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The oral health of secondary school pupils: baseline data from the Brushing Reminder 4 Good oral HealTh (BRIGHT) trial

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Abstract

Background

This paper describes the socio-demographics and oral health of secondary school pupils. They were participants of the BRIGHT trial, which was designed to evaluate the effectiveness of a toothbrushing intervention to reduce dental caries.

Methods

Overall, 4680 pupils aged 11-13 years attending 42 secondary schools in England, Scotland, and Wales with above average proportion of pupils eligible for free school meals were recruited to the trial. Socio-demographic data were collected. Participants had a clinical assessment for caries, plaque and bleeding and completed measures of oral and general health-related quality of life and oral health behaviours (frequency of toothbrushing, dental attendance and cariogenic food/drinks consumed). Regression analyses were performed.

Results

Over one-third (34.7%) of participants had caries experience with 44.5% reporting their oral health had an impact on their daily lives. Factors associated with a statistically significant increased likelihood of caries experience were older age, females, eligibility for free school meals, worse oral health-related quality of life, higher cariogenic intake, less than twice-daily toothbrushing, living in a more deprived area and lower school attendance.

Conclusions

The prevalence and impact of dental caries on the lives of pupils remains high with further oral health promotion activities needed in targeted secondary schools.

Trial registration: ISRCTN12139369.

In Brief

- Highlights the high impact of dental caries on the lives of secondary school children
- Identifies factors that are associated with caries experience in young people (11-13 years)
- Demonstrates the need for continued oral health promotion initiatives in secondary schools in disadvantaged communities

Background

In the UK, dental caries continues to affect around about a third of 12-year-olds and almost half of 15-year-old¹ with inequalities in the prevalence and burden of dental caries on children's lives. Overall, 46% of 12-year-olds and 59% of 15-year-olds eligible for free school meals (FSM) had caries experience compared to 30% and 43%, respectively, who were not. Apart from decennial Child Dental Health Surveys (CDHS), little is known about the dental health of secondary school-age children and associated demographic and behavioural factors. This is surprising given adolescence is a critical developmental period for establishing health-related behaviours.² Adolescence and, in particular, the transition from primary to secondary school are particularly important times where independent health practices are developed³ and often become difficult to change in adulthood.⁴

Individuals' behaviours contribute to caries development⁵, with oral hygiene practices, especially increased toothbrushing frequency, linked to reduced caries experience.^{6,7} Self-reported toothbrushing frequency is validated as a proxy measure for clinical oral hygiene indices and assessment of caries.

The Brushing RemInder 4 Good oral HealTh (BRIGHT) trial was conducted in secondary schools in England, Scotland, and Wales with pupils 11–13 years old.⁸ This three-year trial aimed to assess the clinical and cost-effectiveness of a behaviour change intervention to increase toothbrushing, comprising a school-based lesson and twice-daily Short Messaging Service (SMS) messages, on the prevalence of dental caries. Secondary outcomes included self-reported toothbrushing frequency, oral health-related quality of life

(OHRQoL) and health-related quality of life (HRQoL). Schools with above national average proportion of pupils eligible for FSM were recruited.⁹

This paper describes the socio-demographic and oral health of BRIGHT trial participants and investigates associations between clinical measures, oral health behaviours, OHRQoL, school attendance and measures of deprivation.

Methods

Design

This cross-sectional analysis of baseline data collected for the BRIGHT trial took place over two academic years, 2017–2018 and 2018-2019.¹⁰ Ethical approval was granted by East of Scotland Research Ethics Service (ref: 17/ES/0096).

Participants and Recruitment

School recruitment

Secondary schools eligibility criteria: located in Scotland, England or South Wales; state-funded; at least 60 pupils per year group; and above national average percentage of pupils eligible for FSM.^{11–13}

Participant recruitment

Pupils at participating schools eligibility: aged 11–13 years old (Year 7 or 8 England and Wales; S1 or S2 Scotland), own mobile telephone, and whose parents had not opted them out of the trial. The overall target sample size was 5040 pupils from 42 schools.⁸

Information about the study was distributed to children and their parents. Opt-out consent was obtained from parents and written consent from eligible pupils.

