

# Use of xylitol chewing gum among Finnish schoolchildren

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The preventive, and partly the remineralizing, effect of xylitol was shown in Finland in the Turku Sugar Studies in 1971–73. Since then, several clinical trials in many countries have confirmed these results. In Finland, oral health personnel have recommended daily use of xylitol chewing gum in their dental health education. Moreover, commercial companies have advertised xylitol, emphasizing in particular its caries preventive effects. All Nordic dental associations have given their recommendations for xylitol use. The aim of this study was to describe how this health habit has been adopted by Finnish schoolchildren. The study was part of the comprehensive cross-national survey on Health Behavior in School-aged Children (HBSC Study)—a WHO Collaborative Study. The data were collected using standardized questionnaires to which pupils in grades 5 (11 years), 7 (13 years) and 9 (15 years) responded anonymously in school classrooms during the spring term 1998. The response rate varied between 87% (15-year-old boys) and 94% (11- and 13-year-old girls). Among boys, the percentages of daily users of xylitol chewing gum were 47% (11 years), 46% (13 years), and 44% (15 years), and among girls, 57% (11 years), 65% (13 years), and 69% (15 years), respectively. Use of sugar-sweetened chewing gum was very rare (1%), as also was use of chewing gum with other artificial sweeteners (1%). It may be concluded that since 1991 the use of xylitol chewing gum has further increased in Finland and currently more than a half of all schoolchildren benefit from it. □ *Adolescents; chewing gum; health behavior; xylitol*

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The positive effects of xylitol on dental caries were detected during clinical trials, the Turku Sugar Studies, in Finland in 1971–73 (1). Xylitol chewing gum became commercially available in Finland as early as in 1975, and since that time several other clinical field studies in different countries have confirmed the caries reduction effect by regular use of xylitol chewing gum (Table 1). Dental personnel in Finland adopted xylitol chewing gum rapidly as an additional preventive method, and daily use of xylitol chewing gum was included in routine dental health education information.

In 1977, the frequency of daily use of xylitol chewing gum among Finnish adolescents was still rare, at about 1% (10), but it increased quite rapidly during the 1980s, reaching 15% among boys and 32% among girls by 1991 (11). In a region near Turku, as many as 80% of all 3-year-olds were using xylitol chewing gum (32% of them on a daily basis) by 1990 (12). A special “Smart Habit” Xylitol campaign was organized in Finland in 1992, involving 7,700 13-year-old schoolchildren. Almost half (41%) of the children involved in the campaign used xylitol chewing gum on a daily basis, and this proportion increased during the campaign by 6% (13). Also Finnish university students have reacted favorably to the provision of xylitol chewing gum with lunch: 66% recommended it unconditionally and 31% of the rest accepted it (14). In addition, the benefits of xylitol products have been recognized by Finnish confectionery workers, 81% of whom considered xylitol good for their dental health (15).

The aim of this study was to find out how common the

recommended habit of using xylitol chewing gum on a daily basis was among Finnish schoolchildren.

## Material and methods

The data for this study were collected as part of the Cross-National Survey on Health Behavior in School-aged Children—a WHO Collaborative Study. The philosophy and methods have been described in more detail elsewhere (16, 17). Standardized questionnaires were used, to which pupils answered anonymously in school classrooms during the spring term 1998. The sample ( $n = 4,864$ ; Table 2) was representative of 11, 13, and 15-year-old (in grades 5, 7, and 9) Finnish schoolchildren. The response rate ranged from 87% (15-year-old boys) to 94% (11- and 13-year-old girls). Information concerning daily use of xylitol chewing gum was collected by the question “Do you use chewing gum on a daily basis?”: (i) no; (ii) yes, sugar-sweetened chewing gum, (iii) xylitol chewing gum, (iv) other artificially sweetened chewing gum, (v) whatever chewing gum available. The suitability of the questionnaire in collecting information about the use of xylitol chewing gum has been tested in the Finnish Adolescent Health and Lifestyle Survey (10, 11). Information about age, gender, school performance, and economic situation of family as an indicator of socioeconomic status was also gathered, because all of these factors are known to be associated with the dental health behavior of children (10). The details of these questions have been explained elsewhere (18). There

