

The effectiveness of the Brush Day and Night programme in improving children's toothbrushing knowledge and behaviour

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Background: Regular twice-daily toothbrushing with a fluoridated toothpaste is widely recommended for schoolchildren. The '21-day Brush Day and Night (BDN) programme' includes an educational approach for children and school staff, with a consistent practice of toothbrushing at school for 3 weeks. **Objective:** This study aims to evaluate the improvement in oral hygiene knowledge and behaviour in schoolchildren involved in BDN, the sustainability of this after 6–12 months, and if any particular age group was more receptive to it than others. **Materials and methods:** Ten countries and 7,991 children, 2–12 years old, participated in this longitudinal study, with two BDN interventions at the beginning and 6–12 months afterward. Data were collected via a self-reported questionnaire at baseline/first intervention (T0), 21 days after first intervention (T0D21), at the second intervention (T1), and 21 days after second intervention (T1D21). Improvement in knowledge and behaviour was compared using the chi-square test with an alpha level of 5%. The final data sample of 5,148 schoolchildren was evaluated, and the analysis revealed that 25% more of the schoolchildren brushed their teeth twice a day after the first intervention. The programme was more effective among the 7–9 years age group. The BDN intervention increased brushing-frequency in children at the first intervention, and this was sustained after 6–12 months. Therefore, this programme illustrated a sustainable approach to improve children's oral health knowledge and behaviour.

Key words: Oral health school programme, oral health behavior, toothbrushing, knowledge, schoolchildren, 21-day programme

INTRODUCTION

The importance of preventing oral diseases to achieve good oral and general health is well known¹. There is a global understanding that good oral health behaviours, such as an appropriate diet, plaque control and the use of fluoride toothpaste², can help prevent oral diseases. However, this behaviour is highly influenced by social factors³.

Good oral hygiene practices lead to effective plaque control, improved gingival health and caries prevention, and regular twice-daily toothbrushing with a fluoridated toothpaste is widely recommended for all age groups^{4–9}.

Therefore, one of the objectives for oral health professionals is to educate populations about the best

oral hygiene practices and advise patients on implementation. Although this seems to be a very simple objective and achievable task, experience has shown that it is difficult to implement one strategy that works for all age groups throughout life¹⁰. In particular, the strategy needs to be adapted to multiple settings and for different age groups, implementation settings, social constraints, and locations^{11–13}.

Naturally, good oral health behaviour is an essential component of preventing oral diseases in children¹⁴. There is broad consensus on the importance of introducing good practices in younger age groups because they are more inclined to listen, keener on adopting the good behaviours they learn, and are the best vehicle for disseminating this information to their families^{15–18}.

Oral health in childhood is a major predictor of oral health in adulthood^{19,20}. Establishing good oral

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health behaviours early in life makes it easier to maintain good oral health later in life.

In a public health context, school-based oral health programmes are the most effective way to reach children, considering the pedagogical environment and the opportunity to reach a large number of children that will benefit from the intervention. There is evidence that improvement in knowledge and behaviour in children results in better oral hygiene^{21–27}. Nevertheless, in some cases, improvement in knowledge is insufficient to change behaviour^{28–30}.

Another important factor that must be considered when designing such programmes is the children's capacity to retain information over time and how often they need to be reminded of it to achieve this retention. Reinforcement and repetition of the messages and procedures are crucial for the sustainability of healthy behaviours^{31,32}. In addition, behaviours implemented on a daily basis are known to develop more easily into habits, and habits performed daily have been shown to be more difficult to abandon or forget¹⁸. Most of the existing literature on other oral health programmes demonstrates only short-term gains in terms of behaviour change, especially when looking at single-session programmes. Therefore, longer-term programmes seem more effective and suitable for sustainable outcomes^{10,33}.

School-based oral health programmes should be designed and supervised by oral health professionals. These intervention programmes must have clear objectives, must include the active involvement of the learner³², and should always involve the school staff. The teaching staff will facilitate the continued implementation and maintenance of the school programme on a daily basis in the absence of the dental team. Whenever feasible, the educational part of the programme should also actively involve parents, to extend the benefits of the programme to the family and achieve the desired outcomes.

It was within this context that Unilever, together with FDI World Dental Federation, introduced the '21-day Brush Day and Night (BDN) programme', implemented in schools worldwide for children from 2 to 12 years old. This programme included an educational approach for children and school staff, together with the consistent practice of toothbrushing at school for 3 weeks, aiming to educate and improve oral health, starting with children at school and encouraging the dissemination of the oral health messages to their relatives and friends.