Socio-demographic characteristics of participants

Data were obtained from schools on date-of-birth, year group, sex, current FSM eligibility, school attendance and home postcode of participating pupils. Home postcode was used to obtain participants' Index of Multiple Deprivation (IMD) decile within each devolved nation.¹⁴

Clinical assessment

Dental assessments were conducted under standard conditions by a trained and calibrated dentist. Further details are in the protocol⁸.

Caries assessment

The International Caries Detection and Assessment System¹⁵ (ICDAS) was used to measure permanent teeth where:

- Caries prevalence for obvious decay experience (D_{4-6} MFT): at least one treated or untreated carious lesion, measured using the permanent tooth index 'DMFT' (Decayed, Missing, and Filled Teeth): Decayed - carious lesions extending into dentine - ICDAS levels 4–6; Missing - teeth extracted due to caries; Filled - restoration but not an obvious pit or fissure sealant, i.e. restoration code was between 3 and 7 and caries code was 0, 1, 2 or 3.
- Caries prevalence for all carious lesions (D_{1-6} MFT): at least one treated or untreated carious lesion of any severity (ICDAS levels 1–6).
- The number of teeth with any treated or untreated carious lesions (defined using D_{1-6} MFT).
- The number of teeth with any treated or untreated carious lesions extending into dentine (defined using D_{4-6} MFT).

Plaque and gingivitis assessment

Plaque levels were assessed using Turesky's modification of Quigley Hein Plaque Index.^{16,17} Participants' whole mouth Plaque Index score was calculated by summing the surface codes (0 = no plaque to 5 = plaque covering two-thirds or more of the crown of the tooth) and dividing total score by number of surfaces (maximum $4 \times 14 = 56$ surfaces) examined.

Gingival inflammation was assessed using a modification of Gingival Index of Löe.¹⁸ The mean number of bleeding gingival sites per participant was calculated by summing the number of bleeding sites of each of the eight index teeth and dividing by the number of scorable sites (maximum 16, excluding missing teeth).

Self-reported oral health and behaviours

Participants completed a questionnaire, which contained measures of HRQoL, OHRQoL and questions about oral health behaviours, including: toothbrushing frequency, toothpaste availability, diet, use of dental services and other fluoride use, using CDHS 2013^{1,19} questions.

HRQoL was assessed using the Child Health Utility 9D²⁰ (CHU9D); 9 dimensions (5-point Likert scales).

OHRQoL was assessed using CRIES-QC²¹; 12-items (3-point Likert scale) measuring caries impact on children with higher scores indicating increased impact of caries.

Participants reported the frequency of cariogenic foods/drinks consumed (cakes or biscuits, sweets or chocolate, cola or squash, fruit juices and smoothies, and energy drinks [e.g. Powerade, Lucozade]). These were scored 0='Never' to 5='Four or more times a day'. A cariogenic score was calculated by summing these, dividing by the total possible score N, where $N = 5 \times \text{the number of completed items}$, and multiplying by 100.

Data analysis

The recruitment of schools and pupils and the collection of baseline data is depicted in a flow diagram (Fig. 1). Data are summarised descriptively. Mixed-effect logistic regression analyses were used to investigate the associations between obvious decay experience and age, sex, school attendance, FSM eligibility, IMD (standardised to account for the different scaling between countries), twice-daily toothbrushing, CRIES-QC, CHU9D and cariogenic scores. Mixed-effect bivariate analyses were undertaken initially, adjusting for school as a random effect, then all variables found to be associated with obvious decay experience ($p < 0.05$) were included in a multivariate mixed-effect logistic regression analysis to account for possible confounding. Mixed-effect linear regression was used to consider the effect of twice-daily toothbrushing on plaque and bleeding scores, adjusting for site as a random effect.

