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Non-biological factors associated with tooth retention in Irish adults

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Objectives*:** To identify non-biological factors associated with retention of natural teeth and sound untreated natural teeth among adults in Ireland. ***Design Data were collected in the 2000/'02 epidemiological survey of the oral health of Irish adults. ***Clinical setting*** Participants underwent a clinical oral examination in health board dental clinics and a detailed interview pertaining to oral and general health. ***Participants*** The analysis is based on a random sample of adults aged 16-24 years (n=1,196), 35-44 years (n=978), and 65 years and older (n=714). ***Main outcome measures*** Dependent variables were number of natural teeth present (NT), number of sound untreated natural teeth (SUNT), likelihood of being dentate, having 21 or more NT (21+NT), 28 or more NT (28+NT), and 18 or more SUNT (18+SUNT). Socioeconomic status (SES) was based on being disadvantaged, occupation status and educational attainment. Behavioural factors included smoking, snacking, brushing frequency and dental visiting patterns. Bivariate and multivariate regression analyses were performed. ***Results*** Tooth retention decreased with increasing age group. Level of education, disadvantage status, being in employment, frequent brushing and visiting the dentist for a check-up (instead of when in need or pain) were associated with tooth retention. Attending for a check-up moderated the impact of disadvantage on tooth retention among 35-44 year-olds. ***Conclusions:*** The results of this study indicate that several non-biological determinants are important for dental health in this adult population.

Key words: Brushing, dental attendance, frequent snacking, non-biological, smoking, socioeconomic status, sound untreated natural teeth, tooth retention, water fluoridation

Introduction

In established market economies, there have been major improvements in dental health, such as reductions in caries and increased tooth retention. Commonly used measures of adult dental health include retention of natural and sound teeth. The importance of number of remaining teeth for measuring dental health is clearly shown by the targeting of tooth loss by the Fédération Dentaire Internationale, World Health Organisation and International Association for Dental Research, outlined in their 2003 document "Global goals for oral health 2020". The targets include an increase in the number of natural teeth present, an increase in the number of individuals with functional dentitions (21 or more natural teeth), and a reduction in the number of edentulous persons (Hobdell *et al*., 2003a).

Dental caries and periodontal diseases have been identified as the most important risk factors for tooth loss. Other factors include prosthodontic reasons, trauma, dental fracture, failure of root canal, or restorative treatments. However, tooth loss has also been associated with socio-demographic factors such as gender and level of education (Treasure *et al*., 2001). It is well established that there are socio-economic inequalities in oral health (Watt, 2007), and a socio-economic gradient has been reported in a range of oral health outcomes (Donaldson, 2008; Hobdell *et al*., 2003b; Jamieson and Thomson, 2006; Sanders *et al*., 2006a; Thomson *et al*., 2004). The gradient between health and socio-economic status (SES) is usually referred to as health inequality. According to Watt (2007), "individuals at the top of the social hierarchy enjoy better health than those immediately below them, and as one goes down the social scale, health deteriorates further". The indicators of SES most commonly used when studying oral health inequalities are level of education, income and occupation (Haugejorden *et al*., 2008; Palmqiust *et al*., 2000; Thomson *et al*., 2004; Ylöstalo *et al*., 2004). Income and occupation describe access to and control over material resources, and education is seen to reflect acquired levels of capital, knowledge and skills (Sanders *et al*., 2006b).

A widely-used indicator of SES in Ireland is Medical Card (MC) eligibility, which is often used as an indicator of disadvantage. Most people in Ireland obtain a MC if their income is below a certain level, if the cost of meeting medical needs causes a person financial hardship, or if a person has entitlement under EU regulations. Between July 2001 and January 2009, all adults aged 70 years and over automatically received a MC. It entitles the holder to free medical care, including dental care services under the Dental Treatment Services Scheme.

Although oral health is adversely affected by poor socioeconomic circumstances (Hobdell *et al*., 2003b), water fluoridation has been found to reduce the socio-economic inequalities in oral health (Burt *et al*., 2002).