Therefore, this study had three objectives. First, to evaluate the improvement in oral hygiene knowledge and behaviour in schoolchildren involved in the 21-day BDN programme. Then, to assess the level of knowledge retention 6–12 months after the 21-day period. Finally, to evaluate if any particular age

group was more receptive to the programme than others.

MATERIALS AND METHODS

Study design

A total of 10 countries and 7,991 children between 2 and 12 years old participated in this longitudinal study. Two interventions of the '21-day BDN programme' were performed at the beginning and 6–12 months after by a team comprised of FDI-member National Dental Associations (NDAs) and local Unilever Oral Care partners. This study included four data collection time-points: T0, T0D21, T1 and T1D21.

Oral health knowledge and behaviour information was collected via a self-reported questionnaire at baseline (T0), 21 days after the first intervention (T0D21), 6–12 months after the first intervention (T1), and 21 days after the second intervention (T1D21). Clinical evaluation of caries by the decayed, missing and filled teeth, and the presence of plaque by the Visible Plaque Index was performed at T0 and T1.

This study was in accordance with the Declaration of Helsinki and was submitted to the local ethical clearance authorities. All involved countries received ethical approval, and all parents or legal carers of the participating children signed an informed consent form.

Intervention ('21-day BDN programme')

The 21-day BDN programme was an intense education and behavioural change programme to establish the BDN habit based on the principles of Unilever's Behaviour Change model. The programme was implemented with the support of a team that included two–four dentists and schoolteachers, and targeted the age range 2–12 years old. It included an educational approach for children and school staff, together with the consistent practice of toothbrushing at school for 3 calendar weeks, i.e. 15 school days, aiming to educate and improve oral health, starting with children at school and encouraging the dissemination of the oral health messages to their relatives and friends. The programme included five steps, based on the five levers of Unilever's Behaviour Change Model³⁴.

1. *Make it understood.* Dentists/teachers explained oral hygiene with flipcharts and demonstrated the proper way to brush the teeth. This habit was then reinforced and repeated by the teacher for 21 days.
2. *Make it desirable.* The BDN song and pledge were introduced. Supporting materials included cartoon characters that were attractive to children. A full set of school programme assets was

developed in order to make the programme fun for children.

3. *Make it easy.* The children were provided with toothbrush and toothpaste samples to encourage practice at home. An educational leaflet for parents and care-givers was sent home.
4. *Make it a habit.* A sticker calendar for children and adults allowed twice-daily toothbrushing to be recorded. The parents had to sign a document every day confirming that both adults and children had brushed their teeth twice.
5. *Make it rewarding.* Daily rewards and a 'graduation' celebration completed the programme.

A team of FDI-member NDAs and local Unilever Oral Care partners was involved in the preparation of the fieldwork. The dental team was suitably trained by the NDAs for the programme and the study. They then trained schoolteachers to supervise the programme on a daily basis for 3 consecutive weeks, engaging more than 500 teachers in total.

Children at the schools received brushing materials, such as toothbrushes and fluoride toothpastes, for both school and home use and, in some countries, children also received calendars with stickers for monitoring their brushing at home.

At the start of the 21-day BDN intervention, the teachers and NDA team taught the children a correct brushing technique using a toothbrush and fluoride toothpaste. Then, the trained teachers implemented the daily 3-week programme at school.

Data collection

A project leader from each NDA led the dental team, and was responsible for the selection and training of the other team members, who were all dentists. The project leader was also responsible for translating the questionnaire and providing guidance on its use. For the 2–6 years age group, examiners and teachers were specifically trained to ask questions in an appropriate manner to ensure accuracy of the answers.

At the beginning of the 21-day BDN programme (T0), the dental team assessed children's oral health knowledge and behaviour using the self-reported questionnaire, and performed an oral examination of plaque level and dental caries. After 21 days (T0D21), the dental team returned to the schools and reassessed children's knowledge and behaviour via the same questionnaire, but without performing any oral examination. Whenever feasible, re-evaluation of the children was carried out 6–12 months (T1) after baseline (T0) to measure their oral health knowledge and behaviour (via the questionnaire), as well as their clinical status, using the same evaluation form as at T0. This re-evaluation of knowledge and behaviour was performed again at the end of the second

21-day BDN programme (T1D21) via the same questionnaire.

The self-reported oral health knowledge and behaviour questionnaire was developed by the two partnership experts and delivered using an electronic form. Whenever it was not possible to use the electronic evaluation form, the evaluation form could be printed in A4 or A3 format and completed manually.

