importance of early obesity intervention has been emphasized by the increased number of intervention research studies¹⁰⁻¹⁵ in recent years.

Some promising results from recent randomized clinical trials suggest that prevention interventions directed to mothers in the first years of their child’s life can reduce bottle use and energy intake,¹³ support the development of healthy infant feeding practices,¹² lead to reductions in sweet snack consumption and TV viewing,¹³ and reduce the mean body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) by 0.38 (95% CI, 0.08-0.68) of children at age 2 years.¹⁰ The Healthy Beginnings Trial (HBT) phase 1 was the first randomized clinical trial to show the effectiveness of an early childhood obesity intervention delivered in the first 2 years of life.¹⁰,¹⁶ The provision of healthy infant feeding education, with increased active play and reduced TV viewing time, remains central to these early interventions. A 2014 systematic review of the effect of interventions to prevent obesity or improve obesity-related behaviors in preschool-age children (age range, 0-5 years) concluded that early intervention effects are modest but promising.¹⁵ The authors of the review called for high-quality studies with longer-term follow-up. Indeed, without a long-term follow-up, the sustainability of early intervention effects remains unknown.

To address this evidence gap, children who participated in the HBT phase 1 were followed up for 3 years after intervention (ie, from age 2-5 years) to ascertain whether the benefits at age 2 years were sustained at age 5 years and to examine the quality of life of child participants. The HBT phase 1 used a home-based early intervention designed to improve family and behavioral risk factors for childhood obesity. The rationale and method for this follow-up study (HBT phase 2) were reported in a published protocol¹⁷ before study commencement and involved (1) a longer-term follow-up of the cohort of children at ages 3.5 and 5 years and (2) an economic evaluation of the intervention, which has been reported elsewhere.¹⁸

### Methods

#### HBT Phase 1

In 2007, we commenced the HBT phase 1 with 667 first-time mothers (337 intervention and 330 control) to investigate the effectiveness of a home-based early intervention primarily on children's BMI at age 2 years and, secondarily, on dietary behaviors, physical activity, and TV viewing time of children and their mothers. The intervention comprised 8 home visits from community nurses delivering a staged home-based interven-

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### At a Glance

- Prevention interventions directed to mothers in the first years of their child’s life can improve infant feeding practices and reduce mean BMI.
- Little evidence exists on whether effects of an early obesity intervention are sustainable.
- To address this evidence gap, a further follow-up of the Healthy Beginnings Trial was conducted 3 years after intervention.
- No effects of the early intervention on children’s mean BMI and other obesity-related behaviors were detected at age 5 years.

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### Participants and Consent of the HBT Phase 2

In 2011, we started the follow-up HBT phase 2 study to investigate the long-term effects of the HBT intervention. We asked 497 participating families who had completed phase 1 (255 intervention and 242 control) whether they were willing to participate in a further 3-year study with no intervention from age 2 years onward. In total, 465 of 497 (93.6%) consented to follow-up. No further intervention was carried out in this study from March 2011 to June 2014. Written parental consent was obtained by mail or through home visits by 2 research assistants. Phase 2 baseline was taken as the home visit when the child was aged 2 years. Ethics approval was obtained for the study from Sydney Local Health District Research Ethics Review Committee X10-0312.

#### Data Collection

Two research assistants who were not involved in the HBT phase 1 collected the follow-up data and were blinded to intervention or control status. To ensure measurement consistency, they were trained by experienced early childhood nurses in anthropometry measures and semistructured interviews in the home setting. Data were collected when the children were ages 3.5 and 5 years. At each visit, the child’s anthropometric measurements were undertaken, and a face-to-face questionnaire interview was conducted with the mother.

#### Main Outcome Measures

### Primary Outcomes

The primary outcomes were children’s BMI and BMI z score. Height and weight were measured using standard techniques in the home using a portable stadiometer and electronic scales. Body mass index was calculated,⁷ and BMI z score was calculated using a software program (AnthroPlus; World Health Organization).²⁰ We also categorized BMI as overweight, obese, or not overweight or obese based on internationally accepted criteria.²¹

For weight, measurements were taken using digital scales (TI1582136K; http://www.wedderburn.com.au) by a research assistant from children wearing lightweight clothes and no shoes. The measures were recorded to the nearest 0.1 kg.