Results

Recruitment

Of the 14,083 pupils approached in 42 schools, 4,699 (33.4%) consented, were eligible and were asked to complete baseline data collection.

^aApproximate numbers, based on data available on the number of state-funded secondary schools in Scotland,²² England (South and West Yorkshire)²³ and Wales (Cardiff, Vale of Glamorgan, Rhondda Cynon Taf, and Merthyr Tydfil local authorities)²⁴ in 2016.

^bApproximate numbers, based on data available on the percentage of pupils eligible for FSM in state-funded secondary schools in Scotland,²² England²³ (South and West Yorkshire) and target local authorities in Wales²⁵ in 2016.

Figure 1. CONSORT flow diagram illustrating the flow of schools and pupils through the trial

Following baseline data collection, randomisation was conducted at year group level (i.e. at each school, one year group was randomised to intervention and the other to control). Only data from randomised participants ($n = 4680$) is included here.

Socio-demographic characteristics of participants

Pupils' age at recruitment was mean 12.7 years (SD 0.6) and 54.2% ($n = 2538$) were female (Table 1). Overall, 21.9% ($n = 1025$) were eligible for FSM. The average decile of deprivation for pupils in England, Scotland and Wales was 3.1, 4.4 and 3.3, respectively (decile 1 represents the most deprived 10% of small areas, and decile 10 represents the least deprived 10%).

Table 1
Socio-demographic characteristics of participants

Characteristics		Overall (n = 4680)
Year, n (%)	7/S1	2623 (56.0)
	8/S2	2057 (44.0)
Age, mean (SD)		12.7 (0.6)
Sex, n (%)	Female	2537 (54.2)
	Male	2142 (45.8)
	Rather not say	1 (0.0)
Eligible for free school meals, n (%)	Yes	1025 (21.9)
	No	3483 (74.4)
	Missing	172 (3.7)
School attendance	% pupil attendance in the academic year in which they were recruited up to the point of recruitment, mean (SD)	95.9 (5.8)
Deprivation based on pupils' home postcode IMD decile (1 = least deprived, 10 = most deprived), mean (SD)	English	3.1 (2.4)
	Scottish	4.4 (2.9)
	Welsh	3.3 (2.2)

Clinical data

A dental assessment was carried out for 4625 participants. Reasons for missing data were: absent from school on day of data collection (n = 29); declined (n = 12); no longer at the school (n = 4); and unknown (n = 10).

Table 2 shows the dental data with just over a third of pupils showing evidence of obvious decay experience indicated by presence of $D_{ICDAS4-6}MFT$ in at least one permanent tooth (n = 1603, 34.7%), and nearly two-thirds had at least one treated or untreated carious lesion in any permanent tooth as indicated by $D_{ICDAS1-6}MFT$ (n = 2929, 63.3%). The proportion with untreated decay in at least one tooth was 58.0% for all caries (ICDAS 1–6) and 15.8% for caries into dentine (ICDAS 4–6). Among those with presence of $D_{ICDAS4-6}MFT$ in at least one permanent tooth, the mean number of $D_{ICDAS4-6}MFT$ was 2.2 (SD 1.5, median 2) and $D_{ICDAS1-6}MFT$ was 4.1 (SD 2.7, median 4).

The participants' mean plaque score was 0.89 (SD 0.65), mean gingival bleeding score was 0.13 (SD 0.17) and the mean number of teeth with bleeding gingivae was 1.79 (SD 2.04) with a median of 1 site per participant out of the eight index teeth showing gingivae with bleeding on probing (Table 2).