Questionnaires

The questions assessing oral health knowledge and behaviour are similar to those used in the Live.Learn.-Laugh phase II, which were previously validated¹³. The three core questions served, respectively, to monitor and evaluate children's brushing-frequency behaviour and knowledge (Q1), timing of brushing (Q2), and use of fluoride toothpaste (Q3). The first question (Q1) was 'How often do you brush your teeth?' and the response options were 'never', 'once per day', 'twice per day', 'twice or more per day' and 'not daily'. The second question (Q2) was 'What time of day do you brush your teeth?' and the answers were 'morning', 'evening', 'both morning and evening', and 'other'. The third question (Q3) was 'Do you use toothpaste containing fluoride?'^{13,35–37} with the response options of 'yes', 'no' and 'don't know'.

For data analysis, the answers to the question 'How often do you brush your teeth?' were merged into three options: 'never/not daily', 'once per day' and 'twice per day'. The last option includes answers of 'twice or more per day'. The answers to 'What time of day do you brush your teeth?' were also slightly reorganised by discarding the answers 'both morning and evening'. For easier interpretation of the results, the question can be considered as: 'If you brush your teeth once a day, what time of the day do you brush your teeth?'

The criteria for assessing an improvement in knowledge and behaviour are explained in *Table 1* and are directly related to an adoption of twice-daily toothbrushing, although increases from never or not daily to once per day were also considered an improvement.

Sample

Ten countries conducted the 21-day BDN programme, and a total of 7,991 children participated in this study; 1,058 from Bangladesh, 295 from Chile, 1,388 from Greece, 1,436 from Indonesia, 472 from Morocco, 402 from Myanmar, 1,490 from Nigeria, 300 from Philippines, 588 from Turkey, and 562 from Vietnam.

The recruitment of schools was executed by the NDAs using non-probabilistic convenience sampling.

Table 1 Criteria for defining a change in behaviour regarding the frequency of toothbrushing at different time-points

	If at T0...		
	Never or not daily	Once per day	Twice or more per day
T0D21			
Never or not daily	Equal	Worsened	Worsened
Once per day	Improved	Equal	Worsened
Twice or more per day	Improved	Improved	Equal
T1			
Never or not daily	Equal	Worsened	Worsened
Once per day	Improved	Equal	Worsened
Twice or more per day	Improved	Improved	Equal
	If at T1...		
	Never or not daily	Once per day	Twice or more per day
T1D21			
Never or not daily	Equal	Worsened	Worsened
Once per day	Improved	Equal	Worsened
Twice or more per day	Improved	Improved	Equal

T0, baseline; T0D21, 21 days after the baseline evaluation; T1, 6–12 months after the baseline evaluation; T1D21, 6–12 months and 21 days after the baseline evaluation.

Depending on the country, between one and 26 schools were selected, with a total of 86 schools participating across the 10 countries.

After receiving all data electronically, an Excel database was developed for each country, and exclusion criteria were implemented to comply with the longitudinal analysis.

Of the 7,991 participants with data at baseline (T0), those with no data on the variable frequency of toothbrushing at T0 ($n=1,115$), at T0D21 ($n=1,255$), at T1 ($n=383$) and/or at T1D21 ($n=78$) were excluded. Additional children were excluded from the analysis to avoid statistical inaccuracy due

to the low proportion of children in the age categories of interests: two from Chile aged under 7 years and four aged over 9 years; four from Morocco aged over 9 years; and two from Nigeria with no age data (total $n=12$).

After the exclusion criteria, a sample of 5,148 children (69.5%) from nine countries, with information regarding their country, age and gender distribution (Table 2), was considered.

For the purposes of data analysis, children were divided into three different age groups: < 7 years old; 7–9 years old; and > 9 years old.

Statistical analysis

Excel files were imported into the SPSS statistics 22.0 software and analysed.

The data were presented as frequencies and percentages. Knowledge/behavioural-related characteristics were determined for each evaluation time-point (T0; T0D21; T1; and/or T1D21) and for each country. When appropriate, analyses were stratified by age group (< 7 years old, 7–9 years old, and > 9 years old) and study setting (settings with follow-up after T0 but < 1 year, or 1 year after T0). The proportion of improvement in the frequency of toothbrushing (as defined above) from T0 to T0D21, from T0 to T1 and from T1 to T1D21 was compared by age group, type of study setting and gender, using the chi-square test. The significance level was defined using an alpha level of 5% (statistically significant differences at the level of $P < 0.05$).