For measuring height we used a portable stadiometer with a vertical backboard and movable headboard, the child stood...
erect against the backboard, and the back of the head, shoulder blades, buttocks, and heels made contact with the backboard of the stadiometer. Two measurements were taken by a research assistant and recorded to the nearest 0.1 cm. A third measure was taken if the first 2 measurements differed by 0.5 cm or more, and the mean of these 2 or 3 values was calculated.

Secondary Outcomes
The secondary outcomes included dietary behaviors, quality of life, physical activity, and TV viewing time of children and their mothers according to a published research protocol. We used a validated set of short questions to assess young children's dietary patterns and physical activity. The TV viewing behavioral questions were based on those used in phase 1 of the HBT. Indicators of dietary patterns included the following: questions on daily servings of fruits and vegetables; quantity of specified beverages, including sugary drinks; frequency of snack foods; and eating behaviors, including eating when watching TV or in front of the TV. Indicators of physical activity and TV viewing time included mother-reported outdoor playtime and time spent on screens on a typical weekday and weekend day.

Children's health-related quality of life was assessed using parent proxy reports of a pediatric quality-of-life instrument (PedsQL; http://www.pedsql.org/) comprising 4 generic core subscales pertaining to physical, emotional, social, and school functioning. At 3.5 years, we used the parent report for toddlers (age range, 2-4 years). At 5 years, we used the parent report for young children (age range, 5-7 years).

Secondary outcomes also included the mothers’ eating habits and physical activity, as well as TV viewing time. Information on these outcomes was collected using existing survey instruments, including the New South Wales Adult Health Surveys, which were also used in phase 1 of the HBT.

Sociodemographic Characteristics
At phase 1 baseline, we collected sociodemographic data, including age, employment status, educational level, marital status, language spoken at home, and country of birth of mothers using the standard New South Wales Population Health Survey questions. At phase 2 baseline, we re-collected information on employment status, educational level, and marital status.

Retention Strategies
To maintain participants’ interest in the follow-up study, several retention strategies were used, including the following: (1) sending thank-you cards at the end of the HBT phase 1, (2) sending Christmas or New Year greeting cards, (3) obtaining contact numbers of participants’ relatives (updated at each contact visit), (4) providing brief feedback to participants on their child’s weight and height, and (5) text message reminders for follow-up visits. In addition, small gifts (less than US $8) of appreciation were sent to all participants after completing the 3.5-year data collection.

Statistical Analysis
Using \( \chi^2 \) tests, we compared characteristics of the study participants between the intervention and control groups at baseline of the HBT phase 2 (at age 2 years) and ages 3.5 and 5 years. We also compared characteristics of those remaining in the study and those lost to follow-up at ages 3.5 and 5 years.

The primary outcome variables, BMI and BMI z score, were treated as continuous variables. Secondary outcomes, including eating habits and dietary behaviors, physical activity and outdoor play, and TV viewing time, were dichotomized as for phase 1 of the HBT. For example, cut points were based on the national guidelines for physical activity for children and adults, while the median intake of fruits and vegetables of the study participants was used.

To assess sustained short-term and long-term effects of the intervention on the primary outcomes (child BMI and BMI z score) and secondary outcomes (dietary behaviors, physical activity, and TV viewing time), outcomes were compared between the intervention and control groups at ages 3.5 and 5 years. For continuous variables, including BMI and BMI z score, the means were compared using t tests and then using multiple linear regressions to adjust for baseline differences (at 2 years). For categorical variables, \( \chi^2 \) tests were used, followed by multiple logistic regressions to adjust for baseline differences (at 2 years). The regression analyses were limited to those with 3.5-year or 5-year follow-up data. For the PedsQL quality-of-life subscales, Tobit models were used, specifying right censoring at the maximum subscale score of 100. All models were adjusted for mother’s marital status and employment status, which were found to be significantly different (\( P < .05 \)) between the intervention and control groups at the beginning of the phase 2 study. Other variables (eg, child sex or when the mother was recruited) were assessed for their confounding effect and then dropped from the models. Adjusted regression coefficients (\( \beta \) levels) were calculated with 95% CIs and \( P \) values.

