

ORIGINAL ARTICLE

Long-term effects of a community-based oral health intervention for young children in the Netherlands: A 5-year follow-up

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Abstract

Objectives: The aim of this study was to assess whether referral of parents of 6 months old children by a well-child care (WCC) clinic medical practitioner for an early first dental visit combined with the Non Operative Caries Treatment and Prevention (NOCTP) approach in dental practices was effective to maintain oral health in children.

Methods: The study was conducted as a quasi-experimental comparative pre-post trial with a baseline measurement before the intervention. In total 1347 children were allocated at the age of 6 months and 306 children (intervention group: $n=166$; care as usual (CAU) group: $n=140$) underwent an oral examination at 5 years of age and their parents completed a questionnaire. Nonparametric tests and Hurdle models were used to determine differences in caries experience between the intervention and CAU groups.

Results: Children in the intervention group had significantly lower caries experience ($d_{1,2,3}$ mfs) than children in the CAU group (Median = 2 vs. 5, $r=.15$, $p<.01$). Children in the intervention group had significantly fewer inactive caries lesions compared with children in the CAU group (Median = 2 vs. 3, $r=.18$, $p<.001$). No differences were found for dentin caries experience and also no differences for active caries lesions.

Conclusions: Referral of parents of newborns for a preventive first dental visit by a WCC medical practitioner combined with NOCTP in dental practices may offer a new opportunity to reduce enamel caries lesions in young children.

KEYWORDS

child care, dental caries, dental clinics, preventive dentistry

1 | INTRODUCTION

Dental caries is one of the most prevalent health problems in children worldwide, even though it is largely preventable by changing parental oral health behaviours.^{1–6} A shift towards an adequate level of dental

hygiene (by removing dental plaque with a toothbrush and by using fluoridated toothpaste at least twice a day) and a reduction in daily intake of fermentable carbohydrates, may considerably reduce the development and progression of caries lesions.^{7,8} Parents should be supported to reach this desired level of oral health behaviours as children rely

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completely on their parents/caregivers until approximately the age of 7.⁹ Until then, both their manual and intellectual skills have not developed sufficiently to be able to execute this daily task.

Interventions that promote timely preventive dental care, that is, starting around an age of 6 months, can prevent the deterioration of young children's oral health.¹⁰ A recent study reported that 2.7% of Chinese children had their first dental visit in the first year, and 30% of the mothers were willing to plan the first dental visit in the next 3 months.¹¹ Another study in Turkish children aged 0–5 years showed a mean age at first dental visit of 3.6 years, and 2.9% had their first dental visit in their first year.¹² In 2014, 34% of Dutch 0–4-year olds had visited a dentist, showing that children's first dental visit is relatively late, even though this care is free of costs for Dutch parents.¹³ Dutch guidelines as other international guidelines entail a first visit to a dental practice when the first tooth of the child erupts.¹⁰

Of the Dutch 5-year-olds, 76% had no cavitated lesions in which the dentine can be visually observed ($d_{3mfs}=0$).¹⁴ The overall mean among 5-year-olds was 1.1 d_{3mfs} . Of the Dutch 5-year-olds with a low socioeconomic position (SEP), 30% had no cavitated lesions ($d_{1,2,3mfs}=0$) and for the 5-year-olds with a high SEP this was 41%. The mean $d_{1,2,3mfs}$ were 1.8 for children with a low SEP and 1.9 for children with a high SEP, respectively.

Well Child Care (WCC) clinics are a promising route for infant oral health promotion; for example, in the Netherlands 92% of all parents and children visit these clinics from birth until children are 4 years old, including groups with a low socioeconomic position and diverse ethnicities.¹⁵ However, the encouragement of adequate oral health behaviour is not part of the WCC routine.

An effective way to offer preventive dental care to young children is the non-operative caries treatment and prevention (NOCTP) approach.¹⁶ Danish and Russian studies showed long-term positive effects for oral health using the NOCTP approach implemented to care for groups of children in Nexø and in Moscow.^{17,18} One Dutch randomized controlled trial (RCT) study on the 3 and 6 years effectiveness of the NOCTP approach in 9- and 12-year-olds showed a lower caries increment in the NOCTP group than the control group with regular dental check-ups twice a year.^{19,20}

Evidence is lacking on whether a combination of referral by WCC to dental clinics working according to the NOCTP approach would lead to better child oral health. Therefore, the aim of this study was to assess whether a combination of a referral of parents of newborns by a WCC medical practitioner for an early first dental visit and NOCTP in dental practice is effective to maintain oral health in children.

