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Socioeconomic inequalities in oral health aspects in primary school children: a cross-sectional survey

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Key words

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Healthcare disparities (MeSH)

Social class (MeSH)

Pediatric Dentistry

word count: 3,380

Abstract

Objectives: Oral health inequality in children is a widespread and well-documented problem in oral health care. However, objective and reliable methods to determine these inequalities in all oral health aspects, including both dental attendance and oral health, are rather scarce.

Aims: to explore oral health inequalities and to assess the impact of socio-economic factors on oral health, oral health behaviour and dental compliance of primary schoolchildren.

Methods: Data collection was executed in 2014 within a sample of 2,216 children in 105 primary schools in Flanders, by means of an oral examination and a validated questionnaire. Intermutual Agency database was consulted to objectively determine individuals' social state and frequency of utilization of oral health care services. Underprivileged children were compared to more fortunate children for their mean DMFt, DMFs, Plaque index, Care Index (CI), Restorative Index (RI), Treatment Index (TI), knowledge and attitude. Differences in proportions for dichotomous variables (RI100%, TI100% and being a regular dental attender)were analysed. The present study was approved by the Ethics Committee of the University Hospital Ghent (2010/061). All parents signed an informed consent form prior to data collection. All schools received information about the study protocol and agreed to participate. Children requiring dental treatment or periodic recall were referred to the local dentist.

Results: Underprivileged children showed worse outcomes for all explanatory variables ($p<0.05$). In the low-income group, 78.4% was caries free, compared to 88.4% for the other children. Half of the low-income children could be considered as regular dental attenders, whether 12.6% did not have any dental visit during a five year period.

Conclusion: Oral health, oral hygiene, oral health care level and dental attendance patterns are strongly negatively affected by children's social class, leading to oral health inequalities in Belgian primary school children.

Strenghts and limitations

Strenghts:

-Large and random selected sample of children in the last year of primary school.

-All aspects of oral health and oral health behaviour are considered in this paper.

-Oral health and oral health behaviour are linked to social security databases on oral health care utilization for a 5-year period. This objective information is seldom available in international literature on health care utilization, but is far more reliable than a self-administered questionnaire, avoiding bias.

Limitations:

-Sample only includes Belgian subjects

-The design of the study does not allow us to identify specific causes for inequalities in oral health and dental non-attendance, only associations.

-Since Glimlachen.be® is a four-year longitudinal program visiting schools, most of the subjects will have received previous dental screenings before the present data collection. These screenings might have positively influenced the oral health and oral health behaviour of all children, resulting in an underestimation of oral health related problems. However, this influence should be equal for both compared groups.

Introduction

Background

Although dental caries is largely preventable, it is a major public health problem, since untreated tooth decay remains by far the most common chronic disease worldwide (1). International data on childhood caries epidemiology confirm that dental caries remains a 'significant and consequential disease of childhood', being increasingly localized in a subgroup of high-risk children, both in developing and developed countries (2).

Dental caries is a multifactorial disease. Consumption of sugary substances and poor oral health practices largely affect the occurrence of tooth decay. Literature provides powerful evidence that dental caries is positively correlated to sugar intake (3) and adversely correlated to tooth brushing with a fluoridated toothpaste (4). However, all dietary and behavioural determinants of caries are influenced by people's social context, resulting in worsened oral health outcomes in underprivileged groups. Socio-economic inequalities in pre-school children have already been reported nationally and internationally. Van den Branden not only highlights the occurrence of early childhood caries in preschool children (3-5 years old), but also provides some evidence that a social gradient in early childhood caries can be suggested (5). This confirms results from earlier national reports and is consistent with international literature (2,6,7,8). For the Belgian situation however, the mentioned national reports only include preschool children. Recent data from children attending school are scarce, but certainly needed (9).

The occurrence of dental caries and other oral diseases is not the only domain in which inequalities appear. Use of oral health care facilities and regular preventive dental check-up are also affected by social variables. In adulthood, it is clear that dental non-attenders rank significantly more often at the lower end of the socioeconomic scale (10). Regarding the financial aspect of oral health care in Belgium a fee-for-service payment method is used, combined with a compulsory health insurance. In this system a patient pays the entire dental visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this

sum from his health insurance agency. To reduce inequalities in (oral) health, some national government initiatives have been implemented yet. Underprivileged individuals can be entitled to an increased allowance for health care interventions when the family income is low. In case of excessive medical costs, less fortunate people can also have access to the mechanism known as the "Maximum Bill", calculating a cost limit for medical care. All medical costs exceeding this limit will be completely reimbursed. Furthermore, a full coverage of regular treatment costs for all children under the age of 18 is guaranteed, provided that the dentist acceded to the convention between the national health insurance agency and dental professional organisations. For 2015-2016 period, 62.64% of Belgian dentists partially or completely take part in this convention.

Objectives

Objective data on children's dental non-attendance and health consumption are scarce, not only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national database data on utilization of (oral) health care services, this article provides objective information on oral health consumption and dental attendance.

In this study the authors aimed to explore existing oral health inequalities and to assess the impact of socio-economic factors on oral health, oral health behaviour and dental compliance of primary schoolchildren.

Materials and methods

Study design, settings and population

The present survey fits into the context of Glimlachen.be®, a prospective four-year longitudinal oral health promotion program, visiting primary schools in Flanders (Belgium)

with a mobile dental unit. It is conducted by dentists of the Flemish Dental Association under the authority of the National Institute for Health and Disability Insurance (NIHDI).

The present cross-sectional study reports on the oral health condition of children in the last year of primary school, recruited in all schools in Flanders within the three educational networks (GO – publicly run under the authority of the Flemish Community (15%); OGO publicly funded and publicly run by local authorities or provincial authorities (15%; VGO publicly funded and privately run by private non-profit-making organisations, mainly catholic schools (70%)).

The study population is estimated to be about 68000 children in 2340 schools. The unit of randomisation was the school. Schools were randomly selected with an oversampling of 2% for schools with assistance from special education for disabled children or children with learning or educational difficulties. The sample size was determined based on a confidence level of 95% and a margin of error of 2.5%.

