Community Dent Oral Epidemiol 2004; 32: 354–62

Community Dentistry and Oral Epidemiology

Stability of oral health-related behaviour in a Norwegian cohort between the ages of 15 and 23 years

Anne Nordrehaug Åstrøm[1,2]

[1]Center for International Health, [2]Department of Odontology–Community Dentistry, University of Bergen, Bergen, Norway

Åstrøm AN. Stability of oral health-related behaviour in a Norwegian cohort between the ages of 15 and 23 years. Community Dent Oral Epidemiol 2004; 32: 354-62. © Blackwell Munksgaard, 2004

Abstract – *Objective:* To assess the stability in self-reported oral health behaviour in a Norwegian cohort between the ages of 15 and 23 years. *Methods:* Self-administered questionnaires were used as part of a longitudinal cohort study. In 1992, a representative sample of 963 15-year-old adolescents participated, of which 676 (70%) and 567 (58%) remained in the study at ages 18 and 23 years. A total of 389 (40% of baseline) participated at each data collection, i.e. at ages 15, 18, 19, 21 and 23 years. *Results:* General linear model (GLM) repeated-measures ANOVA revealed statistically significant main effect of time with respect to soft drink and sweet consumption ($F = 22.4$, $P < 0.001$ and $F = 4.3$, $P < 0.05$, respectively). Adjusted mean scale scores of soft drink intake increased from 2.3 at age 15 years to 3.4 at age 23 years. The corresponding figures for consumption of sweets were 2.6 and 2.8. Two-way interactions achieved statistical significance with gender for soft drink consumption and toothbrushing. GLM repeated-measures with each gender revealed that soft drink consumption increased with time more extensively in boys (from 2.9 to 4.2, $F = 13.5$, $P < 0.001$) than in girls (from 1.9 to 2.6, $F = 8.1$, $P < 0.001$). Tracking or maintenance across time of the relative ranking at age 15 years occurred with all the four behaviours investigated. A total of 68–92% remained active and inactive regarding soft drink and sweet consumption, flossing and toothbrushing. *Conclusion:* The results provide evidence of tracking and early consolidation of oral health behaviour. This adds support for the assumption given for early intervention to prevent oral diseases.

Key words: adolescents; longitudinal; oral health behaviour; stability

Anne Nordrehaug Åstrøm, Centre for International Health, Armauer Hansen Building, N-5021, Bergen, Norway
Tel: 47-55974984
Fax: 47-55974979
e-mail: anne.nordrehaug@cih.uib.no

Submitted 22 April 2003;
accepted 25 March 2004

A major assumption underlying health promotion is that adolescence is an important period for learning and maintaining health-related behaviours that can be carried over into adulthood (1). In this regard, a key research question emerges: do different personal health practices tend to be stable through an individual's life and if they are, what is the extent of the stability? Attention should be paid to critical periods of development, the pubertal transition (i.e. early and middle adolescence) and the transition from late adolescence to early adulthood. Longitudinal studies, addressing the stability of health behaviours during the major transitions are generally scarce (2), and few have systematically examined how various oral health behaviours develop across time within a cohort.

The oral health consequences of appropriate use of hygiene measures are fairly well documented (3–5). A wealth of research devoted to young peoples' oral health-related habits have shown, for instance, that less optimal oral hygiene habits are most common among males and in the lower socioeconomic status groups (6, 7). Some research programmes combine consecutive cross-sectional surveys to reveal age- and time-related changes.

Søgaard et al. (8) reported on time trends among Norwegian adults above 15 years and observed that an increase occurred in everyday use of oral hygiene measures between 1981 and 1985. The cross-national study 'Health Behaviour among School Aged Children' (HBSC) conducted in 1997 showed that most Norwegian adolescents and girls more often than boys, reported tooth brushing twice a day (6). Accordingly, Kuusela et al. (9) found that although toothbrushing frequency improved among boys between 1977 and 1995, it lagged behind that of girls. Comparison of results across the HBSC survey years from 1985 to 1997 shows an overall decrease in the rate of toothbrushing, whereas at each follow-up there was a tendency towards decreasing frequencies with age from 11 to 15 years (6). Besides the detrimental consequences for oral health, there is a concern that excessive sugar consumption may displace more nutrient-dense foods and lead to obesity (10). Cross-sectional and longitudinal studies conducted within and outside the Nordic countries indicate that consumption of soft drinks among adolescents increases with age and across time, particularly in boys (6, 11, 12). Changes in the consumption of sweet snacks have been less uniform, although some studies indicate an increase in the consumption from childhood to early adolescence (6, 11, 12).

