









ORIGINAL RESEARCH

Effects of telephone support or short message service on body mass index, eating and screen time behaviours of children age 2 years: A 3-arm randomized controlled trial

Li Ming Wen^{1,2,3,4,5}  | Huilan Xu¹  | Sarah Taki^{1,2,3}  | Limin Buchanan^{1,2,3,4}  |
Chris Rissel^{2,3}  | Philayrath Phongsavan^{2,5}  | Alison J. Hayes^{2,3}  |
Karen Bedford¹ | Renee Moreton⁶ | Louise A. Baur^{2,3,5,7} 

¹Health Promotion Unit, Population Health Research & Evaluation Hub, Sydney Local Health District, Camperdown, Australia

²Faculty of Medicine and Health, Sydney School of Public Health, The University of Sydney, Sydney, Australia

³NHMRC Centre of Research Excellence in the Early Prevention of Obesity in Childhood (EPOCH), Sydney, Australia

⁴Sydney Institute for Women, Children and Their Families, Sydney Local Health District, Camperdown, Australia

⁵Charles Perkins Centre, The University of Sydney, Camperdown, Australia

⁶Population Health, Sydney Local Health District, Camperdown, Australia

⁷Discipline of Child and Adolescent Health, Sydney Medical School, The University of Sydney, Camperdown, Australia

Correspondence

Li Ming Wen, Population Health Research & Evaluation Hub, Sydney Local Health District, Level 9 North, King George V Building, Camperdown NSW 2050, Australia.
Email: liming.wen@health.nsw.gov.au; liming.wen@sydney.edu.au

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Summary

Background: Few randomized controlled trial (RCT) interventions targeted children's early risk behaviours using telephone or short message service (SMS) support.

Objective: To evaluate the effectiveness of telephone or SMS early intervention focusing on mothers' behaviours starting from late pregnancy to improve BMI, and eating and screen time behaviours of children aged 2 years in comparison with the control group.

Methods: A 3-arm RCT was conducted in Australia, 2017–2019. Two arms involved the interventions using nurse-led telephone or SMS support, delivered in nine stages from late pregnancy to age 2 years. The third arm was control. The primary outcome was children's objectively measured BMI and BMI z-score at 2 years. Secondary outcomes included child eating and screen time behaviours as reported by parents at 2 years.

Results: At 2 years, 797 mother–child dyads (69%) completed the telephone survey with 666 (58%) completing weight and height measurements. The study found no statistically significant difference in BMI between the groups. The mean BMI for telephone support was 16.93 (95% CI: 16.73 to 17.13), for SMS 16.92 (95% CI: 16.73 to 17.11) or for control 16.95 (95% CI: 16.73 to 17.16) with a difference of -0.02 (95% CI: -0.31 to 0.27 , $p = 0.907$) in telephone versus control, and a difference of -0.03 (95% CI: -0.30 to 0.24 , $p = 0.816$) in SMS versus control. Telephone support was associated with higher odds of no bottle at bedtime (adjusted odds ratio [AOR]: 2.99; 95% CI: 2.01 to 4.47), family meals (AOR: 2.05; 95% CI: 1.26 to 3.33), drinking from a cup (AOR: 1.89; 95% CI: 1.24 to 2.88), less screen time (<1 h/day) (AOR: 1.56; 95% CI: 1.10 to 2.23) and not eating dinner in front of the TV (AOR: 1.50; 95% CI: 1.09 to 2.06). SMS support was also associated with higher odds of no bottle at bedtime (AOR 2.30, 95% CI: 1.58 to 3.33) than the control.

Conclusion: The telephone or SMS support intervention had no significant effects on BMI, but was effective in increasing no bottle use at bedtime. Telephone support showed more effects than SMS on reducing screen time and eating behaviours.

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KEYWORDS

randomized controlled trial, screen time, short message service, telephone support

1 | INTRODUCTION

The prevalence of obesity in young children is increasing and presents a major public health problem worldwide.¹ There is a strong link between obesity in childhood, adolescence, and adulthood.² The prevention of obesity risk in early childhood is critical for potential short- and long-term health.³ However, current evidence for effective obesity prevention in the first few years of life is scarce,⁴ despite the identification of several modifiable risk factors such as bottle use and TV viewing time.⁴⁻⁶