Data were analyzed using statistical software (Stata, version 12; StataCorp LP). Intent-to-treat principles were used in all primary analyses (ie, we analyzed the results based on participants’ initial group allocation at baseline of the HBT phase 1).

Results
Follow-up and Retention
Of 497 participants who completed the HBT phase 1, 465 (236 intervention and 229 control) agreed to participate in this follow-up study, a consent rate of 93.6% (Figure 1 and Figure 2). Fifty mothers were lost to follow-up at 3.5 years and a further 46 mothers at 5 years. In total, 369 mothers (191 intervention and 178 control) remained at 5 years, giving an overall retention rate of 79.4% over the 3-year period. Of 96 lost to follow-up in phase 2, a total of 45 were from the intervention group, and 51 were from the control group. The main reasons for loss to follow-up were similarly distributed across both groups (Figure 1).

Characteristics of the Study Participants
Table 1 lists characteristics of the study participants at phase 2 baseline and follow-up of the children at ages 3.5 and 5 years. At baseline, most characteristics were similar in the 2 groups, but there were higher proportions of married or de facto part-
Primary Outcomes

At phase 2 baseline, the success of the phase 1 intervention meant that the mean BMI was lower in the intervention group (16.57) than in the control group (16.98). The difference (intervention minus control) was −0.41 (95% CI, −0.71 to −0.10) (P = .009) (Table 2). The mean BMI z score was also lower in the intervention group (0.55 vs 0.84, P = .006). However, there were no differences in these variables between the intervention and control groups when children were aged 3.5 years or 5 years. This was true when either unadjusted (eg, BMI difference at age 5 years was 0.03; 95% CI, −0.30 to 0.37) or after adjusting for baseline differences using multiple linear regression (eg, BMI difference at age 5 years was 0.27; 95% CI, −0.01 to 0.56). Figure 2 and Figure 3 show BMIs and BMI z scores for the groups at 2, 3.5, and 5 years based on observed values.

Body mass index or BMI z score at 2 years was positively associated with BMI (β level, 0.52; 95% CI, 0.42–0.61; P < .001) or BMI z score (β level, 0.52; 95% CI, 0.44–0.62; P < .001) at 3.5 years after controlling for maternal marital status and employment status at baseline. Similarly, BMI or BMI z score at 2 years was also positively associated with BMI (β level, 0.52; 95% CI, 0.44–0.60; P < .001) or BMI z score (β level, 0.51; 95% CI, 0.43–0.58; P < .001) at 5 years.

Secondary Outcomes

As summarized in Table 3, χ² tests and multiple logistic regression analyses found no differences between groups in dietary behaviors, physical activity, or TV viewing time of children and their mothers at 3.5 and 5 years. Children’s consumption of fruits and vegetables remained steady in both groups at 3.5 and 5 years, as did children’s physical activity and TV viewing time.

Quality of life, as measured by the median (interquartile range) total subscale score of the PedsQL, was the same for intervention and control participants at 3.5 years. These median (interquartile range) values at 3.5 years were 91.7 (85.7–95.2) for the intervention group and 91.7 (87.5–95.2) for the control group (P = .89). The median (interquartile range) values at 5 years were 93.5 (89.1–97.2) for the intervention group and 93.5 (88.9–97.2) for the control group (P = .92). Similarly, there were no differences between the 2 groups at 3.5 and 5 years in their physical, emotional, social, and school functioning subscale median scores.