At the population level, prevalence and frequencies of behaviour across time reflect overall trends but disguise individual changes (13, 14). At the group level, maintenance of relative position in rank of behaviour over time, referred to as tracking, has been used to study stability in food choice behaviour (15). According to Kelder et al. (15), tracking is the consistency of the relative position of a person in the distribution at two or more points in time. The degree of relative consistency might be indexed by some measure of association such as Pearson's product moment correlation. Stability at the individual level indicates the extent to which an individual's behaviour or absolute level on a dimension remains the same across various time periods. This study aimed to assess relative (rank order), absolute stability and changes of oral hygiene behaviours and consumption of soft drinks and sweets in a cohort of Norwegian adolescents as they go through the transition towards early adulthood. A previous study of this cohort described oral health behaviours at ages 15–16 and 18 years (16). The present study concerns the second critical period of development between ages 18 and 23 years as well as the whole survey period (age 15–23 years).

Methods

The present work is based on five separate data collections (age 15, 18, 19, 21, 23 years) from The Norwegian Longitudinal Health Behaviour Study (NLHB). The NLHB study began in 1989 and was designed as a prospective 10-year longitudinal two-generation study among adolescents and their parents [for a detailed description of sampling methodology see Ref. (17)]. Information was collected on a wide range of health behaviours by means of questionnaires containing core questions repeated in every survey. Since 1992, oral hygiene behaviours have been included as one part of the questionnaire. The NLHB was approved by the Norwegian Data Inspectorate and has been conducted in full accordance with ethical principles, including the provisions of the World Medical Association Declaration of Helsinki. With the exception of the first three years (13–15 years of age) when the questionnaire was completed at school, participants received questionnaires by mail. All data collection periods occurred in the month of October.

Subjects

Initially, 1195 pupils in 53 seventh grade classes in the county of Hordaland in western Norway were asked to participate in the baseline survey which was performed in October 1990. The sample was selected by schools using a systematic sampling procedure and considered to be representative of the 1977 birth cohort attending ordinary school in the region (17). Refusals from parents ($n = 222$, 18.6%), refusals from pupils ($n = 46$, 3.8%) and exclusion of pupils with obviously incorrect answers, resulted in a final sample of 927 seventh graders (55% boys and 44% girls, mean age 13.3 years) who participated in the baseline study in 1990. The response rate was 77%. In 1992, 963 pupils (55% boys and 44% girls, mean age 15.3 years) in the ninth grade classes, of whom 872 pupils (94.0%) were follow-up cases from the baseline study in 1990, completed a 90-min confidential questionnaire. The response rate was 71%. Table 1 shows the number of participants and response rate at each age and gender from 1992 to 2000. As a result of missing values on single items,

Table 1. The number (*n*) and percentage (%) of participants by age and gender at each data collection wave and total response rate based on participation at baseline at age 15 ($n = 963$)

	Boys [*n* (%)]	Girls [*n* (%)]	Total (% of baseline)
Age (years)			
15	534 (55)	429 (44)	963 (–)
18	382 (49)	397 (51)	779 (80)
19	305 (47)	338 (53)	643 (66)
21	297 (47)	337 (53)	634 (65)
23	307 (49)	320 (51)	627 (64)
Cohorts by age (years)			
15 and 18	342 (51)	334 (49)	676 (70)
15 and 19	286 (49)	298 (51)	584 (60)
15 and 21	276 (48)	296 (52)	572 (59)
15 and 23	283 (50)	284 (50)	567 (58)
18 and 23	260 (47)	295 (53)	555 (57)
15, 18, 21 and 23	196 (46)	232 (54)	428 (44)
15, 18, 19, 21 and 23	177 (46)	212 (54)	389 (40)

the number of participants vary slightly in the analyses.

Measures

To ensure the comparability of data, the questions of oral health behaviours were constructed identically at every data collection period and in accordance with standard questions used in the well-established HBSC survey and oral health surveys of Norwegian adolescents and young adults. Oral health behaviours were assessed by asking respondents how often they had used/consumed the following during the previous 3 months: (1) dental floss, (2) toothbrush (3) sugar-added soft drinks and (4) chocolate/sweets. The response categories for sugar-added soft drinks (with recoded values into times per week in parenthesis) were several times a day (10), once a day (7), three to six times a week (4.5), one to two times a week (1.5) and seldom or never (0.5). The response categories for sugared snacks were every day (7), three to six times a week (4.5), one to two times a week (1.5), seldom (1) and never (0). The response categories for dental floss were several times a day (7), two times a day (6), daily (5), several times per week (4), several times per month but not every week (3), seldom (2) and never (1). Finally, toothbrushing was coded: several times a day (6), twice a day (5), once a day (4), several times a week (3), seldom (2) and never (1). At age 14 years, a 1-week test–retest was performed to assess reliability resulting in a Cohen's kappa in the range of 0.55–0.58 and Pearson's correlation 0.74–0.81 for the oral health behaviours investigated. Similar studies were not carried out at later ages.

