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Changes in oral health behaviours between childhood and adolescence: findings from a UK cohort study.

Running head: Changes in oral health behaviours

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Statement of contribution:

SD Leary developed the concept for this work, prepared the dataset, selected and performed the appropriate statistical analyses, wrote the first draft and produced updated drafts of the manuscript. LG Do commented on drafts of the manuscript.

Abstract

Objective: Oral health is an important part of general health and wellbeing. Health behaviours may change throughout a person's life, but the stage from childhood to adolescence is critical because influences from peers increase while those from parents and other family members decrease. The objective of this study was to identify changes in oral health behaviours between childhood and adolescence, and investigate whether changes differed by sex.

Methods: This study used data on 1860 participants from the Avon Longitudinal Study of Parents and Children (ALSPAC) who completed dental questionnaires at ages 7.5, 10.5 and 17.5 years. Associations between age and oral health behaviours were assessed using random effects logistic regression models. Males and females were analysed together or separately, depending on evidence for sex-age interactions.

Results: At age 7.5, 83% brushed their teeth frequently, 98% visited the dentist frequently, and 90% drank fizzy drinks. The percentage who brushed their teeth at least twice a day decreased with age for males [odds ratio 0.96 (95% confidence interval 0.94, 0.99) per year of age], and increased with age for females [1.03 (1.01, 1.06)]. Electric toothbrush usage decreased with age, with a slightly larger decrease in females [0.82 (0.80, 0.85)] than in males [0.87 (0.84, 0.90)]. The percentage visiting the dentist at least once a year decreased with age [0.77 (0.73, 0.81)]; the decrease was greatest between the older ages. Fizzy drink and juice consumption increased with age [1.38 (1.23, 1.57) and 1.33 (1.24, 1.44) respectively], whereas there was no change in water consumption [1.00 (0.91, 1.09]; these data were available only for the younger two ages.

Conclusions: Unfavourable changes in oral health behaviours, some of which were sex-specific, have been demonstrated in this cohort. Hence childhood to adulthood may be an important intervening time to prevent early deterioration of oral health.

Introduction

Oral health is an important part of general health and wellbeing, and poor oral health can affect the ability to eat, speak and socialise normally.[1] Dental caries and periodontal disease are the most common oral health problems in the UK[2] and other countries.[3, 4] Both are associated with behavioural characteristics including self-care such as toothbrushing,[5] use of dental care[6] and diet, particularly consumption of sugar-sweetened beverages.[7, 8]

Health behaviours may vary throughout a person's life, but the transition from childhood to adolescence is critical because it introduces greater independence and autonomy, [9] and changes between these developmental epochs are likely to determine adult behaviour.[10] This is a time of rapid change for social environmental influences on oral health behaviours, with influences from peers increasing and those from parents and other family members decreasing. Individual characteristics that change as a person gains independence include attitudes, beliefs, knowledge and self-efficacy, as well as lifestyle factors such as perceived time constraints and convenience.

Studies based in China[11] and India[12] have compared oral health behaviours between childhood and adolescence, but based on separate groups at each age studied i.e. change could not be quantified. Some Scandinavian studies[13-15] have reported on patterns of tooth brushing using repeated measurements on the same people over time, but only within the period of adolescence. To our knowledge, few longitudinal studies have been used to investigate changes in oral health behaviours between childhood and adolescence. A study in the US investigating changes in toothbrushing behaviours of adolescents reported that having a strong (compared to weak) intention to brush teeth twice a day in the first wave was associated with increased toothbrushing frequency by the second wave.[16] However, this study reported changes only between two waves of data collection and did not adjust for confounders. The Dunedin Multidisciplinary Health and Development Study, one of the longest running studies with a dental component, reported trajectories of dental plaque accumulation from childhood to adolescence.[5] However, as changes in oral health behaviours were not reported in this study, the question remains as to whether changes in actual oral health behaviours from childhood to adolescence contributed to forming different trajectories of dental plaque. Dental visiting patterns after the age of 15 years were found to be associated with dental health later in life.[6] However, this study did not collect data on longitudinal changes of dental visiting patterns from childhood to adolescence.