A 2019 Cochrane systematic review on preventing obesity in children found that limited interventions reduced body mass index (BMI) in children aged 0-5 years.⁴ A subsequent individual participant data prospective meta-analysis found that intervention programs were associated with a very small reduction in BMI z-score at age 18 to 24 months.⁷ The current evidence has been mainly derived from RCTs of face-to-face education programs delivered through staged home visits^{8,9} or group education sessions.^{10,11} For example, the Healthy Beginnings Trial (HBT), which used a staged home visiting intervention from late pregnancy to age 2 years, was associated with improved dietary behaviours, reduced TV viewing time and decreased mean BMI of children at 2 years.⁸ However, face-to-face education programs have high delivery costs,¹² potentially limiting their population reach and cost effectiveness.¹³

Telehealth, the use of telephone or electronic communication tools for health services and health promotion, provides a potential alternative to the face-to-face approach and can overcome some of its limitations.¹⁴ The role of telehealth in supporting the community has become particularly important during the COVID-19 pandemic when face-to-face health services were hampered.¹⁵ Interventions delivered by telephone-based counselling or short message service (SMS) have been used to promote health behaviour change and obesity prevention in adults.¹⁶⁻¹⁹ For example, a systematic review of reviews on mobile text messaging for health found that the majority of published text messaging interventions were effective when addressing diabetes self-management, weight loss and physical activity.¹⁹ However, there is limited evidence on the use of telephone or SMS support in promoting healthy behaviours and reducing childhood obesity in the first 2 years of life.^{4,20}

To fill this knowledge gap, a 3-arm RCT of communicating Healthy Beginnings advice by telephone (CHAT)²¹ was conducted to determine whether the effects of the home-based HBT^{8,22,23} could be replicated by a staged nurse-led telephone or SMS support intervention over the first 2 years of life from late pregnancy to age 2 years. The findings from the 3-arm CHAT trial at 6 and 12 months of child age have been reported previously.²⁴ The study found that telephone support increased the appropriate timing of introducing solids, early start tummy time, and cup usage, while telephone support and SMS

reduced exposure to screen time and having a bottle at bedtime at 12 months.²⁴

2 | METHODS

2.1 | Study design

A 2-year 3-arm parallel RCT was conducted between February 2017 and October 2019. The study protocol was published prior to the commencement of this trial.²¹ With additional research funds awarded in late 2017, the study protocol and the trial registration were immediately modified to extend the intervention period up to 24 months. The trial is registered with the Australian Clinical Trial Registry (ACTRN12616001470482).

2.2 | Setting, participants and recruitment

The detailed plan and process have been reported elsewhere.^{21,24,25} Briefly, the study was conducted in metropolitan Sydney, New South Wales (NSW), Australia. Research assistants (RAs) recruited pregnant women at weeks 24-34 of pregnancy attending the antenatal clinics of eight hospitals across NSW with a letter of invitation and information about the study.^{24,25}

2.3 | Eligibility criteria

Women were eligible for recruitment if they were aged 16 years and over, able to communicate in English with a mobile phone, and lived in the recruitment areas. Women were excluded if they had a severe medical condition or known major fetal anomalies based on medical advice.

2.4 | Randomization

Participating women were then randomized into one of three arms (i.e., telephone support, SMS or control arm) using randomly permuted blocks ($n = 6$) (<http://www.randomization.com/>), stratified by local health districts.

2.5 | Intervention

The intervention was developed based on the Health Belief Model²⁶ and the previously HBT.^{8,22,23} The details of the initial six staged

interventions from the third trimester to 12 months of the child's age were reported in the 6- and 12-month outcome paper.²⁴ Between 12 and 24 months of age, we implemented staged interventions at three time points: 12–15 months, 15–18 months and 18–24 months. The interventions included continued telephone or SMS support together with three additional intervention packages according to modified intervention protocol (Data S1).

2.5.1 | Intervention arm 1 (telephone support)

Nine telephone support sessions to mothers in this group were made by Child and Family Health Nurses. Each support session was conducted for about 30–60 min after mailing each of the intervention booklets at specific time points. Nine telephone support scripts were developed to guide the intervention sessions (Data S2).

2.5.2 | Intervention arm 2 (SMS)

Nine staged SMS interventions were implemented following mailing of the intervention booklets at the specific time points. A 2-way automated SMS system was used to send the SMSs twice a week for 4 weeks at a predetermined time (10 a.m.–1 p.m.). A full list of SMS text messages for the period of 12 and 24 months can be viewed via Data S3.

2.5.3 | Control arm

Mothers received usual care comprising at least one nurse visit for general support at home and possible multiple home visits for vulnerable families from the local health districts.

2.6 | Main measures and outcomes

For the purpose of consistent reporting and comparison with previous similar study⁸ and as predefined²¹ at 24 months, the primary outcomes were child's BMI and BMI z-score, with secondary outcomes being child's screen time, eating habits (e.g., fruit/vegetable consumption, cup usage, bottle use at bedtime, and having a meal in front of the TV), and active play time. Using the computer-assisted telephone interview the questionnaire was used for secondary outcomes and coding (Data S4) based on the previous HBT.^{8,22,23} Socio-demographic data were also collected at baseline using standard NSW Health Survey questions²⁷ and have been reported in the 6- and 12-month outcome paper²⁴ (Table S1).