Table 1. Clinical trials of use of xylitol in different countries between the 1970s and 1990s

Author(s)	Country	Years	Caries reduction (%)
Sheinin et al. (2)	Finland	1972–74, 1973–74	67, 82
Galliulin (3)	Soviet Union	1975–77	70
Kandelman et al. (4)	French Polynesia	1981–84	37–39
Scheinin et al. (5)	Hungary	1981–84	25–45
Kandelman & Gagnon (6)	Canada	1980s (2 years)	65
Isokangas et al. (7)	Finland	1982–84	33–46
		1982–85	76
Mäkinen et al. (8)	Belize, Central America	1989–93	73
Alanen (9)	Estonia	1994–96	50

Scoring criteria for all studies are not strictly comparable.

were two sources of non-response in the study: (i) schools or classes that refused to participate and (ii) individual pupils who refused to participate (informed consent) or were absent on the data collection day. No attempt was made to follow up on pupils who were absent on the day of the survey. The data were cleaned according to the consistent format of the study program at the University of Bergen, Norway. Variations in the distribution of the variables studied were analyzed using cross-tabulations according to gender, age, child's self-reported school performance, self-reported economic situation of family, and self-reported toothbrushing frequency. Statistical significances were calculated using the chi-squared test. Likelihood ratios (LR) and their confidence intervals (95% CI) were estimated for the use of xylitol chewing gum on a daily basis. Gender (females compared to males), age (13- and 15-year olds/11-year-olds), school performance (excellent and good/poor), economic situation of family (good/average and poor), and toothbrushing frequency (more than once a day/once a day and less than once a day) were included in the logistic regression model.

## Results

### Bivariate analyses

Daily use of xylitol chewing gum was very common (43–69%) (Fig. 1). More girls used xylitol chewing gum than boys ( $P < 0.001$ ). Among girls, daily use of xylitol increased with age, but among boys it decreased slightly. The frequency of using sugar-sweetened chewing gum was very low, only 1%. Use of chewing gum sweetened by other artificial sweeteners was also rare (about 1%).

Table 2. Number of pupils (*n*) and response rates (%) in the Health Behavior in School-aged Children Survey, Finland 1998

Age group	Boys		Girls		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
11 years	822	89	869	94	1,691	92
13 years	805	90	823	94	1,628	92
15 years	770	87	775	88	1,545	88
Total	2,397	89	2,467	92	4,864	91

Daily use of xylitol was not significantly associated with self-reported school performance except among 11-year-old girls ( $P = 0.012$ ). Every other 11-year-old girl with poor school achievement reported regular use of xylitol, whereas 61% of those with excellent or good school performance used xylitol chewing gum on a daily basis.

Daily use of xylitol chewing gum was associated with the self-reported economic situation of the family only among 11-year-old boys. Every other 11-year-old boy reporting that their family was well-off used xylitol daily, while among boys from average and not well-off families the respective figures were 43% and 27% ( $P = 0.023$ ).

Regular toothbrushing frequency was strongly associated with regular use of xylitol among 11- and 13-year-old boys and girls, but not among 15-year-olds (Table 3).

### Multivariate analyses

Gender (female) and toothbrushing frequency (more than once a day) were the strongest explanatory factors of regular use of xylitol chewing gum (Table 4), likelihood ratios being 1.9 and 1.5.

## Discussion

The use of xylitol chewing gum among children seems to have increased consistently in Finland, now with over half

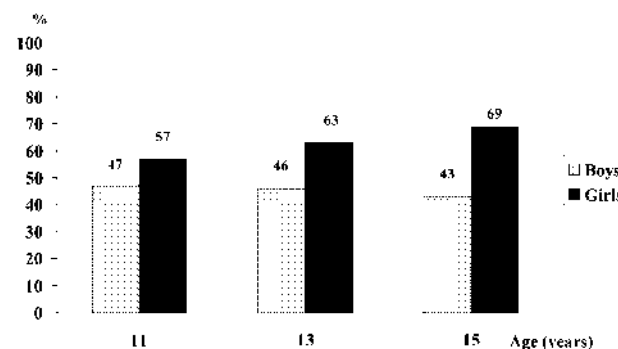


Fig. 1. Daily use (%) of xylitol chewing gum among Finnish school-children in 1998.

