The Effectiveness of School Dental Screening: a Cluster-randomized Control Trial

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ABSTRACT

Dental screening of children in schools is undertaken in many countries. There is no evidence that this activity is effective. The objective of our study was to determine if school dental screening of children reduces untreated disease or improves attendance at the population level. A four-arm cluster-randomized controlled trial was undertaken in the northwest of England. In total, 16,864 children aged 6-9 years in 168 schools were randomly allocated to 3 test groups, which received screening according to different models, and a control, which received no intervention. There were no significant differences in caries increment in the primary and secondary dentitions or in the proportions of children attending a dentist after screening between the control group and the 3 intervention arms. School dental screening delivered according to 3 different models was not effective at reducing levels of active caries and increasing attendance in the population under study.

KEY WORDS: school, dental, screening, children, caries.

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INTRODUCTION

In the United Kingdom, school dental screening is a statutory function of local National Health Service (NHS) bodies and has been a feature of children's dental services for the past hundred years (Education Act, 1918). The process involves a visual dental examination of children in the school setting to identify the presence of dental disease and conditions; parents of children who are screened positive are informed and encouraged to take their child to primary care services for further investigation. Similar programs to identify children with dental problems run in other countries around the world (US Department of Health and Human Services, 1996, 2005; Ontario Ministry of Health, 1997; New South Wales Health, 2001). The WHO has recently endorsed dental screening of children in the school setting, stating that, "Screening of teeth and mouth enables early detection, and timely interventions towards oral diseases and conditions, leading to substantial cost savings. It plays an important role in the planning and provision of school oral health services as well as health services" (WHO, 2003).

Due to the long history of school dental screening in the UK, the aims of the program are vague (Jenner and Lennon, 1986; Milsom, 1995; Tickle and Milsom, 1999). Originally, screening was primarily concerned with the detection of disease so that treatment could be secured. More recently, the focus has shifted toward the identification of children who receive no regular dental care (NHS, 2000). For any screening program to be supported, strong evidence is required to demonstrate its effectiveness. Screening programs should be able to demonstrate that they are beneficial for a population or for those individuals identified as being at risk (National Screening Committee, 1998, 1999). Although there has been endorsement from the WHO and national and state governments for school dental screening, there have been no randomized controlled trials which clearly demonstrate that this process is effective in improving dental health. In an attempt to measure the effectiveness of school dental screening, we undertook a four-arm cluster-randomized controlled trial in the northwest of England. The aim was to establish the impact of school dental screening on untreated dental disease and dental attendance at the population level.

MATERIALS & METHODS

This cluster-randomized control trial tested 3 models of screening against a control. The 'new model' of school dental screening incorporated a consensus view, from clinicians in the northwest of England, on a set of clinical criteria that would prompt a referral following a screening examination (Milsom *et al.*, 1999). The screening dentists were trained and calibrated on the identification of these conditions. The 'traditional model' involved the delivery of the existing school dental screening program according to the principle that a child is referred if, in the opinion of the screening dentist, dental care is required. This approach is used extensively throughout England and Wales (Mander, 1995).

For both models, a child with a positive screening had a letter posted to his/her parents, informing them that the child required dental treatment and encouraging him/her to attend a dentist. In accordance with current UK practice, no additional method was used to ensure that the children identified with dental disease did in fact visit a dentist. The third intervention tested was a dental information leaflet, distributed *via* the schools, which encouraged parents to examine their child's mouth and to take their child to a dentist if any problems were noted. Children attending the control schools received no intervention during the study period.

The study population was comprised of all children aged 6-8 yrs attending state-maintained schools in two health districts: St Helens & Knowsley and Halton in the northwest of England. Children attending special schools were excluded. All eligible schools in the two districts agreed to participate in the study. The study was reviewed and approved by the local research ethics committee. Those children whose parents declined the invitation to participate, and children who refused to be examined on the day of the screening examination, were excluded from the study.