Data analysis

All analyses were performed with SPSS for Windows (version 12.0) on the cross-sectional samples, on cohorts consisting of those participating at the two time points in question and with intact cohorts of 389 and 428 individuals (Table 1). As a control of the robustness of the results, the analyses following the individual position from year-to-year throughout the survey period were performed with an intact cohort consisting of those who participated at all follow-ups between ages 15 and 23 years ($n = 389$). As inadequate sample size per cell precluded analyses stratified by gender, these analyses were run for girls and boys combined. The findings left the results presented in this paper essentially unchanged.

Cross-tabulation, chi-square statistics, one-way analysis of variance (ANOVA), and general linear model (GLM) repeated-measures were conducted to assess gender differences at each survey year, to perform tracking analyses and to assess the time effect on oral health behaviours across the 8-year survey period (1992–2000). All measures were dichotomized for use in cross-tabulation analyses. With respect to soft drinks and sweets 'active consumers' were defined as those who consumed drinks and sweets at least once a day (≥7). With respect to dental floss and toothbrushing, active performers were defined as those who reported the performance at least several times a week (≥4) and at least twice a day (≥5), respectively. The proportion of adolescents who made a shift in category from one survey period to another and those who maintained their position within the active/inactive category (absolute stability) were calculated. Periods of interest for the analysis of absolute stability were the overall survey period (15–23) and times of major transitions for Norwegian adolescents; i.e. between the ages of 15 and 18 years (change to upper voluntary school) and between the ages 18 and 23 years (change to university or work). Stability in rank at the group level was examined according to the definition of Kelder et al. (15), using reported frequencies of behaviours at age 15 years to define tracking groups. At age 15 years, the original response categories of soft drinks and sweets were reduced to three in terms of at least daily (≥7), three to six times a week (4.5) and less than or equal to one to two times a week (≤1.5). Two tracking categories (as described for

use in analysis of absolute stability, active and inactive) were used for dental floss and toothbrushing. One-way ANOVA was employed to compare sociodemographic characteristics and behaviours among participants and drop-outs at age 15 and 18 years.

Participants versus drop-outs

Five hundred and seventy-four of the 963 participants at baseline, i.e. age 15 years did not participate at the follow-ups at age 18, 19, 21 and 23 years. The sex composition of drop-outs and follow-up participants at age 15 years differed as 54% of the follow-up participants versus 38% of the drop-outs were girls ($P < 0.001$). Based on their reports at age 15 years, drop-outs were more likely than the follow-ups to confirm soft drink consumption and to be boys ($P < 0.001$). As to the other oral health behaviour measures, there were no statistically significant differences between participants and drop-outs at age 15 years.

Results

Tables 2 and 3 show the cross-sectional data at each age with respect to the prevalence of daily consumption of soft drinks and sweets, the daily performance of flossing and toothbrushing and the corresponding mean frequencies of consumption/performance.

Table 2. Prevalence of active soft drink and sweet consumption (%) (at least once a day) and frequency of consumption (mean times per week and 95% CI) for boys and girls from age 15–23 years ($n = 963$)

	Boys		Girls	
	% active	Times per week (95% CI)	% daily	Times per week (95% CI)
Soft drinks				
15	13	2.9 (2.5–3.1)	3**	1.9 (1.6–2.1)**
18	30	4.5 (4.1–4.9)	14**	2.7 (2.3–3.1)**
19	30	4.4 (4.0–4.7)	13**	2.7 (2.3–3.0)**
21	29	4.4 (3.9–4.8)	14**	2.5 (2.1–2.9)**
23	29	4.2 (3.7–4.5)[a]	15**	2.6 (2.3–3.0)[a]**
Sweets				
15	9	2.9 (2.6–3.1)	5*	2.5 (2.3–2.7)
18	11	3.1 (2.8–3.4)	10	3.1 (2.8–3.3)
19	10	3.2 (2.9–3.5)	8	2.9 (2.6–3.2)
21	9	3.1 (2.7–3.4)	9	2.9 (2.6–3.1)
23	9	2.9 (2.5–3.1)	6	2.8 (2.5–3.0)[b]

Gender differences at each survey year: *$P < 0.05$, **$P < 0.001$.
GLM repeated measure: [a]$P < 0.001$, [b]$P < 0.05$.