Sex differences in oral health behaviours have been observed; for example, the UK National Survey of Children's Dental Health[17] recorded oral health behaviours in separate groups of children aged 5, 8, 12 and 15 years. A higher percentage of females than males in all age groups brushed their teeth at least twice a day, whereas the percentage who had attended the dentist within the last year was slightly lower except for at 5 years. Tolvanen et al.[18] collected repeated measures of oral health behaviours for 1362 11 to 12-year-olds over the period of approximately three years in Finland. They found sex differences for every behaviour, with girls having better behaviours, improving more often, and being more successful at maintaining good behaviours on average. However, these findings were based on data from a randomised controlled trial of an oral health promotion intervention in which all participants had at least one active caries lesion at baseline, so may be less applicable to the general population. Hence, it is of interest to use a cohort study to investigate whether changes in oral health behaviours between childhood and adolescence differ by sex.

Accordingly, the aim of this study was to describe changes in important oral health behaviours between childhood and adolescence, based on repeated measurements at ages 7.5, 10.5 and 17.5 years of participants in the Avon Longitudinal Study of Parents and Children (ALSPAC). The study also investigated sex differences in changes in oral health behaviours.

Methods

Sample and study design

ALSPAC is a geographically-based birth cohort investigating the health and development of children, which is described in detail elsewhere.[19, 20] Briefly, all pregnant women living in three health districts of Bristol (formerly known as the Avon Health Area), England with expected delivery dates between April 1st 1991 and December 31st 1992 were eligible to take part in the study. A total of 14, 541 pregnancies were enrolled, and there were 14, 062 live born children. Detailed data have been collected by self-completed questionnaires (relating to the mother, her partner, and her offspring) from pregnancy onwards. Ethical approval was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

This study was based on the ALSPAC participants who completed all three of the dentally related questionnaires which were: 'My teeth' administered at age 7.5 years; 'Teeth and things', administered at age 10.5 years (both may have required help from parent or carer in order for the child to complete them); and the 'Dental health questionnaire', administered at age 17.5 years. The study website provides details of all data that are available through a fully searchable data dictionary (www.bris.ac.uk/alspac/researchers/our-data), including those three dental questionnaires.

Demographic characteristics

Maternal education - When the mother was 32 weeks pregnant, she was asked to complete a questionnaire which included recording her highest education level; this was collapsed into none/Certificate of Secondary Education (CSE) (national school examinations at age 16), vocational, O level (national school examinations at age 16, higher than CSE), A level (national school examinations at age 18), or degree.

Social class – In the 32-week pregnancy questionnaire the mother was asked to record the occupations of both herself and her partner, which were used to allocate them to social class groups (classes I (highest) to V (lowest), with III split into non-manual and manual), using

the classification of the Office of Population Censuses and Surveys.[21] The lowest class of the mother and her partner was used as the reference group in the analysis.

Sex and date of birth - The offspring's date of birth and sex were abstracted from obstetric records and birth notifications.

Oral health behaviours

Dental questionnaires were sent in the post to participants/carers as soon as the participants were age 7.5 and 10.5 years, and given to participants at the age 7.5 clinic, where they were asked to complete and return them by post. Oral health behaviours were selected for inclusion in this study if they were available at more than one of the three timepoints, and were recorded in such a way that it was possible to compare across time points. These included tooth brushing frequency (at ages 7.5, 10.5 and 17.5), electric toothbrush usage (at ages 10.5 and 17.5), dental attendance (at ages 7.5 and 10.5 and 17.5) and beverage consumption of fizzy drinks, juices and water (at ages 7.5 and 10.5).

Tooth brushing frequency – In the age 7.5 questionnaire, participants were asked to record the number of times per day they cleaned their teeth. In both other questionnaires, participants were asked to tick the relevant box from a choice of none, once, twice, or more than twice a day. From this information, a new variable was created at each of the three timepoints which indicated whether the participants brushed their teeth at least twice a day.

Electric toothbrush usage – In the age 10.5 questionnaire, participants were asked whether or not they used an electric toothbrush. In the 17.5 year questionnaire, they were asked what they usually cleaned their teeth with, and responses included non-electric toothbrush, electric/battery operated toothbrush, dental floss, mouthwash and toothpick; from this, a new variable indicating whether or not they used an electric toothbrush was created.

Dental attendance – In the age 7.5 and 10.5 questionnaires, participants were asked how often they went to the dentist, with the options of every 4 months, every 6 months, once a year, or don't go regularly. In age 17.5 questionnaire, the question asked why they usually go to the dentist, with the options of regular (every 6 months or 1 year) routine dental check-ups, occasional (less than every 2 years) dental check-up, only when they have trouble with some of their teeth, they don't ever go to the dentist, or they go for some other reason. From all

this information, it was possible to create a new variable for each of the three timepoints indicating whether they visited the dentist at least every year.