The unit of randomization was the school. The sample size was based on the detection of a reduction (from 7% to 3%) in the proportion of children with active caries in their first permanent molars. A final sample size of 35 children in 40 clusters (schools) in each arm of the study was calculated to have a greater than 90% power for this reduction to be detected, based on the assumption that the intra-class correlation coefficient was 0.03. To ensure that the schools in the 4 study arms were balanced, we stratified them into high, medium, and low levels of social deprivation, using the Townsend Index of material deprivation score (Townsend *et al.*, 1988) of the electoral ward (district) in which the school was located. The schools within each stratum were randomly allocated to the 4 intervention arms by reference to a random number table. The study statistician carried out the stratified randomization and concealed the randomization codes from the fieldworkers and co-investigators until analysis was complete.

A team of six dentists (three Traditional model, three New model) performed the screening interventions. The leaflet was distributed to the children by school staff. Baseline epidemiological examinations were undertaken in all schools by trained and calibrated dental epidemiologists on the same day as, but independent of, the screening examinations. Outcome epidemiological examinations were undertaken in the schools, after a four-month period, by trained and calibrated dental examiners who were blinded to the study arm to which each school had been allocated. The baseline data collection started on 16.09.2002 and finished on 12.02.2003. Outcome data collection started on 03.02.2003 and was completed on 21.07.2003. Children who were present at the time of outcome examination, but not at the baseline examination, were excluded from the study.

The principal outcome measures were prevalence (DT > 0) and mean number of teeth with active caries (DT) in the permanent dentition and prevalence (dt > 0) and mean number of teeth with active caries (dt) in the primary dentition. Secondary outcome measures were prevalence of oral sepsis, gross plaque or calculus, and dental trauma to incisor teeth. The analyses of the clinical outcomes were confined to all children who received both baseline and follow-up epidemiological assessment.

The effect of screening on dental attendance within a four-month period following the screening intervention was also measured. In England and Wales, the Dental Practice Board (DPB) holds an electronic record of all patients who attend a NHS dentist working in either the General Dental Services or Personal Dental Services. We matched the study data file to the relevant DPB databases to identify all children who attended a dentist working in these services in the 4 mos following the baseline epidemiological assessment. Children can also attend the Community Dental Service (CDS), which does not hold computerized records. We conducted hand searches of the treatment records in all CDS clinics within the study area to identify subjects who attended this service. Analyses of attendance included all children in the randomization process.

Since there were only small changes in the outcome variables from baseline, binary outcomes were formed as reduction from baseline (yes/no) for dt and DT. Generalized Estimating Equation (GEE) models were fitted according to the 'xtgee' procedure in Stata (StataCorp, 2001) for these outcome variables with logit link function, and an equal (exchangeable) within-cluster correlation structure was specified. The study population was divided into quintiles of socio-economic status based on the 2004 Index of Multiple Deprivation (IMD2004) (Office of the Deputy Prime Minister, 2004), and this was included as an explanatory variable. These analyses accounted for children being clustered in schools; for continuous data, they represent extensions of multiple linear regression, and, for dichotomous data, extension of logistic regression.

RESULTS

In total, 17,098 children in 169 clusters (schools) were eligible for inclusion in the study, since their names appeared on the registration lists of the participating schools. One school was withdrawn from the study because of failure to agree to follow the trial protocol. The remaining 16,864 children from 168 schools were included in the study. Some 15,004 children were available for baseline examination in 168 schools. The 1860 children unavailable at baseline, either due to absence from school or who refused the examination, were excluded from the analyses of clinical outcomes. A further 1434 children were also excluded from this analysis, because they were examined at baseline but were not present on the day of the outcome examination. This left 13,570 children, in 168 schools, who received a baseline and outcome epidemiological examination, representing 80.5% of the eligible population (Fig.).

The mean baseline levels of caries experience in both the primary and permanent dentitions were slightly greater in the control group children (3.20, 0.31, respectively) than for the study population as a whole (2.97, 0.25) (Table 1).

After adjustment for clustering of children in schools, there was no significant difference in the reduction from baseline in untreated caries between the study groups in either the primary or permanent dentition (Table 2). The results from the GEE models for dt as the dependent variable, when the control was compared with other groups, gave an adjusted odds ratio of 1.18 (95%CI = 0.97, 1.44; intracluster correlation coefficient = 0.0271), and when DT was included as the dependent variable, when the control was compared with other groups, the adjusted odds ratio was 1.35 (95%CI = 0.95, 1.84; intracluster correlation coefficient = 0.0272). No significant differences were found when the secondary outcome measures of prevalence of sepsis, presence of gross plaque or calculus, and trauma to the permanent incisor teeth when the reductions from baseline were compared across the 4 arms of the study.