Discussion

Principal Findings of the Study

This follow-up study shows that the differences in children’s BMI and BMI z score between the intervention and control groups at age 2 years disappeared over time. By age 5 years, no difference was detected nor were any effects of the early intervention on dietary behaviors, quality of life, physical activity, and TV viewing time detected across time.
Meaning of the Study
It is clear that the initial significant effect of this early life home-visiting intervention was not sustained without further intervention with the participants. The design of health promotion interventions and policies aimed at reducing the prevalence of childhood obesity needs to be considered within a life course framework, requiring frequent interventions addressing multiple factors at various stages of life.\textsuperscript{25,26} These factors can range from the social or built environment (macroenvironment) through behavior and physiology.\textsuperscript{26} Our results also reaffirmed that overweight or obesity is already established in the early years of life. Sustainable intervention programs are essential to address the social, cultural, economic, and environmental factors that are associated with childhood obesity over all life stages.

What the Study Adds
First, without the findings of the HBT phase 2, it is unlikely that appropriate recommendations for early childhood prevention programs could have been made purely based on the results of the HBT phase 1. The effectiveness and sustainability of this early intervention program in the Australian context would remain unknown. Our results are consistent with findings from a recent meta-analysis\textsuperscript{27} of early obesity intervention programs that in-
volve parents, which concluded that interventions with parental involvement are effective at short-term follow-up but that effects were not retained in the long run.

Second, a Cochrane review of interventions for preventing obesity in children indicated that there were promising findings in those aged 0 to 5 years, particularly for interventions conducted in home or health care settings. At the same time, the research gaps evident from that review included the need to study the effectiveness of interventions for this age group. Our phase 2 study is the first to date to address this research gap of a lack of long-term follow-up studies. Other (possibly differently designed) intervention strategies are needed with longer-term follow-up.

Third, a systematic review of effective strategies for reducing screen time among young children has identified several research gaps, one of which was limited long-term follow-up data (>6 months). The review called for more work to be done to understand the potential for interventions in children younger than 6 years and in low-income and racial/ethnic or minority participants.

### Unanswered Questions and Future Research

Early life interventions that target modifiable maternal and child risk factors hold significant promise, but potentially sustained benefits beyond the intervention period are possibly moderated by obesogenic environments. Long-term follow-up by similar studies is required to build a better understanding of whether weight-related behavioral changes attributed to intensive early child obesity interventions are sustainable. Potentially, the success of interventions such as the HBT diminishes across time, pre-

### Table 2. Descriptive Statistics of BMI and BMI z Score of Children by Group Allocation and Comparisons of BMI and BMI z Score Between Groups Using Multiple Regression Analyses at 2 Years, 3.5 Years, and 5 Years

<table>
<thead>
<tr>
<th>Group Allocation</th>
<th>Cross-sectional Analyses</th>
<th>Intervention Minus Control Mean Difference (95% CI)</th>
<th>Multiple Regression Analyses</th>
<th>Adjusted Mean Difference (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median (Range)</td>
<td>Adjusted Mean Difference (95% CI)</td>
<td>P Value</td>
<td></td>
</tr>
<tr>
<td>At 2 y (n = 465)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>16.57 (1.65)</td>
<td>16.6 (12.8 to 22.7)</td>
<td>−0.41 (−0.71 to −0.10)</td>
<td>−0.40 (−0.71 to −0.10)</td>
<td>.01*</td>
</tr>
<tr>
<td>Control</td>
<td>16.98 (1.61)</td>
<td>16.9 (13.8 to 25.1)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Child BMI z score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>0.55 (1.17)</td>
<td>0.63 (−2.87 to 4.21)</td>
<td>−0.29 (−0.50 to −0.08)</td>
<td>−0.29 (−0.50 to −0.07)</td>
<td>.01*</td>
</tr>
<tr>
<td>Control</td>
<td>0.84 (1.08)</td>
<td>0.87 (−1.97 to 5.37)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>At 3.5 y (n = 415)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>16.74 (1.93)</td>
<td>16.4 (11.4 to 24.9)</td>
<td>−0.06 (−0.41 to 0.28)</td>
<td>0.15 (−0.16 to 0.46)</td>
<td>.33b</td>
</tr>
<tr>
<td>Control</td>
<td>16.80 (1.64)</td>
<td>16.6 (13.6 to 25.3)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Child BMI z score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>0.89 (1.29)</td>
<td>0.79 (−3.54 to 5.92)</td>
<td>−0.08 (−0.30 to 0.16)</td>
<td>0.08 (−0.12 to 0.28)</td>
<td>.44b</td>
</tr>
<tr>
<td>Control</td>
<td>0.97 (1.06)</td>
<td>0.89 (−1.43 to 5.46)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>At 5 y (n = 369)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Child BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>16.31 (1.70)</td>
<td>16.0 (12.8 to 23.3)</td>
<td>0.03 (−0.30 to 0.37)</td>
<td>0.27 (−0.01 to 0.56)</td>
<td>.06b</td>
</tr>
<tr>
<td>Control</td>
<td>16.28 (1.56)</td>
<td>16.0 (11.8 to 23.1)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Child BMI z score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>0.65 (1.04)</td>
<td>0.53 (−2.12 to 4.60)</td>
<td>0.02 (−0.19 to 0.22)</td>
<td>0.17 (−0.0004 to 0.36)</td>
<td>.06</td>
</tr>
<tr>
<td>Control</td>
<td>0.63 (0.97)</td>
<td>0.52 (−3.18 to 3.89)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NA, not applicable.