2 | METHODS

2.1 | Study design

The study was conducted as a quasi-experimental comparative pre-post trial with a baseline measurement before the intervention. The protocol of this study has been registered as NTR5587. In the current paper the *clinical primary outcome* caries experience

only was reported. The study is reported following the CONSORT guidelines.²¹

2.2 | Study setting and participants

The study included 1347 children, aged 4–11 months and their parents, in 2015/2016 from four deprived regions of the Netherlands, with one intervention and one care as usual (CAU) region being urban (The Hague) and one intervention and one CAU region being rural (Northern Netherlands). The city of The Hague has half a million citizens of whom nearly 50% with a Dutch ethnicity and the Northern Netherlands region has approximately 120.000 residents of whom more than 80% with a Dutch ethnicity. These areas were chosen taking into account that families with low educational levels and families with different ethnicities also could be reached. Inclusion criteria were as follows: (1) children lived in the municipality covered by the WCC they were visiting; and (2) a valid email address, home address or phone number was available. Analyses were restricted to children who were aged 4.5–6 years at the clinical oral examination.

2.3 | Sample size

The required sample size was determined based on the primary outcome caries experience at the age of 5 years. A difference of 0.25 dmft between children in the intervention group and children in the CAU group was considered to be clinically relevant at $\alpha=.05$ and power=.80. The difference of 0.25 dmft was based on the level of d_{3mft} caries lesions in 2011. For 5-year olds the mean d_{3mft} for 5-year-olds in the Netherlands was 1.6. So, at that time, 0.25 d_{3mft} was a difference of 15%, which was considered to be clinically relevant in a consensus meeting with Dutch dentists as the inception of the study preparation.

2.4 | Ethical approval

The Medical Ethics Committee of the University Medical Center Groningen provided a waiver for ethical permission because it was not considered to be medical scientific research with humans (METc2014.175). Performance was in accordance with the Helsinki Declaration. Participating parents signed informed consent at inclusion.

2.5 | Allocation

Participants were allocated per WCC clinic in the city of The Hague and the Northern Netherlands region. In city of The Hague four WCC clinics participated; two were assigned to the intervention group and two to the CAU group. For Northern Netherlands, three intervention WCC were included, as well as three CAU WCC.

2.6 | Intervention

The intervention, named 'Healthy teeth; all aboard!' (HTAA), regarded timely (i.e. before or at the age of 12 months) referral from the well-baby clinic to a dental clinic for preventive care, that is with individually determined recall intervals. In more detail, Table 1 illustrates the procedure of the intervention.

Medical practitioners and nurses from the WCC's were trained during a 2h workshop given by the first author (DAV) about preventive oral health messages for parents and how to communicate and clarify the advice for the first dental visit to parents. Medical practitioners and nurses of the WCC received flyers on oral health messages for parents and postcards for parents with all the information for the first dental visit. Another postcard for parents contained a QR-code for an educational web-based oral health film in Dutch for parents.

Oral health professionals were trained in the NOCTP strategy by authors JHV and DAV. The training consisted of a plenary one-day workshop about the theory of NOCTP and an on-site visit to practice their skills at their own dental clinic. All participating dental practices received documentation with illustrative photographs and symbols to clarify the preventive messages, especially for parents who did not *speak* Dutch or had a low level of health literacy. The NOCTP intervention was based largely on oral advice provided by the whole dental team, including dentists, dental hygienists and dental nurses. Also, a flyer was handed out to parents with all important child oral health guidelines. The duration of the NOCTP intervention was approximately 4.5 years with an average of eight dental appointments per child.

TABLE 1 Contents of the procedure of the 'Healthy teeth; all aboard!' (HTAA) intervention.

The HTAA intervention consisted of two parts, a WCC part and a dental clinic part. The WCC part entailed a referral for a timely first dental visit of children by the doctor of the WCC clinic during the appointment at 6 months, that is, when the first tooth erupts, or at 11 months when the 6 month's appointment was missed. WCC practitioners referred parents to local dental clinics that participated in this trial. Practitioners emphasized that dental care of children is covered in the basic health insurance package in The Netherlands until the age of 18 years.