Table 2
Data for participants with valid dental assessments

Variable		Total (n = 4625)
Presence of D _{ICDAS4-6} MFT, n (%)		1603 (34.7)
Number of D _{ICDAS4-6} MFT per pupil	Mean (SD)	0.76 (1.37)
	Median (IQR)	0.0 (0.0, 1.0)
	<i>Number of:</i>	0.27 (0.77)
	<i>-D: decayed teeth (ICDAS 4-6), mean (SD)</i>	0.09 (0.52)
	<i>-M: teeth extracted due to caries, mean (SD)</i>	0.40 (0.91)
	<i>-F: filled teeth (ICDAS 4-6), mean (SD)</i>	
Presence of D _{ICDAS1-6} MFT, n (%)		2929 (63.3)
Number of D _{ICDAS1-6} MFT per pupil	Mean (SD)	2.13 (2.55)
	Median (IQR)	1.0 (0.0, 3.0)
	<i>Number of:</i>	1.75 (2.32)
	<i>-D: decayed teeth (ICDAS 1-6), mean (SD)</i>	0.09 (0.52)
	<i>-M: teeth extracted due to caries, mean (SD)</i>	0.29 (0.73)
	<i>-F: filled teeth (ICDAS 1-6), mean (SD)</i>	
Plaque score, mean (SD)		0.89 (0.65)
Gingival bleeding score, mean (SD)		0.13 (0.17)
Number of teeth with bleeding gingivae per pupil	Mean (SD)	1.79 (2.04)
	Median (IQR)	1.0 (0.0, 3.0)

OHRQoL, HRQoL and oral health behaviours

The mean raw CARIES-QC score was 3.7 (SD 3.5) and mean CHU9D score was 0.9 (SD 0.1) (Table 3). Just under half of participants felt their teeth were either “a bit” or “a lot” of a problem for them (n = 2082, 44.5%). Over three-quarters reported brushing their teeth at least twice a day (n = 3631, 77.6%). There were 1.7% of participants who reported never having been to the dentist and 13.8% only when they had a problem. Three-quarters (75.1%) had used manual toothbrushes and 54.3% powered toothbrushes over the previous month (therefore, around 1 in 3 (34.2%) used both). Nearly two-thirds (65.8%) had used mouthwash. In terms of product availability, 29 participants stated they had not used toothpaste with 2.2% reporting only sometimes having toothpaste available and 0.5% having to share or not having a toothbrush. The mean cariogenic score was 39.5 (SD 16.9) out of 100.

Table 3
Diet (cariogenic score), OHRQoL, HRQoL and oral health behaviours of participants

		Overall (n = 4680)
Diet	<i>Cariogenic score of reported diet, mean (SD)</i>	39.5 (16.9)
HRQoL	<i>CHU9D, mean (SD)</i>	0.93 (0.09)
OHRQoL	<i>CARIES-QC raw score, mean (SD)</i>	3.7 (3.5)
	<i>How much of a problem are your teeth for you?, n (%)</i>	Not at all 2529 (54.0)
		A bit 1915 (40.9)
		A lot 167 (3.6)
		Missing 69 (1.5)
	<i>How often do you usually brush your teeth?, n (%)</i>	> 3x a day 73 (1.6)
		3x a day 292 (6.2)
		Twice a day 3266 (69.8)
		Once a day 857 (18.3)
		<Once a day 116 (2.5)
		Never 12 (0.3)
		Missing 64 (1.4)
	<i>Do you usually go to the dentist?, n (%)</i>	For a check up 3882 (82.9)
		Only when I have trouble with my teeth 645 (13.8)
		I have never been to the dentist 78 (1.7)
		Missing 75 (1.6)
	<i>Over the last year have you regularly used any of the following products to look after your teeth or mouth?, n (%)</i>	Toothbrush (non-electric) 3514 (75.1)
		Electric/battery operated toothbrush 2539 (54.3)
		Toothpaste 4544 (97.1)
		Mouthwash 3081 (65.8)
		Dental floss 1262 (27.0)
		Sugar free or dental chewing gum 1459 (31.2)
		Other 289 (6.2)
	<i>Do you have your own toothbrush?, n (%)</i>	Yes, I have my own toothbrush 4589 (98.1)
		No, I share one 17 (0.4)