Data were collected in 2014 from a representative sample of 2,216 primary school children in 105 different schools in Flanders.

Data collection

In all participants, oral health condition was recorded by visual inspection with a mobile dental unit in school premises by 44 well-trained and calibrated dentist-examiners. Calibration was undertaken to avoid bias, using a series of full-mouth photographs simulating the clinical examination of patients, set up in a PowerPoint presentation. Intra Class Correlation Coefficient (ICC) for all examiners was 0.86 with a 95% confidence interval of 0.82 to 0.90. General kappa score was 0.72.

Individual children have been examined for several oral health parameters. DMFT was used as outcome variable to count the number of decayed (D), missing (M) and filled (F) teeth. Caries detection was based on the International Caries Detection and Assessment System (ICDAS), using six subcategories of caries going from first visible change in enamel (score 1) to extensive cavity with visible dentin possibly reaching the pulp (score 6). Both caries at D1 level (score > 0: early enamel lesions and decay into dentine) and D3 level (score ≥4: obvious decay into dentine, excluding early lesions restricted to the enamel) are taken into account. The level of provided care has been approached through the restorative index (RI= (Ft/D3Ft) *100), care index (CI= (Ft/D3MFt)*100) and treatment index (TI= (MF/D3MFt)*100), all ranging from 0 to 100%. Restorative and treatment index were also dichotomized to divide subjects into two groups: children without untreated caries (RI = 100%, TI=100%) and children with untreated caries (RI<100%, TI<100%).

Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Löe (11). This index calculates the mean buccal surface plaque score of six reference teeth on a scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).

Both knowledge and attitude were assessed by a validated and reliable questionnaire, answered by the children. An expert panel tested the content validity of the items, after which the questionnaire was pretested in a small subgroup of primary school children on two different time points to check the discriminatory power and reliability (test-retest). A higher score out of ten correlates to more knowledge and a better attitude.

To explore the impact of social environment on oral health and oral health related behaviour, knowledge and attitude, a summary measure was used to characterize the deprivation level. All parameters have been analysed in children eligible for the “Maximum Bill” for at least one year between 2009 and 2013, compared to those who cannot take profit of this system

(dichotomous explanatory variable). The Maximum Bill measure is automatically assigned to individuals in order to reimburse medical costs exceeding a certain limit, based on income levels. Accordingly, those who benefit from it correspond to underprivileged individuals. Those without can be considered as middle and high-income subjects. The combined questionnaire and oral health examination data were supplemented with the Intermutual Agency (IMA) national database data on utilization of (oral) health care services, in order to trace individuals who can make use of the Maximum Bill and to obtain information on participants' frequency of utilization of oral health care services. This includes all attested dental treatments and regular preventive dental check-ups over a period from 2009 to 2013. By consensus, participants are considered as regular dental attenders if IMA database reported at least one dental visit in three different years over a four-year period, excluding urgency treatments. Subsequently, a dichotomous variable has been created to distinguish regular dental attenders from non-regular dental attenders.

Data analysis

Data analysis was carried out in the IBM SPSS Statistics V22.0 (SPSS Inc., Chicago, IL, USA). Independent Sample T-test was used to compare underprivileged and more fortunate individuals for their mean DMFT, DMFS, Plaque index, Care Index, Restorative Index, Treatment Index, knowledge and attitude scores. A parametrical test was used, based on the central limit theorem. Differences in proportions for dichotomous variables (RI100%, TI100% and being a regular dental attender) have been compared in crosstabs, using a Chi Square statistical test. Alpha was set at < 0.05.

The approach used to deal with uncomplete records and so to avoid bias, was to compare the proportion of children eligible for the "Maximum Bill" in both responders and non-responders (no clinical data available), by using the Chi Square statistical test. This social parameter

could be determined for all children by using the national registration number of the child and the IMA database.

Ethical aspects

The present study was approved by the Ethics Committee of the University Hospital Ghent (2010/061). All parents signed an informed consent form prior to data collection. All schools received information about the study protocol and agreed to participate. Children requiring dental treatment or periodic recall were referred to the local dentist.

Results

Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years (±0.68). Data analysis could be performed in 88.2% (n=1,954). Uncomplete records are due to failure to obtain consent and child's absence from school on the day of examination. From these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of responders and non-responders, there was no relationship between the missingness of data and the distribution of the social indicator (p=0.4).

More than 19% (n=374) of the children made use of the Maximum Bill. Being part of this subgroup significantly affected oral health and oral health behaviour, as demonstrated in table 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a higher plaque index and higher DMFt and DMFs scores, both at D1 and D3 level. Overall care level was significantly lower, resulting in a lower care index, treatment index and restorative index. Both knowledge and attitude scores were slightly but significantly lower in low-income children.

Regarding the proportion of participants being completely treated for caries, underprivileged children again differ from their more fortunate counterparts. According to table 2, 78.4% of the low-income children was caries free (DMFT=0), compared to 88.4% for the high income group. From those having a DMFT>0, 55.3% of the Maximum Bill group children were found to have a 100% Treatment index against 65.8% for children of higher social class. The same trend appeared when comparing the 100% Restorative index, resulting in strongly significant differences. Half of the low-income children (50.3%) could be considered as regular dental attenders for the period between 2009 and 2013, whether 12.6% did not have any dental visit during these five year period. Middle- and high-income children visited the dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only 3.4% of these children did not report any dental visit. All of these differences proved to be statistically significant.

Discussion

Oral health inequalities are clearly visible within the present sample of primary school children. Since 2,216 subjects were randomly selected in 105 different primary schools in Flanders, results can be extrapolated to the entire Flemish region.

All oral health related parameters are strongly and significantly affected by participants' social class. Not only caries experience, by means of DMFt and DMFs, proves to be higher in underprivileged groups, but also oral hygiene (plaque index) and the level of care seems to depend on families' social context. A 10% gap emerges when comparing Care index, Treatment index and Restorative index for middle/high-income and low income children, in disadvantage of the latter group. Statistical analysis clearly demonstrates underprivileged children to visit less frequently the dental practitioner. One out of eight low-income children

(12.6%) did not see a dentist one single time during the five years prior to data collection. This dental absenteeism is almost four times higher in underprivileged groups compared to the more fortunate subgroups.