Beverage consumption – No information on beverage consumption was included in the age 17.5 questionnaire. In the age 7.5 and 10.5 questionnaires, participants were asked how they drank different kinds of drink, with the options of sip it a little at a time, drink it all in one go, froth and swish it around the mouth for a while, drink it with a straw (10.5 years only), or don't have it. All options except the last one were grouped together to create binary variables indicating consumption. Three types of beverage were of interest: fizzy drinks (including cola, lemonade and other fizzy drinks); fruit juice (including pure juices from a carton or freshly squeezed); and water.

Statistical methods

First, the characteristics of those who were included in this study were summarized using percentages, and compared to those who were not included, to assess how representative those included were of the population of interest. Next, all oral health behaviours available at each timepoint were summarized as percentages for the whole group, and also for males and females separately. Random effects logistic regression models were then used to compare outcomes across the two or three timepoints (as appropriate). The random effects were used to account for the dependence within the data (i.e. repeated measurements on the same person over time), and logistic regression was used because all outcomes were binary. Odds ratios (with 95% confidence intervals) were interpreted as the change in the odds of the outcome per year of age. An interaction term (sex multiplied by age) was included in each model to test whether males and females should be analysed together or separately. The main models (labelled model 1) were then fitted for either males or females separately, or males and females together (adjusting for sex) as appropriate. A second set of models (labelled model 2) were fitted with additional adjustment for social class and maternal education. Sensitivity analyses were used to investigate whether estimates were affected by missing social class and/or maternal education data, and also by having included twins. All analyses were undertaken in Stata version 15 (StataCorp).

Results

When the participants were approximately 17.5 years old they were invited to attend a clinic comprising a number of sessions, including one for completion of a dental questionnaire. Of the 9568 that were invited to the clinic, 4881 (51.0%) attended, and of those, 2495 (51.1%) completed the dental questionnaire. Twenty four participants have now withdrawn consent for the study, of which two had completed this dental questionnaire. Analysis for this study was based on the 1860 participants who had completed dental questionnaires at ages 7.5 and 10.5 years, as well as at 17.5 years. Demographic variables were compared between this group, and those who had not completed the dental questionnaires, as shown in Table 1. For those included in the analysis there were a higher proportion of females, in higher social classes, and with mothers educated to a higher standard, compared to those not included in the analysis.

The median (inter-quartile range) ages at which the three dental questionnaires were sent to participants were 7.6 (7.6,7.7), 10.7 (10.7, 10.8) and 17.7 (17.5, 17.8) years respectively. The oral health behaviours are summarised in Table 2, for males, females, and all participants combined; note that not all variables were recorded at all timepoints. Over three-quarters of participants brushed their teeth at least twice a day at age 7.5 years, with a slight decrease in males and a slight increase in females as they got older. Just over half used an electric toothbrush at age 10.5 years, but this had reduced substantially, particularly in females, by age 17.5 years. A very high percentage visited the dentist at least once a year at ages 7.5 and 10.5 years, but this had decreased by age 17.5 years. Beverage consumption data were available only for the first two timepoints. The consumption of both fizzy drinks and fruit juice was high, and increased between 7.5 and 10.5 years. Water consumption remained stable (at 90%) for both timepoints.

Associations between the oral health behaviours and age are shown in Table 3. There was some statistical evidence of sex-age interactions for both tooth brushing frequency ($p=0.001$) and electric toothbrush usage ($p=0.01$); thus, models for these were fitted for males and females separately. There was no evidence of sex interactions for dental attendance (0.04) or beverage consumption ($p=0.3$ to 0.995) so models for these were fitted for males and females combined.

Between childhood and adolescence, tooth brushing frequency decreased in males and increased in females, while electric toothbrush usage decreased substantially between the latter two timepoints for both sexes but more so in females. The percentage visiting the dentist at least once a year decreased over time; the decrease was greatest between the second and third timepoints (see Table 2 for raw percentages). Consumption of both fizzy drinks and fruit juice substantially increased between the first two timepoints, and consumption of water remained the same.

Adjusting for social class and maternal education altered the ORs only slightly (Table 3), and when restricted to the 1688 with complete social class and maternal education data, model estimates were almost identical (Supplementary Table 1). Similarly, when analyses were restricted to the 1833 singletons, model estimates were almost identical (Supplementary Table 2).

Discussion

To our knowledge this study, based on a large population-based cohort, is the first to investigate changes in key oral health behaviours specifically between childhood and adolescence, using repeated measurements on the same people. As the children moved from childhood to adolescence, the frequency of tooth brushing decreased in males and increased in females. Electric toothbrush usage decreased with age, with a slightly larger decrease in females than males. Dental attendance decreased with age, and the pattern was similar for both males and females. Fizzy drink and juice consumption increased with age while there was no change in water consumption; again patterns were similar for both males and females. Adjusting for social class and maternal education made little difference to the changes in oral health behaviours between childhood and adolescence.