Table 3. Daily use of xylitol gum associated with toothbrushing frequency according to age and gender among Finnish schoolchildren in 1998

Gender and age	Toothbrushing frequency (%)			P-value and significance
	Less than once a day	×1	Less than once a day	
<b>Boys</b>				
11-year-olds	55	46	36	0.0022**
13-year-olds	55	45	34	0.0003***
15-year-olds	48	42	43	0.3131 n.s.
<b>Girls</b>				
11-year-olds	65	54	31	0.000***
13-year-olds	68	62	46	0.0032**
15-year-olds	71	65	59	0.0917 n.s.

\*\*\*  $P < 0.001$ , \*\*  $P < 0.01$ , n.s. = non-significant.

of all Finnish adolescents benefiting from daily use. The popularity of this product has increased since the Adolescent Health and Life-Style Surveys in Finland in 1979 (10) and 1991 (11) (Fig. 2). There may be several explanations. Xylitol for caries prevention was initially tested in Finland. There has also been commercial interest, because for several years all xylitol and xylitol chewing gums were produced in Finland. Xylitol chewing gum manufacturers have been active in promoting its caries preventive effect in their advertising. Finnish dentists have strongly advocated the use of xylitol chewing gum especially for high-risk group children who are reluctant to make necessary dietary changes. With evidence accumulating from different studies in different countries (Table 1), Finnish dentists have become convinced of the importance of xylitol in the caries prevention armamentarium. The national recommendations of the Finnish Dental Association further emphasize the role of xylitol in dental health education and have increased public awareness about the issue. The dental associations of all Nordic countries have later accepted similar recommendations for the use of xylitol products. Because it was a new method, the public and individual patients often asked

Table 4. Likelihood ratios (LR) and their 95% CI for daily use of xylitol gum among Finnish schoolchildren in 1998 by gender, age, school performance, economic situation of family and toothbrushing frequency

Variable	LR	95% CI	P-value and significance for LR
Gender (female/male)	1.87	1.65–2.10	0.0000***
Age (13–15/11 years)	1.16	1.02–1.32	0.0238*
School performance (excellent and good/poor)	1.05	0.93–1.19	0.4456 n.s.
Economic situation of family (good/average and poor)	1.16	1.03–1.31	0.0188*
Toothbrushing frequency (more than once a day/once a day and less than once a day)	1.54	1.35–1.75	0.0000***

\*\*\*  $P < 0.001$ , \*  $P < 0.05$ , n.s. = non-significant.

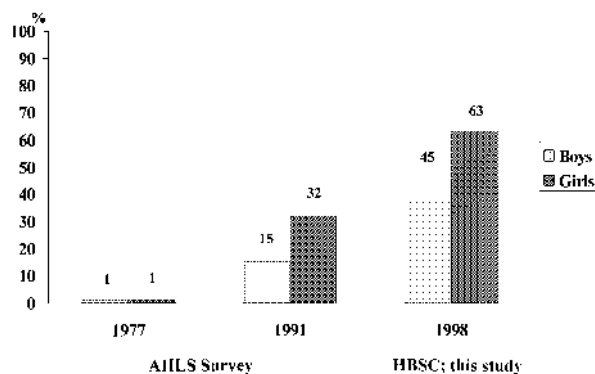


Fig. 2. Daily use (%) of xylitol chewing gum among Finnish schoolchildren in the Adolescent Health and Lifestyle Survey (AHLS) in 1977 and 1991 (12-, 14-, 16- and 18-year-olds), and in the Health Behavior in School-aged Children Survey (HBSC; this study) in 1998 (11-, 13- and 15-year-olds).

their dentists about the theoretical background of the preventive effect of xylitol. Currently, almost all dental health educators (94–100%) include xylitol as a separate topic in the dental health education they provide (19). Moreover, Finnish children have been aware of the xylitol issue, and on their initiative the Finnish Parliament passed a special law exempting xylitol products from sweet taxation in 1994.