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Introduced in Ireland in 1964, approximately 71% of the Irish population now have access to fluoridated water supplies. Water fluoridation has been found to reduce caries experience, one of the most important risk factors for tooth loss (Whelton *et al*., 2007). Other non-biological factors that have been found to be associated with tooth retention include behavioural factors such as smoking, snacking, frequency of brushing (Morita *et al*., 2006), reason for attendance (Treasure *et al*., 2001) and frequency of visiting the dentist for a check-up (Ylöstalo *et al*., 2004).

In this paper, we investigate whether non-biological factors are significant in tooth retention in the Republic of Ireland. We also examine whether other explanatory variables moderate the relationship between SES and tooth retention.

Methods

Data used for this analysis are from the 2000/'02 national survey of adult oral health (Whelton *et al*., 2007). The survey of a stratified random sample of 2,888 adults was conducted by the Oral Health Services Research Centre (OHSRC), University College Cork. The three age groups targeted were 16-24 (n=1,196), 35-44 (n=978) and 65+ year-olds (n=714). The survey consisted of a thorough clinical oral examination and a detailed interview pertaining to oral and general health, perception of oral health services and oral health related quality of life. Full details of the survey methods are provided in the survey report (Whelton *et al*., 2007).

The sample was weighted (adjusted) according to gender, MC status, and age so as to be representative of the population as a whole. Weighting was based on estimates of Irish population totals from the Quarterly National Household Survey (QNHS) in the 3rd quarter of 2001. A tooth was defined as present when at least part of it was visible, and was considered sound if it was not decayed, filled, otherwise restored or traumatised on its coronal surface.

The outcome variables used in this study were number of natural teeth present (NT), number of sound untreated natural teeth (SUNT), 21 or more NT (21+NT), 28 or more NT (28+NT), and 18 or more SUNT (18+SUNT) and dentate status. According to Steele *et al*. (2000), it is around 21 or more teeth, or above, that people tend to experience dietary freedom and can rely on natural teeth without dentures for comfortable function. 18+SUNT was used as an arbitrary measure of dental health in previous surveys, including the most recent survey of adult oral health in Ireland (Whelton *et al*., 2007), and is used here for completeness.

NT and SUNT, which are counts of the number of natural teeth and sound untreated natural teeth present, were used as outcome measures in all age groups. According to Long and Freese (2006), applying linear regression to count outcomes can result in inefficient, inconsistent, and biased outcomes: they recommend the use of the Poisson Regression (PR) and/or Negative Binomial Regression (NBR) models, which are specifically designed for count outcomes. The NBR model is more appropriate (established by the Likelihood Ratio test) in the presence of over-dispersion. However, for the 16-24 year-olds, NT was characterised by under-dispersion, and the generalised 2-parameter log-gamma model (Hardin and Hilbe, 2007) was the best fit. Other outcome measures were selected by age group to reflect different clinical conditions. Logistic regression was used to estimate how each explanatory variable affects the probability of being dentate or of having 21+NT, 28+NT or 18+SUNT (binary outcomes).

The explanatory variables included socio-demographic indicators (gender, occupation, disadvantage status, level of education, exposure to water fluoridation), behavioural variables (smoking, snacking and brushing frequency, use of fluoride toothpaste) and dentist visiting variables (frequency of, and reasons for, dental visits). The data for the socio-demographic variables were collected by asking whether the subject was employed at the time of the survey, whether they had a Medical Card, and at what level they finished full time education. As Medical Card holders generally have a low level of income, having a Medical Card is used as a surrogate for disadvantage in this paper. Gender and number of year's exposure to fluoridated water were also recorded. Percentage of lifetime exposure to water fluoridation was calculated by dividing number of year's exposure to water fluoridation by age in years, and multiplying by 100. Behaviour was assessed by asking the subjects whether they smoked, how frequently they consumed sweet foods or drinks and brushed their teeth, and whether they used fluoride toothpaste. Dental visiting behaviour was assessed by determining frequency of visiting the dentist over the last few years and the reason that they normally visit the dentist.