The dental visit part regarded the following. At the first dental visit, parents and children received a dental preventive program based on the Non-Operative Caries Treatment Programme (NOCTP) of Ekstrand & Christiansen.^{16,17} NOCTP (also known as 'the Nexø method') is an effective oral health program which focusses on the active involvement of the parent/caregiver from the eruption of the first primary tooth.^{16–20} Several preventive messages such as brushing teeth with fluoridated toothpaste twice a day, brushing/additional brushing by parents/caregivers until the age of 7 years, and a reduction in daily intake of fermentable carbohydrates were educated to parents. For every child an individual return interval was established.

2.7 | Care as usual

Parents in the care as usual group (CAU) received standard WCC visits (no specific oral health interventions in the WCC) and standard dental care. In the Netherlands, a first dental visit was at start of the study advised at 2 years of age followed by regular preventive visits twice a year.²²

2.8 | Procedure

First, all parents in the intervention and CAU groups completed a questionnaire at their first visit to WCC clinic at about child age 6 months (T0) on sociodemographic characteristics, respectively. Second, at the child's age of 5 years parents received an invitation for an oral examination for their child at the dental clinic. These oral examinations were performed by three trained research dentists visiting local dental practices. The three examiners were calibrated, and the ICC was 0.95 for dmfs for a similar research project that was running simultaneously. These examiners were blinded to intervention allocation. Caries experience was observed during a clinical oral examination that comprised visual inspection of the teeth with documentation of caries lesions and any subsequent treatment (i.e. restoration or extraction).

2.9 | Clinical primary outcomes

In the current paper the clinical primary outcomes are reported. These clinical primary outcomes are caries experience, measured by the dmfs (the total number of decayed, missing and filled surfaces in the primary teeth). The d-component was both measured on the d_{1,2} level (enamel) and d₃ level (dentine).²³ Nyvad criteria scores were used to categorize the activity of the caries lesions. Active caries lesions regarded Nyvad criteria scores 1–3 and 8; inactive caries lesions regarded Nyvad criteria scores 4–6 and 9 (Table S1); sound surfaces regarded Nyvad criteria score 0; and filled surfaces regarded Nyvad criteria score 7.²⁴

2.10 | Sociodemographic characteristics

Sociodemographic characteristics of the study were gender of the child, age of the child, ethnicity of the mother (dichotomized Dutch, Non-Dutch) and educational level of the mother (dichotomized Low, High). Educational level was operationalized as the highest level of education completed by the mother of the child, categorized following the International Standard Classification for Education (ISCED, 2011) as low (ISCED levels 0–4) or high (ISCED 5–8).²⁵

2.11 | Statistical analyses

First, the participants' flow was determined. Second, sociodemographic characteristics of the Intervention and CAU groups

were assessed. Third, whether this intervention decreased caries experience in children was assessed. Differences using nonparametric independent samples Mann–Whitney U tests for caries experience were tested, and effect sizes r were calculated.²⁶ Furthermore, differences in caries experience, inactive and active caries lesions between the intervention and CAU group were assessed using Hurdle models adjusted for ethnicity and SES.²⁷ Hurdle models have the advantage of estimating two separate parameters to accommodate many zero counts: one estimate for the dichotomization of zero versus non-zero (i.e. $dmft=0$ or not) and one for caries experience in cases of not-caries-free.²⁵ Since the count part had a negative binomial distribution, a negative binomial hurdle model was used. Hurdle analyses yield odds ratios for the probability of having any caries lesions, and in the case of those with caries lesions ($dmft > 0$), rate ratios comparing the greater caries experience of children in the intervention group than that of children in the CAU group. Bivariate analyses were performed using SPSS Statistics for Windows, version 28.0 (IBM, Armonk, NY, USA), and negative binomial hurdle models using R version 3.3.2 (R Core Team, 2020), and RStudio Server (RStudio Team, 2020). A p -value $< .05$ was considered statistically significant.

