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The TOTS Community Intervention to Prevent Overweight in American Indian Toddlers Beginning at Birth: A Feasibility and Efficacy Study

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Abstract Excess weight gain in American Indian/Alaskan native (AI/AN) children is a public health concern. This study tested (1) the feasibility of delivering community-wide interventions, alone or in combination with family-based interventions, to promote breastfeeding and reduce the consumption of sugar-sweetened beverages; and (2) whether these interventions decrease Body Mass Index (BMI)-*Z* scores in children 18–24 months of age. Three AI/AN tribes were randomly assigned to two active interventions; a community-wide intervention alone (tribe A; $n = 63$ families) or community-wide intervention containing a family component (tribes B and C; $n = 142$ families). Tribal staff and the research team designed community-tailored interventions and trained community health workers to deliver the family intervention through home visits. Feasibility and acceptability of the intervention and BMI-*Z* scores at 18–24 months were compared between tribe A and tribes B & C combined using a separate sample pretest, posttest design. Eighty-six percent of enrolled families completed the study. Breastfeeding initiation and 6-month duration increased 14 and 15%, respectively, in all tribes compared to national rates for American Indians. Breastfeeding at 12 months was comparable to national data. Parents expressed confidence in their ability to curtail family consumption of sugar-sweetened beverages. Compared to a pretest sample of children of a similar age 2 years before the study begun, BMI-*Z* scores increased in all tribes. However, the increase was less in tribes B & C compared to tribe A (−0.75, $P = 0.016$). Family, plus community-wide interventions to increase breastfeeding and curtail sugar-sweetened beverages attenuate BMI rise in AI/AN toddlers more than community-wide interventions alone.

Keywords Obesity prevention · Infants · Toddlers · Breastfeeding · Sugar-sweetened beverages

Abbreviations

BMI	Body Mass Index
PedNSS	Pediatric Nutrition Surveillance System
WHO	World Health Organization
IHS	Indian Health Service

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Introduction

The prevalence of overweight in children aged 2–5 years in the US has increased, with children from racial and ethnic minority populations showing the greatest increases [1, 2]. American Indian/Alaskan Native (AI/AN) children have a high risk of overweight, and potential for adult obesity. The prevalence of overweight (BMI $\geq$ 85th percentile) among AI/AN children 5–17 years of age is approximately 47%, compared to 33.6% in similarly aged children of other races [3]. The risk for overweight may begin at birth in AI/AN children. Pima Indian infants, for example, gain weight more rapidly in the first 6 months of life than reference children, and the most potent predictor of adolescent weight among the Pima is weight at 5 years of age [4, 5]. Approximately 12.6% of AI/AN infants (0–11 months) and 24% of toddlers (12–23 months) are at risk for overweight, compared to 10.9 and 17%, respectively, for infants and toddlers from the general population [4]. Among preschoolers, 40% of AI/AN children are overweight, compared to 31.2% in the general population of preschoolers aged 2–5 years [6].

Obesity prevention efforts targeted at younger children in populations experiencing excess weight gain in early life are needed. Breastfeeding and curtailment of sugar-sweetened beverage consumption may prevent excess weight gain in children [7, 8]. We describe results of a pilot intervention to prevent excess weight gain in AI/AN toddlers, by promoting breastfeeding and curtailment of sugar-sweetened beverage consumption.

Methods

The toddler overweight and tooth decay prevention study (TOTS) was an obesity prevention community-based study. We compared two active interventions to prevent obesity; (1) a community wide intervention and (2) a community wide intervention with an added family-based component, as methods for the promotion of breastfeeding and reducing consumption of sugar-sweetened beverages. Our goal was to assess the feasibility, acceptability and efficacy of these approaches in preventing toddler overweight.