The use of xylitol chewing gum has been found to be more prevalent among girls than among boys. This has also been observed in earlier studies (10, 11). Girls adopt new health education messages more readily, and are more health-oriented in their behavior than boys. In one study, Finnish girls also demonstrated more health-oriented behavior than their Irish counterparts (20). In general, girls are also more concerned about their weight and they might have been more willing to use xylitol products because of the misconception that xylitol is a non-caloric sweetener (21), although its caloric content is equal to that of sucrose. A health-oriented motive could also explain the increase of xylitol use in relation to age among girls. This was consistent among girls but was not the case among boys. However, the increase among girls approaching puberty may well be a case of fashionable behavior without further health interest, which could explain the observed increase.

The frequency of toothbrushing also seemed to be related to daily use of xylitol chewing gum when the association between these two variables was studied (bivariate analysis) (11). Use of xylitol in this study was also studied using multivariate analysis. A logistic regression model is an appropriate way of examining the simultaneous effects of several interrelated explanatory factors. The factors which were included in the multivariate analysis are presented in Table 4. Gender and age appeared to be powerful explanatory variables for this

behavior. School performance could be regarded as a measure describing such individual factors as motivation, intelligence, and pleasing or normative behavior, which might to some extent also reflect the future socioeconomic status (SES) of the child. The economic situation of the family was a plain SES indicator, while toothbrushing frequency was a conscious indicator of health behavior. In the analysis, gender, age, economic situation of family, and toothbrushing frequency were significant explanatory variables. Obviously the economic situation of the family and toothbrushing frequency were strongly interrelated, as in other studies (11, 18). The non-significant association of school performance was contrary to earlier findings (11). This may be explained by the strong association between economic situation of the family and toothbrushing frequency.

The habitual use of xylitol chewing gum seems to result in a significant reduction in caries incidence in children (Table 1). According to the study of Virtanen et al. (22), the participation of subjects in a xylitol chewing gum trial resulted in a significant reduction in the number of initial restorations and hence in costs during the decade after the onset of gum use. Xylitol could be very useful as part of a preventive program especially during the maturation of the permanent teeth. The benefits of prevention are significant especially during vulnerable maturation periods of the permanent molars immediately after eruption also in combination with other preventive methods as sealants (23) and intensified toothbrushing (24).

The aim in this study was to describe how adolescents have adopted this already established preventive method at national level. The high prevalence figures seem to reflect a continuous and consistent increase of this habit in Finland. The high prevalence of daily users of xylitol chewing gum in Finland might be an important additional explanatory factor for explaining the lowest DMFT figures at the ages of 12 among industrialized countries together with Australia and Switzerland (25).