The numbers and proportions of children in each arm of the

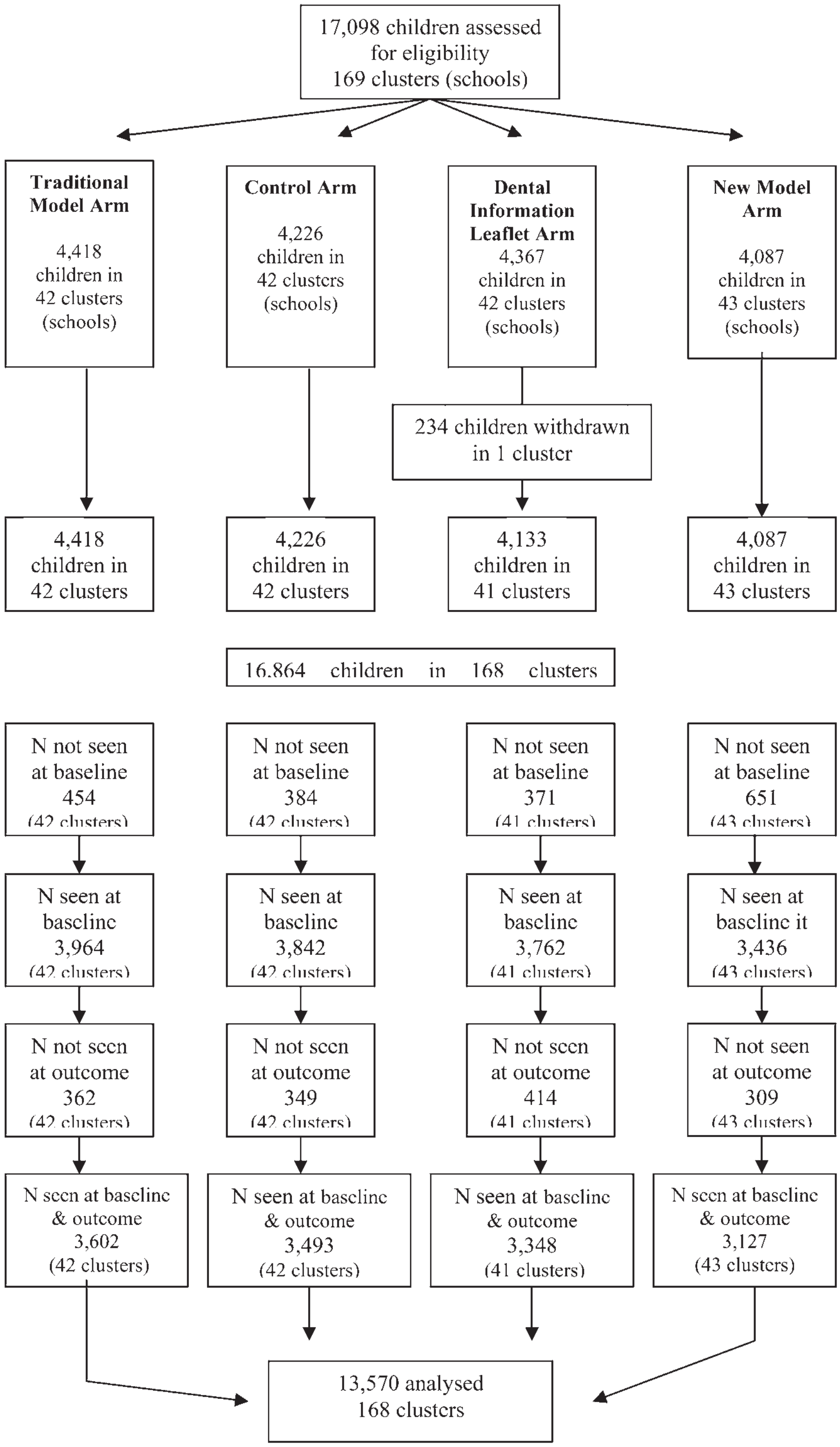

Figure. Flow diagram: number of clusters and children involved in the screening study.