Table 3. Prevalence of active flossing % (at least several times a week) and active toothbrushing (at least twice a day) and frequency of flossing and brushing [mean times per week and 95% confidence interval (CI)] for boys and girls from age 15–23 years ($n = 963$)

	Boys		Girls	
	% active	Mean (95% CI)	% active	Mean (95% CI)
Floss				
15	22	2.4 (2.2–2.6)	38**	2.9 (2.8–3.1)**
18	18	2.2 (2.1–2.4)	28*	2.7 (2.5–2.9)**
21	18	2.3 (2.2–2.5)	31**	2.8 (2.5–2.9)**
23	16	2.2 (2.1–2.4)	32**	2.8 (2.6–2.9)**
Toothbrushing				
15	76	4.9 (4.8–5.0)	91**	5.2 (5.1–5.3)**
18	72	4.8 (4.7–4.9)	89**	5.2 (5.1–5.2)**
21	75	4.9 (4.8–5.0)	90**	5.2 (5.0–5.2)**
23	76	5.0 (4.8–5.1)[b]	88**	5.1 (5.0–5.2)**

Gender differences at each survey year: *$P < 0.05$, **$P < 0.001$.
GLM repeated measure: [b]$P < 0.05$.

General linear model repeated-measure analysis with each oral health behaviour as within-subject factor (time) and gender as a between-subject factor revealed statistically significant main effects (Wilk's lambda) of time with respect to soft drink [$F(4,373) = 22.4$, $P < 0.001$], and sweet consumption [$F(4,372) = 4.3$, $P < 0.05$]. The main effect of time regarding flossing only approached statistical significance [$F(3,413) = 2.3$, $P = 0.073$]. The adjusted mean scale scores revealed that for the study group as a whole, consumption of soft drinks increased with time from 2.3 (95% CI 2.1–2.5) at age 15 years to 3.4 (95% CI 3.1–3.7) at age 23 years. The corresponding figures for consumption of sweets, flossing and brushing were: from 2.6 (95% CI 2.5–2.9) to 2.8 (95% CI 2.6–3.0), from 2.7 (95% CI 2.5–2.8) to 2.5 (95% CI 2.4–2.7) and from 5.1 (95% CI 5.0–5.1) to 5.0 (95% CI 4.9–5.1), respectively. Two-way interactions with gender achieved statistical significance with respect to soft drink consumption and toothbrushing (Wilk's lambda) [$F(4,373) = 2.5$, $P < 0.05$ and $F(3,413) = 3.2$, $P < 0.05$, respectively]. This indicates differential trends for boys and girls. Stratified analyses (Wilk's lambda) revealed that soft drink consumption increased from an average of 2.9 to 4.2 among boys ($F = 13.5$, $P < 0.001$) and from 1.9 to 2.6 ($F = 8.1$, $P < 0.001$) in girls. The corresponding figures with respect to toothbrushing were from 4.9 to 5.0 ($P < 0.05$) in boys and from 5.2 to 5.1 (n.s.) in girls. Sweet consumption increased in girls from 2.5 to 2.8 ($F = 4.2$,

$P < 0.05$) during the period 1992–2000. The major changes occurred between the ages of 15 and 18 years in both genders (Tables 2 and 3). At all ages, the rates of soft drink consumption was higher in boys than in girls, whereas the rates of flossing and toothbrushing were significantly higher in girls ($P < 0.001$).

Figures 1–4 present the mean frequency of soft drink and sweet consumption and the mean frequency of flossing and brushing plotted at the ages of 18, 19, 21 and 23 years within the age 15-year categories of daily and weekly consumption/performance. If the mean values within the age 15-year categories would be expected to remain separate and distinct over time or maintain a relative position in rank compared with that in the other categories, this was interpreted as evidence of tracking. As shown in Fig. 1, a parallel separation between the groups was observed that visually supports tracking of soft drink consumption, i.e. the 15-year age rankings are likely to remain across time. At each follow-up period (i.e. age 18, 19, 21 and 23 years), one-way ANOVA revealed that the mean frequency of soft drink consumption of those in the daily and three to six times a week categories were statistically significantly different ($P < 0.05$) from those in the less than or equal to one to two times a

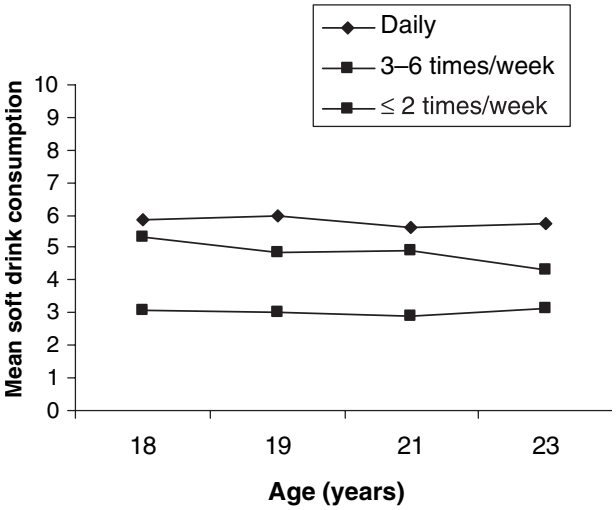

Fig. 1. Mean consumption frequency of soft drink consumption at ages 18–23 years in groups reporting consumption daily, three to six times a week or less than or equal to one to two times a week at age 15 years.