* Adjusted for mother’s marital status and employment status.

b Adjusted for mother’s marital status, mother’s employment status, and child’s BMI (or BMI z score) at 2 years.

---

Figure 3. Mean Body Mass Index (BMI) z Score for the Groups at 2 Years, 3.5 Years, and 5 Years

The sample sizes were 465 participants, 415 participants, and 369 participants at 2 years, 3.5 years, and 5 years, respectively.
sumably because obesogenic factors within communities that put families and young children at risk of engaging in weight-related behaviors remain in place. Future research needs to explore early interventions beyond individual behaviors and family conditions that are related to overweight and obesity.

### Strengths and Limitations

The HBT phase 1 study demonstrated the effectiveness of a home-based early childhood obesity intervention, with a mean reduction in BMI of 0.38 for children at age 2 years.10 The HBT phase 2 study, a further 3-year follow-up of the phase 1 par-

### Table 3. Comparisons of Dietary Behaviors, Physical Activity, and TV Watching of Children and Their Mothers Between the Intervention vs Control Group at 3.5 Years and 5 Years

<table>
<thead>
<tr>
<th>Secondary Outcome</th>
<th>At 3.5 y No. (%)</th>
<th>P Value</th>
<th>aOR (95% CI)</th>
<th>At 5 y No. (%)</th>
<th>P Value</th>
<th>aOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dietary behaviors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables ≥2 servings per daya</td>
<td>94 (44.5)</td>
<td>.95</td>
<td>0.95 (0.62-1.45)</td>
<td>81 (42.4)</td>
<td>.90</td>
<td>0.89 (0.56-1.40)</td>
</tr>
<tr>
<td>Fruits ≥2 servings per dayb</td>
<td>147 (69.7)</td>
<td>.82</td>
<td>1.11 (0.71-1.74)</td>
<td>139 (72.8)</td>
<td>.30</td>
<td>1.31 (0.81-2.14)</td>
</tr>
<tr>
<td>Food for reward</td>
<td>172 (81.5)</td>
<td>.27</td>
<td>1.56 (0.93-2.62)</td>
<td>119 (62.3)</td>
<td>.52</td>
<td>0.97 (0.61-1.53)</td>
</tr>
<tr>
<td>Salty snack</td>
<td>154 (73.0)</td>
<td>.80</td>
<td>1.14 (0.72-1.81)</td>
<td>125 (65.4)</td>
<td>.69</td>
<td>0.95 (0.60-1.50)</td>
</tr>
<tr>
<td>Confectionery</td>
<td>169 (80.1)</td>
<td>.96</td>
<td>1.05 (0.63-1.75)</td>
<td>151 (79.1)</td>
<td>.06</td>
<td>0.71 (0.40-1.28)</td>
</tr>
<tr>
<td>Soft drink</td>
<td>70 (33.2)</td>
<td>.35</td>
<td>1.26 (0.80-1.99)</td>
<td>71 (37.2)</td>
<td>.67</td>
<td>0.91 (0.58-1.42)</td>
</tr>
<tr>