RESULTS

The final sample for data analysis included nine countries with a total of 5,148 children, of which 51.3% were male, 1,364 were under 7 years old, 2,495 were

Table 2 Study design and participants' characteristics

Country	Age			Total sample [†] (<i>n</i> , % [†])	Males (<i>n</i> , %)	Evaluation time-points [‡]				
	Range	No.*				T0	T0D21	T1	T1D21	
		< 7 years	7–9 years							> 9 years
Bangladesh	4–12	133	351	354	838 (72.2)	414 (49.4)	Y	Y	Y	Y
Chile	5–12	0	199	0	199 (67.5)	149 (74.9)	Y	Y	Y, 6M	N
Greece	2–5	573	0	0	573 (41.3)	296 (51.7)	Y	Y	Y, 6M	Y
Indonesia	7–12	0	709	313	1022 (71.2)	547 (53.5)	Y	Y	Y	Y
Morocco	7–12	0	121	0	121 (25.6)	67 (55.4)	Y	Y	Y, 7M	Y
Myanmar	6–8	193	209	0	402 (100.0)	184 (45.8)	Y	Y	N	N
Nigeria	5–12	98	639	622	1359 (91.2)	654 (48.1)	Y	Y	N	N
Philippines	3–6	271	0	0	271 (90.3)	133 (49.1)	Y	N	Y, 8M	N
Vietnam	6–9	96	267	0	363 (64.6)	199 (54.8)	Y	Y	Y	Y
All countries		1,364	2,495	1,289	5,148 (69.5)	2,643 (51.3)				

*Sample size of complete data (children with all evaluation time-points).

[†]From the overall sample recruited at T0.

[‡]Evaluation performed (Y = yes or N = no) at T0 (baseline), T0D21 (21 days after T0), T1 [1 year after T0; if not, the time between T0 and T1 is stated in months (M)]; T1D21 (21 days after T1).

between 7 and 9 years old, and 1,289 were between 9 and 12 years old (Table 2). Greece, Indonesia, Morocco, Bangladesh and Vietnam collected data at the four time-points of the study. Chile, Nigeria and Myanmar participated in two or three time-points, and Philippines evaluated the programme only at the beginning (T0) and after 8 months (T1).

A great variation between countries in the percentage of children who brushed their teeth twice a day at T0 was observed. About 30–35% of children from Nigeria (29.5%), Greece (34%) and Bangladesh (35.8%) brushed their teeth twice a day, while 40–45% from Morocco (41.6%) and Myanmar (44.5%), and 70–85% from Chile (72.2%), Philippines (80%), Indonesia (83.8%) and Vietnam (85.7%) brushed twice-daily.

An overall improvement was observed (Table 3). At the first time-point (T0) 51.3% of the children brushed their teeth twice a day, increasing to 76.7% after the 21-day programme (T0D21). At the third time-point (T1) 74.4% were brushing twice a day, increasing to 82.2% at T1D21. Answers on the use of fluoride toothpaste show that 11.2% of the children reported not using it at T0, but this percentage decreased to between 6.7% and 7.2% at the following time-points.

Considering the answers to the question ‘how often do you brush your teeth’ by age group, between T0 and T0D21, the percentage of children under 7 years old who brushed their teeth twice a day increased from 46.0% to 61%. The percentage of children between 7 and 9 years old undertaking this habit rose from 58.7% to 91.3%, and in children over 9 years old it increased from 42.5% to 87.4% (Figure 1).

The answers to the question ‘If you brush your teeth once a day, at what time of day do you brush

your teeth?’ show that most of the children (81%) brushed their teeth in the morning at T0. At T1D21, 49.7% of the children brushed in the morning and 43.6% in the evening (Table 3).

Moreover, the improvement from T1 to T1D21 is almost negligible in children under 7 years old, and is about 9%–12% in older children.

Figure 2 depicts the proportion of children that improved their knowledge and behaviour from one time-point to another, by age group and country. All countries and age groups showed an overall improvement. Nigeria presented an improvement of 67.4%, 49.8% and 56% for each age group from T0 to T0D21. In Bangladesh, children aged 7–9 years old showed an improvement of 39.6% from T0 to T0D21, 34.5% from T0 to T1, and 13.7% from T1 to T1D21.