Study Population and Setting

Expectant mothers and their families were recruited from three AI tribes who are members of the Northwest Portland Area Indian Health Board (NPAIHB). The NPAIHB is within the Portland Area Indian Health Service (IHS) cluster (Idaho, Oregon, and Washington). Tribes were divided into two groups: tribe A received community-wide interventions only; tribes B & C received community-wide interventions with family-based components. We did not recruit an active control group. Instead, we used a separate sample pretest–posttest design, also known as simulated before and after design [9]. In this design, two equivalent groups are identified, one sample (the pre-test sample) is measured before the intervention and a different (but equivalent) sample (post-test sample) is measured after the intervention. In our case the "pre-test sample" was a cohort of AI/AN children born 2 years earlier in the same tribes, and whose data was collected as part of the Centers for Disease Control and Prevention's Pediatric and Nutrition Surveillance System (PedNSS). This pre-test sample gave us the baseline prevailing levels of overweight in the participating tribes.

The Portland Area IHS Institutional Review Board approved the study. In addition to parental informed consent, each tribe gave permission for researchers to conduct the study and access the PedNSS longitudinal data. Anonymity of the participating tribes is retained as per their request.

Intervention Design

Intervention Goals were to: (1) increase breastfeeding initiation and duration; (2) limit the introduction of sugar-sweetened beverages to infants and toddlers; and, (3) promote the consumption of water for thirst among toddlers. Interventions were informed by focus groups and interviews conducted at the beginning of the project.

Community-wide interventions were designed in 6-month cycles, using five strategies: (a) raising awareness (b) providing health education (c) facilitating individual behavior change, (d) augmenting public health practice and (e) modifying environments and/or policies related to breastfeeding, sugar-sweetened beverages and water consumption. A sample intervention plan targeting sugar-sweetened beverages is shown in Appendix 1—supplemental materials. Most interventions were media-based, taking the form of brochures, videos, newspaper articles, flyers, or other media.

Family Interventions were delivered in eight-visit clusters by community health workers (CHWs) using a home-visiting model [10, 11]. Each visit cluster could have up to three distinct contacts, and only one of these was required to be a face-to-face contact; the other two could be conducted by phone. This visit structure means that participants could receive 7–21 visits during the time they were on the study. The structure was necessary to introduce flexibility into the visits and to allow tailoring of the intervention to specific needs of participating families. As an example, a mother experiencing difficulties establishing lactation may need more than a single contact during the first week or two after the baby is born, while those establishing lactation easily would not need more than one contact in the early weeks of the baby's life.

The first two visit clusters were intended to establish rapport, solidify contact guidelines between participants and their assigned CHWs, and collect baseline data. CHWs created a client-specific plan for initiating and maintaining breastfeeding along with water and sugar-sweetened beverage interventions in cluster 1–3. Clusters 4–7 consisted of intervention implementation and monitoring, while the final cluster covered closure activities.

Cluster 1 occurred *before* the baby's birth, to facilitate counseling that would encourage early decisions to breastfeed. Clusters 2–4 occurred within 0–3 months of the baby's birth, while the remaining visits were spread out over the rest of the project period. The interval between visit clusters, or contacts within a cluster, was timed to match the age of the baby, individual family's needs and the workload of individual CHW. CHWs received training in the delivery of one-to-one counseling to reduce sugar-sweetened beverage consumption and promote water consumption, using principles of home visiting and outreach [10, 11], behavior change [12] and motivational enhancement [13, 14].

Measurements

Community-wide interventions were tracked monthly, with each tribe logging completed interventions and comparing them to planned Interventions. Plans judged to be complete, or those that were not very well received (as subjectively determined by project staff), were replaced with new plans at the 6-month point.

Family interventions were tracked and recorded separately within each cluster for each family. Visit forms used for this purpose contained information needed to facilitate counseling (visit date, content discussions, referrals, etc.).

Breastfeeding status was defined as any form of breastfeeding including full, partial or complementary breastfeeding, as defined by the World Health Organization (WHO) [15]. Breastfeeding status was obtained from the Women, Infants, and Children (WIC) and from Maternal and Child Health (MCH) clinic charts, and confirmed through direct interviews at 6, 12, 18, and 24 months. PedNSS data was not used to determine breastfeeding for the PedNSS "pretest" sample, since this dataset did not contain information on timing of breastfeeding cessation.

