

Community health worker intervention to improve tooth brushing in young children: Results from a cluster randomized controlled trial

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Abstract

Objectives: Coordinated Oral health Promotion (CO-OP) Chicago is a cluster randomized controlled trial testing the efficacy of a community health worker (CHW) intervention to improve tooth brushing in low-income children.

Methods: Four hundred twenty children under 3 years old (mean 21.5 months) were recruited from 20 sites in or near Chicago, IL. Children were identified mainly as Black race (41.9%) or Hispanic ethnicity (53.8%) and most (85.2%) had Medicaid. Intervention families were offered four CHW home visits over 1 year. Brushing frequency was self-reported. Plaque score was determined from images collected in homes using disclosing solution. Analyses used GEE logistic models with variable selection at $p < .05$.

Results: At enrolment, 45.0% of families reported twice a day or more child brushing frequency, and child plaque scores were poor (mean of 1.9, SD: 0.6). Data were obtained from 87.1% of children at 6 months and 86.2% at 12 months. In the CHW intervention arm (10 sites, $N = 211$), 23.7% received 4 visits, 12.8% 3 visits, 21.3% 2 visits, 23.2% 1 visit and 19% no visits from CHWs. No intervention effect was seen for brushing frequency or plaque score. Child brushing frequency improvement over time was associated with a range of child and caregiver factors. The only factor associated with a change in plaque score over time was parent involvement in brushing.

Conclusions: Oral-health-specific CHW services were not associated with improved brushing behaviours in these young children. However, caregiver involvement with brushing supported more quality brushing. More robust interventions are needed to support families during this critical developmental period.

KEYWORDS

disparities, oral health, pediatric dentistry, prevention

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1 | INTRODUCTION

Despite expanded dental coverage for children in the United States, caries remains the most common chronic disease of childhood.¹ Young children who develop severe disease often require treatment under sedation or general anaesthesia.² The cost of childhood caries includes the social cost of pain and adverse effects on cognitive development, school absenteeism, caregiver missed work and lower oral health-related quality of life.³ Furthermore, these burdens continue over the life-course and are intergenerational.^{4,5}

Caries disproportionately affects children from disadvantaged subgroups, with documented disparities in dental care utilization, access to healthy food choices, food security, oral health literacy and exposure to high-risk behaviours.⁶⁻⁸ Therefore, addressing caries risk requires multi-level interventions that recognize threats to effective oral health behaviours on not only the individual/family level, but also the organization, community and public health levels.⁹

Caries risk begins before birth, and early childhood is a time when formative patterns of behaviour and beliefs are established.¹⁰ However, research to date on children under the age of 3 years old is limited. The Coordinated Oral Health Promotion (CO-OP) Chicago study was funded by the National Institute for Dental and Craniofacial Research (NIDCR) as part of a consortium to develop and test behavioural interventions to address oral health disparities in young children.¹¹ The CO-OP Chicago intervention was based on Social Ecological Theory.^{12,13} The community health worker (CHW) intervention operated on the individual level with children (addressing knowledge and behaviours), the family level with their caregivers (addressing knowledge, beliefs and behaviours through social modelling, social network engagement and self-management skills support), and the organizational level with local social service agencies and medical clinics (addressing access and oral health messaging and social norms).¹¹ The CHW intervention delivery was guided by Social Cognitive Theory.¹⁴ Behaviour is shaped and maintained by consequences, particularly by immediate feedback from both objective sources (such as observation of brushing technique) and an individual's social network (beliefs and traditions of family and friends). The oral health CHW intervention measured and supported these behaviours and social networks using self-management skills.¹¹ Although a well-defined behavioural and social intervention in other disease areas, the ability of CHWs to improve oral health outcomes had not been rigorously tested in the United States.¹⁵⁻¹⁹

This study describes the primary outcomes of the CO-OP Chicago cluster randomized trial. The trial tested if a multi-level oral health CHW intervention was associated with improved tooth brushing in low-income urban young children. The cluster design was chosen because a component of the intervention occurred at the site level, although outcomes were measured at the individual level. The primary oral health behaviour for this age group was operationalized as tooth brushing frequency and quality because twice-daily tooth brushing with fluoridated toothpaste is a cost-effective way to reduce caries.²⁰ The hypothesis was that children offered oral health CHW intervention in their homes and communities