Children's anthropometry was measured at home visits by RAs using a strict protocol (Data S5). Weight was measured by Seca 803 scales and height by the Seca 213 portable stadiometer. The WHO Anthro program,²⁸ software that provides means to analyse anthropometric data for children under 5 years of age, was used to obtain BMI-, weight- and length-for-age z-scores at 24 months.

2.7 | Intervention engagement

To monitor the intervention engagement and participants' satisfaction, a process evaluation was conducted and has been reported elsewhere.²⁹ The numbers of telephone support sessions held or SMS messages sent were also recorded.

2.8 | Sample size

We estimated that a total sample of 1056 mothers (352 in each arm) was required to detect a mean difference in the primary outcome, BMI z-score of 0.29 units (according to the finding from HBT⁸) between each intervention group and the control at age 24 months, with 80% power and two-sided 5% significance level.

2.9 | Blinding

The RAs who measured child's weight and height were blinded to group allocation. We contracted a market survey company to use the computer-assisted telephone interview for collecting secondary outcomes. The survey interviewers were unaware of the research hypotheses and were blinded to treatment allocation.

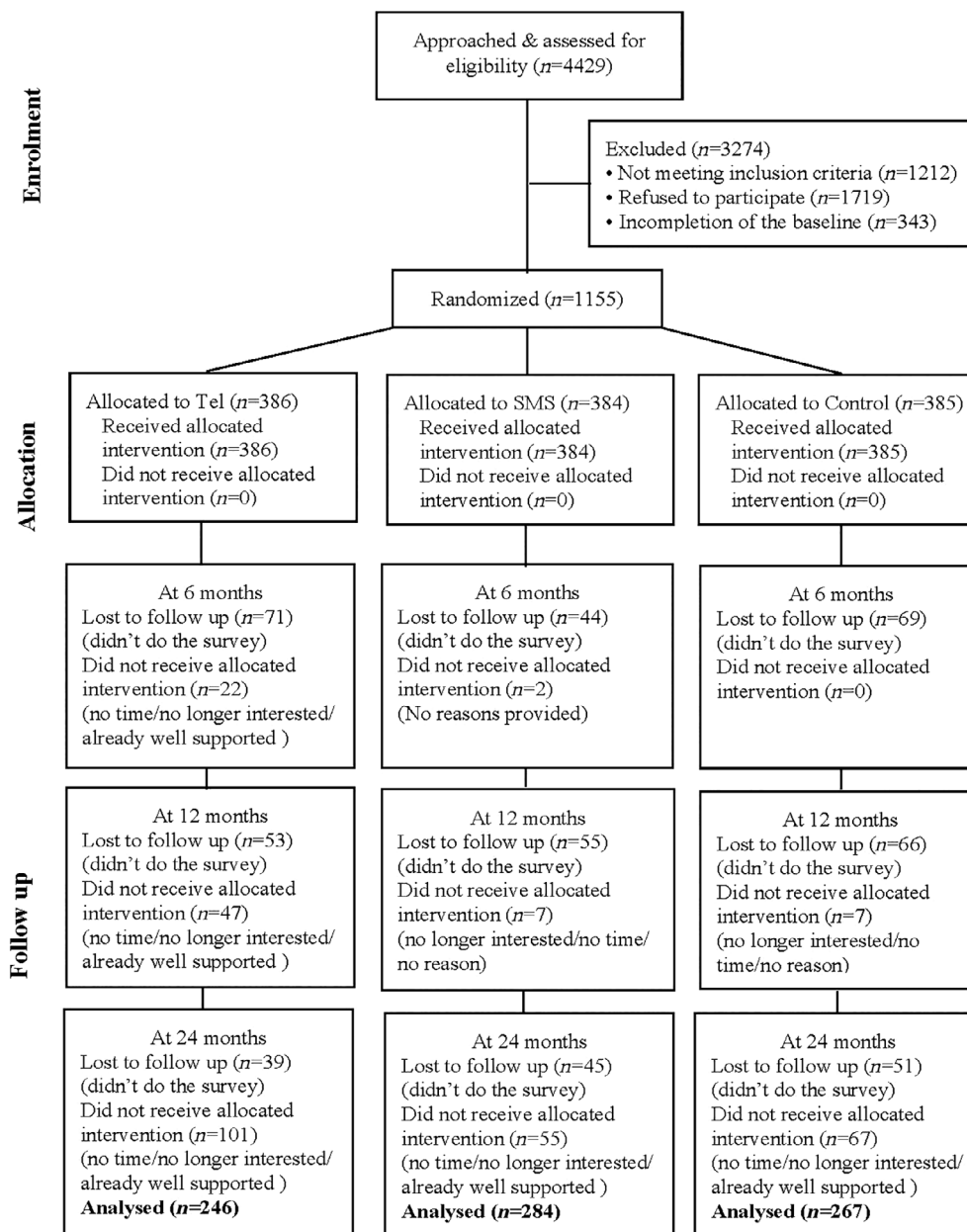
2.10 | Data analysis

A statistical analysis plan was developed while preparing the study protocol.²¹ This was modified and published in late 2019 prior to the commencement of this analysis.²⁴ Briefly, we used Stata, version 13 (StataCorp, College Station, TX) in conducting the data analysis, and applied the intention-to-treat principle to all data analyses. We conducted both complete-case and multiple imputation analyses to address potential bias due to missing values. Outcome variables were dichotomized based on a mean or medium value or the recommended guidelines, a similar approach to that used in previous studies.^{8,23,24} We also categorized children at age 2 years with overweight/obesity or not, based on the International Obesity Taskforce recommended age-standardized BMI cut points.³⁰

For outcomes that were only measured at 24 months including child BMI, outdoor play and screen time, cross-sectional comparisons were made between each of the interventions and the control. For outcomes that were repeatedly measured at 12 and 24 months such as child eating habits, longitudinal data analyses using multilevel mixed-effects models were conducted. All hypothesis tests are two tailed with 80% power and 5% significance level. The Bonferroni procedure was used to adjust for multiple comparisons of the secondary outcomes.