Comparing the overall improvement of knowledge and behaviour for each time-frame (Table 4), there is a statistically significant difference ($P < 0.001$) for all age groups from T0 to T0D21, and also from T0 to T1, with the older children (> 9 years old) showing a greater improvement. The same can be observed when comparing children under 7 years old, and those between 7 and 9 years old, if we exclude the data for Indonesia in both time-frames. The exclusion of data for Nigeria does not influence the statistical results.

Considering only the time-frame T0–T1, countries were grouped by those that repeated the programme after 6–8 months and those that repeated it after 12 months. In countries that repeated the programme before 1 year had passed, there is a significant difference ($P < 0.001$) in the improvement in knowledge and behaviour from T0 to T1 in schoolchildren between 7 and 9 years old when compared with those under 7 years old. Comparing the improvement in

Table 3 Knowledge and behaviour frequency at different time-points in all study settings

	Evaluation moments*							
	T0 (<i>n</i> = 5,148)		T0D21 (<i>n</i> = 4,877)		T1 (<i>n</i> = 3,387)		T1D21 (<i>n</i> = 2,956)	
	<i>N</i>	%	<i>n</i>	%	<i>N</i>	%	<i>n</i>	%
How often do you brush your teeth?								
Never or not daily	282	5.5	51	1.0	134	4.0	32	1.1
Once per day	2,226	43.2	1,084	22.2	732	21.6	495	16.8
Twice or more per day	2,640	51.3	3,742	76.7	2,521	74.4	2,429	82.2
If you brush your teeth once a day, What time of day do you brush your teeth?								
Morning	1,807	81.2	816	75.3	381	52.0	246	49.7
Evening	321	14.4	208	19.2	271	37.0	215	43.4
Other	94	4.2	60	5.5	78	10.7	34	6.9
No answer	4	0.2	0	0.0	2	0.3	0	0.0
Do you use toothpaste containing fluoride?*								
Yes	2,394	46.5	3,584	73.5	2,233	65.9	2,216	75.0
No	578	11.2	327	6.7	245	7.2	205	6.9
Do not know	2,122	41.2	932	19.1	892	26.3	502	17.0
No answer	54	1.0	34	0.7	17	0.5	34	1.1

*At each evaluation time-point, except T0, numbers do not always sum 5,148 children because of the countries that did not perform the evaluation at that time-point.

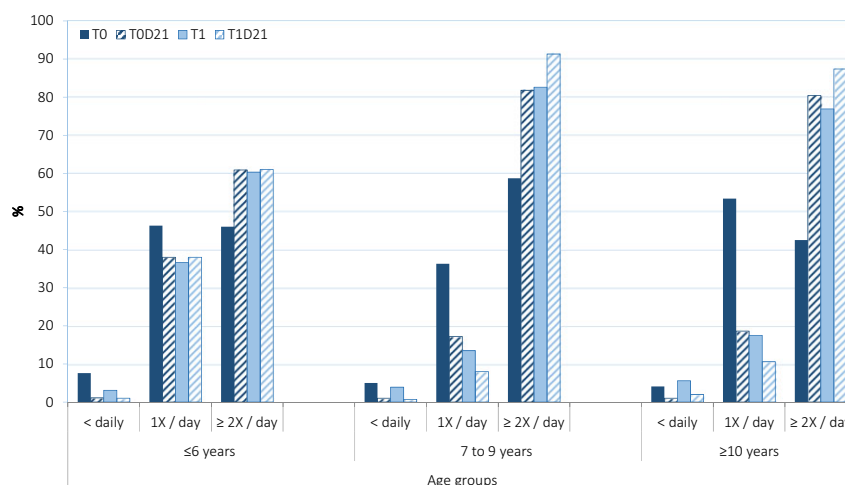


Figure 1. Response to the question 'how often do you brush your teeth' by age group.