The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon, but are in accordance with global findings. International literature is overloaded with recent evidence demonstrating social inequalities in oral health. A systematic review by Scwendicke shows that low social class is associated with an increased risk of dental caries, especially in more developed countries (12). Childhood financial hardship not only has a main impact on individuals oral health during childhood, but also in later life. Poulton et al. (13) revealed that low childhood socio-economic status (SES) contributes to increased adult levels of caries and periodontal disease, even after adjusting for adult SES. Listl et al. (14) confirmed these findings, showing the long-term adverse effects of financial problems in childhood on oral health in middle and later adulthood.

The todays' persistence of social inequalities, both in Flanders and in the entire world, is food for thought. From the most negative point of view, one could state that all previous oral health promotion campaigns, health promoting schools and governmental interventions simply failed to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not able to uncover a specific reason for this failure. What needs to be considered and further investigated, is the key role played by the family and environmental context in children's dental adherence. It is clear that 12-year old children cannot be taken fully responsible for being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that parental oral health habits affects children's oral health. For this reason, the authors of this review state that oral health promotion programs need to put emphasis on the entire family context, concerning their lifestyle and oral health behaviour.

Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for all children under the age of 18, so in fact differences in utilization of health care services for financial reasons are not expected. However, in most dental practices, the often high dental fee needs to be paid first by the client, to get it reimbursed by the health insurance agency afterwards. Third party payment is allowed for minors, but not well established. Further, 37.36% of the Belgian dentists did not take part in the fee convention, bearing a risk of potentially increased dental costs. Further research is needed to evaluate the effects of different provider payment methods on social inequalities.

Although oral health inequalities have always existed and are still remaining, society cannot simply acquiesce in its existence. Dental caries is largely preventable, but still remains the most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16). Dental treatment is expensive, absorbing a considerable part of overall health care budget (17). Focussing on prevention and tackling oral health inequalities not only improve individuals' oral health and quality of life, but can also help in reducing governmental costs. Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream public health approach, targeting the deeper social, political and economic causes of oral health inequalities. They advocate new multidisciplinary preventive strategies at local, regional, national and international levels, based on a common risk factor approach. Quoting the authors, "collaborative efforts among researchers, policy makers, public health practitioners, clinical teams, and the public are urgently required". So, decisions on oral health promotion and tackling oral health inequalities should not exclusively be made by policymakers, but also involve dentists and intermediate partner organizations.

The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by introducing the method of 'proportionate universalism'. Interventions don't need to focus

only on the most disadvantaged individuals, but should be universal and contain a scale and intensity in accordance with subgroups' level of disadvantage.

Conclusion

Oral health inequalities are an undeniable reality in primary school children in Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance patterns are strongly negatively affected by children's social class.

Acknowledgement

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Contributorship statement

All authors declare to have had substantial contributions to the conception and design of the work, to have drafted and revised the work for important intellectual content. All authors gave final approval of the version to be published; and agreement to be accountable for all aspects of the work.

The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University, department of Community Dentistry and Oral Public Health. His task was to analyze data and write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L. Martens are the PhD supervisors of drs. Lambert. They are all participating in the 'Glimlachen.be' project from its very beginning. In that way, they could provide essential

information on data collection procedure and other methodological aspects of the present study. Their expertise was indispensable to realize this publication.

Competing interests

All co-authors declare no competing interests

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Data sharing statement

Patient leveled data or full data set and statistical code book are available from the corresponding author on request.

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Table 1: significant differences between children utilizing the "Maximum Bill" and those not using it

	Maximum Bill	N	Mean	SD	p-value
Mean Plaque index	No	1602	0.41	0.48	**<0.001**
(missing = 1)	Yes	351	0.59	0.58	
DMFt (D1-level)	No	1601	1.68	2.05	**<0.001**
(missing = 1)	Yes	352	2.79	2.43	
DMFt (D3-level)	No	1600	0.78	1.42	**<0.001**
(missing = 2)	Yes	352	1.25	1.68	
DMFs (D1-level)	No	1602	2,30	3.25	**<0.001**
(missing = 0)	Yes	352	4,02	4.07	
DMFs (D3-level)	No	1602	1,18	2.51	**<0.001**
(missing = 0)	Yes	352	2,00	3.16	
Care index*	No	544	70.33	42.14	**<0.001**
(missing = 0)	Yes	170	58.46	45.17	
Treatment index*	No	544	73.13	40,83	**0.02**
(missing = 0)	Yes	170	64.79	43,75	
Restorative index*	No	537	72.18	41.57	**0.01**
(missing = 0)	Yes	164	62.22	44,79	
Knowledge	No	1483	7.58	2.12	**<0.001**
(missing = 183)	Yes	288	6.78	2.49	
Attitude	No	1482	8.37	1.32	**0.002**
(missing = 183)	Yes	289	8.10	1.44	

*Of those having DMF>0

Table 2: cross-table comparing children using the "Maximum Bill" to more privileged children, for dichotomous explanatory variables

	Maximum Bill		
Variable	No	Yes	p-value
Treatment index (TI=100%)	65.8% (n=358)	55.3% (n=94)	**0.01**
Restorative index (RI=100%)	65.4% (n=351)	53.7% (n=88)	**0.008**
Regular dental attender*	77.7% (n=1344)	50.3% (n=188)	**<0.001**
No dental visit between 2009 and 2013	3.4% (n=59)	12.6% (n=47)	**<0.001**
Caries free proportion	88.4% (n=1414)	78.4% (n=276	**<0.001**

* at least one dental visit in three different years over a four-year period, excluding urgency treatments

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	*(*a) Indicate the study's design with a commonly used term in the title or the abstract **Cross-sectional survey (title page)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **Page 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **Background (page 4)**
Objectives	3	State specific objectives, including any prespecified hypotheses **Objectives (page 5)**
Methods		
Study design	4	Present key elements of study design early in the paper **Page 6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Page 6**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **Page 6**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Data collection (page 6-7)**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **(Page 7)**
Bias	9	Describe any efforts to address potential sources of bias **Calibration of examiners (Page 6-7)**
Study size	10	Explain how the study size was arrived at **Study design, settings and population (Page 6)**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Page 7-8**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Data analysis (page 8)**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 8**
		(*c*) Explain how missing data were addressed **Page 9**