Confidence to implement study goals was an aspect of acceptability of the intervention. It was assessed by asking parents/guardians to indicate their confidence and rate the usefulness of TOTS in helping them achieve these goals. Parents/guardians rated statements such as "I am sure I can serve water as the main beverage during meals" by using a 5-point scale anchored at the lower end (1) with "strongly disagree" and the upper end with "strongly agree" (5), with a score of three being neutral. We calculated the percentage of participants with a score of four or higher and those with a score of two or lower, to assess acceptance and implementation of the goals by participants.

Weight, height/length of lightly clothed children were collected as part of routine WIC or MCH clinic visits every 6 months by trained staff using calibrated scales and infantometers/toddler stadiometers. Measurement training for WIC and MCH staff at each site was provided by WIC trainers before the start of the study to ensure standardized measurements across all sites. Length/height measurements shifted from recumbent length to standing height at the first visit after the child's second birthday.

Statistical Methods

The analysis of anthropometric outcomes focused on changes in *z*-scores (for age) of BMI, weight, and height, from birth to 24 months. Due to the disparity of *z*-score distributions between tribes, an adjustment was made using the PedNSS data from the 2-year period preceding the intervention study. Each study child was paired with a PedNSS child from the same community, matched by gender, calendar birth month (to correct for seasonal growth effects), and age at the 18–24-month measurement point. The purpose of this procedure was to construct a sample in which birth-to-24-month changes represented the community-specific growth patterns in the absence of any intervention. The use of *z*-scores partially adjusts for different ages in addition to the age-adjustment inherent in the process of matching to PedNSS data.

The analytic model was:

$$\Delta\mathrm{Y} = \beta_0 + \beta_1\mathrm{T} + \beta_2\mathrm{B} + \beta_3\mathrm{C} + \beta_4\mathrm{T}\cdot\mathrm{B} + \beta_5\mathrm{T}\cdot\mathrm{C} + \beta_6\mathrm{W} + \mathrm{error}$$

where ΔY represents a change from baseline in the outcome variable (such as weight-for-age *z*-score), T is an indicator of being in the TOTS study group as opposed to being in the PedNSS sample ($T = 1$ for TOTS, $T = 0$ for PedNSS), B and C are indicators of communities B and C, and W is birth weight *z*-score. The "error" term is taken to be uncorrelated with the explanatory factors, as a matter of definition of the regression model. The interpretation of the parameters is as follows: β_1 = effect of the TOTS study in the community intervention only site (Site A); β_2 = difference between site B and site A prior to the TOTS study; β_3 = difference between site C and site A prior to the TOTS study; β_4 = effect of the TOTS study on site B, relative to the effect of the TOTS study on site A; β_5 = effect of the TOTS study on site C relative to the effect of the TOTS study on site A. All of these effects are adjusted for birth weight. For additional clarity, the

Table 1 Effect variables (T, B, C, TB, TC) and parameters (β's) in the analytic model

	A (Community intervention only)	B (Community + family intervention)	C (Community + family intervention)
Site-level control (PedNSS)		B	C
2 years before TOTS	β_0 (reference)	$\beta_0 + \beta_2$	$\beta_0 + \beta_3$
TOTS project	T	T + B + TB	T + C + TC
	$\beta_0 + \beta_1$	$\beta_0 + \beta_1 + \beta_2 + \beta_4$	$\beta_0 + \beta_1 + \beta_3 + \beta_5$

β_0 = effect present at all sites; β_1 = secular effect on site A; β_2 = difference of site B from site A, 2 years before TOTS; β_3 = difference of site C from site A, 2 years before TOTS; β_4 = TOTS effect on site B, relative to the secular effect at the control site A; β_5 = TOTS effect on site C, relative to the secular effect at the control site A

meanings of the model effects are shown in tabular form in Table 1.