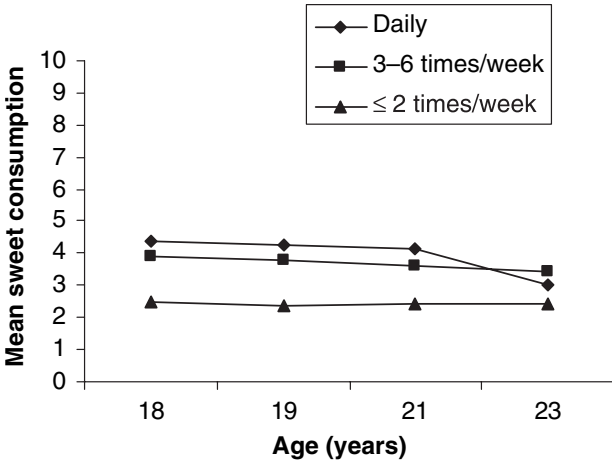

Fig. 2. Mean consumption frequency of sweet consumption at ages 18–23 years in groups reporting consumption daily, three to six times a week or less than or equal to one to two times a week at age 15 years.

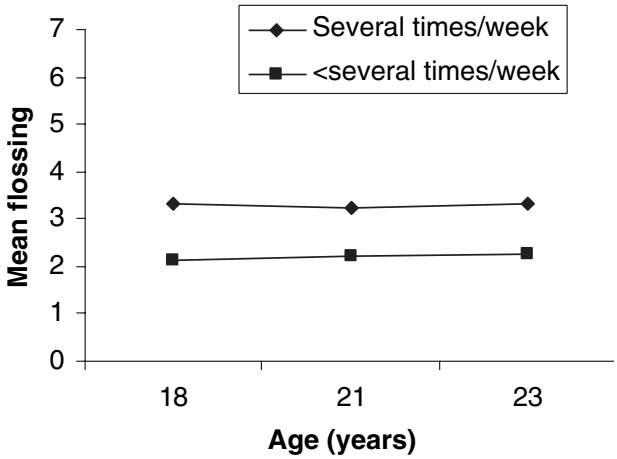

Fig. 3. Mean flossing frequency at age 18–23 years in groups reporting flossing weekly and less than weekly at age 15 years.

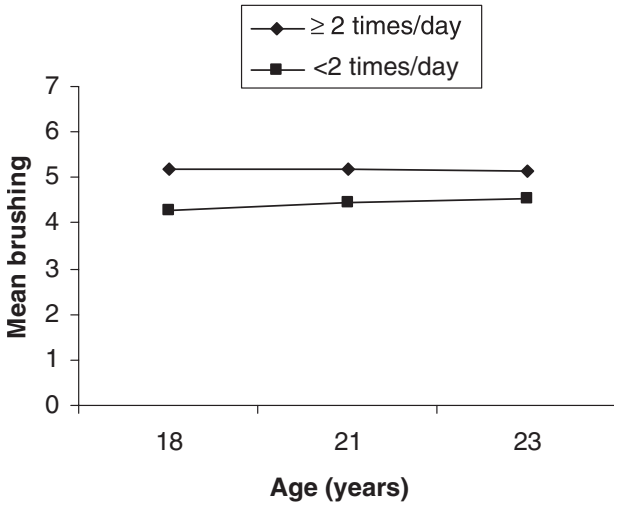

Fig. 4. Mean toothbrushing frequency at ages 18–23 years in groups reporting toothbrushing greater than or equal to two times a day and less than two times a day at age 15 years.