(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **Page 6**
(*e*) Describe any sensitivity analyses **Not applicable**

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Page 9**
		(b) Give reasons for non-participation at each stage **Page 10**
		(c) Consider use of a flow diagram **Not applicable (cross-sectional design)**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Page 10**
		(b) Indicate number of participants with missing data for each variable of interest **Table 1 (Page 18)**
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **Tables page 17-18**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized **Table 2 (Page 19)**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **Not applicable**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Not applicable**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Page 10**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Strenghts and limitations (page 3)**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Page 10-11**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 10**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Acknowledgement (page 13)**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic inequalities in caries experience, care level and dental attendance in primary school children in Belgium: a cross-sectional survey

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Introduction

Background

Although dental caries is largely preventable, it is a major public health problem, since untreated tooth decay remains by far the most common chronic disease worldwide (1). International data on childhood caries epidemiology confirm that dental caries remains a 'significant and consequential disease of childhood', being increasingly localized in a subgroup of high-risk children, both in developing and developed countries (2).

Dental caries is a multifactorial disease. Consumption of sugary substances and poor oral health practices largely affect the occurrence of tooth decay. Literature provides powerful evidence that dental caries is positively correlated to sugar intake (3) and adversely correlated to tooth brushing with a fluoridated toothpaste (4). However, all dietary and behavioural determinants of caries are influenced by people's social context, resulting in worsened oral health outcomes in underprivileged groups. Socio-economic inequalities in pre-school children have already been reported nationally and internationally. Van den Branden not only highlights the occurrence of early childhood caries in preschool children (3-5 years old), but also provides some evidence that a social gradient in early childhood caries can be suggested (5). This confirms results from earlier national reports and is consistent with international literature (2,6,7,8). For the Belgian situation however, the mentioned national reports only include preschool children. Recent data from children attending school are scarce, but certainly needed (9).

The occurrence of dental caries and other oral diseases is not the only domain in which inequalities appear. Use of oral health care facilities and regular preventive dental check-up are also affected by social variables. In adulthood, it is clear that dental non-attenders rank significantly more often at the lower end of the socioeconomic scale (10). Regarding the

financial aspect of oral health care in Belgium a fee-for-service payment method is used, combined with a compulsory health insurance. In this system a patient pays the entire dental visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this sum from his health insurance agency. To reduce inequalities in (oral) health, some national government initiatives have been implemented. Underprivileged individuals can be entitled to an increased allowance for health care interventions when the family income is low. In case of excessive medical costs, people can also have access to the mechanism known as the "Maximum Bill", calculating a cost limit for medical care for every individual. The higher the family income, the higher the cost limit. When medical costs exceed this limit, they will be entirely and automatically reimbursed. Furthermore, a full coverage of regular treatment costs for all children under the age of 18 is guaranteed, provided that the dentist acceded to the convention between the national health insurance agency and dental professional organisations. For 2015-2016 period, 62.64% of Belgian dentists partially or completely took part in this convention.

Objectives

Objective data on children's dental non-attendance and health consumption are scarce, not only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national database data on utilization of (oral) health care services, this article provides objective information on oral health consumption and dental attendance.

In this study the authors aimed to explore existing oral health inequalities and to assess the impact of socio-economic factors on oral health, oral health behaviour and dental compliance of primary schoolchildren.

Materials and methods

Study design, settings and population

The present survey fits into the context of Glimlachen.be®, a prospective four-year longitudinal oral health promotion program, visiting primary schools in Flanders (Belgium) with a mobile dental unit. It is conducted by dentists of the Flemish Dental Association under the authority of the National Institute for Health and Disability Insurance (NIHDI).

The present cross-sectional study reports on the oral health condition of children in the last year of primary school, recruited in all schools in Flanders within the three educational networks (GO – publicly run under the authority of the Flemish Community (15%); OGO publicly funded and publicly run by local authorities or provincial authorities (15%; VGO publicly funded and privately run by private non-profit-making organisations, mainly catholic schools (70%)).

Data were collected in 2014 from a representative sample of 2,216 primary school children in 105 different schools in Flanders. The total study population is estimated to be about 68000 children in 2340 schools. Schools were randomly selected, based on a two-step stratification. In the first step, a stratified randomisation was executed at school-level, based on three strata: number of pupils, region and educational network. In the next step, randomisation occurred at the individual level. There was an oversampling of 2% for schools with assistance from special education for disabled children or children with learning or educational difficulties. The sample size was determined based on a confidence level of 95% and a margin of error of 2.5%. There were several sample size estimations, depending on the variability of the different outcome variables. The authors decided to include as many children as practically possible, based on the availability of three mobile dental units and the number of school days.

Data collection

In all participants, oral health condition was recorded by visual inspection with a mobile dental unit in school premises by 44 well-trained and calibrated dentist-examiners. All examiners were blinded to the socioeconomic status of the children they examined. Calibration was undertaken to avoid bias, using a series of full-mouth photographs simulating the clinical examination of patients, set up in a PowerPoint presentation. Intra Class Correlation Coefficient (ICC) for all examiners was 0.86 with a 95% confidence interval of 0.82 to 0.90. General kappa score was 0.72.

Individual children have been examined for several oral health parameters. DMFT was used as outcome variable to count the number of decayed (D), missing (M) and filled (F) teeth. Caries detection was based on the International Caries Detection and Assessment System (ICDAS), using six subcategories of caries going from first visible change in enamel (score 1) to extensive cavity with visible dentin possibly reaching the pulp (score 6). Both caries at D1 level (score > 0: early enamel lesions and decay into dentine) and D3 level (score ≥4: obvious decay into dentine, excluding early lesions restricted to the enamel) were taken into account. The level of provided care has been approached through the restorative index (RI= (Ft/(D3+Ft)) *100), with Ft standing for "filled teeth", care index (CI= (Ft/(D3+M+Ft))*100) and treatment index (TI= ((M+F)/(D3+M+Ft))*100), all ranging from 0 to 100%. These indices can only be calculated for those children having a DMFT score > 0. For the other children (DMFT=0), it is mathematically impossible to calculate RI, CI and TI, since the formula should request to divide by "0". Restorative and treatment index were also dichotomized to divide subjects into two groups: children without untreated caries (RI = 100%, TI=100%) and children with untreated caries (RI<100%, TI<100%).

Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Löe (11). This index calculates the mean buccal surface plaque score of six reference teeth on a scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).

Both knowledge and attitude were assessed by a validated and reliable questionnaire, answered by the children. A higher score out of ten correlates to more knowledge and a better attitude. An expert panel tested the content validity of the items, after which the questionnaire was pretested in a class of 25 primary school children (convenience sample) on two different time points (test-retest). Internal consistency was analysed by means of the Cronbach's Alfa, resulting in a score of 0.75, which fits into the required interval of 0.70<Cronbach's Alpha<0.90.

To explore the impact of social environment on oral health and oral health related behaviour, knowledge and attitude, a summary measure was used to characterize the deprivation level. All parameters have been analysed in children eligible for the "Maximum Bill" for at least one year between 2009 and 2013, compared to those who cannot take part of this system (dichotomous explanatory variable). The Maximum Bill measure is automatically assigned to individuals in order to reimburse medical costs exceeding a certain limit, based on income levels. Accordingly, those who benefit from it correspond to underprivileged individuals. Those without can be considered as middle and high-income subjects. The combined questionnaire and oral health examination data were supplemented with the Intermutual Agency (IMA) national database data on utilization of (oral) health care services, in order to trace individuals who can make use of the Maximum Bill and to obtain information on participants' frequency of utilization of oral health care services. This includes all attested dental treatments and regular preventive dental check-ups over a period from 2009 to 2013. By consensus, participants are considered as regular dental attenders if IMA database reported at least one dental visit in three different years over a four-year period, excluding urgency

treatments. Subsequently, a dichotomous variable has been created to distinguish regular dental attenders from non-regular dental attenders.

Data analysis

Data analysis was carried out in the IBM SPSS Statistics V22.0 (SPSS Inc., Chicago, IL, USA). Independent Sample T-test was used to compare underprivileged and more fortunate individuals for their mean DMFT, DMFS, Plaque index, Care Index, Restorative Index, Treatment Index, knowledge and attitude scores. A parametrical test was used, based on the central limit theorem. Differences in proportions for dichotomous variables (RI100%, TI100% and being a regular dental attender) have been compared in crosstabs, using a Chi Square statistical test. Alpha was set at < 0.05.

The approach used to deal with uncomplete records and so to avoid bias, was to compare the proportion of children eligible for the "Maximum Bill" in both responders and non-responders (no clinical data available), by using the Chi Square statistical test. This social parameter could be determined for all children by using the national registration number of the child and the IMA database.

Ethical aspects

The present study was approved by the Ethics Committee of the University Hospital Ghent (2010/061). All parents signed an informed consent form prior to data collection. All schools received information about the study protocol and agreed to participate. Children requiring dental treatment or periodic recall were referred to the local dentist.

Results

Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years (SD 0.68). Data analysis was performed in 88.2% (n=1,954). Incomplete records were due to

failure to obtain consent and child's absence from school on the day of examination. From these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of responders and non-responders, the proportion of children eligible for the 'Maximum Bill' was equal for both groups (Chi Square Test; p=0.4).

More than 19% (n=374) of the children made use of the Maximum Bill. Being part of this subgroup significantly affected oral health and oral health behaviour, as demonstrated in table 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a higher plaque index and higher DMFt and DMFs scores, both at D1 and D3 level. Overall care level was significantly lower, resulting in a lower care index, treatment index and restorative index. Both knowledge and attitude scores were slightly but significantly lower in low-income children.

Regarding the proportion of participants being completely treated for caries, underprivileged children again differ from their more fortunate counterparts. According to table 2, 78.4% of the low-income children were caries free (DMFT=0), compared to 88.4% for the high income group. From those having a DMFT>0, 55.3% of the Maximum Bill group children were found to have a 100% Treatment index against 65.8% for children of higher social class. The same trend appeared when comparing the 100% Restorative index, resulting in strongly significant differences. Half of the low-income children (50.3%) could be considered as regular dental attenders for the period between 2009 and 2013, whether 12.6% did not have any dental visit during these five year period. Middle- and high-income children visited the dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only 3.4% of these children did not report any dental visit. All of these differences proved to be statistically significant.

Discussion

Oral health inequalities are clearly visible within the present sample of primary school children. Since 2,216 subjects were randomly selected in 105 different primary schools in Flanders, results can be extrapolated to the entire Flemish region.

All included oral health parameters were strongly significantly affected by participants' social class. Not only caries experience, by means of DMFt and DMFs, proved to be higher in underprivileged groups, but also oral hygiene (plaque index) and the level of care seemed to depend on families' social context. This level of care was assessed by means of the restorative index, care index and treatment index. These indices could only be calculated for children having a DMFT > 0. This was mathematically declared in the methodological section, by explaining that it is impossible to divide by "0", which would be the case for those having a DMFT =0. Also clinically, this would be irrelevant, because the indices aim to calculate the proportion of the decayed teeth which have been restored or extracted. If there is no caries experience at all (DMFT=0), these indices are not applicable.

An arithmetic gap of 11.87, 8.34 and 9.96 emerges when comparing Care index, Treatment index and Restorative index for middle/high-income and low income children, in disadvantage of the latter group. The three indices do not all have the same meaning. Restorative index (RI= (Ft/(D3+Ft)) *100) does not consider the missing teeth, because there can be doubts whether teeth were removed due to caries or due to other factors (trauma, periodontal infection). Care index (CI= (Ft/(D3+M+Ft))*100) partially involves the missing teeth, but the index does not consider a tooth extraction as a 'solution', but as part of the problem. Children are literally 'missing' a tooth, so tooth extraction it is seen as a 'lost chance'. On the other hand, Treatment Index (TI= ((M+F)/(D3+M+Ft))*100) proposes tooth extraction as part of the solution, because it removes a (potential) focus of infection. It gives

the same value to fillings and extractions. None of these indices can be considered as 'all-embracing', so it is good to compare them. When two subgroups differ significantly in restorative index, but not in treatment index, this means that one of the groups received more tooth extractions, which can be relevant to explore the severity of the disease and the way of treating it. The present findings suggest that the low-income children had more teeth being extracted, although it is hard to determine the clinical relevance of a 1% difference between treatment index and restorative index.