			Overall (n = 4680)
<i>Do you have toothpaste you can use?, n (%)</i>	No, I do not have a toothbrush		6 (0.1)
	Missing		68 (1.5)
	There is always toothpaste I can use		4490 (95.9)
	There is sometimes toothpaste I can use		101 (2.2)
	There is no toothpaste I can use		16 (0.3)
	Missing		73 (1.6)

Associations between socio-demographic characteristics, oral health behaviours, HRQoL, OHRQoL and dental caries experience

In bivariate analyses, older pupils, females, those eligible for FSM, and pupils with a higher CARIES-QC score (worse OHRQoL) and cariogenic score were more likely to have obvious decay experience. Those reporting toothbrushing at least twice a day, pupils living in less deprived areas, with higher school attendances and those with higher CHU9D index values (better HRQoL) were less likely to have obvious decay experience ($p < 0.001$ for all except CHU9D, $p = 0.06$) (Table 4). The statistically significant associated factors ($p < 0.05$) were included in a multivariate regression analysis, and the original bivariate associations remained.

Table 4
Factors associated with obvious dental caries experience

Factor	Bivariate association		Multivariate association	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Age	1.29 (1.16, 1.44)	< 0.001	1.41 (1.23, 1.62)	< 0.001
Sex, female	1.27 (1.12, 1.45)	< 0.001	1.34 (1.13, 1.58)	0.001
Eligible for FSM, yes	1.77 (1.53, 2.05)	< 0.001	1.51 (1.24, 1.83)	< 0.001
Percentage school attendance	0.97 (0.96, 0.98)	< 0.001	0.98 (0.97, 1.00)	0.02
IMD decile (1 = least deprived, 10 = most deprived)	0.76 (0.70, 0.83)	< 0.001	0.84 (0.76, 0.92)	< 0.001
Self-reported daily toothbrushing, \geq twice a day	0.75 (0.65, 0.97)	< 0.001	0.78 (0.63, 0.95)	0.01
CARIES-QC score	1.06 (1.05, 1.08)	< 0.001	1.06 (1.03, 1.08)	< 0.001
CHU9D score	0.51 (0.25, 1.03)	0.06	-	-
Cariogenic score (0-100, higher score worse)	1.011 (1.008, 1.015)	< 0.001	1.006 (1.001, 1.011)	0.03

Associations between self-reported toothbrushing and proxy clinical objective indicators (plaque levels and gingivitis)

Pupils reporting toothbrushing at least twice a day had lower plaque and bleeding scores than pupils reporting less frequent brushing (adjusted mean difference - 0.23, 95% CI -0.27 to -0.19, $p < 0.001$, and - 0.03, 95% CI -0.04 to -0.02, $p < 0.001$, respectively). These differences equate to standardised effect sizes (Hedges' g) of -0.35 (95% CI -0.41 to -0.29) and - 0.17 (95% CI -0.23 to -0.12).

Discussion

This paper reports baseline data collected for dental caries prevalence, self-reported oral health behaviours, OHRQoL and HRQoL in a sample of 4680 pupils aged 11–13 years, attending UK secondary schools, participating in the BRIGHT trial.

CDHS are conducted every 10 years, with the last CDHS sampling 2532 participants aged 12 years, compared to this study of nearly twice as many participants with a mean age of 12.7 years. This paper adds to the sparse literature on the oral health of secondary school children, at an age where oral health behaviours are established that remain throughout the life course (5). This is particularly important as few oral health promotion programmes are delivered in secondary schools in contrast to primary schools.

Overall, 34.7% had dental caries experience at $D_{ICDAS4-6}$ MFT level. In the most recent CDHS, the equivalent findings for 12-year-olds were 43.0% in 2003 and 34.0% in 2013. This CDHS also oversampled schools and pupils in deprived areas and, as expected, the deprivation level of the area in which a pupil lived was a factor associated with caries experience. However, we found high levels of missing data where schools were unable to provide valid postcodes. Schools for BRIGHT were chosen where FSM eligibility was above the national average. As FSM eligibility was found to be associated with caries experience, this may be a useful approach to targeting schools for future oral health promotion activities.