CO-OP Chicago Consort Diagram

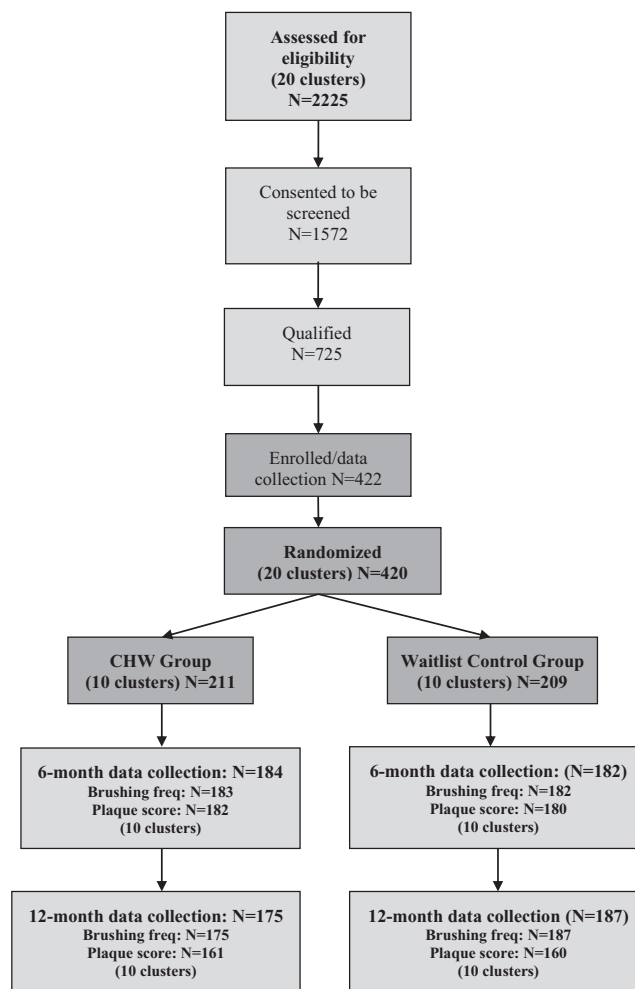


FIGURE 1 CO-OP Chicago consort diagram

would brush more frequently and have less plaque than children not offered a CHW intervention.

2 | METHODS

See the Supplemental Protocol File for additional protocol details (Appendix S1).

2.1 | Design, recruitment and randomization

The CO-OP Chicago Trial is a two-arm, cluster randomized controlled trial with repeated measurements.¹¹ Participants (420 child/caregiver dyads) were recruited from 10 Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) centres and 10 paediatric medical clinics in the Chicago metro area (20 clusters total) from January 2018 to February 2019 (Figure 1). Active patients aged 6–36 months in one of these centres/clinics with at least two fully erupted primary maxillary incisors were included. The

caregivers had to be 18 or older, speak English or Spanish and be a primary caregiver living with the child at least 5 days out of the week. Children with medical conditions that would limit their ability to conduct trial activities were excluded. Matched randomization of clusters was conducted by the coordinating centre prior to the start of recruitment. Once sites reached 90% of their recruitment goal, group allocation was revealed to specific unblinded CO-OP Chicago team members, who then informed the sites and participants. Cluster-level covariates included in randomization were race/ethnicity of the site population (Black, Hispanic or White), site size (large, medium, small) and setting (WIC or clinic).¹¹ All trial staff not working directly with CHWs were blind to study arm; participants and sites could not be blinded.

2.2 | Outcomes

The primary outcomes were tooth brushing frequency and plaque score; child dental visits were a secondary outcome. Participant-level data were collected by research assistants (RAs) at baseline, 6, and 12 months post-randomization using a structured protocol that included caregiver self-report, clinical assessment and observation. Data collection in homes was preferred, but families could choose other locations. RAs began by verbally asking caregivers about caregiver and child demographics, brushing frequency, previous dental visit frequency and purpose, insurance and quality of life; child water source and sugary beverage and food consumption; and caregiver general oral health knowledge, social support and psychosocial stressors.¹¹ RAs then applied a plaque disclosing solution to the children's primary maxillary incisors, photographing the teeth before and after application. Disclosed images were asynchronously scored by calibrated clinicians using the Oral Hygiene Index - Maxillary Incisor Simplified (OHI-MIS).²¹ The training and calibration associated with the plaque image process are described in the Supplemental Protocol File. Then RAs asked families to demonstrate how the children's teeth are brushed; the observed process, technique, equipment used and length of brushing activity were recorded. Caregivers received \$40 after completion of each data collection visit.