week category. *Post hoc* analyses showed that the mean frequency of soft drink consumption of those in the daily category were statistically significantly different from that in the three to six times a week category in one (age 23 years) of the three follow-up periods. A similar picture was presented with respect to mean frequency of consumption of sweets (Fig. 2). At each time of measurement, the mean frequency of consumption of those in the three to six times a week category were statistically significantly different ($P < 0.05$) from those in the less than or equal to one to two times a week category. Moreover, the mean consumption of those in the daily category were statistically significantly different from those in the less than or equal to one to two times a week category, except at age 23 years. As shown in Fig. 2, a clearly defined pattern of tracking could be observed between the ages of 18 and 21 years followed by a steep decrease in the highest category (daily) between ages 21 and 23 years. Frequency of flossing declined slightly over time in the highest group (at least weekly flossing), whereas frequency of brushing increased over time in the lowest group (less than twice a day) (Figs 3 and 4). Flossing showed stability in ranking between ages 18 and 23 years with the active and inactive categories being statistically significantly different at each follow-up period ($P < 0.001$). GLM repeated-measures with oral health behaviours as within-subject factors (time) and the age 15-year categories of daily and weekly consumption/performance as between-subject factors revealed no statistically significant two-way interaction. This confirms the visual evidence of stability in rank presented in Figs 1–4.

Approximately 68–92% of boys and girls fell in the same category (absolute stability) with respect to consumption of soft drinks and sugar-added snacks between the ages of 15 and 23 years (Table 4). During the same period, about 5–25% of boys and girls moved to a higher category, whereas between 0% and 9% moved to a lower category of soft drink and sweet consumption. With respect to flossing and brushing 69–74% and 80–84% of boys and girls remained in the same category between 15 and 23 years, whereas 8–12% became active and 9–20% became inactive, respectively (Table 5). The stability of boys and girls in the inactive category of sweet consumption and the active category of flossing and brushing performance was particularly consistent at all time points studied.

Discussion

It might be safe to conclude that the present sample remained relatively stable through the major transition periods with respect to the oral health behaviours investigated, yet the results present a mixed picture of stability and change. At the population level between the ages 15 and 23 years, adolescents increased their consumption of soft drinks, sweets and toothbrushing frequency but remained stable with respect to flossing. Soft drink consumption increased more strongly in boys than in girls, whereas toothbrushing and sweet consumption increased only in girls and boys, respectively. Moreover, stability in rank

Table 4. Absolute stability in responses provided by individuals (% of total sample of boys or girls) regarding the prevalence consuming sugar-added snacks and drinks between ages 15 and 18, 19 and 23 and 15 and 23 years

	Sugar-added soft drinks		Sugar-added snacks	
	Boys	Girls	Boys	Girls
15 and 18 years (n total group = 676)				
Stable active (at least daily)	7	1	2	1
Stable at inactive (less than once a day)	63	86	83	87
From inactive to active	24	12	9	9
From active to inactive	6	2	6	3
18 and 23 years (n total group = 555)				
Stable active	14	3	5	3
Stable inactive	58	77	84	88
From inactive to active	13	11	5	3
From active to inactive	15	10	7	6
15 and 23 years (n total group = 567)				
Stable active	4	1	2	1
Stable inactive	64	87	83	91
From inactive to active	25	11	7	5
From active to inactive	7	0	9	4

Table 5. Absolute stability in responses provided by individuals (% of total sample of boys or girls) regarding the prevalence of flossing and toothbrushing between ages 15 and 18, 19 and 23 and 15 and 23 years ($n = 963$)

	Flossing		Brushing	
	Boys	Girls	Boys	Girls
15 and 18 years (n total group = 676)				
Stable at active	9	17	65	83
Stable at inactive	70	53	17	3
From inactive to active	7	10	7	6
From active to inactive	13	19	12	8
18 and 23 years (n total group = 555)				
Stable active	7	16	66	82
Stable inactive	74	57	16	5
From inactive to active	9	15	11	7
From active to inactive	10	12	7	6
15 and 23 years (n total group = 567)				
Stable active	7	19	67	81
Stable inactive	67	50	13	3
From inactive to active	8	12	9	8
From active to inactive	16	20	11	9

order position within a certain group and absolute stability was calculated (15). Figures 1–4, which show the tracking data at the group level for the oral health behaviours considered, offer visual evidence of tracking. The upward and downward trends across the variables indicate that adolescents are indeed changing across time but that this change is relative to their peers. At the individual level, the majority of adolescents maintained their behaviours, although considerable proportions changed their sugar consumption and oral hygiene habits in a less and more oral health enhancing direction.

Two limitations of the present study, the attrition and the crude behavioural measures should be acknowledged before the results are discussed further. Unfortunately a way to distinguish true stability from unreliability with respect to the oral hygiene measures was not included. Test–retest results at age 14 years showed satisfactory correlation coefficients for the oral health behaviours investigated, although the kappa statistics indicated only fair agreement (0.55–0.58). An equally important concern is not having data for all adolescents at all age periods because of attrition. Nevertheless, results of the analyses performed with the individuals available at all time points were essentially the same as those presented in this paper. A bias towards girls and more oral health-conscious individuals with respect to consumption of soft drinks is a well-known problem in surveys with voluntary participation (18). This attrition bias might have influenced the data on sugared foods and drinks keeping them unrealistically low. It might be unclear whether self-reported sugar consumption accurately reflects the actual intake of sugar. Nevertheless, use of brief self-report instruments to assess oral health behavioural patterns is common and recognized as useful in epidemiological research (19). Self-reported oral health behaviour is also subject to social desirability or repeated testing that introduces additional within- and between-person variation. Additional variance caused by measurement errors would, however, tend to reduce the chances of detecting tracking.