3 | RESULTS

3.1 | Flow of participants

In total, 1347 children (and their parents) were contacted by the research team. Of these, 306 children participated in the oral examination, see Figure 1, that is, 23%. Table 2 shows the baseline characteristics of the mother at baseline and of those who participated in the oral examination 5-year follow-up after baseline. At baseline the proportion of non-Dutch mothers and of low educated mothers were statistically significantly larger in the intervention group than in the CAU group. Retention rates at follow up did not statistically significantly differ for the sociodemographic characteristics maternal education, ethnicity and maternal oral health behaviours at baseline (own tooth brushing and visit of dentist) between the intervention and CAU group. More specifically, the retention rates were (intervention vs. CAU) regarding non-Dutch respondents 21% and 19%; regarding low educational level 21% and 21%; regarding maternal tooth-brushing ≥ 2 times a day at baseline 23% and 24%; and regarding recent dental visit in the last year at baseline 25% and 26%, respectively.

3.2 | Sociodemographic characteristics

Table 3 shows sociodemographic characteristics of parents who completed both the first questionnaire and the dental examination.

3.3 | Effects on primary outcome: caries experience

Children in the intervention group had lower caries experience in enamel ($d_{1,2}$) (median=2, 25th–75th percentile=0–4) compared to the CAU group (median=3, 25th–75th percentile=1–7, $p < .01$). Figure 2 shows the cumulative distribution of enamel caries lesions for 5-year-olds in the intervention group and the CAU group. It clearly shows that until the 98% of enamel caries in the group is reached, children in the intervention group had fewer enamel caries lesions, than children in the CAU group.

Regarding caries experience, in the intervention group 26.6% of the children had no enamel or dentin caries experience ($d_{1,2,3}mfs$) versus 19.3% of the children in the CAU group. For no dentin caries experience (d_3mfs), this regarded 69.4% of children in the intervention group versus 72.1% of the children in the CAU group, $p > .05$. Children in the intervention group had significantly lower $d_{1,2,3}mfs$ than children in the CAU group, $p < .01$ (median 2 vs. 5) (Table 4). Children in the intervention group had significantly lower levels of inactive caries lesions compared to children in the CAU group (median 2 vs. 3), $p < .01$. The effect sizes r for caries experience in enamel and dentin ($d_{1,2,3}mfs$) was 0.15 and for inactive caries lesions it was 0.18.

For the 5-year-olds with caries experience ($d_{1,2,3}mfs > 0$), the caries experience for those in the intervention group was 26% lower than for children in the CAU group ($RR=0.74$, 95% $CI=0.54–0.99$, $p < .05$). No statistically significant differences were found between the intervention and CAU groups for their dentin caries experience (d_3mfs).

4 | DISCUSSION

The effectiveness on oral health at the age of 5 years of referral of parents and their newborns for a first dental visit by a well-baby clinic medical practitioner combined with the NOCTP approach in dental practices was assessed. Children who were offered early preventive dental care using an individualized approach with parents had lower enamel caries experience at 5 years of age, than children in the CAU group. The differences regarded the enamel and not the dentin lesions. That the lesions were only incipient is possibly related to the still young age of the child. Furthermore children in the intervention group showed fewer inactive caries lesions than children in the CAU group. The effect sizes regarding enamel lesions and inactive lesion were small, that is, below 0.2. These effects are small but they regard all children, and small effects in large populations may still have a considerable population impact.

In the current study at age 5 was found that children in the intervention group showed lower enamel and dentin caries experiences and fewer inactive caries lesions than children in the CAU group, suggesting a positive though relatively small effect of this intervention. As this is the first study to assess the effects of such