Statistical analysis clearly demonstrates underprivileged children to visit less frequently the dental practitioner. One out of eight low-income children (12.6%) did not see a dentist one single time during the five years prior to data collection. This dental absenteeism is almost four times higher in underprivileged groups compared to the more fortunate subgroups.

The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon, but are in accordance with global findings. International literature is overloaded with recent evidence demonstrating social inequalities in oral health. A systematic review by Schwendicke shows that low social class is associated with an increased risk of dental caries, especially in more developed countries (12). Childhood financial hardship not only has a main impact on individuals oral health during childhood, but also in later life. Poulton et al. (13) revealed that low childhood socio-economic status (SES) contributes to increased adult levels of caries and periodontal disease, even after adjusting for adult SES. Listl et al. (14) confirmed these findings, showing the long-term adverse effects of financial problems in childhood on oral health in middle and later adulthood.

The todays' persistence of social inequalities, both in Flanders and in the entire world, is food for thought. From the most negative point of view, one could state that all previous oral health promotion campaigns, health promoting schools and governmental interventions simply failed

to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not able to uncover a specific reason for this failure. What needs to be considered and further investigated, is the key role played by the family and environmental context in children's dental adherence. It is clear that 12-year old children cannot be taken fully responsible for being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that parental oral health habits affects children's oral health. For this reason, the authors of this review state that oral health promotion programs need to put emphasis on the entire family context, concerning their lifestyle and oral health behaviour.

Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for all children under the age of 18 without distinction, so in fact differences in utilization of health care services for financial reasons are not expected. However, in most dental practices, the often high dental fee needs to be paid first by the client "out of pocket", to get it reimbursed by the health insurance agency afterwards. Third party payment, in which the health insurance agency pays the dental fee directly to the dental practitioner instead of the client, is allowed for all minors, but not well established. Further, 37.36% of the Belgian dentists did not take part in the fee convention, bearing a risk of potentially increased dental costs. The authors cannot draw conclusions in this respect, but want to express the need to determine the principal cause(s) of oral health inequalities. The specific provider payment method can be one of the factors, but probably not the only one. Regarding knowledge and attitude of the children in this study, there are statistically significant differences between both social subgroups. However, a mean difference of 0.27 in attitude (on a score out of ten) might be of little clinical relevance to explain the existing inequalities. For children's knowledge, this gap is bigger, with a mean difference of 0.80 in knowledge scores. Differences in knowledge and health literacy, attitude and lifestyle need further investigated, not only for children, but also for the parents.

Although oral health inequalities have always existed and are still remaining, society cannot simply acquiesce in its existence. Dental caries is largely preventable, but still remains the most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16). Dental treatment is expensive, absorbing a considerable part of overall health care budget (17). Focussing on prevention and tackling oral health inequalities not only improve individuals' oral health and quality of life, but can also help in reducing governmental costs. Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream public health approach, targeting the deeper social, political and economic causes of oral health inequalities. They advocate new multidisciplinary preventive strategies at local, regional, national and international levels, based on a common risk factor approach. Quoting the authors, "collaborative efforts among researchers, policy makers, public health practitioners, clinical teams, and the public are urgently required". So, decisions on oral health promotion and tackling oral health inequalities should not exclusively be made by policymakers, but also involve dentists and intermediate partner organizations.

The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by introducing the method of 'proportionate universalism'. Interventions don't need to focus only on the most disadvantaged individuals, but should be universal and contain a scale and intensity in accordance with subgroups' level of disadvantage.

Strenghts and limitations

Strenghts:

The authors understand that the oral health status of Belgian children might be of less relevance in international literature. Although, this survey describes a very relevant theme: social inequalities in health. Off course, many other authors did research on this topic. However, the present study certainly has an added value. What pleads in favour, is the large

sample of children with the same age, but more important, the objective and reliable link that was provided between children's oral health, their social status and their oral health care utilization. Oral health was investigated by calibrated and blinded dentists. Afterwards, these findings were linked to people's social class, not by interviewing the patients or their parents, but by exploring data of the national health institute. In this way, dental examiners were blinded, and people could not 'hide' their social status for the researchers. Furthermore, the same database revealed the most reliable information on oral health care utilization. Mostly, dental attendance is assessed by means of a questionnaire, inevitably leading to bias. In this survey, every single dental visit of a child could be linked to its corresponding record. It is obvious that this kind of survey requires a strict procedure, to ensure children's medical data and privacy. Because of the sensitive character of the information, studies with the same setting are very rare. A short literature search on Pubmed with the following string "Oral Health"[Mesh] AND "health care utilization"[All Fields]" resulted in only 7 hits. Two Nigerian surveys reported on almost the same subject, but both of them used a self-administered questionnaire (20-21).

Limitations:

The authors also have to report some limitations of the study. Although oral health figures can be comparable with other western countries, the present sample only included Belgian subjects. Further, the cross-sectional study design does not allow the authors to identify specific causes for inequalities in oral health and dental non-attendance, only associations.

Since Glimlachen.be® is a four-year longitudinal program visiting schools, most of the subjects will have received previous dental screenings before the present data collection. These screenings might have positively influenced the oral health and oral health behaviour of

all children, resulting in an underestimation of oral health related problems. However, this influence should be equal for both compared groups.

Conclusion

Oral health inequalities are an undeniable reality in primary school children in Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance patterns are negatively affected by children's social class.

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Contributorship statement

All authors declare to have had substantial contributions to the conception and design of the work, to have drafted and revised the work for important intellectual content. All authors gave final approval of the version to be published; and agreement to be accountable for all aspects of the work.

The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University, department of Community Dentistry and Oral Public Health. His task was to analyze data and write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L. Martens are the PhD supervisors of drs. Lambert. They are all participating in the 'Glimlachen.be' project from its very beginning. In that way, they could provide essential

information on data collection procedure and other methodological aspects of the present study. Their expertise was indispensable to realize this publication.