trial who attended a dentist during the four-month period following the baseline epidemiological examination are shown in Table 3. These analyses were performed on all children included in the randomization (N = 16,864). Overall, 6676 children (39.6%) attended a dentist during the study period. In the control group, 1624 children (38.4%) attended—more than in the leaflet arm (N = 1519, 36.8.%)—while, in the Traditional and New models of screening, slightly higher proportions attended (41.6%, 41.5%) (Table 3). There was a borderline statistically significant (p = 0.04) difference between attendance in the dental information leaflet group compared with the other arms, attendance being less likely in the leaflet group, but there was no significant difference in attendance between children in the control arm and those in the new and traditional model arms.

We examined the attendance patterns of the excluded children unavailable for examination at baseline (N = 1860) and the children lost to follow-up (N = 1434), to investigate the possible impact of these exclusions on the findings of the trial. A total of 652 (35%) children who did not receive a baseline epidemiological examination attended a dentist during the follow-up period. The 1434 children who received a baseline examination, but were not available for outcome measurement, were distributed across the study arms as follows: 362, traditional model; 349, control group; 414, leaflet; and 309, new model. In total, 508 (35%) of the 1434 children attended a dentist during the follow-up period: 136 (37.6%) from the traditional model, 112 (32.1%) from the control group, 135 (32.6%) from the leaflet group, and 125 (40.5%) from the new model.

DISCUSSION

This large cluster-randomized controlled study did not demonstrate that, at the public health level, school dental screening, as practiced in the UK, is effective at reducing untreated dental caries in either the primary or permanent dentition of young children living in urban communities in the northwest of England. Furthermore, screening was not effective in stimulating dental attendance at the population level.

It could be argued that the four-month interval between baseline and outcome examinations was insufficient for dental treatment to have been completed; however, waiting times for NHS dental treatment in the communities were short, and there were no financial barriers to those accessing care, since NHS dental services are provided free for children. The results of a previous UK study of dental screening also suggest that 4 mos are sufficient for dental attendance and treatment to take place (Zarod and Lennon, 1992).

Several children were not included because they were not available for a baseline examination, or were unavailable for outcome examination. In reality, no screening program can screen all of its target population, and the impact of the program on a population will be diluted by non-attenders. The

Table 1. Baseline Characteristics of Children Who Attended First and Second Epidemiological Examinations (N = 13,570)

	Traditional Model	Dental Information Leaflet	New Model	Control	Total
Mean number *per* children *per* school (standard deviation)	86 (37)	82 (36)	73 (29)	83 (37)	81 (35)
Mean age (95% Confidence Interval)	7.8 (7.7, 7.8)	7.8 (7.8, 7.8)	7.7 (7.7, 7.7)	7.8 (7.7, 7.8)	7.8 (7.7, 7.8)
Mean dmft[1] (95% CI)	2.7 (2.7, 2.8)	3.0 (2.9, 3.1)	3.0 (2.9, 3.1)	3.2 (3.1, 3.3)	3.0 (2.9, 3.0)
Mean DMFT[2] (95% CI)	0.2 (0.2, 0.2)	0.3 (0.2, 0.3)	0.2 (0.2, 0.3)	0.3 (0.3, 0.3)	0.3 (0.2, 0.3)
Mean IMD[3] score (95% CI)	40.7 (40.0, 41.3)	42.8 (42.1, 43.4)	40.2 (39.6, 40.9)	43.3 (42.6, 44.0)	41.8 (41.4, 42.1)

1 'dmft' is the average number of decayed, missing, or filled primary teeth *per* child.
2 'DMFT' is the average number of decayed, missing, or filled permanent teeth *per* child.
3 'IMD' is the Index of Multiple Deprivation.