Multiple regression models were built to examine the differences in main outcomes between each intervention group (telephone or SMS) and control group. Multiple linear regression models were used for continuous outcomes measured at 24 months (e.g., child BMI, outdoor play and screen time). Mean differences in outcomes with 95% CI are reported. Multiple logistic models were built for binary outcomes measured

FIGURE 1 CONSORT diagram



(e.g., outdoor play and screen time, having dinner in front of TV). Multi-level mixed-effects logistic models were built for binary outcomes repeatedly measured at 12 and 2 months (e.g., cup or bottle usage, and other eating habits). AOR and 95% CI are reported. All multiple regression models were adjusted for recruitment sites.

Multiple imputation by chained equations was used in dealing with missing values including continuous, binary, and categorical variables. Missing outcome values were imputed for a full intention-to-treat analysis of all 1155 participants recruited at baseline. The number of 20 imputations³¹ was selected to reach a relative efficiency of more than 99% and a power fall off of less than 1%. By using Stata's "mi estimate" command, we calculated the mean and 95% CI for continuous outcomes, the number and proportions for binary outcomes by treatment groups. The absolute differences in percentage for the binary outcomes were tested by two-proportion z-tests. We also calculated the mean difference of

each of the continuous outcomes for those in the telephone and SMS groups compared with the control group by fitting multiple linear regression models, and AORs for each of the binary outcomes for those in the telephone and SMS groups compared with the control group by fitting multilevel mixed-effects logistic models, as we did for the complete-case analysis models. When appropriate, adjustments for demographic covariates were conducted (see table footnotes).

3 | RESULTS

3.1 | Baseline characteristics and follow-up

We reported baseline characteristics of the study participants ($n = 1155$) in the 6- and 12-month outcome paper²⁴ (Table S1). Figure 1 shows that

TABLE 1 Comparisons of the primary outcome between telephone or SMS support and control group at 24 months on both complete-case and MI multiple imputations analyses