2.3 | Intervention

Details of the CHW intervention have been published previously.^{11,22} CHWs were hired to match the target population on educational background, race, ethnicity and language skills. They were trained in oral health education, motivational interviewing, care coordination, mental health first aid, resource navigation and self-management skills development. The family-level CHW intervention consisted of four in-person visits that were followed 1–2 weeks later by phone follow-ups. Families were offered two visits/calls during months 0–6, and two visits/calls during months 7–12. CHWs administered the non-clinical portion of the Caries-risk Assessment

Tool²³ first to explore family needs. CHWs then covered oral health topics that included oral health basics (what are caries, causes, prevention), tooth brushing (when to start, frequency, technique, equipment, toothpaste), fluoride (water, other sources), weaning (when, sippy cups, nighttime feeds), nutrition (sugar-sweetened beverages, juice, healthy foods) and seeing the dentist (when, what to expect, role of paediatricians).²² CHWs used motivational interviewing and employed formal self-management skills, including problem-solving, self-discovery and action planning. The timing and amount of focus on topics varied by family needs and interest. The CHWs also discussed non-oral health topics that arose, such as insurance, immigration and childcare. CHWs ended visits with an action planning exercise. The site-level CHW intervention consisted of CHWs providing brief general oral health education for several hours weekly to anyone interested in the waiting areas of the clinics and WIC centres randomized to CHW intervention. CHW interventions included no monetary incentives.

2.4 | Wait-list control

The control group received usual care during the trial. After final data collection, control group families and sites were offered a CHW intervention.

2.5 | Participants

Institutional Review Boards at the University of Illinois Chicago [2017–1090], University of California San Francisco [16–19920], and Chicago Department of Public Health [16–06] approved the trial. Caregivers provided written informed consent prior to randomization. Sites did not require consent. Trial oversight was also provided by a Data Safety Monitoring Board, an external monitor reporting to the funder, and a Community Advisory Board.

2.6 | Analyses

Power was intended to detect an effect size of an odds ratio (OR) of 2.0 for frequency of brushing and 0.40 for plaque score.¹¹ Allowing for repeated observations and 15% attrition at 12-months, 21 participants from each of the 20 sites (clusters) equalled a sample size of 420 with 80% power. This calculation controlled for the multiplicity of having two outcome measures by Bonferroni adjustment (Type 1 error = 0.025).

Missing data was limited, with missingness for the outcome variables between 9% and 13%. In order to perform intention-to-treat (ITT) analysis, multiple imputation was performed to allow all participants and observations to be included in the final models. For categorical outcomes, chained equations were used to allow flexibility.²⁴ For numeric values, linear regression was used while ordered logit latent variable models were used for categorical variables. The variables