The analyses were performed using Stata/SE10. Initial analysis included an assessment of the distribution of variables by age group, and a bivariate analysis to identify significant relationships between explanatory and outcome variables. Only variables that were statistically significant at the 5% level were included in the final multivariate analyses. Further analyses examined whether water fluoridation and behavioural factors moderated the relationship between SES and tooth retention. This involved using moderated multiple regression to analyse interactions between SES (as measured by disadvantage status, level of education and occupation) and regular visits to a dentist, attending for a check-up, frequent brushing and percent of lifetime exposure to water fluoridation.

Results

Descriptive statistics for the two count dependent variables, NT and SUNT, are presented in Table 1, and the distribution of characteristics by age group is presented in Table 2. The proportion of the Irish population who were male, employed and who had primary education only is also provided, based on 2002 Census figures (available from the Central Statistics Office), to demonstrate representativeness of the sample.

Mean number of NT and SUNT decreased with increasing age group: the 16-24, 35-44 and 65+ year-olds have mean NT of 28.2, 25.2 and 8.5 respectively, and mean SUNT of 23.3, 15.3 and 5.2 respectively (Table 1). Percentages dentate, with 21+NT, 28+NT and 18+SUNT

Table 1. Descriptive statistics for number of natural teeth present (NT) and number of sound untreated natural teeth (SUNT) by age group

		Mean	*SD*	*Percentiles*			*Min*	*Max*
				25%	50%	75%		
16-24	NT	28.2	2.0	28	28	29	18	32
	SUNT	23.3	4.9	21	24	27	0	32
35-44	NT	25.2	5.2	24	27	28	0	32
	SUNT	15.3	6.2	11	15	20	0	32
65+	NT	8.5	9.1	0	6	17	0	32
	SUNT	5.2	6.0	0	3	10	0	29

also decreased with increasing age group (Table 2). In terms of SES, 76.1% of 35-44 year-olds were in employment, and 37.9% and 71.1% of 65+ year-olds had primary education only and were disadvantaged, respectively. Smoking and frequent snacking were highest among the 16-24 year-olds, and frequent brushing, fluoride toothpaste use, regular visits, and visiting for a check-up were highest for 35-44 year-olds.

Table 3 presents, for each variable and age group, the results of the bivariate and multivariate analyses. It shows the percentage change in expected number of NT and SUNT, and percentage change in the odds of having 21+NT, 28+NT, 18+SUNT, and being dentate. Table 4 presents results from moderated multiple regression analysis, testing whether attending for a check-up moderated the relationship between being disadvantaged and retention of natural teeth (NT). Interactions between SES and regular visits to a dentist, attending for a check-up, frequent brushing and percent of lifetime exposure to water fluoridation were tested for all outcome measures, however only one significant interaction was found.

For 16-24 year-olds (Table 3), holding all other variables constant, being male significantly increased the expected number of NT and SUNT by 1.5% and 5.0% respectively, and increased the odds of having 28+NT by 33.2%. Being in employment increased the expected number of NT by 1.5%, and the odds of having 28+NT and 18+SUNT were 30.3% and 34.7% lower, respectively, for disadvantaged than non-disadvantaged 16-24 year-olds. Smoking decreased the expected number of SUNT by 3.1%, and frequent brushing increased the expected number of SUNT by 5.6%. Visiting the dentist regularly had a significant effect on all outcome measures, and had the largest effect on 18+SUNT. For every increase in percentage lifetime exposure to fluoridated water, expected number of SUNT increased by 0.04%. Percent lifetime exposure to fluoridated water also had a significant effect on 18+SUNT (0.6%). For 35-44 year-olds (Table 3), holding all other variables constant, being male significantly increased the expected number of SUNT by 8.4%. Being in employment increased the expected number of NT by 5.5%, and the odds of having 21+NT were 128.3% larger for those in employment than those who were not. Having only primary education decreased the expected number of NT by 9.8%. Smoking significantly decreased the expected number of NT by 5.3% and decreased the odds of having 21+NT by 55.1%. Frequent snacking had the largest effect on expected number of SUNT, and decreased the expected number of SUNT by 8.6%, and the odds of having 21+NT by 45.6%. Visiting the dentist regularly had the largest effect on the odds of having 21+NT and 18+SUNT. The odds of having 21+NT were 99.1% higher for those who visited the dentist regularly than those who did not; however the odds of having 18+SUNT were 32.5% lower. As percentage of lifetime exposure to water fluoridation increased, expected number of NT and SUNT increased by 0.1% and 0.2% respectively, and the odds of having 21+NT and 18+SUNT increased by 1.4% and 1.2% respectively. Moderated multiple regression found that there was a significant interaction between attending for a check-up and disadvantage status in retention of NT (Table 4).