<td><strong>Physical activity and TV watchingc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor play ≥120 min/d</td>
<td>140 (66.4)</td>
<td>.65</td>
<td>0.96 (0.62-1.48)</td>
<td>129 (65.7)</td>
<td>.63</td>
<td>1.07 (0.67-1.71)</td>
</tr>
<tr>
<td>TV is on during meal</td>
<td>137 (64.9)</td>
<td>.07</td>
<td>0.84 (0.54-1.31)</td>
<td>134 (70.2)</td>
<td>.80</td>
<td>1.12 (0.69-1.80)</td>
</tr>
<tr>
<td>Eat dinner in front of TV</td>
<td>135 (64.0)</td>
<td>.56</td>
<td>0.95 (0.62-1.46)</td>
<td>106 (55.5)</td>
<td>.93</td>
<td>1.15 (0.74-1.77)</td>
</tr>
<tr>
<td>TV viewing time &lt;60 min/d</td>
<td>24 (11.4)</td>
<td>.07</td>
<td>1.68 (0.79-3.58)</td>
<td>19 (10.0)</td>
<td>.90</td>
<td>0.89 (0.44-1.83)</td>
</tr>
<tr>
<td><strong>Mothers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dietary behaviors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables ≥2 servings per daya</td>
<td>133 (63.0)</td>
<td>.08</td>
<td>0.71 (0.45-1.11)</td>
<td>140 (73.3)</td>
<td>.51</td>
<td>1.07 (0.64-1.80)</td>
</tr>
<tr>
<td>Fruits ≥2 servings per dayb</td>
<td>109 (51.7)</td>
<td>.49</td>
<td>1.15 (0.77-1.74)</td>
<td>79 (41.4)</td>
<td>.42</td>
<td>0.78 (0.50-1.22)</td>
</tr>
<tr>
<td>Soft drink ≥7 cups per week</td>
<td>65 (30.8)</td>
<td>.51</td>
<td>0.87 (0.55-1.37)</td>
<td>37 (19.4)</td>
<td>.84</td>
<td>1.15 (0.65-2.04)</td>
</tr>
<tr>
<td>Fast food</td>
<td>164 (77.7)</td>
<td>.06</td>
<td>0.64 (0.37-1.09)</td>
<td>148 (77.5)</td>
<td>.28</td>
<td>0.77 (0.45-1.34)</td>
</tr>
<tr>
<td>Processed meat ≥3 times per week</td>
<td>50 (23.7)</td>
<td>.69</td>
<td>1.16 (0.71-1.90)</td>
<td>35 (18.3)</td>
<td>.39</td>
<td>0.82 (0.48-1.41)</td>
</tr>
<tr>
<td><strong>Physical activity and TV watchingc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total physical activity time ≥150 min/wk</td>
<td>93 (44.1)</td>
<td>.59</td>
<td>0.83 (0.54-1.28)</td>
<td>155 (81.2)</td>
<td>.12</td>
<td>0.62 (0.33-1.17)</td>
</tr>
<tr>
<td>Watching TV &lt;120 min/d</td>
<td>132 (62.6)</td>
<td>.32</td>
<td>1.38 (0.89-2.14)</td>
<td>94 (49.2)</td>
<td>.45</td>
<td>0.88 (0.57-1.36)</td>
</tr>
</tbody>
</table>

Abbreviation: aOR, adjusted odds ratio.

*The numbers of participants in the intervention and control groups differ in the tables because of missing data for some variables.

*χ² Test comparing intervention vs control.

*Using multiple logistic regression adjusted for mother’s marital status, mother’s employment status, and baseline difference of the outcome.