Main outcomes	Tel-support Mean (95% CI)	SMS Mean (95% CI)	Control Mean (95% CI)	Tel-support-control Mean difference (95% CI)	SMS-control Mean difference (95% CI)	p
Complete cases analysis (n = 200 in telephone support, 242 in SMS, 220 in control) ^a						
BMI	16.89 (16.69 to 17.09)	16.90 (16.70 to 17.11)	16.94 (16.74 to 17.14)	-0.05 (-0.34 to 0.24)	-0.05 (-0.32 to 0.23)	.724
BMI-for-age z-score	0.83 (0.70 to 0.97)	0.84 (0.70 to 0.98)	0.86 (0.72 to 0.99)	-0.03 (-0.22 to 0.17)	-0.03 (-0.21 to 0.16)	.791
Weight-for-age z-score	0.49 (0.37 to 0.63)	0.57 (0.45 to 0.71)	0.54 (0.40 to 0.69)	-0.05 (-0.25 to 0.14)	0.03 (-0.15 to 0.22)	.590
Length-for-age z-score	-0.15 (-0.30 to 0.003)	-0.001 (-0.14 to 0.14)	-0.08 (-0.22 to 0.06)	-0.08 (-0.29 to 0.13)	0.09 (-0.11 to 0.28)	.451
Multiple imputation analysis (n = 386 in Tel-support, 384 in SMS, 385 in control) ^b						
BMI	16.93 (16.73 to 17.13)	16.92 (16.73 to 17.11)	16.95 (16.73 to 17.16)	-0.02 (-0.31 to 0.27)	-0.03 (-0.30 to 0.24)	.907
BMI-for-age z-score	0.86 (0.72 to 0.99)	0.85 (0.71 to 0.98)	0.87 (0.72 to 1.02)	-0.01 (-0.20 to 0.18)	-0.02 (-0.21 to 0.16)	.916
Weight-for-age z-score	0.55 (0.42 to 0.68)	0.61 (0.48 to 0.73)	0.57 (0.44 to 0.70)	-0.02 (-0.21 to 0.16)	0.04 (-0.14 to 0.21)	.810
Length-for-age z-score	-0.10 (-0.25 to 0.06)	0.03 (-0.12 to 0.17)	-0.04 (-0.19 to 0.11)	-0.06 (-0.27 to 0.16)	0.07 (-0.15 to 0.29)	.605

^aMean differences from multiple regression models adjusted for recruitment sites, mother's age, country of birth, language spoken at home, annual household income, education level, employment and marital status at baseline.

^bMean differences from multiple regression models adjusted for recruitment sites.

TABLE 2 Differences of secondary outcomes in mean or percentage between each of the intervention groups and control group using multiple imputations

Secondary outcomes	Tel-support n (%)	SMS n (%)	Control n (%)	Tel-support-Control		SMS-Control	
				% Difference (95% CI)	p*	% Difference (95% CI)	p*
Outdoor playtime ≥ 3 h/day	203 (53)	181 (47)	187 (48)	5 (−2.9 to 11.2)	1	−1 (−8.4 to 5.7)	1
Screen time < 1 h/day	195 (51)	188 (49)	152 (40)	11 (4.0 to 17.9)	0.024	9 (2.4 to 16.4)	0.096
No dinner in front of TV	182 (47)	176 (46)	143 (37)	10 (2.9 to 16.7)	0.072	9 (1.5 to 15.4)	0.204
Drinking from cup	330 (85)	326 (85)	297 (77)	8 (2.8 to 13.8)	0.036	8 (2.2 to 13.3)	0.072
No bottle at bedtime	238 (62)	210 (55)	146 (38)	24 (16.9 to 30.6)	<0.0001	17 (9.8 to 23.7)	<0.0001
Vegetable ≥ 2 serves/day	222 (57)	229 (60)	211 (55)	2 (−4.4 to 9.6)	1	5 (−2.3 to 11.7)	1
Fruit ≥ 2 serves/day	282 (73)	300 (78)	273 (71)	2 (−4.2 to 8.4)	1	7 (1.1 to 13.4)	0.252
No fast food	179 (46)	157 (41)	146 (38)	8 (1.4 to 15.3)	0.228	3 (−3.9 to 9.9)	1
No soft drink	340 (88)	345 (90)	338 (88)	0 (−4.2 to 5.0)	1	2 (−2.3 to 6.6)	1
Having meal together	299 (77)	292 (76)	297 (77)	0 (−5.7 to 6.1)	1	−1 (−7.2 to 4.7)	1
Having family meal	301 (78)	270 (70)	268 (70)	8 (2.2 to 14.6)	0.096	0 (−5.9 to 7.1)	1
No food for reward	341 (88)	342 (89)	343 (89)	−1 (−5.4 to 3.5)	1	0 (−4.5 to 4.3)	1
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean difference (95% CI) ^a	p*	Mean difference (95% CI) ^a	p*
Outdoor play time (min/day)	183 (170.0 to 195.5)	176 (163.5 to 188.5)	182 (168.8 to 195.3)	1 (−16.5 to 18.0)	1	−6 (−23.3 to 11.2)	0.982
Screen time (min/day)	66 (57.4 to 75.2)	72 (64.3 to 80.1)	81 (72.1 to 89.0)	−15 (−26.6 to −2.0)	0.046	−9 (−19.8 to 3.2)	0.310

^aMean differences from multiple regression models adjusted for recruitment sites.

*p value after Bonferroni correction.