For 65+ year-olds (Table 3), holding all other variables constant, being male significantly increased the expected number of NT and SUNT by 11.3% and 18.9% respectively. Being disadvantaged, having primary education only and being a smoker significantly decreased the expected number of NT by 10.5%, 12.1% and 16.7% respectively. Frequent snacking had the largest effect on SUNT, and decreased the expected number of SUNT by 29.0%. Frequent brushing increased the expected number of NT by 11.7% and the odds of having 21+NT were 114.6% greater for those who brushed frequently than those who did not. Visiting the dentist for a check-up, instead of when in need or in pain, had the largest effect on the odds of being dentate, and had the next largest effect after frequent brushing of having 21+NT.

Discussion

Mean NT was high for 16-24 year-olds despite the fact that the third molars (wisdom teeth) would not yet have erupted in some of the younger participants. Mean NT for 16-24 year-olds was 28.2; the median and 25th percentile were 28, and 75.2% of this age group had 28+NT, therefore 28+NT was used as a measure of dental health instead of the more frequently used 21+NT. In addition, dentate status was used instead of 18+SUNT for 65+ year-olds as 40.9% of this age group were edentulous and only 3.3% of dentate adults had 18+SUNT.

Table 2. Distribution of characteristics in sample by age group

		16-24		*35-44*		*65+*	
		n	*%*	*n*	*%*	*n*	*%*
Dependent Variables:							
Dentate	= 1 if at least one natural tooth present (dentate)	1194	100.0	968	99.1	422	59.1
	= 0 if no natural teeth present (edentulous)	0	0.0	9	0.9	292	40.9
21+NT	= 1 if 21 or more natural teeth present	1192	99.8	842	87.3	104	13.3
	= 0 if less than 21 natural teeth present	2	0.2	134	12.7	608	86.7
28+NT	= 1 if 28 or more natural teeth present	877	75.2	361	40.0	18	2.5
	= 0 if less than 28 natural teeth present	317	24.8	615	60.0	694	97.5
18+SUNT	= 1 if 18 or more sound untreated natural teeth present	1045	90.0	344	36.8	28	3.3
	= 0 if less than 18 sound untreated natural teeth present	151	10.0	634	63.2	686	96.7
Socio-demographic Variables:							
Male	= 1 if male	511	50.5	367	49.4	331	43.4
	Census 2002		(50.8)*		(49.7)		(43.4)
	= 0 if female	685	49.5	611	50.6	383	56.6
Occupation (employment)	= 1 if work full-time, part-time or self-employed	502	48.0	687	76.1	61	7.1
	Census 2002		(38.5)*		(72.3)		(6.3)
	= 0 if unemployed, homemaker, retired or student	667	52.0	258	23.9	602	92.9
Primary education	= 1 if primary education only	8	0.7	45	4.6	260	37.9
	Census 2002		(2.4)*		(7.9)		(49.9)
	= 0 if left education during second level, after second level, third level, or if still in full time education	1173	99.3	913	95.4	432	62.1
Disadvantaged	= 1 if disadvantaged (Medical Card holder)	263	19.0	197	17.4	456	71.1
	= 0 if not disadvantaged (no Medical Card)	920	81.0	761	82.6	242	28.9
% life Fl exposure	percentage lifetime exposure to fluoride (continuous variable) mean (standard deviation)	71.2	(41.9)	60.6	(34.8)	34.8	(19.8)
Behavioural Variables:							
Smoker	= 1 if smoker	376	32.1	285	29.7	112	17.4
	= 0 if non-smoker	798	67.9	661	70.3	580	82.6
Frequent snacks (dentate only)	= 1 if consume sweet food, or drink sweet drinks, at least three times/day	363	31.1	184	19.3	41	11.2
	= 0 if never, once a day or twice a day	808	68.9	759	80.7	349	88.8
Frequent brushing (dentate only)	= 1 if brush teeth twice/day or more	851	68.5	695	70.9	209	52.0
	= 0 if once a day/ a few times a week/ about once a week/never	336	31.5	258	29.1	192	48.0
Fluoride toothpaste (dentate only)	= 1 if always use	802	71.3	685	73.4	194	50.7
	= 0 if sometimes/never/do not use toothpaste/ previously used a fluoride toothpaste but don't anymore	383	28.7	264	26.6	205	49.3
Dentist Visiting Variables:							
Regular visits	= 1 if visit the dentist at least once a year	377	32.1	389	39.8	123	17.7
	= 0 if visit every 12-24 months/every 2 years or more/ occasionally/ never	796	67.9	560	60.2	566	82.3
Check-up	= 1 if visit the dentist for a check-up (prevention)	547	48.4	532	54.2	159	27.9
	= 0 if visit when in need or in pain (symptomatic)	560	51.6	401	45.8	408	72.1