TABLE 1 Baseline demographics and oral health behaviours¹¹

	Usual Care Group, N = 209	CHW Group N = 211	Total N = 420
Caregiver female (%)	197 (94.3)	208 (98.6)	405 (96.4)
Caregiver age (years), mean (SD)	29.7 (6.3)	29.5 (6.9)	29.6 (6.6)
Caregiver highest degree earned (%)			
Less than high school	30 (14.4)	38 (18.0)	68 (16.2)
High school/GED	68 (32.5)	64 (30.3)	132 (31.3)
More than high school	111 (53.1)	109 (51.7)	220 (52.4)
Caregiver relationship status (%)			
Single	72 (34.5)	70 (33.2)	142 (33.8)
Living with partner/spouse	130 (62.2)	127 (60.2)	257 (61.2)
Separated/Divorced/Widowed	7 (3.4)	14 (6.6)	21 (5.0)
Child female (%)	109 (52.2)	104 (49.3)	213 (50.7)
Child's age (months), mean (SD)	20.8 (7.0)	22.4 (6.8)	21.5 (6.9)
Child Hispanic (%)	111 (53.1)	115 (54.5)	226 (53.8)
Child Hispanic ethnicity (%) ^a			
Mexican	78 (69.6)	88 (76.5)	166 (73.1)
Other	34 (30.4)	27 (23.5)	61 (26.9)
Child race (%)			
White	33 (15.8)	21 (10.0)	54 (12.9)
Black	85 (40.7)	91 (43.1)	176 (41.9)
Other	91 (43.5)	99 (46.9)	190 (45.2)
Household size, mean (SD)	5.0 (1.8)	4.7 (1.5)	4.8 (1.7)
Children in household, mean (SD)	2.6 (1.3)	2.4 (1.3)	2.5 (1.3)
Child has health insurance (%)	202 (96.7)	199 (94.3)	401 (95.5)
Child health insurance source (%) ^b			
Medicaid	175 (86.6)	183 (92.0)	358 (89.3)
Other	27 (13.4)	16 (8.0)	43 (10.7)
Child has dental insurance (%)	172 (82.3)	172 (81.5)	344 (81.9)
Child dental insurance source (%) ^c			
Medicaid	151 (87.8)	160 (93.0)	311 (90.4)
Other	21 (12.2)	12 (7.0)	33 (9.6)
Length since child's last dental visit (%) ^d			
Never has been	123 (59.1)	127 (60.2)	250 (59.7)
≤6 months	69 (33.2)	70 (33.2)	139 (33.2)
>6 months	16 (7.7)	14 (6.6)	30 (7.2)
Child's brushing/wiping frequency (%)			
Never	12 (5.7)	13 (6.2)	25 (6.0)
Sometimes, but not everyday	25 (12.0)	39 (18.5)	64 (15.2)
Once a day	73 (34.9)	69 (32.7)	142 (33.8)
Twice a day	89 (42.6)	79 (37.4)	168 (40.0)
More than twice a day	10 (4.8)	11 (5.2)	21 (5.0)
Plaque score, mean (SD) ^d	1.9 (0.6)	2.0 (0.6)	1.9 (0.6)

Abbreviation: CHW, community health worker.

^aN = 227 for Total; N = 112 for Usual Care; N = 115 for CHW.

^bN = 401 for Total; N = 202 for Usual Care; N = 199 for CHW.

^cN = 344 for Total; N = 172 for Usual Care; N = 172 for CHW.

^dN = 419 for Total; N = 208 for Usual Care; N = 211 for CHW.

TABLE 2 Completed Community Health Worker (CHW) Visits by Site in Intervention Arm

		0 visits		1 visit		2 visits		3 visits		4 visits	
		#	% ^a	#	% ^a	#	% ^a	#	% ^a	#	% ^a
All sites	N = 211	40	19.0	49	23.2	45	21.3	27	12.8	50	23.7
Clinic sites	N = 99	21	22.2	26	26.3	23	23.2	11	11.1	18	18.2
1	N = 21	4	19.0	6	28.6	7	33.3	0	0.0	4	19.0
2	N = 18	4	22.2	2	11.1	6	33.3	3	16.7	3	16.7
3	N = 19	1	5.3	6	31.6	5	26.3	6	31.6	1	5.3
4	N = 22	3	13.6	6	27.3	4	18.2	0	0.0	9	40.9
5	N = 19	9	47.4	6	31.6	1	5.3	2	10.5	1	5.3
WIC Sites	N = 112	19	17.0	23	20.5	22	19.6	16	14.3	32	28.6
6	N = 23	2	8.7	3	13.0	4	17.4	6	26.1	8	34.8
7	N = 23	3	13.0	4	17.4	3	13.0	6	26.1	7	30.4
8	N = 23	5	21.7	4	17.4	6	26.1	0	0.0	8	34.8
9	N = 21	4	19.0	0	0.0	7	33.3	3	14.3	7	33.3
10	N = 22	5	22.7	12	54.5	2	9.1	1	4.5	2	9.1

Abbreviation: CHW, community health worker.

^aDenominator is row (site) specific.

used for stratifying clusters before randomization (type of site, site size and site majority race/ethnicity) were included in all models. To account for within-site clustering, variables that differed by site¹¹ were included in all models: child age, length of time since child's last dental visit, caregiver highest degree, caregiver race/ethnicity and caregiver health insurance presence/source. Finally, group, time and group-by-time interaction were included in all models. To avoid multicollinearity, variables of interest that were highly intercorrelated (Spearman's rho > 0.4) were excluded. Backward elimination (significance at $p < .05$) was then used to reduce the number of additional covariates from the remaining 23 to those included in the final models.

Brushing frequency was collapsed into a dichotomous variable (less than 2x/day vs. 2x/day or more) and was analysed using logistic regression with generalized estimating equations (GEE) to account for the repeated measures. Brushing frequency intra-class correlation (ICC) was estimated using Laplace (approximate maximum likelihood) using variance components for the type of the variance-covariance G matrix. ICC on the child level was 0.53, on the site level was 0.00.