Growth curve of the form $\alpha + \beta\ (1-\exp\ (-r \times \text{age}))$ was fitted to each study child, based on longitudinal measurements taken every 6 months, to assess growth trajectory. The fitted curves were used to provide values on a monthly grid, and these were then averaged every month. A comparison curve was generated from the WHO normative data, matched for gender. No inference was performed for these data, which were generated primarily to illuminate the primary analysis. All analyses were performed in STATA (Version 9 College Station TX).

Results

Baseline Population Characteristics

Table 2 shows characteristics of the study population and the PedNSS cohort.

We enrolled 75% of all children born during the recruitment year and collected final measurements on 86% (64.5% of complete annual birth cohort) of enrolled children. Reasons for dropping out included: moving (6% of families); loss of interest in project (6% of families); and change in child custody (2% of the children).

Figure 1 shows the distribution of BMI *z*-scores among PedNSS children compared to WHO normative data, and is an indication of the prevailing levels of overweight in the communities studied prior to the TOTS intervention. The average BMI *z*-score of the PedNSS group was 1.70. The majority (72%) of the PedNSS cohort had BMI *z*-scores one standard deviation above the WHO distribution, and 39% had BMIs two standard deviations above the WHO children.

Community-Intervention Plan Completion and Home-Visit Completion Rates

Community-wide interventions executed and home-visit completion rates are shown in Table 3. Breastfeeding

Table 2 Baseline population characteristics

	Tribe A	Tribe B	Tribe C	All tribes combined
Study cohort				
Number born during recruitment year	90	67	115	272
Number enrolled in the study	63	62	80	205
Number completing study	53	56	69	178
Maternal/guardian age (range)	25.0 (17–38)	25.6 (17–41)	24.8 (15–39)	25.0 ± 5.8
Average birth weight (kg)	3.30 ± 0.68	3.41 ± 0.58	3.28 ± 0.48	3.28 ± 0.57
Average birth length (cm)	50.8 ± 3.4	52.8 ± 2.9	50.7 ± 2.5	51.4 ± 3.1
Average birth BMI	12.7 ± 1.7	12.2 ± 1.5	12.2 ± 1.6	12.3 ± 1.6
Comparison cohort (PedNSS 2 years earlier)				
Number matched to study cohort	63	62	80	205
Maternal/guardian age	N/A	N/A	N/A	N/A
Average birth weight (kg)	3.46 ± 0.65	3.61 ± 0.51	3.34 ± 0.50	3.46 ± 0.56
Average birth length (cm)	50.4 ± 3.3	52.9 ± 2.3	50.9 ± 2.9	51.3 ± 3.0
Average birth BMI	13.6 ± 2.0	12.9 ± 1.2	12.9 ± 1.4	13.1 ± 1.6

[a] PedNSS = Pediatric Nutrition Surveillance System [6]

[b] This information was not available for the PedNSS population

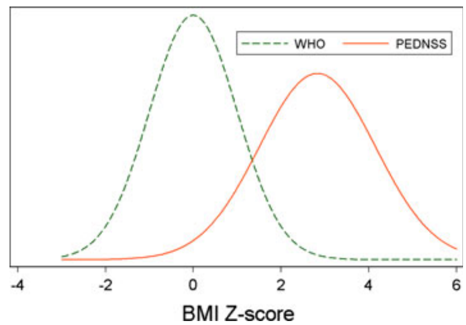

Fig. 1 PedNSS (PedNSS = Pediatric Nutrition Surveillance System [6]) BMI *z*-Score distribution in 24-month old children at study initiation compared to WHO (WHO = World Health Organization) standards

Table 3 Community plans executed and home visits completed by tribe at the end of intervention

	Tribe A	Tribe B	Tribe C	Total
Community interventions executed				
Breastfeeding	24	23	20	22.3
Sugar-sweetened beverage	10	18	14	14.0
Water	14	31	32	25.7
Home visits				
Average number of visits	N/A	4.9	8.2	6.8
% completing 7 clusters	N/A	18	54	38
% completing 4–6 clusters	N/A	55	30	41
% completing 3 clusters or less	N/A	27	16	21

interventions were comparable across all tribes. Completion of sugar-sweetened beverage and water interventions was lower in tribe A than in tribes B & C.