The main strengths of this study are its size, the availability of longitudinal measurements with up to three time points per person from a well-characterised cohort which included social class and maternal education data, and use of advanced statistical modelling. ALSPAC is a population-based prospective birth cohort that enables extrapolation of the study's findings to the general child population. The prospective design of the study allowed for concurrent information to be collected at different life stages. From this, appropriate

evidence-based preventive policies can be formed to improve oral health of the child population.

This study also has some limitations. It is possible that different findings would have been obtained if all children whose mothers originally enrolled in the study were able to be included, and some differences in characteristics from those who were not included in the analysis have been identified. However, findings were similar if the sex-adjusted analyses were restricted to those with complete data on social class and maternal education rather than including any with available data, providing some reassurance that attrition is unlikely to have biased findings. Not all oral health behaviour variables were recorded at all timepoints; in particular toothpaste use was only recorded at the last time point. Therefore, it was not possible to consider the amount of fluoride in toothpaste used by the participants. However, it is likely that changes in use of fluoride in toothpaste would largely be reflected by changes in toothbrushing frequency, and also that the amount of toothpaste used per brushing would have been established in this age group. The oral health behaviour variables were self-reported and so may be prone to recall bias. Despite this limitation, it was demonstrated that self-reported toothbrushing frequency can be used a proxy for clinically measured oral hygiene in a study of 12-year-olds in Brazil.[22]

A number of key oral health behaviours that determine oral health were investigated in this study. A great deal of evidence over a number of decades has found that regularly brushing children's teeth with fluoridated toothpaste reduces the risk of dental decay.[23] Toothbrushing not only removes plaque, which consists mostly of bacteria and is a risk factor for oral disease, but can be used to apply fluoride to the teeth via the application of toothpaste. While research comparing electric toothbrushing with manual toothbrushing is relatively limited, evidence of better plaque removal by the former has been reported among children and adolescents.[24, 25] Attending for annual dental check-ups is often advocated, to access preventive dental care or allow diagnosis of dental problems at an early stage which can facilitate treatment before the disease progresses.[26] Favourable dental visiting patterns established since young adulthood have been shown to predict oral health later in life.[6] Consumption of sugar-sweetened beverages has been considered as a risk factor for dental health.[8] Given the role of those oral health behaviours, it is important to note the age-related changes reported in our study; dental attendance declined with age while the consumption of fizzy drinks increased during the transition from childhood to adolescence, and males were

less likely to brush at least twice a day as they aged. Those changes are likely to put adolescents at higher risk for dental caries.

Evidence from comparable prospective longitudinal studies is rare, making comparison with the existing body of knowledge difficult. This scarcity of evidence further emphasises the importance of prospective research in dental health.

In conclusion, changes in oral health behaviours between childhood and adolescence, some of which were sex-specific, have been demonstrated in this cohort. There is a need for confirmation of these findings in other cohorts with repeated measurements of oral health behaviours on the same people over the period from childhood to adolescence. If these findings are replicable, they can be used by healthcare professionals to plan healthcare interventions for improving oral health. In addition, investigating whether changes in oral health behaviours vary by socio-economic status would further inform these interventions.

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Table 1: Comparison of demographic variables between those who were and were not included in the analysis

		Included in analysis (max N=1860)		Not included in analysis (max N=12165*)	
		Number	**%**	**Number**	**%**
Sex	Males	724	38.9	6527	53.7
	Females	1136	61.2	5638	46.4
Social class	IV/V	229	13.6	2085	22.1
	III	410	24.3	2917	30.9
	I/II	1051	62.2	4453	47.1
Maternal	CSE/none	149	8.1	2360	22.3
education	Vocational	126	6.8	1098	10.4
	O level	587	31.9	3721	35.1
	A level	547	29.7	2243	22.2
	Degree	432	23.5	1171	11.1

*14062 livebirths – 13 triplets/quads – 24 withdrawals – 1860 with required dental data