Comparing the present figures with those of the general adolescent and young adult population in Norway might throw light upon the quality of the data. Thus, the moderate prevalence of consumption of sugar-added snacks and use of dental floss and the high prevalence of toothbrushing are in line with much of what has been learned from previous HBSC studies and from the oral health surveys of young adults in Norway (6, 7, 11). A Norwegian study of 18-year olds found that about 50% of the participants had more than the recommended 10% of their total energy intake from sugar (20). Moreover, longitudinal analyses of American children approaching early adolescence have revealed changes similar to those described here; an increase in soft drink consumption and small changes in the consumption of sweet snacks (12).

Very few previous studies have provided evidence of tracking and absolute stability at the individual level with respect to health- and oral health-related behaviours (13, 15, 16, 21, 22). Consistent with the findings of Kuusela et al. (22), respondents who brushed their teeth at least twice a day (active) were more stable through adolescence when compared with their counterparts who

brushed less often (inactive). The present data suggest that early adopters of an inactive status of flossing and soft drink consumption (i.e. those who reported flossing less than several times a week and soft drink consumption less than once a day) are less likely to give up this position during the years of transition towards young adulthood. Sutton (23) has noted that the best predictor of future behaviour is often an early measure of that same behaviour. Studies concerned with health-related behaviours from both industrialized and nonindustrialized countries have provided support to this general assumption (24, 25). Moreover, health behaviour that is repeatable on a regular basis is usually highly predictable over time and might produce high stability coefficients (23). Consistent with this evidence, the most stable behaviours concerned in this study were those that might be referred to as routines, i.e. use of dental floss and toothbrushing frequency. Food choices such as soft drink and sweet consumption, which may vary with price fluctuations and seasonal patterns, showed less convincing evidence of tracking.

Within the overall increase and decrease in frequency of soft drink consumption and flossing, changes were characteristic of the transition between ages 15 and 18 years, whereas the period between 18 and 23 years showed, increases, maintenance as well as decreases in consumption and performance. Major changes in adolescent's physical and social environments that take place during this period might explain some of the changes observed in this study. Alternatively, the changes might be attributed to a secular trend, for instance, of increasing soft drink consumption (26). However, tracking might be seen as evidence of a stable social environment. Thus, it is probably that oral health behaviours learned through primary socialization continue through periods when other influencing agents outside the home become important (27, 28).

From an oral health educational point of view, evidence of tracking suggests that consolidation in oral health behaviour starts before the age of 15 years and that intervention in early school grades is defensible. The observation that groups maintain relative ranking indicates that there are subgroups of adolescents who remain at higher risk than their peers and thus need additional intervention to improve their risk profile. Even those who performed oral hygiene behaviours most frequently and those who were consuming soft drinks less frequently relative to their peers showed deterioration in oral health promoting behaviour across time. The overall declining trend in use of dental floss and the sharp increase in daily intake of soft drinks strongly suggest that oral health education aimed at Norwegian teenagers are warranted.

In conclusion, the present data indicates that oral health behaviours track during adolescence from age 15 to 23 years although an overall downward and upward trend was identified with respect to use of dental floss and soft drinks, respectively. Avenues for further research will be to highlight those persons who maintained or changed their oral health behaviours for better and for worse. Among the key unanswered questions are: For how many years is tracking evident and what are the genetic, social, psychological and environmental factors explaining stability and change in oral health behaviours across time?

Acknowledgement

The NLHB Study was initiated and conducted by the Research Centre for Health Promotion, Faculty of Psychology, University of Bergen and is currently co-ordinated by Dr Bente Wold.