Plaque score was treated as a continuous variable and modelled using a linear mixed model (LMM) to account for the repeated measures. Using restricted maximum likelihood, the ICC for plaque score on the child level was 0.26 and the site level was 0.03.

As a secondary analysis, child dental utilization was collapsed into a dichotomous variable (in the last 6 months versus not in the last 6 months) and analysed in the same way as brushing frequency.

All data analyses were performed using SAS/STAT Version 9.4.

3 | RESULTS

Recruitment ran from 20 January 2018, to 23 February 2019; data collection continued for 1 year after the date of enrolment. (Data

collection officially ended on 20 August 2020, after an extension granted due to the COVID-19 pandemic to collect data from the final 34 participants). At enrolment (Table 1),¹¹ the mean child age was 21.5 (SD: 6.9) months, with a range of 9–35 months. Forty-five percent of caregivers reported brushing their children's teeth the recommended twice a day or more. The mean OHI-MIS plaque score was 1.9 (SD: 0.6), indicating a 'high' level of plaque.²⁵ Over half of children (59.7%) had never been to a dentist.

Missing data fell within the anticipated limits for sample size calculations, with 86.2% complete at 12 months (Figure 1). All sites completed the trial and this did not differ by group.

Community health worker visits and calls occurred between April 2018 and February 2020. Among individual participants in the CHW group ($N = 211$, 420 total visits), 19% received no CHW visits; 23.2% received one, 21.3% received two, 12.8% received three and 23.7% received four CHW visits. Completed CHW visits varied by site (Table 2). Follow-up calls followed a similar pattern. Most visits (93.1%) occurred in homes. The mean visit duration was 63.7 (SD: 21.8) minutes, with a range of 9–195 min. The mean follow-up call duration was 4.7 (SD: 5.5) minutes. When the child was present ($N = 347$), the child actively participated by playing a game or practising a behaviour with the caregiver and CHW a lot of the time (65.1%) and some of the time (31.1%). CHWs also provided approximately 1255 h of general oral health education at the 10 sites, with sites receiving 9–11 months of CHW intervention. CHWs documented conversations with 867 individuals, although this is an underestimate as some individuals listened peripherally and were not counted. No adverse events were reported.

Child brushing frequency did not differ by intervention group at 12 months (Table 3). Child brushing frequency improved for all over time and for children who were older at the start, children who had seen the dentist in the last 6 months compared with those who

Parameter	OR	95% CL		p value
Intercept	0.82	0.25	2.74	.75
CHW group [vs. wait-list control group]	0.82	0.55	1.23	.34
Time	1.06	1.02	1.10	<.01
Group by time interaction	1.00	0.95	1.06	.89
Child age	1.05	1.03	1.08	<.01
Child's last dental visit [vs. never]				
In last 6 months	1.37	1.00	1.88	.05
More than 6 months ago	0.83	0.54	1.30	.42
Caregiver education [vs. more than high school]				
Completed high school/GED	0.76	0.56	1.03	.07
Less than high school	0.96	0.64	1.45	.85
Caregiver race/ethnicity [vs. non-Hispanic other]				
Hispanic	0.92	0.51	1.65	.78
Non-Hispanic Black	0.97	0.55	1.71	.91
Caregiver medical insurance [vs. public]				
No insurance	0.98	0.69	1.38	.89
Private insurance	1.02	0.70	1.48	.92
Caregiver brushes once/day or less [vs. twice or more]	0.17	0.12	0.24	<.01
Caregiver mouth condition [vs. Poor]				
Fair	0.56	0.35	0.89	.01
Good/very good	0.49	0.30	0.78	<.01
Adults help brush child's teeth [vs. never/rarely]				
Always	2.32	1.42	3.79	<.01
Sometimes/most of the time	1.99	1.20	3.27	.01
Activities of daily life interfere with brushing [vs. never]				
Always/most of the time	0.37	0.21	0.63	<.01
Sometimes	0.49	0.34	0.71	<.01
WIC site [vs. healthcare clinic]	0.85	0.61	1.18	.33
WIC/Clinic size [vs. medium]				
Large	0.76	0.55	1.05	.10
Small	0.94	0.66	1.32	.71
WIC/Clinic race/ethnicity [vs. majority Hispanic]				
Majority non-Hispanic Black	0.97	0.59	1.60	.91
Mixed non-Hispanic Black/Hispanic	0.72	0.49	1.05	.09

Abbreviations: CHW, community health worker; WIC, Women, Infants, and Children.