The majority of families (79%) in tribes B & C received at least four cluster visits. Significantly more families in tribe C received the full complement of visits compared to tribe B. Debriefing interviews with community coordinators and CHWs indicated that the additional visits in tribe C were to assist with breastfeeding.

Breastfeeding

Tribal PedNSS records did not contain the time of breastfeeding termination, making it difficult to estimate breastfeeding duration. So we compared the TOTS breastfeeding rates to the national PedNSS data for American Indian mothers. Compared to the national PedNSS sample of AI/AN, breastfeeding initiation and 6-month rates were 14 and 15% points higher, respectively, at the conclusion of TOTS (Table 4).

Sugar-Sweetened Beverage Consumption

Sugar-sweetened beverage and water consumption were assessed retrospectively, by asking parents to indicate their confidence in implementing the study recommendations for their children and families, and to indicate the usefulness of the project in helping them change targeted behaviors. Parents expressed high confidence (a score of 4 or above on a 5-point scale) in their abilities to implement the recommendations of the study. All interventions except breastfeeding were given a score of four or higher by 60% of the participants, indicating confidence in the usefulness of TOTS in implementing target behaviors (Table 5).

Environmental, Public Health Practice, and Policy Changes

Breastfeeding policy changes included: (1) hospitals becoming more "baby friendly" [16] (allowing co-rooming, increasing access to lactation counseling, eliminating free formula sample packs); and (2) tribal employers allowing longer breaks for mothers returning to work to pump breast milk. Beverage-related policy included (1) placing water vending machines next to soda vending machines (2) passing tribal resolutions to not purchase sugar-sweetened beverages with tribal government dollars; (3) replacing sugar-sweetened beverages with water at events where children are present; and (4) subsidizing cost of providing water in tribal health facilities.

Anthropometric Measures

Mean and standard deviations of the 24-month anthropometric measures, including PedNSS values, are shown in Table 6. BMI *z*-score decreased by 0.75 in tribes B and C ($P = 0.016$) combined and; there was not an appreciable

Table 4 Breastfeeding initiation and duration of participating tribes during the intervention, compared to national AI breastfeeding rates

Breastfeeding	Tribe A (%)	Tribe B (%)	Tribe C (%)	Total (%)	National AI rates (%)[a]
Initiation	72	86	63	74	60
6-months	49	48	18	38	23
12-months	19	23	9	17	17
18-months	10	5	5	7	N/A
24 months	6	3	2	4	N/A

[a] Average of rates reported by CDC (PedNSS) for years 2003–2005

Table 5 Percent of participants expressing confidence and usefulness of the TOTS study in assisting with target behavior change

	Tribe A	Tribe B	Tribe C	Total
Confidence in implementing recommendations				
Breastfeeding	64	54	56	57
Limiting sugar-sweetened beverages for the family	93	92	71	82
Serving water as the primary beverage at meal times	89	80	73	79
Serving water when family members are thirsty	73	48	63	62
Usefulness of the TOTS study in helping change targeted behaviors				
Breastfeeding	40	65	43	49
Help family drink more water	96	92	81	90
Help family drink fewer sugar-sweetened beverages	88	89	80	86

A score of 4.0 or higher on a 5-point scale

Table 6 24-Month[a] BMI, weight and height-for-age *z*-scores [mean (SD)]