Both OHRQoL and HRQoL were factors associated with caries experience. The results suggest caries has a significant impact on pupils' lives with 44.5% of participants responding that their oral health was “a bit” or “a lot” of a problem. The mean CARIES-QC score was 3.7 which was lower than reported by Gilchrist and colleagues in 2018²¹ but their study involved a clinical sample.²⁶ The mean CHU9D score of 0.93 was similar to that found in a study of children with caries in New Zealand (mean 0.88). The use of child self-reported outcome measures was a strength of this study, avoiding parent/carers as proxy reporters.

Frequency of toothbrushing was also associated with caries experience even at the relatively high toothbrushing frequencies reported; three-quarters reported brushing at least twice a day. The association between frequency of brushing and plaque and bleeding scores continues to support their use as clinical objective indicators of oral hygiene efficacy. In comparison to CDHS the proportion of participants using a powered toothbrush (54.3%) was higher than previously found (37.0%) which may reflect further adoption of powered toothbrushes by young people, a group comfortable with technology. While it was not possible to compare the cariogenic score found here with the CDHS, it was clear that some pupils reported high frequency of consumption of sugary foods and drinks, which was also a significant factor associated with caries experience. The BRIGHT trial evaluated a behaviour change intervention to increase the frequency of toothbrushing with a fluoride toothpaste and not to reduce sugar consumption, further research is needed to address this oral health behaviour in this age group.

Interestingly, although school attendance was high at a mean of 95.9%, school attendance was still associated with caries experience. A previous systematic review concluded children with caries experience had a higher probability of poor school attendance than children with no obvious caries experience based on studies of school aged children. The authors discussed whether this may be related to dental pain, attendance at dental appointments or may be confounded by factors such as socio-economic status.²⁷

One of the limitations in generalising the results of this study to the wider UK population is that pupils had to own a mobile telephone to be eligible for the BRIGHT trial and a very small proportion (1.9%, 270/14083) had to be excluded on this basis. In addition, the method of consent was different to the CDHS. In the BRIGHT trial, parents were first given the opportunity to opt their child out of the trial before pupils themselves provided consent. This approach to consent was approved by the ethics committee but is not typically used in the CDHS.

Conclusion

Over one-third of secondary school pupils had caries experience with 44.5% responding that their oral health impacted their daily lives. Factors significantly associated with caries experience were age, sex, eligibility for FSM and deprivation, school attendance, HRQoL and OHRQoL, food cariogenicity and toothbrushing frequency. Further research is needed to establish effective approaches reducing the prevalence of caries in secondary school pupils.

Declarations

No competing interests are declared by NI, ZM, CF, SE, KW, HA, IC, PD, DD, CH, KH, DH, SP, MR, LRS, DT, ET. During the BRIGHT trial CH was a member of the NIHR HTA commissioning committee and Deputy Chair, member of NIHR CTU Standing Advisory Committee,

Author contribution statements

NI and ZM are the co-principal investigators for the grant and contributed to the design and conduct of the trial and led the development and writing of this paper. CF is the trial statistician and contributed to design and conduct of the trial and writing this paper, in particular the statistical methods and analysis sections. SE contributed to the conduct of the trial and contributed to writing this paper. HA is the study Trial Manager and has contributed to the design and conduct of the trial and writing this paper. KW, DH, KH and LRS were study Trial Coordinators and ET was study Trial Support Officer and have contributed to the conduct of the trial and this paper. IC, PD, SP, MR led regional research teams, contributed to the design and conduct of the trial and the development of this paper. DD provided expert school and education advice and CH and DT provided expert methodological advice, they contributed to the design and conduct of the trial and the development of this paper. All authors read and approved the final manuscript.