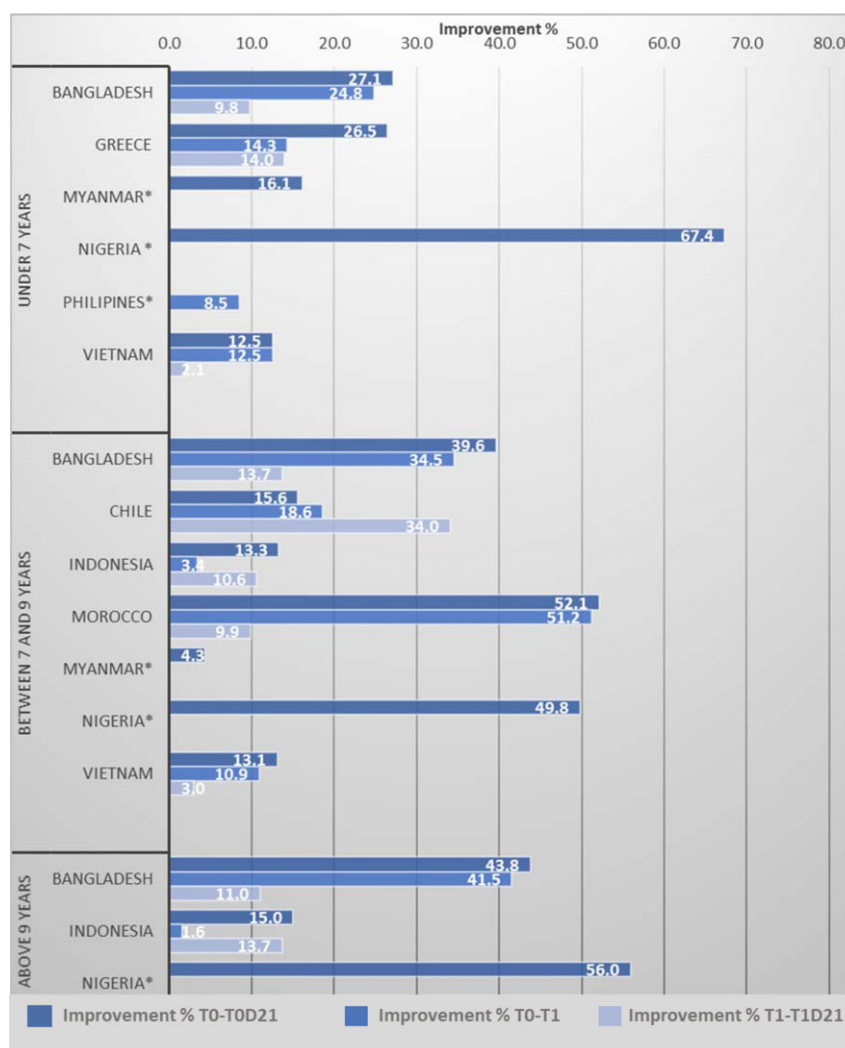


Figure 2. Proportion of children who improved behaviour at each time-point. *Countries with less than three evaluation time-points.

knowledge and behaviour by gender, it is always greater for the older age group (>9 years old; $P < 0.05$). Some variability in the results is observed

without any statistically significant differences, except for the 7-year-old schoolboys from countries that repeated the programme after <12 months, who

Table 4 Overall proportion of children who improved their behaviour at each time-point, by gender and study setting

Time-point	Sample for comparison*	% improvement by age groups			P-value†	
		< 7 years	7–9 years	> 9 years	All age groups	< 7 vs. 7–9 years
T0–T0D21	All study settings (5 + 7 + 3)	27.2	27.6	42.7	< 0.001	0.785
	Excluding Indonesia (5 + 6 + 2)	27.2	33.3	51.5	< 0.001	0.001
	Excluding Indonesia and Nigeria (4 + 5 + 1)	23.2	24.2	43.8	< 0.001	0.612
T0–T1	All study settings (4 + 5 + 2)	14	16.6	22.8	< 0.001	0.068
	Females	12	16.8	20.2	0.005	
	Males	15.9	16.4	25	< 0.001	
	Excluding Indonesia (4 + 4 + 1)	14	26.6	41.5	< 0.001	< 0.001
	Countries with T1 < 1 year‡	12.4	30.9	—	< 0.001	< 0.001§
	Females	9.4	34.6	—	< 0.001	
	Males	15.4*	29.2	—	< 0.001	
	Countries with T1 = 1 year¶	19.6	13.1	22.8	< 0.001	0.009
	Females	21.2	14	20.2	0.019	0.044
	Males	18	12.3	25	< 0.001	0.1
	All study settings (3 + 5 + 2)	11.8	10.6	12.3	0.462	0.378
T1–T1D21	Excluding Indonesia (3 + 4 + 1)	11.8	10.7	11	0.758	0.466

*In parentheses, the number of countries: (number of countries for children < 7 years + number of countries for children 7–9 years + number of countries for children > 9 years).

†P-value represents the comparison of the proportion according to age groups.

‡Chile, Greece, Morocco, Philippines.

§Equals the comparison for all age groups because no children above 9 years were evaluated in these countries.

¶Bangladesh, Indonesia, Vietnam.