	Tribe A *N* pairs = 53	Tribe B *N* pairs = 56	Tribe C *N* pairs = 68	Total B + C *N* pairs = 124
BMI for age *z*-scores				
Study populations	2.69 (1.06)	1.41 (1.57)	2.00 (1.44)	1.73 (1.52)
PedNSS (comparisons)	1.96 (1.47)	1.35 (1.26)	1.74 (1.18)	1.56 (1.23)
Weight for age *z*-score				
Study populations	1.74 (0.83)	1.15 (1.28)	1.22 (1.25)	1.19 (1.26)
PedNSS (comparisons)	1.38 (0.90)	1.09 (1.18)	1.06 (1.16)	1.07 (1.17)
Height for age *z*-score				
Study populations	−0.34 (1.45)	0.21 (1.40)	−0.38 (1.12)	0.12 (128)
PedNSS (comparisons)	−0.08 (1.42)	0.20 (1.10)	−0.28 (1.27)	−0.07 (1.22)

[a] Change from birth to 24 months, compared to tribe A, adjusted for PedNSS data as described in the text, and adjusted for baseline values

difference in BMI *z* scores between these two tribes. Height and weight were not statistically different between the three tribes (Table 7).

Figure 2 shows patterns of growth from birth to 18–24 months for tribe A alone, and for tribes B and C combined, and compares these patterns to a WHO reference population for BMI, height/length, and weight. AI children appear to grow faster than the WHO reference children, gaining more weight, height, and BMI over the first 6–9 months of life. After this initial difference in growth rates, trajectories appear to be similar, with tribes B & C resembling the WHO trajectories more closely than tribe A. These growth curves show no interruption of linear growth as a consequence of the intervention. The higher BMIs in AI children appear to be the result of very rapid weight gain in the first 6–9 months of life.

Discussion

Child overweight and obesity will likely decrease the quality of life and raise national health-care costs as these children enter adulthood [17]. Growth within the first year, and possibly the first months, of life may predict adolescent and adult obesity [18]. Interventions that limit early increases in adiposity, and establish healthful behavior patterns that persist in later childhood, may prevent the likelihood of adult obesity and its attendant consequences.

The purpose of this study was to test the feasibility of an intervention to prevent obesity, and to obtain preliminary efficacy data of such an intervention in preventing child overweight beginning at birth. Growth data collected in AI/AN children prior to the initiation of this project suggested birth as a logical time to institute prevention efforts, since obesity was established early and did not reverse itself in late toddlerhood and pre-school years.

Our results show that the community-based intervention targeting breastfeeding and sugar-sweetened beverage consumption to prevent toddler overweight, is feasible. We recruited 75% of children born in participating tribes during the year-long recruitment period. Retention and participation rates were high, with 86% of families recruited providing anthropometric data for their children at the end of the study. We attribute the high participation rates to a

Table 7 Intervention effects on changes in anthropometric measures from birth to 24 months

	Tribe A *N* pairs = 53	Tribe B *N* pairs = 56	Tribe C *N* pairs = 68	Total B + C *N* pairs = 124
BMI for age *z*-score				
Change from 0 to 24 months—study populations	2.92 (1.82)	1.86 (1.72)	2.44 (1.84)	2.18 (1.80)
Change from 0 to 24 months—PedNSS (comparison)	2.03 (2.22)	1.74 (1.46)	2.23 (1.52)	2.01 (1.50)
Intervention effect[a]		−0.81, $P = 0.025$	−0.70, $P = .036$	−0.75, $P = .016$
Weight for age *z*-score				
Change from 0 to 24 months—study populations	1.57 (1.64)	0.52 (1.35)	1.20 (1.50)	0.89 (1.46)
Change from 0 to 24 months—PedNSS (comparison)	1.22 (1.75)	0.41 (1.23)	1.01 (1.19)	0.75 (1.24)
Intervention effect		−0.29, $P = .167$	−0.20, $P = .242$	−0.24, $P = .173$
Height for age *z*-score				
Change from 0 to 24 months—study populations	−0.90 (1.81)	−1.59 (1.67)	−0.97 (1.52)	−1.25 (1.61)
Change from 0 to 24 months—PedNSS (comparison)	−0.43 (2.37)	−1.62 (1.42)	−1.01 (1.42)	−1.27 (1.45)
Intervention effect		0.28, $P = .798$	0.17, $P = .700$	0.23, $P = .781$