Secondary outcomes	Tel-support versus Control		SMS versus Control	
	AOR ^a (95% CI)	p*	AOR ^a (95% CI)	p*
Outcomes ^b				
Outdoor playtime ≥ 3 h/day	1.18 (0.85 to 1.64)	0.927	0.95 (0.68 to 1.32)	1
Screen time < 1 h/day	1.56 (1.10 to 2.23)	0.042	1.47 (1.05 to 2.05)	0.072
No dinner in front of TV	1.50 (1.09 to 2.06)	0.036	1.42 (1.01 to 2.00)	0.135
Outcomes ^c				
Drinking from cup	1.89 (1.24 to 2.88)	0.027	1.57 (1.06 to 2.32)	0.216
No bottle at bedtime	2.99 (2.01 to 4.47)	<0.0001	2.30 (1.58 to 3.33)	<0.0001
Vegetable ≥ 2 serves/day	1.02 (0.71 to 1.48)	1	1.36 (0.92 to 2.02)	1
Fruit ≥ 2 serves/day	1.04 (0.75 to 1.44)	1	1.51 (1.06 to 2.16)	0.207
No fast food	1.45 (1.02 to 2.07)	0.342	1.19 (0.87 to 1.64)	1
No soft drink	1.03 (0.67 to 1.59)	1	1.49 (0.96 to 2.32)	0.675
Having meal together	0.66 (0.24 to 1.80)	1	0.60 (0.18 to 1.98)	1
Having family meal	2.05 (1.26 to 3.33)	0.036	1.21 (0.79 to 1.85)	1
No food for reward	1.20 (0.75 to 1.93)	1	1.07 (0.69 to 1.67)	1

Abbreviation: AOR, adjusted odds ratio.

^aAOR adjusted for recruitment sites.

^bMultiple regression models.

^cMixed models.

*p value after Bonferroni correction.

TABLE 3 AORs for each of the intervention groups on secondary outcomes compared to control group

1155 women were randomized into either telephone support ($n = 386$), SMS support ($n = 384$) or control ($n = 385$). At 24 months, 797 mothers (telephone = 246, SMS = 284, or control = 267) completed the

telephone survey (retention rate of 69%), and 666 children (58%) had their height and weight measured at home. Mothers were more likely to be lost to follow-up if they were younger, unemployed, unmarried or had

a de-facto partner, and had lower income or education level (Table S2). Table S3 shows comparisons of characteristics among those who completed the follow-up survey at 2 years by group allocation. It shows demographic characteristics were evenly distributed across three groups except for mothers' employment status.

3.1.1 | Primary outcome

Table 1 shows comparisons of means (95% CIs) of child BMI, BMI z-score, weight-for-age z-score and length-for-age z-score at 24 months between each intervention (telephone or SMS) and control group using both complete-case and multiple imputation analyses. At 24 months, there was no statistically significant difference in BMI or BMI z-score between the groups ($p > 0.05$). The mean BMI for telephone support was 16.93 (95% CI: 16.73 to 17.13), for SMS 16.92 (95% CI: 16.73 to 17.11) or for control 16.95 (95% CI: 16.73 to 17.16) with a difference of -0.02 (95% CI: -0.31 to 0.27 , $p = 0.907$) in telephone versus control, and a difference of -0.03 (95% CI: -0.30 to 0.24 , $p = 0.816$) in SMS vs control. The mean BMI z-score for telephone support was 0.86 (95% CI: 0.72 to 0.99), for SMS 0.85 (95% CI: 0.71 to 0.98) or for control 0.87 (95% CI: 0.72 to 1.02) with a difference of -0.01 (95% CI: -0.20 to 0.18 , $p = 0.916$) in telephone versus control and a difference of -0.02 (95% CI: -0.21 to 0.16 , $p = 0.812$) in SMS versus control.

In complete-case analysis, we found that the proportion of children who were classified with overweight or obesity was non-significantly lower in the telephone support group ($n = 33/200$, 16.5%), and the SMS group ($n = 45/242$, 18.6%) than the control ($n = 48/220$, 21.8%) with χ^2 test ($df = 2$) = 1.708, $p = 0.426$.

3.1.2 | Secondary outcomes

Using complete-case analysis with adjustments

Comparisons of secondary outcomes in differences of mean or percentage or AORs between each intervention support (telephone or SMS) and control group are presented in Tables S4 and S5. Telephone support was significantly associated with improvements in the outcomes including less screen time, no dinner in front of TV, drinking from a cup, no bottle at bedtime and having family meals (p values < 0.05 after Bonferroni correction). SMS support was also significantly associated with reduced screen time and no bottle use at bedtime (p values < 0.05 after Bonferroni correction).