* Note the age group in Census 2002 data was 15-24 years.

Table 3. Results from bivariate (BV) and multivariate (MV) analyses: percentage change in expected number of NT and SUNT, and in the odds of having 21+NT, 28+NT, 18+SUNT or being dentate

	16-24 year-olds															
	NT				*SUNT*				*28+NT*				*18+SUNT*			
	BV		*MV*		*BV*		*MV*		*BV*		*MV*		*BV*		*MV*	
male	1.7	***	1.5	***	4.1	***	5.0	***	38.8	*	33.2	*	23.5			
employment	1.7	***	1.5	***	-0.4				14.0				-10.3			
disadvantaged	-1.0				-2.0				-32.6	**	-30.3	*	-35.9	*	-34.7	*
primaryedonly	0.4				-3.8				7.8				-76.5	*	-79.1	
smoker	0.8				-3.5	**	-3.1	*	-18.5				-23.9			
frequentsnacks	-0.3				-2.2				7.3				-7.3			
frequentbrushing	0.5				4.0	**	5.6	***	13.8				47.3	*	39.2	
fluoridetoothpaste	-0.4				1.9				-9.8				18.1			
regularvisits	-1.3	**	-1.2	**	-4.5	***	-4.6	***	-30.2	**	-30.5	**	-36.4	**	-39.9	**
check-up	0.0				2.3				8.1				9.1			
% life Fl exposure	0.0				0.1	***	0.04	**	0.1				0.6	**	0.6	**

	35-44 year-olds															
	NT				*SUNT*				*21+NT*				*18+SUNT*			
	BV		*MV*		*BV*		*MV*		*BV*		*MV*		*BV*		*MV*	
male	1.1				6.9	*	8.4	**	13.5				29.7			
employment	7.9	***	5.5	***	4.6				159.0	***	128.3	***	0.7			
disadvantaged	-9.0	***	-3.0		1.3				-65.4	***	-31.4		24.8			
primaryedonly	-16.4	***	-9.8	**	-9.0				-59.5	**	-19.0		-12.9			
smoker	-8.9	***	-5.3	***	-5.2				-64.2	***	-55.1	***	1.1			
frequentsnacks	-5.7	***	-3.1		-8.3	**	-8.6	**	-57.8	***	-45.6	*	-27.2			
frequentbrushing	6.5	***	2.9		1.2				75.2	**	19.6		8.6			
fluoridetoothpaste	3.3	*	1.0		2.9				32.7				19.2			
regularvisits	8.3	***	1.4		-4.2				228.0	***	99.1	*	-32.0	**	-32.5	**
check-up	10.9	***	3.4		1.0				189.8	***	15.7		-15.2			
% life Fl exposure	0.1	***	0.1	***	0.2	***	0.2	***	1.2	***	1.4	***	1.2	***	1.2	***