All *P*-values are one-sided, to detect a decrease in BMI in tribes receiving the community + family intervention relative to the tribe receiving only the community intervention

[a] Change from birth to 24 months, compared to tribe A, adjusted for PedNSS data as described in the text, and adjusted for baseline values

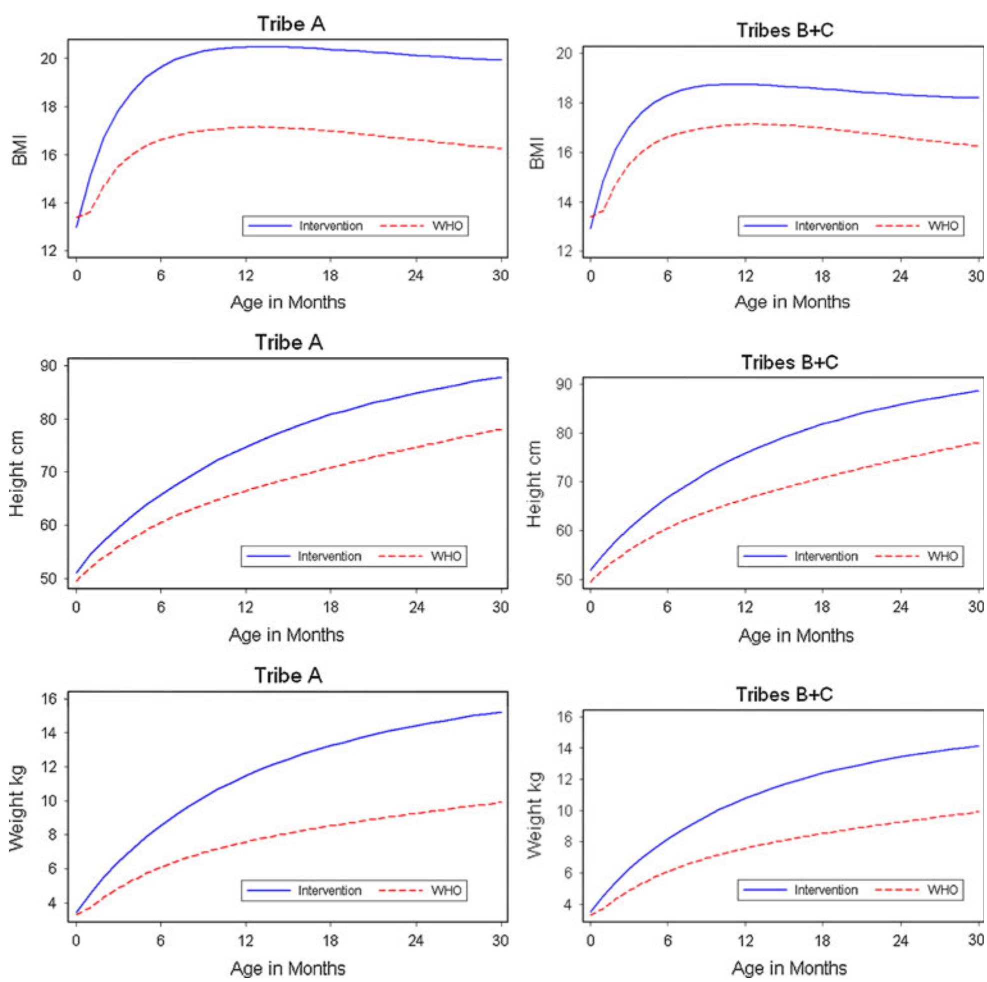

Fig. 2 Growth patterns comparing TOTS children to WHO standards for A and B + C tribes

strong collaboration during the formative phase, where we consulted with tribes in honing the intervention, data collection, and implementation logistics. The resulting design integrated the study into existing MCH clinic visits, and created a peer-counseling model that tailored the intervention to family needs and availability. Our results also show that a home- visiting program is a feasible intervention approach in tribal communities, as the majority of participants received more than half the planned home visits.