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## References

- Scheinin A, Mäkinen KK, editors. Turku sugar studies I–XXI. *Acta Odontol Scand* 1975;33 Suppl 70:1–349.
- Scheinin A, Mäkinen KK, Tammissalo E, Rekola M. Turku sugar studies. XIV. Incidence of dental caries in relation to 1-year consumption of xylitol chewing gum. *Acta Odontol Scand* 1975;33: Suppl 70:307–16.
- Galliulin AN. Evaluation of the caries-preventive action of xylitol. *Ksazan Med Zh* 1981;67:16–8.
- Kandelman D, Bär A, Hefti A. Collaborative WHO xylitol field study in French Polynesia. *Caries Res* 1988;22:55–62.
- Scheinin A, Banoczy J, Szoke J, et al. Collaborative WHO xylitol field studies in Hungary, I. Three-year caries activity in institutionalized children. *Acta Odontol Scand* 1985;43:327–47.
- Kandelman D, Gagnon G. A 24-month clinical study of the incidence and progression of dental caries in relation to consumption of chewing gum containing xylitol in school preventive programs. *J Dent Res* 1990;69:1771–5.
- Isokangas P, Tiekso J, Alanen P, Mäkinen KK. Long-term effect of xylitol chewing gum on dental caries. *Community Dent Oral Epidemiol* 1989;17:200–3.
- Mäkinen KK, Bennett Ca, Hujoel PP, et al. Xylitol chewing gums and caries rates: A 40-month cohort study. *J Dent Res* 1995;74:1904–13.
- Alanen P. Eestin kenttäkokeen tulokset osoittavat: Ksylitolipastilli ehkäisee tehokkaasti kariesta (The results of an Estonian clinical trials indicate: Xylitol lozenges is effective to prevent caries). *Xylitol News* 1998 (in Finnish).
- Honkala E. Dental health habits of Finnish adolescents. *Proc Finn Dent Soc* 1984;80 Suppl II:1–73 + appendixes.
- Honkala E, Rimpelä A, Karvonen S, Rimpelä M. Chewing of xylitol gum—a well-adopted practice among Finnish adolescents. *Caries Res* 1996;30:34–9.
- Paunio P, Rautava P, Sillanpää M, Kaleva O. Dental health habits of 3-year-old Finnish children. *Community Dent Oral Epidemiol* 1993;21:4–7.
- Nordblad A, Suominen-Taipale L, Murtomaa H, Vartiainen E, Koskela K. Smart Habit Xylitol campaign, a new approach in oral health promotion. *Community Dent Health* 1995;12:230–4.
- Murtomaa H, Vuopio T, Turtola L. The use of xylitol chewing gum in oral health promotion for Finnish students. *Health Promotion Int* 1993;8:271–4.
- Masalin K. Caries-risk-reducing effects of xylitol-containing chewing gum and tablets in confectionery workers in Finland. *Community Dent Health* 1992;9:3–10.
- Aarø LE, Wold B. Health behavior in schoolchildren. A WHO Cross-National Survey. Research protocol for the second survey 1985–86. Department of Social Psychology, University of Bergen, and WHO Euro, Copenhagen, 1985.
- King A, Wold B, Tudor-Smith C, Harel Y. The health of youth. A cross-national survey. A report of the 1993–94 survey results on the Health Behaviour in School-aged Children. A WHO Cross-National Study. Canada: WHO Regional Publications, European Series No. 69, 1996.
- Kuusela S, Honkala E, Kannas L, Tynjälä J, Wold B. Oral hygiene habits of 11-year-old schoolchildren in 22 European countries and Canada in 1993/1994. *J Dent Res* 1997;76:1602–9.
- Laiho M, Honkala E, Kannas L. How is oral health education conducted in Finnish health centers? *Community Dent Oral Epidemiol* 1995;23:119–24.
- Pattison K, Freeman R, Kuusela S, Honkala E. Adolescent sugar choices in Belfast and Kuopio. *J Inst Health Educ* 1996;34:75–9.
- Turtola L. Kokeilu ksylitolipurukumin käytöstä osana opiskelijateriaa (A trial of adding xylitol chewing gum to a part of university students' meal). *Ylioppilaiden terveydenhoitosäätiön tutkimuksia* 30, Helsinki 1990 (Finnish, English summary).
- Virtanen JI, Bloigu RS, Larmas MA. Timing of first restorations before, during, and after a preventive xylitol trial. *Acta Odontol Scand* 1996;55:211–6.
- Kolmakow S. Clinical forms of caries in permanent teeth among Finnish and Russian children. *Publ Univ Kuopio, Medicine, Orig Rep* 4/89, Kuopio, 1989.
- Carvalho JC, Thylstrup A, Ekstrand KR. Results after 3 years of non-operative occlusal caries treatment of erupting permanent first molars. *Community Dent Oral Epidemiol* 1992;20:187–92.
- World Health Organization. Global data on dental caries levels for 12 years and 35–44 years 1997. Oral health programme, Division of non-communicable disease. WHO, 1997.

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