References

1. Jessor R. Critical issues in research on adolescents health promotion. In: Coates TJ, Petersend AC, Perry CL, editors. Promoting adolescent health. A dialogue on research and practices. New York: Academic Press; 1982. p. 447–65.
2. Nyssonen V, Honkala E. Toothbrushing frequency in 4 consecutive studies of Finnish adolescents. J Clin Periodontol 1984;11:682–8.
3. Rugg-Gunn AJ. Nutrition and dental health. Oxford: Oxford University Press; 1993.
4. Addy M, Dummer PMH, Hunter ML, Kongdon A, Shaw WC. The effect of toothbrushing frequency, toothbrushing hand, sex and social class on the incidence of plaque, gingivitis and pocketing in adolescence: a longitudinal cohort-study. Community Dent Health 1990;7:237–47.
5. Sreebny LM. Sugar availability sugar consumption and dental caries. Community Dent Oral Epidemiol 1982;10:1–7.
6. Åstrøm AN, Samdal O. Time trends in oral health behaviors among Norwegian adolescents: 1985–97. Acta Odontol Scand 2001;59:193–200.
7. Åstrøm AN, Rise J. Socio-economic differences in patterns of health and oral health behavior in 25 year old Norwegians. Clin Oral Invest 2001;5:122–8.
8. Søgaard AJ, Grytten J, Holst D. Recent changes in health related behaviours in Norway. Community Dent Oral Epidemiol 1991;19:241–5.

9. Kuusela S, Honkala E, Rimpela A, Karvonen S, Rimpela M. Trends in toothbrushing frequency among Finnish adolescents between 1977 and 1995. Community Dent Health 1997;14:84–8.
10. Lyhne N, Ovesen L. Added sugars and nutrient density in the diet of Danish children. Scand J Nutr 1999;43:4–7.
11. Kuusela S, Kannas L, Tynjala J, Honkala E, Tudor-Smith C. Frequent use of sugar products by school-children in 20 European countries, Israel and Canada in 1993/1994. Int Dent J 1999;49:105–14.
12. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time. Results from a cohort study. Am J Health Promot 2000;14:222–8.
13. Alsaker FD, Olweus D. Stability of global self-evaluations in early adolescence: a cohort longitudinal study. J Res Adolesc 1992;2:123–45.
14. Twisk JWR, Kemper HVG, van Mechelen W, Post GB. Tracking of risk factors for coronary heart disease over a 14 year period: a comparison between lifestyle and biological risk factors with data from the Amsterdam growth and health study. Am J Epidemiol 1997;145:888–98.
15. Kelder SH, Perry CL, Klepp KI, Lytle LA. Longitudinal tracking of adolescent smoking, physical activity and food choice behaviors. Am J Public Health 1994;84:1121–6.
16. Åstrøm AN, Jakobsen R. Stability of dental health behavior: a 3 year prospective cohort study of 15-, 16-, and 18-year old Norwegian adolescents. Community Dent Oral Epidemiol 1998;26:129–38.
17. Aas HN. Alcohol expectancies and socialization: adolescents learning to drink (thesis). Bergen: University of Bergen; 1995.
18. Burr M. Cohort studies. In: Margetts BM, Nelson M, editors. Design concepts in nutritional epidemiology. 2nd edn. Oxford: Oxford University Press; 1997. p. 383–98.
19. Kann L, Kinchen SA, Williams BI, Ross JG, Lowry R, Grunbaum JA, Kolbe LJ. Youth risk behaviour surveillance-United States, 1999. J Sch Health 2000;70:271–85.
20. Andersen LF, Nes M, Sandstad B, Bjørneboe GE, Drevon CA. Dietary intake among Norwegian adolescents. Eur J Clin Nutr 1995;49:555–64.
21. Andersen N, Klepp KI, Aas H, Jakobsen R. Stability in physical activity levels in young adolescents. Eur J Public Health 1994;4:175–80.
22. Kuusela S, Honkala E, Rimpela A. Toothbrushing frequency between the ages of 12 and 18 years old – longitudinal prospective studies of Finnish adolescents. Community Dent Health 1996;13:34–9.
23. Sutton S. The past predicts the future: interpreting behaviour relationships in social-psychological models of health behaviour. In: Rutter DR, Quine L, editors. Social psychology and health: European perspectives. Aldershot: Avebury; 1997. pp. 71–88.
24. Rise J, Åstrøm AN, Sutton S. Predicting intentions and use of dental floss among adolescents. An application of the theory of planned behaviour. Psychol Health 1998;13:223–36.
25. Masalu JR, Åstrøm AN. Predicting intended and self-perceived sugar restriction among Tanzanian students using the theory of planned behavior. J Health Psychol 2001;6:435–45.
26. Guthrie JF, Morton JF. Food sources of added sweeteners in the diets of Americans. J Am Diet Assoc 2000;100:43–51.
27. Lau RR, Quadrell MJ, Hartman KA. Development and change of young adults' preventive beliefs and behavior: influences from parents and peers. J Health Soc Behav 1990;31:240–50.
28. Åstrøm AN. Parental influences on adolescents' oral health behavior: two year follow up of the Norwegian Longitudinal Health Behavior study. Eur J Oral Sci 1998;106:922–30.