Table 2: Summary of oral health behaviours

Values are percentages	**Sample**	**Age 7.5 years**	**Age 10.5 years**	**Age 17.5 years**
Brushed teeth at least twice/day	Males	80.8	73.5	75.0
(Total N ≥ 1829)	Females	83.6	77.6	85.2
	Combined	82.5	76.0	81.2
Used an electric toothbrush	Males	-	51.3	30.8
(Total N ≥ 1822)	Females	-	53.8	25.0
	Combined	-	52.8	27.3
Visited dentist at least once a year	Males	98.9	99.3	93.1
(Total N ≥ 1795)	Females	98.0	98.9	91.8
	Combined	98.3	99.1	92.3
Drank fizzy drinks	Males	91.6	94.1	-
(Total N ≥ 1819)	Females	88.9	92.7	-
	Combined	89.9	93.3	-
Drank fruit juice	Males	82.0	89.5	-
(Total N ≥ 1807)	Females	79.9	88.4	-
	Combined	80.7	88.8	-
Drank water	Males	91.2	90.0	-
(Total N ≥ 1817)	Females	89.6	90.3	-
	Combined	90.2	90.2	-

Table 3: Associations between oral health behaviours and age

Outcome	Sample[a]	Model 1[b]			Model 2[c]		
		N	OR (95% CI)	P value	N	OR (95% CI)	P value
Brushed teeth at least twice a day							
	Males	724	0.96 (0.94, 0.99)	0.02	647	0.96 (0.93, 0.99)	0.02
	Females	1136	1.03 (1.01, 1.06)	0.01	1041	1.04 (1.01, 1.07)	0.01
Used an electric toothbrush							
	Males	724	0.87 (0.84, 0.90)	<0.001	647	0.86 (0.83, 0.90)	<0.001
	Females	1136	0.82 (0.80, 0.85)	<0.001	1041	0.82 (0.80, 0.85)	<0.001
Visited dentist at least once a year							
	All	1860	0.77 (0.73, 0.81)	<0.001	1688	0.77 (0.73, 0.81)	<0.001
Drank fizzy drinks							
	All	1859	1.39 (1.23, 1.57)	<0.001	1687	1.41 (1.24, 1.61)	<0.001
Drank fruit juice							
	All	1860	1.33 (1.24, 1.44)	<0.001	1688	1.31 (1.21, 1.42)	<0.001
Drank water							
	All	1860	1.00 (0.91, 1.09)	0.96	1688	1.01 (0.92, 1.10)	0.90

[a]Modelled separately for males and females if statistical evidence for a sex-age interaction exists.

[b]Model 1: Adjusted for sex only; [c]Model 2: Model 1+ social class and maternal education.

OR = odds ratio from random effects model, CI = confidence interval

Supplementary Table 1: Associations between oral health behaviours and age; restricted to those with social class and maternal education data (N=1688)

Outcome	Sample[a]	Model 1[b]		
		N	OR (95% CI)	P value
Brushed teeth at least twice a day				
	Males	647	0.96 (0.93, 0.99)	0.02
	Females	1041	1.04 (1.01, 1.07)	0.01
Used an electric toothbrush				
	Males	647	0.86 (0.83, 0.90)	<0.001
	Females	1041	0.82 (0.80, 0.85)	<0.001
Visited dentist at least once a year				
	All	1688	0.77 (0.73, 0.81)	<0.001
Drank fizzy drinks				
	All	1687	1.40 (1.23, 1.60)	<0.001
Drank fruit juice				
	All	1688	1.31 (1.21, 1.42)	<0.001
Drank water				
	All	1688	1.01 (0.92, 1.10)	0.86

[a]Modelled separately for males and females if statistical evidence for a sex-age interaction exists.

[b]Model 1: Adjusted for sex only

OR = odds ratio from random effects model, CI = confidence interval

Supplementary Table 2: Associations between oral health behaviours and age; restricted to singletons (N=1833)

Outcome	Sample[a]	Model 1[b]		
		N	OR (95% CI)	P value
Brushed teeth at least twice a day				
	Males	720	0.96 (0.94, 0.99)	0.01
	Females	1113	1.03 (1.00, 1.06)	0.03
Used an electric toothbrush				
	Males	720	0.87 (0.84, 0.90)	<0.001
	Females	1113	0.82 (0.80, 0.85)	<0.001
Visited dentist at least once a year				
	All	1833	0.77 (0.73, 0.81)	<0.001
Drank fizzy drinks				
	All	1832	1.37 (1.21, 1.55)	<0.001
Drank fruit juice				
	All	1833	1.33 (1.23, 1.43)	<0.001
Drank water				
	All	1833	1.01 (0.92, 1.10)	0.88

[a]Modelled separately for males and females if statistical evidence for a sex-age interaction exists.

[b]Model 1: Adjusted for sex only

OR = odds ratio from random effects model, CI = confidence interval