^aVariables in the final model were selected through backward elimination or they were included because they had been previously shown to differ by site (child age, child's last dental visit, and caregiver degree and health insurance)¹¹ or were used for the cluster randomization (type of site, site size, and site race/ethnicity).

had never seen the dentist, and children who 'always' had adults to help brush their teeth or 'sometimes/most of the time' compared with 'never'. Child brushing frequency was worse for children whose caregivers brushed less than twice a day, whose caregivers had 'fair' or 'good/very good' mouth conditions compared with those with 'poor' mouth conditions, and those whose family activities of daily living interfered with brushing routines 'always/most of the time' and 'sometimes' compared with 'never'.

Plaque score was not different by intervention group at 12 months (Table 4). When controlling for all other variables, children whose caregivers reported that adults 'always' helped their children brush their teeth had lower plaque scores than children whose caregivers reported adults never helped. No other factors were associated with plaque score.

Child brushing frequency and plaque score did not vary by amount of CHW intervention received (Figure S1).

TABLE 3 Multiple logistic regression analysis to compare the odds ratio (OR) of child twice daily or more brushing frequency over 12 months by group (CHW intervention compared with wait-list control), controlling for co-variables^a

TABLE 4 Multiple linear regression analysis to compare child plaque scores (reported as beta estimates [Est] in the table) over 12 months by group (CHW intervention compared with wait-list control), controlling for co-variables^a

Parameter	Est	95% CL		p value
Intercept	2.06	1.69	2.43	<.01
CHW group [vs. wait-list control group]	0.08	-0.04	0.19	.19
Time	-0.00	-0.01	0.01	.49
Group by time interaction	-0.01	-0.02	0.01	.46
Child age	0.00	-0.00	0.01	.40
Child's last dental visit [vs. never]				
In last 6 months	0.00	-0.010	0.010	1.00
More than 6 months ago	-0.01	-0.14	0.11	.86
Caregiver education [vs. more than high school]				
Completed high school/GED	0.03	-0.10	0.17	.60
Less than high school	0.04	-0.07	0.14	.49
Caregiver race/ethnicity [vs. non-Hispanic other]				
Hispanic	-0.06	-0.24	0.12	.53
Non-Hispanic Black	0.03	-0.15	0.21	.75
Caregiver medical insurance [vs. public]				
No insurance	-0.05	-0.16	0.06	.35
Private insurance	0.01	-0.10	0.12	.82
Adults help brush child's teeth [vs. never/rarely]				
Always	-0.17	-0.30	-0.03	.02
Sometimes/most of the time	-0.11	-0.25	0.03	.12
WIC site [vs. healthcare clinic]	-0.03	-0.14	0.08	.58
WIC/Clinic size [vs. medium]				
Large	-0.10	-0.21	0.01	.07
Small	-0.04	-0.16	0.07	.48
WIC/Clinic race/ethnicity [vs. majority Hispanic]				
Majority non-Hispanic Black	0.07	-0.10	0.24	.43
Mixed non-Hispanic Black/Hispanic	-0.06	-0.18	0.07	.40

Abbreviations: CHW, community health worker; WIC, Women, Infants, and Children.

^aVariables in the final model were selected through backward elimination or they were included because they had been previously shown to differ by site (child age, child's last dental visit, and caregiver degree and health insurance,¹¹ or were used for the cluster randomization (type of site, site size and site race/ethnicity).

As a secondary analysis, changes in children seeing the dentist in the past 6 months were assessed. There was no difference by intervention group (Table S1). Children were more likely to see the dentist over time if they were older at baseline, if the child brushed twice a day or more, if the child brushed for 1-2 min compared with more than 2 min, if the child used toothpaste with fluoride and if the caregiver had been to the dentist in the past year. Children from households with more chaos and from sites that were mixed race/ethnicity were less likely to have been to the dentist.