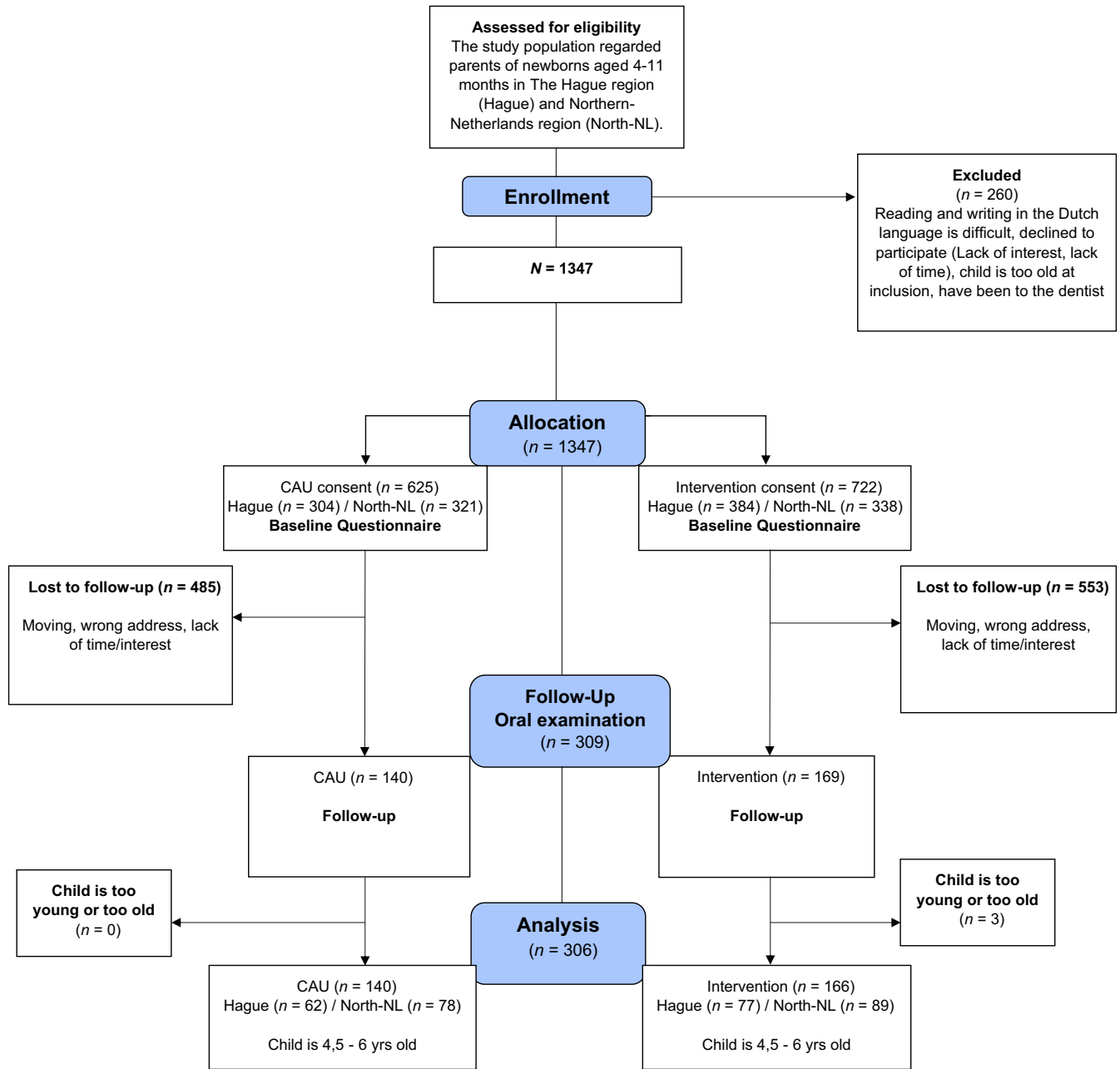


FIGURE 1 Flow chart of the 'HTAA' study population.

TABLE 2 Baseline characteristics of participants in CAU and Intervention (I) groups.

Baseline characteristics of Mother	Baseline			Follow-up		
	CAU n = 625	I n = 722	p	CAU n = 140	I n = 166	p
Non-Dutch (%)	23	30	0.007	19	26	ns
Low educated (%)	56	66	<0.001	51	60	ns
Toothbrushing 2x/day or more (%)	84	83	ns	85	81	ns
Last dental visit in the last year (%)	85	83	ns	91	85	ns

a combined intervention of early referral and NOCTP, it is hard to compare with previous findings. Our finding that including oral health promotion in WCC seems promising to prevent some of the enamel lesions in young children differs somewhat from findings of a

study in Belgium.²⁸ That study assessed the effectiveness of an oral health education program that was added to a standard preventive care program in WCC during the first 3 years of life. The researchers reported limited to no effects on caries experience at the age

	Intervention <i>n</i> = 166 %	CAU <i>n</i> = 140 %	<i>p</i> Value
Male gender of child	49	42	ns
Dutch ethnicity of mother	74	81	ns
Educational level of mother			ns
Low	60	51	ns
High	40	49	
Mean age of child in months (Tukey's Hinges 25th and 75th Percentile)	65.37 (62.32–68.47)	63.70 (61.34–66.02)	<i>p</i> < .01

TABLE 3 Background characteristics of the participating children in the intervention and CAU groups.