Using multiple imputation analysis with adjustments

Table 2 shows the differences in mean or percentage of secondary outcomes between each of the intervention groups and control group at 2 years of age. For example, compared with children in the control group, those in the telephone support group had an average of 15 min less screen time or 11% more in the category of reduced screen time (< 1 h/day). The telephone support group also had 24% more of children in having no bottle at bedtime while SMS group had 17% more in having no bottle at bedtime. These differences were significant with p values < 0.05 after Bonferroni correction.

Table 3 shows the AORs for each of the intervention groups on those secondary outcomes compared with the control group. Telephone support was associated with higher odds (AORs > 1) of having less screen time (< 1 h/day) and not having dinner in front of the TV, drinking from a cup, having no bottle at bedtime, and having family meals than the control group. SMS support was also associated with having no bottle at bedtime than the control. These improvements were statistically significant with p values < 0.05 after Bonferroni correction.

3.2 | Intervention engagement

Only 253 mothers (66%) received the stage 7 and 8 telephone sessions, while just 244 (63.2%) received the stage 9 telephone sessions. As reported previously, for the period from late pregnancy to 12 months, the percentages of mothers receiving support sessions went from 61% to 87%.²⁴ A total of 60 participants opted out from the SMS intervention by the end of 24 months. The scheduling SMS system does not allow us to identify at what time point the participants decided to opt out. Overall, 324 (84.3%) participants received all SMS.

4 | DISCUSSION

4.1 | Principal findings of the study

The study found that no effects on BMI and weight status were observed as a result of the telephone or SMS support intervention at age 2 years. However, both the nurse-led telephone support and SMS interventions were effective in no bottle use at bedtime. Telephone support also showed effects on reducing screen time, not having dinner in front of the TV, drinking from a cup and having family meals.

4.2 | Meaning of the study

Unlike the previous home-based HBT,⁸ which found a statistically significant reduction in mean BMI and BMI z-score, neither the telephone nor SMS support was associated with a significant reduction in mean BMI of children aged 2 years. These findings are similar to those of several multicomponent lifestyle intervention trials on children of similar age that observed improved feeding practices but no intervention effects on children's BMI.^{10,11} However, a recent study found that an intervention using multiple strategies combined with text messaging and health coaching was associated with lower odds of overweight of infants at 6 and 12 months.³²

4.2.1 | Plausible explanations for BMI outcome

The current study showed intervention effects on eating habits and screen time; however, these effects did not translate to corresponding

effects on the anthropometric outcomes at a statistically significant level. One plausible explanation could be high variability in growth parameters shown between aged 0–2 years, and inter-individual variations in weight gain rate may become less from 2 years onwards.^{33,34} Two interventions in the United States observed significant decreases in BMI³⁵ and a slower linear BMI growth³⁶ among their study children. Both studies included children from 2 years onwards.

4.2.2 | Comparisons with the health beginnings trial (HBT)

This trial was unable to replicate the effect of the home-based HBT⁸ on BMI reduction at age 2 years using a staged telephone or SMS support intervention. The original HBT program delivered eight home visits by specially trained community nurses from late pregnancy to child aged 2 years. The results showed that mean BMI was significantly lower in the intervention group (16.53) than in the control group (16.82), with a difference of 0.29 (95% CI: –0.55 to –0.02; $p = 0.04$). In addition, the home-based intervention showed some positive effects on children's vegetable consumption, not being given food as reward, and TV viewing time.⁸ There are some possible explanations for the difference in BMI outcomes between this study and HBT.⁸ Firstly, participants in HBT were first-time mothers and more socially disadvantaged as compared to the CHAT study. However, we conducted a post-hoc analysis and found no interaction between intervention and first-time mothers or other socio-economic characteristics. Secondly, variations in breastfeeding duration between the two studies may also have contributed to the difference in BMI-for-age-z-score between the two studies as several studies have shown beneficial effects on childhood BMI.^{37–39} The HBT intervention was associated with significant improvements in breastfeeding rate and duration²³ as compared to this study in which a lesser effect on breastfeeding was observed.²⁴ Thirdly, it is also possible that the interventions tested did not have a sufficient dose to impact weight outcomes adequately.

Consistent with previous evidence,^{8,9,23,24} this study suggests that the nurse-led telephone support can reduce bottle feeding and screen time of young children while SMS support can reduce bottle use at bedtime. This is of particular public health significance because both bottle feeding and screen time are linked to early onset of childhood obesity.^{5,6,20} It is recommended that infants from 6 months of age should be introduced to drinking from a cup, and the use of a bottle should be actively discouraged after the age of 12 months.^{40,41} However, we found a substantial proportion of children at 24 months still used a bottle for drinking (15%) or had a bottle at bedtime (38%).