Competing interests

All co-authors declare no competing interests

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Data sharing statement

Patient leveled data or full data set and statistical code book are available from the corresponding author on request.

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Table 1: Oral health and oral health behaviour between children from low income (utilizing the 'Maximum Bill') and middle-to-high income families.

	Maximum Bill	N	Mean	SD	Mean diff.	95%CI	p-value
Mean Plaque index	No	1602	0.41	0.48	-0.17	[-0.23;-0.12]	**<0.001**
(missing = 1)	Yes	351	0.59	0.58			
DMFt (D1-level)	No	1601	1.68	2.05	-1.12	[-1.36; -0.87]	**<0.001**
(missing = 1)	Yes	352	2.79	2.43			
DMFt (D3-level)	No	1600	0.78	1.42	-0.47	[-0.64; -0.30]	**<0.001**
(missing = 2)	Yes	352	1.25	1.68			
DMFs (D1-level)	No	1602	2,30	3.25	-1.72	[-2.11; -1.32]	**<0.001**
(missing = 0)	Yes	352	4,02	4.07			
DMFs (D3-level)	No	1602	1,18	2.51	-0.83	[-1.13; -0.52]	**<0.001**
(missing = 0)	Yes	352	2,00	3.16			
Care index*	No	544	70.33	42.14	11.87	[4.47; 19.27]	**<0.001**
(missing = 0)	Yes	170	58.46	45.17			
Treatment index*	No	544	73.13	40,83	8.34	[1.18; 15.51]	**0.02**
(missing = 0)	Yes	170	64.79	43,75			
Restorative index*	No	537	72.18	41.57	9.96	[2.54; 17.38]	**0.01**
(missing = 0)	Yes	164	62.22	44,79			
Knowledge	No	1483	7.58	2.12	0.80	[0.52; 1.07]	**<0.001**
(missing = 183)	Yes	288	6.78	2.49			
Attitude	No	1482	8.37	1.32	0.27	[0.10; 0.44]	**0.002**
(missing = 183)	Yes	289	8.10	1.44			

*of those having DMFt>0

Table 2: Dental Compliance and Caries Free proportions between children from low income (using the "Maximum Bill") and middle-to-high income families

	Maximum Bill		
Variable	No	Yes	p-value
Treatment index (TI=100%)^	65.8% (n=358)	55.3% (n=94)	**0.01**
Restorative index (RI=100%)^	65.4% (n=351)	53.7% (n=88)	**0.008**
Regular dental attender*	77.7% (n=1344)	50.3% (n=188)	**<0.001**
No dental visit between 2009 and 2013	3.4% (n=59)	12.6% (n=47)	**<0.001**
Caries free proportion	88.4% (n=1414)	78.4% (n=276)	**<0.001**

^ Dichotomous explanatory variable

* at least one dental visit in three different years over a four-year period, excluding urgency treatments

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	*(*a) Indicate the study's design with a commonly used term in the title or the abstract **Cross-sectional survey (title page)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **Page 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **Background (page 4)**
Objectives	3	State specific objectives, including any prespecified hypotheses **Objectives (page 5)**
Methods		
Study design	4	Present key elements of study design early in the paper **Page 6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Page 6**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **Page 6**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Data collection (page 6-7)**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **(Page 7)**
Bias	9	Describe any efforts to address potential sources of bias **Calibration of examiners (Page 6-7)**
Study size	10	Explain how the study size was arrived at **Study design, settings and population (Page 6)**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Page 7-8**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Data analysis (page 8)**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 8**
		(*c*) Explain how missing data were addressed **Page 9**

(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **Page 6**
(*e*) Describe any sensitivity analyses **Not applicable**

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Page 9**
		(b) Give reasons for non-participation at each stage **Page 10**
		(c) Consider use of a flow diagram **Not applicable (cross-sectional design)**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Page 10**
		(b) Indicate number of participants with missing data for each variable of interest **Table 1 (Page 18)**
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **Tables page 17-18**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized **Table 2 (Page 19)**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **Not applicable**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Not applicable**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Page 10**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Strenghts and limitations (page 3)**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Page 10-11**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 10**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Acknowledgement (page 13)**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic inequalities in caries experience, care level and dental attendance in primary school children in Belgium: a cross-sectional survey

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Socioeconomic inequalities in caries experience, care level and dental attendance in primary school children in Belgium: a cross-sectional survey

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Abstract

Objectives: Oral health inequality in children is a widespread and well-documented problem in oral health care. However, objective and reliable methods to determine these inequalities in all oral health aspects, including both dental attendance and oral health, are rather scarce.

Aims: to explore oral health inequalities and to assess the impact of socio-economic factors on oral health, oral health behaviour and dental compliance of primary schoolchildren.

Methods: Data collection was executed in 2014 within a sample of 2,216 children in 105 primary schools in Flanders, by means of an oral examination and a validated questionnaire. Intermutual Agency database was consulted to objectively determine individuals' social state and frequency of utilization of oral health care services. Underprivileged children were compared to more fortunate children for their mean DMFt, DMFs, Plaque index, Care Index (CI), Restorative Index (RI), Treatment Index (TI), knowledge and attitude. Differences in proportions for dichotomous variables (RI100%, TI100% and being a regular dental attender)were analysed. The present study was approved by the Ethics Committee of the University Hospital Ghent (2010/061). All parents signed an informed consent form prior to data collection. All schools received information about the study protocol and agreed to participate. Children requiring dental treatment or periodic recall were referred to the local dentist.

Results: Underprivileged children had higher D1MFT (95%CI [0.87-1.36]), D3MT (95%CI [0.30-0.64]) and plaque scores (95%CI [0.12-0.23], and lower care level ($p<0.02$). In the low-income group, 78.4% was caries free, compared to 88.4% for the other children. Half of the low-income children could be considered as regular dental attenders, whether 12.6% did not have any dental visit during a five year period.

Conclusion: Oral health, oral hygiene, oral health care level and dental attendance patterns are negatively affected by children's social class, leading to oral health inequalities in Belgian primary school children.