*One serving is ½ cup of cooked vegetables or 1 cup of salad vegetables. The median intake per day was 2 servings of vegetables.

*One serving is 1 medium piece or 2 small pieces of fruits or 1 cup of diced pieces. The median intake per day was 2 servings of fruits.

1 For children’s physical activity, the national physical activity guidelines recommend that children aged 3 to 5 years should be physically active every day for at least 3 hours spread throughout the day. The national physical activity guidelines recommend that screen time for children aged 2 to 5 years should be less than 60 minutes per day.

*For physical activity, the national physical activity guidelines for adults recommend at least 30 minutes of moderate-intensity physical activity on most days and preferably all days. For TV viewing time, no national guidelines exist for adults, but it is recommended that this should be a maximum of 2 hours per day for children ages 12 to 18 years.

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participants, has generated new knowledge about the sustainability of the early intervention. Evidence produced by this study can enable policy makers and health care professionals to refocus on the life course approach to obesity prevention with a long-term commitment to tackle the obesity epidemic. A sustained and continuing support to mothers with young children is vital, particularly in socially and economically disadvantaged communities.

The study plan was transparent with a published research protocol.\textsuperscript{17} The participation rate was high, with 93.6\% of families who remained at the end of the HBT phase 1 being recruited for phase 2. The retention rate of 79.4\% over the 3-year follow-up period after intervention was reasonable. Characteristics of the study participants were similar in the 2 groups except for marital status at the end of this study. The main outcome measures were assessed using validated, well-developed, and widely used population survey tools.\textsuperscript{21-23} Blinding to treatment allocation was applied for data collection, data entry, and analysis.

However, the study has several limitations. First, conducting an overall 5-year longitudinal study of the HBT phases 1 and 2 provides challenges for maintaining the study cohort.\textsuperscript{30} As a result, loss to follow-up may have led to incomplete study results and may have biased the results, although the main reasons for loss to follow-up were similar across both groups. Second, the study was limited by non-blinded participating mothers and self-reported behavioral measures. Third, we did not assess many other potential factors (eg, environmental, school, and community) that may also have influenced mothers’ and children’s physical activity and dietary behaviors. Fourth, the results may have been substantially biased because only those participants who completed all of phase 1 and phase 2 were included. However, it is likely that if sustained effects were to be seen, they would be in this most highly engaged group. Nevertheless, with the analysis limited to this group, no detectable effect at age 3.5 or 5 years was noted.

**Conclusions**

In conclusion, the effect of this early life home-visiting intervention on child BMI was not sustained without further intervention. With a substantial proportion of young children being overweight or obese, there is a need for ongoing research to identify intervention programs.

**ARTICLE INFORMATION**

**Accepted for Publication:** January 28, 2015.
**Published Online:** April 20, 2015. doi:10.1001/jamapediatrics.2015.0258.

**Author Contributions:** Dr Wen had full access to all the data in this study and takes responsibility for the integrity of the data and the accuracy of the data analyses.

**Study concept and design:** Wen, Baur, Risell. Acquisitions, analysis, or interpretation of data: Wen, Simpson, Xu, Hayes.

**Drafting of the manuscript:** All authors.

**Obtained funding:** Wen, Baur, Simpson, Hayes, Hardy, Risell. Administrative, technical, or material support: Wen, Baur, Simpson, Xu, Hayes, Hardy, Risell.

**Conflict of Interest Disclosures:** None reported.

**Funding/Support:** This project is funded by grants 393212 and 1003780 from the Australian National Health and Medical Research Council. Dr Hayes was supported by grant 571372 from the Australian National Health and Medical Research Council.

**Role of Funder/Sponsor:** The fundings source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

**Additional Contributions:** We thank Vicki Flood and the members of the steering committee for their advice and support. We also thank the project team, including Lauren Viney, Maxine Goodwin, Maria Domenico, Emma Wood, Karen Wardle, and Angela Balafas. We thank all the families for their participation in this study.

**REFERENCES**