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Figures

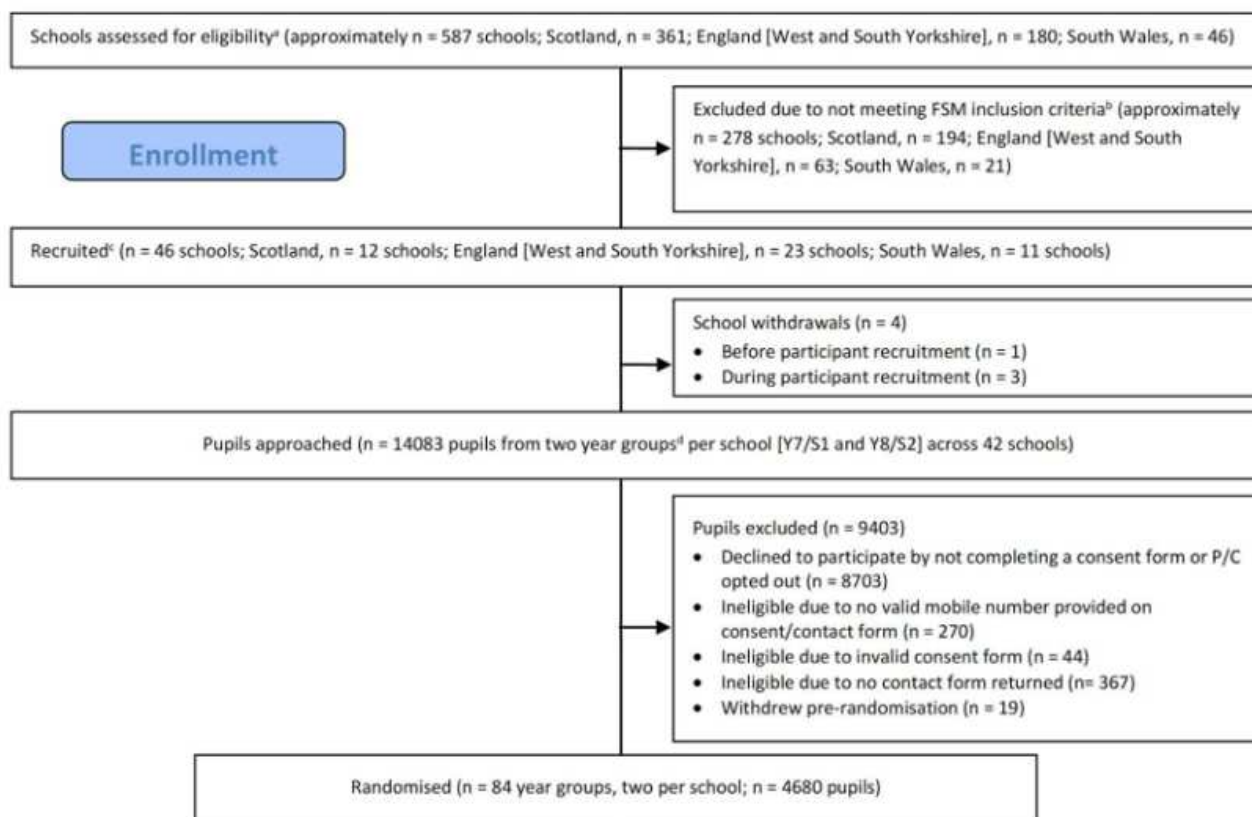


Figure 1

CONSORT flow diagram illustrating the flow of schools and pupils through the trial

^aApproximate numbers, based on data available on the number of state-funded secondary schools in Scotland,²² England (South and West Yorkshire)²³ and Wales (Cardiff, Vale of Glamorgan, Rhondda Cynon Taf, and Merthyr Tydfil local authorities)²⁴ in 2016.

^bApproximate numbers, based on data available on the percentage of pupils eligible for FSM in state-funded secondary schools in Scotland,²² England²³ (South and West Yorkshire) and target local authorities in Wales²⁵ in 2016.