Table 2. Prevalence (%) of Untreated Caries and Mean Number of Untreated Carious Teeth in the Primary and Permanent Dentitions at Baseline and Outcome Examinations and the Incremental Change (N = 13,570)

	Traditional Model	Dental Information Leaflet	New Model	Control	Total
Prevalence of dt[1] > 0 at baseline	54	56	58	59	57
Prevalence of dt > 0 at outcome	54	56	56	58	56
Change in prevalence dt > 0 between baseline and outcome	-0.7	0	1.9	1.2	0.6
Prevalence of DT[2] > 0 at baseline	10	11	10	14	11
Prevalence of DT > 0 at outcome	10	12	10	13	11
Change in prevalence DT > 0 between baseline and outcome	-0.4	-0.5	-0.5	1.0	-0.03
Mean dt at baseline (95% Confidence Interval)	1.5 (1.5, 1.6)	1.6 (1.5, 1.6)	1.7 (1.6, 1.8)	1.8 (1.7, 1.9)	1.6 (1.6, 1.7)
Mean dt at outcome (95% Confidence Interval)	1.5 (1.4, 1.5)	1.5 (1.5, 1.6)	1.6 (1.5, 1.6)	1.6 (1.5, 1.7)	1.5 (1.5, 1.6)
Change in mean dt between baseline and outcome (95% Confidence Interval)	< 0.1	< 0.1	0.1 (0.1, 0.2)	0.2 (0.2, 0.2)	0.1 (0.1, 0.1)
Mean DT at baseline (95% Confidence Interval)	0.2 (0.1, 0.2)	0.2 (0.2, 0.2)	0.2 (0.1, 0.2)	0.2 (0.2, 0.2)	0.2 (0.2, 0.2)
Mean DT at outcome (95% Confidence Interval)	0.2 (0.1, 0.2)	0.2 (0.2, 0.2)	0.2 (0.1, 0.2)	0.2 (0.2, 0.2)	0.2 (0.2, 0.2)
Change in mean DT between baseline and follow-up (95% Confidence Interval)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

1 'dt' is the average number of decayed (untreated) primary teeth *per* child.
2 'DT' is the average number of decayed (untreated) permanent teeth *per* child.

analyses of clinical outcomes in this study did not include non-attenders; therefore, the study is an evaluation of the impact of dental screening on a population in which everybody received the intervention. As such, it would be expected that the impact of screening reported in the trial would be greater than that possible to achieve in an operational program.

Some children received the intervention, but were unavailable for outcome examination because they were not at school. These children were randomly distributed across all arms of the trial, and the proportion attending a dentist during the follow-up period was broadly similar across the arms of the trial. We conclude therefore that unavailability at baseline and loss to follow-up of subjects had no material impact on the results of this study.

In the northwest of England, approximately 70% of children are registered with and regularly attend a dentist. This trial had little impact on stimulating additional attendance during follow-up, and one of the main reasons why screening was not effective in reducing untreated disease was that insufficient screened-positive children attended the dentist (Milsom *et al.*, 2006). The follow-up procedure for screened-positive children in this trial was similar to usual UK practice (Threlfall *et al.*, in press). In the UK, it is the sole responsibility of parents or caregivers to act on the information received if their child is screened positive, and to take their child to see a dentist, with minimal intrusion from Government agencies. It has been demonstrated that, with

Table 3. Number (%) of Children Attending a Dentist in Each Arm of the Trial (N = 16,864)

Trial Arm	Number in Trial Arm	Number (%) Attending in Study Period
Traditional Model screening	4418	1838 (42)
Control	4226	1624 (38)
Dental Information Leaflet	4133	1519 (37)
New Model screening	4087	1695 (41)
Total	16864	6676 (40)

intensive follow-up, a greater proportion of screened-positive children will attend a dentist (Zarod and Lennon, 1992); however, a further analysis of our results found that only half of the screened-positive children who attend a dentist go on to complete appropriate treatment (Milsom *et al.*, in press). For dental screening to reduce untreated disease significantly in the population, not only do a large proportion of screened-positive children need to attend a dentist, but they also need to complete appropriate treatment. A trial might be able to demonstrate that the use of more forceful follow-up procedures is effective in reducing untreated disease, but the additional cost of more intensive follow-up would need to be balanced against any benefit.

This cluster-randomized controlled trial conducted in the UK failed to show that the intervention used in a national school dental screening program significantly reduces active dental caries levels or increases dental attendance rates at the public health level. The current method of school dental screening is no longer tenable. Alternative ways to ensure that vulnerable children receive adequate dental care need to be explored.

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