	65+ year-olds															
	NT				SUNT				21+NT				Dentate			
	BV		MV		BV		MV		BV		MV		BV		MV	
male	29.6	*	11.3	*	23.5	**	18.9	**	55.8	*	34.2		53.9	**	45.4	
employment	44.6				16.1				155.3	**	97.1		82.6	*	125.0	
disadvantaged	-37.8	***	-10.5	*	-7.9				-59.9	***	-26.4		-50.7	***	-10.8	
primaryedonly	-40.5	***	-12.1	*	-3.9				-65.9	***	-44.6		-52.7	***	-26.6	
smoker	-40.2	**	-16.7	*	-18.0				-63.3	**	-54.3		-45.5	**	-29.4	
frequentsnacks	-18.2	*	-14.4		-30.8	***	-29.0	**	-60.6							
frequentbrushing	20.4	***	11.7	*	4.3				141.1	***	114.6	**				
fluoridetoothpaste	8.7				10.5				7.6							
regularvisits	136.1	***	4.9		7.2				305.6	***	-14.2		2146.1	***	142.2	
check-up	105.3	***	12.6		5.9				282.4	***	108.3	*	2012.7	***	1260.9	***
% life Fl exposure	0.4				0.2				0.3				0.5			

*p<=0.05; **p<=0.01; ***p<=0.001

Table 4. Results from moderated multiple regression analysis: percentage change in expected number of NT for 35-44 year-olds

	NT	*p-value*
disadvantaged	-10.8	<0.001
check-up*	6.9	<0.001
disadvantaged × check-up	9.7	0.008

*moderator variable

Despite significant overall improvements in oral health in recent decades, social inequalities have remained (Watt, 2007). As with health in general, those with the least resources have higher levels of disease. Population groups that suffer the worst oral health status tend to also be those who have the highest poverty rates and the lowest education (Timiş and Dănilă, 2005). Our results show that tooth retention was negatively associated with SES factors such as lower educational attainment and being disadvantaged and it was positively associated with being in employment. These findings are in agreement with results from previous studies. None of the indicators of SES were significant in SUNT, indicating no inequalities using this measure of dental health. Socio-economic gradients have been found in the retention of sound teeth (Donaldson *et al*., 2008), retention of natural teeth (Sanders *et al*., 2006a) and edentulism (Jamieson and Thomson, 2006). According to Watt (2007), "the universal social gradient in both general and oral health highlights the underlying influence of psychosocial, economic, environmental and political determinants".

The association between education level and tooth retention is consistent with the results of other studies (Palmqvist *et al*., 2000; Skudutyte-Rysstad *et al*., 2009; Treasure *et al*., 2001). It has been suggested that high educational attainment improves health through economic factors, psychosocial qualities, access to health services and health-related practices (Hammond, 2003).

Thomson *et al*. (2004) found, using life-course approach, that changes in socioeconomic advantage or disadvantage were associated with differing levels of oral health in adulthood. Being disadvantaged was significant in some measures of dental health. Whelton *et al*. (2007) found, in a national survey of adult oral health, that being disadvantaged was associated with poorer oral health. Although dental treatment is free to disadvantaged adults (MC holders) through the Dental Treatment Services Scheme, there are those who may not realise their entitlements. Many disadvantaged adults have a low level of income or are unemployed. Income has been associated with tooth retention (Haugejorden *et al*., 2008; Palmqvist *et al*., 2000). The importance of employment in predicting dental status is also supported (Ylöstalo *et al*., 2004). Although employment was significant in NT for 16-24 year-olds, its impact was modest.