4.3 | What the study adds

The results demonstrate that nurse-led staged telephone support can be an alternative approach to widely used face-to-face approaches in promoting healthy eating habits and reducing screen time. In particular, while face-to-face health service contacts are restricted temporarily due

to events such as the COVID-19 pandemic, nurse-led staged telephone intervention support has great public health potential.¹⁵ The results also demonstrate that the use of telephone support showing more beneficial effects than SMS intervention can ideally be integrated into existing early childhood health services to improve child feeding practices and reduce screen time given the lower costs.¹²

4.4 | Unanswered questions and future research

This study found several positive effects of the telephone on eating and screen time behaviours at 24 months, but no significant effect on BMI of young children, which highlight that interventions to impact children's BMI are difficult. Our results underscore the importance of also measuring behaviour change since healthier behaviours could have benefits beyond BMI change. Our study findings are in line with a recent systematic review as most interventions were effective on a behavioural outcome only.⁴² It is evident that there is great need to unpack the active and effective ingredients of early interventions. There is also a need for a better understanding of early life modifiable risk factors for childhood obesity. To date, feeding practices, screen time, physical activity and sleep have been identified as key modifiable risk factors,^{43,44} but by how much and in what way each of these factors contributes to the early risk of childhood obesity are worth investigation. In addition, optimal intensity or dose of either telephone or SMS support to yield BMI outcomes remains to be further tested.

4.5 | Strengths and limitations

Strengths include a large scale RCT with 2-year intervention from late pregnancy to 2 years of child age. The intervention was theory-based and well informed by the previous successful HBT.^{8,22,23} The primary outcome of BMI was based on objectively measured weight and height, and secondary outcomes were assessed using validated questionnaires by blinded interviewers through telephone interviews.

However, several limitations are worth noting. First, the percentages of mothers in the telephone support group received telephone support calls varied from 61% to 87% with an average of 69%, which could have reduced the effect of the telephone support. Second, the retention rate of the study was around 69% for almost 25 months from late pregnancy to 2 years of child age, but there were no significant differences in dropout rates across three arms. Only 58% of the participants had objectively measured weight and height for BMI as the primary outcome, which was due to the resource constraints (i.e., lack of research staff to travel to all participants' homes for measuring height and weight). This could also influence the results, although we used multiple imputations for missing data. Third, findings could be limited by using mothers' self-report questionnaire assessments. This is however, an approach in line with all other similar studies. Fourth, this intervention did not include some important influences on child obesity risk, for example sugary beverage consumption and consumption of fibre-rich, minimally processed foods as

highlighted in Thompson's recent review.⁴⁵ A high proportion of study participants who spoke languages other than English reflects the population demographics in the study regions (i.e., Sydney, South Western and South Eastern Local Health Districts), which, however, could limit the generalizability of the study findings to broader Australian community. In addition, the outcome measures could be limited without measuring consumption of fruit and vegetable purees and pouches given evidence linking it to childhood obesity risk.⁴⁶

5 | CONCLUSION

The staged early intervention from late pregnancy to age 2 years using either nurse-led telephone or SMS support shows no significant effect on BMI, but was effective in reducing bottle use at bedtime. Telephone support showed more effects than SMS on reducing screen time, not having dinner in front of the TV, drinking from a cup and having family meals. Whether telephone or SMS support can have some beneficial effects on BMI and weight status warrants further investigations in addition to determining optimal dose or intensity of the intervention. Exploring determinants of childhood obesity other than the risk factors examined in this study is also needed.

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CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

ETHICAL APPROVAL

The trial was granted ethics approval by the Ethics Review Committee of Sydney Local Health District (Protocol No: X16-0360 & LNR/16/

RPAH/495 and Protocol No X18-0387 & HREC/18/RPAH/545). Written informed consent was obtained from all study participants.

DATA AVAILABILITY STATEMENT

De-identified data and material can be available on request pending on ethics approval from Dec 30, 2021 to Dec 30, 2026.

ORCID

Li Ming Wen  <https://orcid.org/0000-0003-1381-4022>

Huilan Xu  <https://orcid.org/0000-0002-9488-8121>

Sarah Taki  <https://orcid.org/0000-0002-7228-8993>

Limin Buchanan  <https://orcid.org/0000-0002-4438-5761>

Chris Rissel  <https://orcid.org/0000-0002-2156-8581>

Philayrath Phongsavan  <https://orcid.org/0000-0003-2460-5031>

Alison J. Hayes  <https://orcid.org/0000-0002-8679-6040>

Louise A. Baur  <https://orcid.org/0000-0002-4521-9482>

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SUPPORTING INFORMATION

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