*P = 0.008.

showed a significant improvement compared with girls of the same age ($P = 0.008$).

DISCUSSION

Evidence suggests that the best strategy to educate different populations and age groups on the implementation of good oral health practices has been continuously discussed and investigated³. Two important components on this subject are the transfer of knowledge, and the behaviour changes resulting from this increased knowledge.

In this sense, this study aimed to evaluate the impact of an oral health school programme on the knowledge and behaviour of different age groups, and the repetition and reinforcement of the programme for the same age- and gender-groups in different countries.

Ostberg *et al.*³⁸ suggested that oral health behaviour is a multidimensional phenomenon influenced by individual differences, experiences, and perceived risks and benefits. They also stated that understanding how to improve oral health behaviour in adolescents is complex³⁸. That is why the 21-day BDN programme was implemented only for children under 13 years of age³⁹.

Two interventions were performed in this longitudinal study, one at the beginning, and one either 6–8 months or 1 year later, depending on the country's specific environment, logistical context, school calendar, societal constraints and NDA capacity.

The sample size considered for the statistical analysis was reduced to 69.5% (5,148) of the initial sample

due to some children being absent between the intervention day and the recall visits (dropouts), and due to unreliable, invalid, missing or lost data. Participants from Turkey ($n = 588$) were excluded at T0D21 according to the exclusion criteria. For data analysis, the results for each country were considered first, and then all countries' results were compared. Despite potential differences in social status, ethnicity or religion³, some questions may be answered in a similar way across countries or regions.

According to Marinho *et al.*⁴⁰ and Axelsson *et al.*⁴¹, oral health promotion is beneficial for schoolchildren's oral health behaviour, and it is beneficial for them to brush their teeth twice a day with a fluoride toothpaste⁴².

The data in Table 3 show that, at the end of the study, the majority (75%) of children were using fluoride toothpaste and only 6.9% stated they were not. The increase in fluoride toothpaste use from T0 (46.5% of children) to T1D21 (75% of children) is probably related to an initial lack of knowledge at baseline, addressed through the 21-day intervention, and highlights the need to educate people about the importance of fluoride in caries prevention and treatment². This awareness alone will not change children's behaviour as it is parents who purchase these products, but children can play an important role in passing on this information to parents.

In the question regarding timing of toothbrushing, the answer 'both morning and evening' was discarded to consider only the answers of children who brushed once a day, morning or evening. This was justified by

the similarity of answers to this timing question, and the question on frequency of toothbrushing for children who brushed twice daily. In this sense, the question 'How often do you brush your teeth' is considered as the reference for determining a potential improvement in oral health knowledge and behaviour.

Results presented in *Table 3* demonstrate a positive change of brushing behaviour, shifting from no or once a day toothbrushing to twice-daily toothbrushing following the 21-day BDN intervention. Such improvement occurred for 25.4% of the children after the first intervention and 7.8% after the second intervention. The difference observed between both interventions most likely reflects the sustainable impact of the programme: after the first intervention, 76.7% of the children were brushing twice daily (compared with 51.3% at baseline) and 74.4% of them retained the twice-daily toothbrushing habit 6–12 months after the first intervention. Therefore, more than a fifth of the children (21.3%) involved in the first 21-day BDN intervention kept the twice-daily toothbrushing habit, and despite this higher threshold of children brushing their teeth twice a day that was reached, the second intervention still empowered almost 8% of children to similarly change their brushing habits.

With regard to national trends, all countries, regardless of age groups, showed an overall improvement, demonstrating the importance of the 21-day BDN programme. In some countries, there was a high frequency of children brushing their teeth twice a day at T0, which was a limitation for achieving greater improvement. For instance, 83% of children from Indonesia already brushed their teeth twice a day, meaning the percentage improvement could never surpass 17%. In other countries, such as Nigeria, the initial percentage of children brushing their teeth twice a day was low and, thus, there was a bigger margin for improvement.

The results are in agreement with those of other studies that have shown an improvement in oral health knowledge after the introduction of a school programme^{21–23,26,43,44}. The improvement in knowledge and associated behaviours is common when measured immediately after interventions^{24,27,43,45}. The sustainability of knowledge and behaviours, however, is known to be difficult to achieve over the long term^{31,32}. In this sense, the observed 2.2% long-term decrease in children's twice-daily brushing habits in the 21-day BDN programme was lower than expected in 7- to 9-year-old schoolchildren.