4 | DISCUSSION

The primary aim of this research was to determine whether a multi-level oral health CHW intervention was associated with improved tooth brushing behaviours after 12 months in low-income urban

children under 3 years old. The families that participated met these criteria, providing new information on a population underrepresented in prior oral health research. Intervention delivery went as expected, with 81% receiving some CHW intervention and 24% completing the entire intervention protocol. This degree of CHW intervention uptake is consistent with other CHW studies and better than many clinical interventions.^{26,27,28} Despite the strong intervention evidence base and careful fidelity monitoring, oral health CHW services were not associated with changes in brushing frequency or plaque score.

Although CO-OP Chicago measured behaviours, not caries, the findings appear to conflict with those obtained by similar interventions in Brazil, England and Australia, where home visits for oral health education and support were associated with reduced caries incidence for very young children.¹⁵⁻¹⁷ The interventions in those studies were comparable to CO-OP Chicago but the countries have

different health services structures that may have played a role in intervention responsiveness. Despite CO-OP CHWs employing evidenced-based methods to support behaviour change,^{14,22,29,30} perhaps the oral health messaging and family and organizational support were not delivered frequently enough or in sufficient depth to enact behaviour change. It may also be that the intervention did not address change at a time of developmental readiness or did not address behaviour changes of highest priority for these families who struggled with many social and financial issues. The CHWs may have needed more advanced training in motivational interviewing. Another theory is that families of these young children were not sufficiently motivated to make oral health behaviour changes owing to a lack of visible consequences of poor oral health behaviours. Oral health CHW intervention may be more effective when embedded as part of overall health messaging and coordination.³¹ Another strategy may be to incorporate CHWs in secondary or tertiary prevention when caries is present. Most CHW interventions that have shown success in other disease areas were for individuals struggling with chronic disease management and acute illness.^{24,27,28,32}

Despite a lack of intervention effect, this trial offers an opportunity to better understand brushing behaviours in young children over time. Brushing frequency is a common way to measure oral health behaviours and is known to prevent caries.²⁰ Not surprisingly, child brushing frequency was higher for older children, those with established dental care, and children who received more adult help. Caregiver behaviours also aligned with brushing frequency, with less child brushing when caregivers brushed their own teeth less and in households with chaotic brushing routines. Others have reported similar patterns.³³ Of interest, caregivers who reported better oral health for themselves also reported lower child brushing frequency. In CO-OP's pilot work that included focus groups with caregivers, some caregivers described less concern for their children's oral health if their own oral health was good.³⁴ This type of attitude is concerning. Child nutrition is different than it was several decades ago with much higher consumption of sugar and processed foods among some populations.³⁵ Access to fluoride is also changing as more people consume nonfluoridated bottled water.³⁶ Sugar plays a major causal role in caries development and fluoridated water is protective.^{35,36}

Plaque score was used as a clinician-rated verification of brushing behaviour and obtained very different findings than with self-reported brushing. Plaque scores started out poor and did not improve. In fact, the only factor associated with a change in plaque score was if caregivers always brush their children's teeth. This suggests that only effective brushing by an adult is sufficient to reduce plaque. Parents consider it a positive milestone when they teach their children to brush their own teeth, but young children have limited manual dexterity and developmental capacity³⁷; they may simply just not be up to the task.

This trial has several limitations. Self-reported brushing frequency is a standard measure in the field, but it remains prone to respondent bias. Although plaque is one known risk factor for future

caries, its predictive power has limitations. While careful attention was paid to the design and monitoring of the plaque protocol, this is a new adaptation, and therefore, has no comparison. Due to the age of the children, the trial focused only on their four maxillary incisors and did not measure caries. The trial did not capture all the factors that influence brushing and plaque. One year may be a short duration for follow-up when measuring a behaviour change that is complicated by a range of family and social issues. And finally, the trial was conducted with only low-income urban families, which limits the ability to apply these results to all children.

In conclusion, this trial demonstrated suboptimal brushing behaviours in a cohort of low-income children under the age of 3 years old. Oral health CHW intervention did not improve these behaviours. These findings conflict with a large body of evidence showing the utility of the CHW model in marginalized and disadvantaged populations around the world in a range of disease areas. Therefore, CHWs remain of interest in oral health. The American Dental Association has been funding a type of CHW called Community Dental Health Coordinators since 2006 to support oral health services and outreach. The specific role of CHWs in oral health requires additional investigation, especially for young children who are establishing their first oral health behaviours. Recognizing CHW influences at multiple levels, not just the individual, and using a community-based participatory research approach in this future research will enhance understanding of the practical utility of CHWs in oral health.^{9,38}

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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