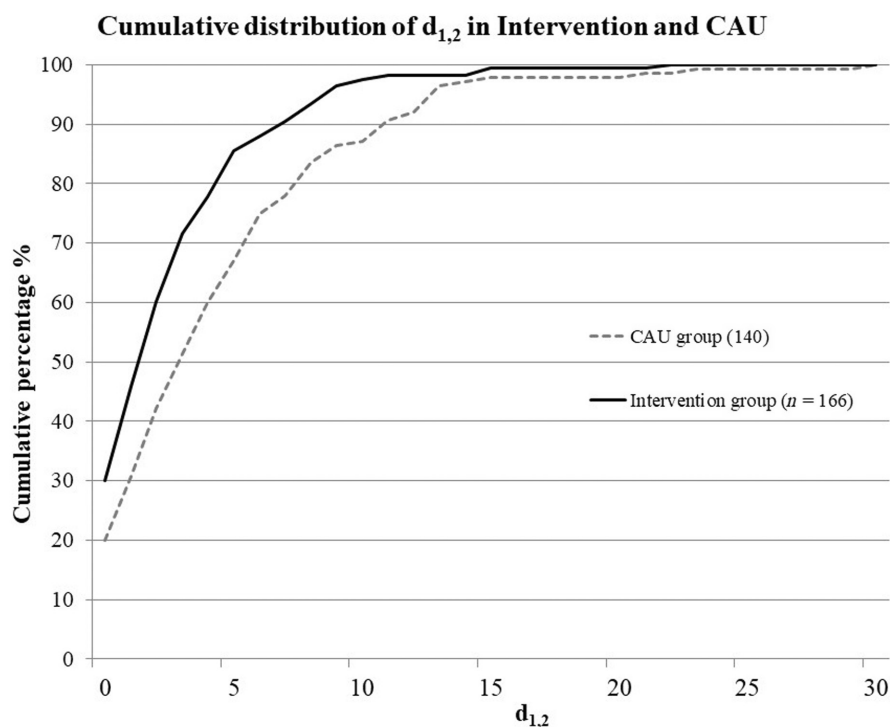


FIGURE 2 Cumulative distribution of $d_{1,2}$ of children in the intervention group and CAU group.

TABLE 4 Odds ratios (OR) and rate ratios (RR) on primary outcomes dentin caries experience (d_3 mfs), enamel and dentin caries experience ($d_{1,2,3}$ mfs), active and inactive caries in deciduous teeth in children in the intervention (I) and CAU group according to group.

	Median (Tukey's Hinges 25th–75th percentile)			Crude hurdle model (I vs. C)		Adjusted ^a hurdle model (I vs. C)	
	I <i>n</i> = 166	CAU <i>n</i> = 140	Effect size <i>r</i>	OR 95% CI	RR 95% CI	OR 95% CI	RR 95% CI
$d_{1,2,3}$ mfs	2 (0–7)	5 (1–10)	.15**	0.71 (0.41–1.22)	0.83 (0.60–1.13)	0.62 (0.35–1.08)	0.74* (0.54–0.99)
d_3 mfs	0 (0–2)	0 (0–2)	.04	1.18 (0.72–1.94)	1.15 (0.67–1.97)	0.99 (0.59–1.66)	0.99 (0.58–1.68)
Active caries	0 (0–1)	0 (0–1)	.06	0.84 (0.51–1.40)	0.62 (0.30–1.27)	0.71 (0.42–1.20)	0.51 (0.23–1.11)
Inactive caries	2 (0–4)	3 (1–6)	.18***	0.51 (0.30–0.85) **	0.84 (0.65–1.08)	0.45 (0.27–0.77)**	0.82 (0.63–1.05)

Abbreviation: CI, confidence interval.

^aAdjusted models were adjusted for SES and ethnicity.

p* < .05, *p* < .01, ****p* < .001.

of 5 years. The difference regarding enamel lesions between these studies might be explained by the fact that the intervention in the Belgian study did not include collaboration with and referral by WCC for dental care.

Next, the small positive effects regard a combined intervention which leaves to decide which component adds most. On the one hand, its effects on earlier first visits is evident. Referral of parents of babies by the WCC for their first preventive dental visit leads to earlier initiation of preventive dental care for those children. Overall 54% in the referral intervention group versus 7% in the control group had their first preventive dental visit in their first year of life.²⁹ Furthermore, strong evidence supports the effectiveness of NOCTP in dental practice to improve oral health of children, albeit mostly at older ages.¹⁶⁻²⁰ In short, this combined intervention may add to prevention of enamel caries lesions at age 5, with probably both the WCC early referral and the NOCTP parts adding to that.