The results show that there is a relationship between exposure to fluoridated water supplies and tooth retention, and it remained significant in multivariate analyses. Although its effect may seem modest, it was significant in sound teeth for 16-24 year-olds and in all outcome measures for 35-44 year-olds. Percentage lifetime exposure to water fluoridation is a continuous variable, so the results indicate that the benefits of water fluoridation for tooth retention may increase with increasing lifetime exposure. Therefore, water fluoridation may be responsible for the greater chance of having more teeth and more healthy teeth. The significance of water fluoridation is supported elsewhere (Burt *et al*., 2002). According to Burt *et al*. (2002), it is the most effective and practical method of reducing the SES-based inequalities in the burden of dental caries.

Retention of teeth is highly dependent on behaviour. The main aspects of good dental self-care are: the use of fluoride, the regular cleaning of one's teeth and the avoidance of excessive sugar consumption, all of which are supported by the results of this study. The negative relationship between smoking and retention of teeth is consistent with findings in other studies. For example, Ylöstalo *et al*. (2004) and Yanagisawa *et al*. (2009) found that smoking was associated with missing teeth, and Morita *et al*. (2006) found that smoking and frequent snacks were associated with tooth retention in Japanese adults.

Our results show that tooth retention was positively associated with frequent brushing and attending for a check-up. In keeping with other findings (Morita *et al*., 2006; Treasure *et al*., 2001; Vyšniauskaité *et al*., 2005; Ylöstalo *et al*., 2004), there was a significant association between frequent brushing and tooth retention. However, as most teeth were brushed with fluoride toothpaste, it is likely that the effect of tooth-brushing is actually as a result of fluoride application.

Visits to the dentist for a check-up can stimulate self-care, and allow dentists to provide preventive services, early diagnosis, and treatment of oral conditions. Treasure *et al*. (2001) found that attending regularly for a check-up was associated with tooth retention. They also found that those who reported attending the dentist only with trouble had significantly higher odds of having decayed and unsound teeth or un-restorable teeth. In this study, visiting the dentist regularly was negatively associated with retention of teeth for 16-24 year-olds; however, less than one third of this age group visited the dentist regularly and just over half of visits were when in need or pain. Attending for a check-up had a very large effect on having 21+NT or being dentate among 65+year-olds. The 35-44 year-olds had the highest proportion attending at least once a year and for a check-up, however this age group also had the greatest proportion in employment, many of whom would be eligible for the Dental Treatment Benefit Scheme. This scheme entitles adults (and their spouses) who have sufficient Pay-Related Social Insurance contributions to a free oral examination once a year. Results show that attending for a check-up appears to moderate the relationship between disadvantage status and NT for 35-44 year-olds.

Regular dental attendance is more prevalent in high socio-economic groups (Jamieson and Thomson, 2006), and is associated with better oral health outcomes (Sanders *et al*., 2006a). Donaldson *et al*. (2008) found that the socio-economic gradient in the number of sound teeth in adults is partially explained by dental attendance, which in turn is determined by the effect of SES on barriers to regular dental attendance. They suggest that reducing barriers to, and promoting, regular dental attendance for low-socio-economic groups may reduce oral health inequalities. Watt (2007) suggests that, to reduce inequalities, an approach is needed which addresses the underlying social determinants of oral health through complementary public health strategies.

Conclusion

This study identifies non-biological determinants associated with retention of natural teeth and sound untreated natural teeth among adults in Ireland. Identifying people

at high risk for tooth loss is important in terms of clinical interventions to preserve the natural dentition and ensure that it remains functional and socially acceptable. The results show that education, occupation, disadvantage status, smoking, frequent snacking, brushing, regular dental visits, and reasons for dental visits influence retention of teeth. The study highlights the impact of diet and lifestyle on retention of teeth, and the importance of good oral hygiene and regular dental visits. It is worth noting that whilst many of the associations found were statistically significant, their clinical significance was not assessed in this project.

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