Process measures show that tribes created effective community plans, as well as policy and environmental changes, to increase breastfeeding and curtail consumption of sugar-sweetened beverages by infants and toddlers. This study began before the national attention to sugar-sweetened beverage consumption that has occurred in recent years [19]. It is therefore unlikely that the changes we report here are due to secular trends in sugar-sweetened beverage consumption. Nevertheless, it is difficult to fully assess the impact of these community initiatives on behaviors and practices that affect child BMI. As an example, our study did not have a pure control tribe (a tribe that received no community or family intervention). Such a design would have allowed us to assess the effect of the community-wide intervention alone, as well as assess whether the observed changes were due to secular changes. Similarly, a design that included a tribe receiving the family intervention alone would have allowed us to assess the separate impact of the family intervention. Despite these limitations, this study demonstrates that these community-based initiatives are feasible and acceptable to AI tribes.

Our results show that a combination of two relatively simple interventions (increasing breastfeeding and curtailing consumption of sugar-sweetened beverages in favor of water) results in an attenuated community-level increase in child BMIs at 18–24 months in tribes receiving both a community-wide and an individualized family intervention. The lower BMIs were achieved without a detectable effect on linear growth, as the increase in height/length was similar in all tribes.

We are aware of only one other study that has explored prevention of overweight in children beginning at birth. Costom and Shore [20] provided individualized feeding counseling that tailored the advice to the growth patterns of 182 infants. The authors concluded that individualized counseling is more effective that a one-size-fits-all counseling program in preventing excess adiposity [20]. Our study differs from that of Costom and Shore in focusing on specific approaches to preventing overweight (breastfeeding and curtailment of sugar-sweetened beverages), but is similar in its customization of the intervention to the needs of the communities and families.

BMI ‘s were lower in tribes receiving community plus family interventions, but still higher than those of children in the PedNSS sample 2 years earlier. This outcome may be due to a number of factors. Toddler overweight has many contributing factors. It is possible that a more comprehensive intervention incorporating other aspects of feeding (delay of complementary foods, introducing healthier food choices, etc.) and/or physical activity (reducing sedentary activities, facilitating natural play, etc.) would have slowed BMI escalation more profoundly.

There were fewer than the expected number of community interventions completed in the tribe receiving the community intervention only, and the average number of home visits differed between the two tribes that received home visits. This “dilution” of the intervention may explain the less-than-expected moderation of BMI increase. It is more likely, however, that the BMI increase is a reflection of a secular trend towards increased BMIs during the study period. Although we did not have a pure control tribe in which to track secular trends, national trends show that the percent of AI/AN children 2 years or younger defined as overweight (weight for length $\geq$95th percentile) rose from 17.2 to 18.4% during the time TOTS was underway.

We have assumed that the change in BMI at 18–24 months was mediated by changes in breastfeeding and sugar-sweetened beverage consumption. It is possible, however, that parents made other changes that we did not track, since we did not collect quantitative measures of sugar-sweetened beverage consumption, nor did we directly observe changes in these intervention components. As an example, reliable baseline breastfeeding initiation and duration data were not available. Our estimation of change is based on comparing post-study data to national data. Thus it is not possible to gauge whether the higher breastfeeding initiation and duration rates, compared to a national sample, were causally related to the outcomes. However, policy shifts were documented (e.g. increased support of breastfeeding mothers at worksites), making it plausible that some improvement may have been due to the project-related activities to promote breastfeeding. Similarly, parents indicated that their confidence in implementing recommended changes had increased at the time of the exit interview. Stronger measures of change in mediating variables may be needed in future to better understand which factors have the greatest impact on children’s BMIs.

Conclusion

This pilot study demonstrates that interventions to prevent excess adiposity in infants and toddlers are both feasible and acceptable to the AI/AN tribes. Our results suggest that simple interventions may slow down trends in escalating overweight and obesity in children. Comprehensive studies in diverse populations, and more rigorous assessments, are needed to further understand and hone approaches to prevent BMI escalation in children.

Appendix

See Supplementary material

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