No differences for dentin caries experience or active caries lesions were found between children in the intervention and children in the CAU group. This might be explained by the fact that the children in the study group were only 5 years old during the oral examinations and in The Netherlands, the group with dentin caries experience or active caries lesions at this age is rather small.¹⁴ This limits the power to detect differences between the groups. However, these differences can be expected to become bigger when the children are growing older. A second explanation could be that the intervention group was slightly more disadvantaged given its composition regarding SES and ethnicity of the mother, leading to an underestimation of the intervention effect. In sum, the effects as found may underestimate the full effects. A third possible explanation that there was no difference found for dentin caries experience or active caries experience might be the fact that the intervention was not effective in the highest risk groups of children. Finally, the outcomes were based on clinical examinations whereas radiographs might have been more sensitive. However, ethical regulations do not allow its use for research purposes in the Netherlands.

4.1 | Strengths and limitations

The main strength of the current study was its prospective design with a follow-up of 5 years. The second strength is the inclusion of groups at increased risk of poor oral health, for example, low educated families and families with migration backgrounds. Finally, this study is performed in collaboration with several WCC clinics and dental practices, showing its feasibility in routine practice.

The current study had some limitations as well. First, the current study had a quasi-experimental design having as risk that effect estimated are influenced by confounding due to differences in the composition of the intervention and CAU group. However, adjustment for differences in important determinants of the outcomes such as educational level and ethnicity of the mother

yielded quite similar estimates, suggesting the impact of this to be limited. Moreover, the baseline differences that occurred, all regarded higher prevalences of factors favourable for the development of child dental health in the CAU group (i.e. parents in the CAU groups more often were higher educated and more often had a Dutch background, Table 2). So, if leading to bias, this will probably have led to an underestimation of the real effects. Furthermore, this study had a relatively high drop-out, which may have led to including the more involved parents. The retention rate was rather low partly explained by the fact that the clinical examination was performed in 2021 when the covid pandemic prevailed. The retention rates were, however, similar in both groups, that is, 23% in the intervention group and 22% in the CAU group, and were similar regarding the sociodemographic characteristics most likely affecting the clinical primary outcomes, suggesting the impact of a selective retention to be limited. Third, an underestimation of the intervention effect is possible because of incomplete delivery of NOCTP, in particular due to COVID-challenges. Fourth, a multilevel clustering effect in the sample size calculation was not accounted for because the likelihood of such an effect was assumed to be small. Post hoc the intracluster correlation coefficient (ICC) at WCC level for $d_{123}mfs$ as outcome was found to be small indeed, 0.04, and nonsignificant. Fifth, sociodemographic characteristics like socioeconomic position were dichotomized to obtain sufficient numbers across the categories for sociodemographic characteristics. In this, we adhered to the cut-offs used by Statistics Netherlands but it may have led to some residual confounding.³⁰ However, given the quasi-experimental design of the current study, this potential bias is considered to be small.

5 | CONCLUSION

In conclusion, the results of the study suggest that early dental visits combined with NOCTP leads to a small reduction in less enamel caries experience and less inactive decayed lesions in children in the intervention group. Collaboration of WCC professionals and oral health professionals may offer a new opportunity for prevention of enamel lesions among young children and their parents.

AUTHOR CONTRIBUTIONS

Verlinden collected data, drafted the initial manuscript, conducted the analyses and revised the manuscript. Schuller and Vermaire conceptualized and designed the study, coordinated data analyses, reviewed and revised the manuscript. Reijneveld made contributions to the design, coordinated data analyses, and critically reviewed and revised the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest relevant to this article to disclose.

DATA AVAILABILITY STATEMENT

Deidentified individual participant data will be made available on reasonable request to the first and second author. Further enquiries can be directed to the first author.

PATIENT CONSENT STATEMENT

Written informed consent was obtained from all participants' parents or legal guardians to participate.

CLINICAL TRIAL REGISTRATION

The study was part of the "Healthy teeth, all aboard" (HTAA) study and was registered in 2015 (Trial NL4174).

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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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