The trend of significant differences ($P < 0.001$) between age groups is demonstrated in *Table 4*. The reason for excluding Indonesia in this analysis is to demonstrate that countries with a high percentage of twice-daily toothbrushing at T0 can affect the overall results. Nigeria's results on the other hand, which

showed a huge improvement, do not interfere with the overall results.

The T0–T1 time-frame still seems to show the same differences between age groups, even when dividing the T1 groups by those that received the second intervention < 1 year after T0 ($P < 0.001$) and those that received it 1 year after T0 ($P < 0.001$). Again, the 7- to 9-year-old age group seems to receive more benefit than the under 7-year-old age group ($P < 0.001$) in the time-frame 6–8 months, but not at 1 year. Interestingly, this difference is not observed when all study settings are considered ($P = 0.068$).

Nevertheless, reinforcement and repetition of the messages and procedures are crucial. Some programmes designed for adolescents have shown the ability to maintain behaviour over 6 months without additional reinforcement⁴⁶. A similar outcome was observed in this study in children over 9 years old. Although some investigations have shown a slight trend for toothbrushing-frequency to decrease with age, both among girls and boys⁴², a continuous improvement in the over 9 years old age group was observed for all time-points, regardless of gender. Only two countries involved children aged over 9 years at T1 and T1D21, and observed very different outcomes. For this reason, from a statistical point of view, it is not possible to compare or analyse this age group.

Children younger than 7 years old demonstrated the lowest improvement in brushing-frequency. Some children who improved their behaviour from T0 to T0D21 returned to their baseline frequency of brushing (T0) after 1 year. For 2- to 6-year-old children, it is clear that the parents' role in long-term habits is very important, and that interventions must also include them⁴⁷. Some studies have shown that parents' involvement in establishing regular twice-daily brushing in early childhood increases the probability of children maintaining the behaviour throughout the preschool years^{47–49}. Although the important role that parents play in children's oral health behaviour is recognised, the best strategy to reach them on this issue is yet to be established^{6,50}. Thus, the study results reinforce this view that programmes addressing 2- to 6-year-old children must always consider parents' participation.

These results show a clear sustainability in 7- to 9-year-old children, especially after 6–8 months, and an overall improvement of knowledge and behaviour. So, it can be assumed that this age group is the most amenable to these kinds of programmes. This tendency may result from children at these ages wanting to demonstrate that they are mature and know how to care for themselves.

Special attention should be given to the time between interventions, as this study shows better

results on sustainability of knowledge and behaviour if the second intervention occurs <1 year after the first intervention. On the other hand, school summer holidays may interfere with the sustainability of knowledge and behaviour of these children. Therefore, it would be interesting to investigate if a session at the beginning of the school year and another near the end of the year would result in a better outcome for any of these age groups.

Some authors found a larger improvement in girls when compared with boys, which was not observed in this case⁴². The exception is seen when considering those who received the intervention <1 year after T0, where boys showed a significant improvement ($P = 0.008$). Significant differences ($P < 0.001$) between age groups of the same gender was observed.

The fact that the convenience sample studied may not be representative of the entire population, and that some countries and individual children dropped out before the end of the study period, are limitations of this report. The questionnaire does not provide information about the quality of toothbrushing, which is another important component of the oral health status besides brushing-frequency⁴². The subjectivity of the answers is also a limitation of this study, as some children might have given the more socially accepted answers. Due to the heterogeneous nature of the multi-country study population and the broad age range, caution should be taken when drawing conclusions from the data pooling all age groups and all study settings. Pooled results for all age groups and all study settings are provided to demonstrate general trends from the entire BDN programme.

This study provides a wider perspective on the maintenance of oral health knowledge and behaviour, and the relevant short- and medium-term outcomes. Additionally, the impact of repeating the intervention is also an important issue that must be studied further in order to understand its true importance.

CONCLUSIONS

This study demonstrated that the 21-day BDN intervention improves oral health knowledge and behaviour of the enrolled schoolchildren. Particularly, their toothbrushing-frequency increased after the 21-day programme. The first intervention also demonstrated a significant improvement in brushing frequency that was sustained after 6–12 months. A second intervention is important, bringing additional improvement and sustainability. Therefore, this programme leads to a sustainable improvement in children's oral health knowledge and behaviour, with the best outcomes achieved by 7- to 9-year-old children.

Acknowledgements

The work presented in this article was made possible through an unrestricted grant from Unilever Oral Care. All authors are grateful to Mr Sean Taylor for his editorial review of this article.

Conflict of interest

Sinead Malone is employed by Unilever Oral Care.

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