Introduction

Background

Although dental caries is largely preventable, it is a major public health problem, since untreated tooth decay remains by far the most common chronic disease worldwide (1). International data on childhood caries epidemiology confirm that dental caries remains a 'significant and consequential disease of childhood', being increasingly localized in a subgroup of high-risk children, both in developing and developed countries (2).

Dental caries is a multifactorial disease. Consumption of sugary substances and poor oral health practices largely affect the occurrence of tooth decay. Literature provides powerful evidence that dental caries is positively correlated to sugar intake (3) and adversely correlated to tooth brushing with a fluoridated toothpaste (4). However, all dietary and behavioural determinants of caries are influenced by people's social context, resulting in worsened oral health outcomes in underprivileged groups. Socio-economic inequalities in pre-school children have already been reported nationally and internationally. Van den Branden not only highlights the occurrence of early childhood caries in preschool children (3-5 years old), but also provides some evidence that a social gradient in early childhood caries can be suggested (5). This confirms results from earlier national reports and is consistent with international literature (2,6,7,8). For the Belgian situation however, the mentioned national reports only include preschool children. Recent data from children attending school are scarce, but certainly needed (9).

The occurrence of dental caries and other oral diseases is not the only domain in which inequalities appear. Use of oral health care facilities and regular preventive dental check-up are also affected by social variables. In adulthood, it is clear that dental non-attenders rank significantly more often at the lower end of the socioeconomic scale (10). Regarding the financial aspect of oral health care in Belgium a fee-for-service payment method is used, combined with a compulsory health insurance. In this system a patient pays the entire dental visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this sum from his health insurance agency. To reduce inequalities in (oral) health, some national government initiatives have been implemented. Underprivileged individuals can be entitled to an increased allowance for health care interventions when the family income is low. In case of excessive medical costs, people can also have access to the mechanism known as the "Maximum Bill", calculating a cost limit for medical care for every individual. The higher the family income, the higher the cost limit. When medical costs exceed this limit, they will be entirely and automatically reimbursed. Furthermore, a full coverage of regular treatment costs for all children under the age of 18 is guaranteed, provided that the dentist acceded to the convention between the national health insurance agency and dental professional organisations. For 2015-2016 period, 62.64% of Belgian dentists partially or completely took part in this convention.

Objectives

Objective data on children's dental non-attendance and health consumption are scarce, not only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national database data on utilization of (oral) health care services, this article provides objective information on oral health consumption and dental attendance.

In this study the authors aimed to explore existing oral health inequalities and to assess the impact of socio-economic factors on oral health, oral health behaviour and dental compliance of primary schoolchildren.

Materials and methods

Study design, settings and population

The present survey fits into the context of Glimlachen.be®, a prospective four-year longitudinal oral health promotion program, visiting primary schools in Flanders (Belgium) with a mobile dental unit. It is conducted by dentists of the Flemish Dental Association under the authority of the National Institute for Health and Disability Insurance (NIHDI).

The present cross-sectional study reports on the oral health condition of children in the last year of primary school, recruited in all schools in Flanders within the three educational networks (GO – publicly run under the authority of the Flemish Community (15%); OGO publicly funded and publicly run by local authorities or provincial authorities (15%; VGO publicly funded and privately run by private non-profit-making organisations, mainly catholic schools (70%)).

Data were collected in 2014 from a representative sample of 2,216 primary school children in 105 different schools in Flanders. The total study population is estimated to be about 68000 children in 2340 schools. Schools were randomly selected, based on a two-step stratification. In the first step, a stratified randomisation was executed at school-level, based on three strata: number of pupils, region and educational network. In the next step, randomisation occurred at the individual level. There was an oversampling of 2% for schools with assistance from

special education for disabled children or children with learning or educational difficulties. The sample size was determined based on a confidence level of 95% and a margin of error of 2.5%. There were several sample size estimations, depending on the variability of the different outcome variables. The authors decided to include as many children as practically possible, based on the availability of three mobile dental units and the number of school days.

Data collection

In all participants, oral health condition was recorded by visual inspection with a mobile dental unit in school premises by 44 well-trained and calibrated dentist-examiners. All examiners were blinded to the socioeconomic status of the children they examined. Calibration was undertaken to avoid bias, using a series of full-mouth photographs simulating the clinical examination of patients, set up in a PowerPoint presentation. Intra Class Correlation Coefficient (ICC) for all examiners was 0.86 with a 95% confidence interval of 0.82 to 0.90. General kappa score was 0.72.

Individual children have been examined for several oral health parameters. DMFT was used as outcome variable to count the number of decayed (D), missing (M) and filled (F) teeth. Caries detection was based on the International Caries Detection and Assessment System (ICDAS), using six subcategories of caries going from first visible change in enamel (score 1) to extensive cavity with visible dentin possibly reaching the pulp (score 6). Both caries at D1 level (score > 0: early enamel lesions and decay into dentine) and D3 level (score ≥4: obvious decay into dentine, excluding early lesions restricted to the enamel) were taken into account. The level of provided care has been approached through the restorative index (RI= (Ft/(D3+Ft)) *100), with Ft standing for “filled teeth”, care index (CI= (Ft/(D3+M+Ft))*100) and treatment index (TI= ((M+Ft)/(D3+M+Ft))*100), all ranging from 0 to 100%. These

indices can only be calculated for those children having a DMFT score > 0. For the other children (DMFT=0), it is mathematically impossible to calculate RI, CI and TI, since the formula should request to divide by "0". Restorative and treatment index were also dichotomized to divide subjects into two groups: children without untreated caries (RI = 100%, TI=100%) and children with untreated caries (RI<100%, TI<100%).

Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Löe (11). This index calculates the mean buccal surface plaque score of six reference teeth on a scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).

Both knowledge and attitude were assessed by a validated and reliable questionnaire, answered by the children. A higher score out of ten correlates to more knowledge and a better attitude. An expert panel tested the content validity of the items, after which the questionnaire was pretested in a class of 25 primary school children (convenience sample) on two different time points (test-retest). Internal consistency was analysed by means of the Cronbach's Alfa, resulting in a score of 0.75, which fits into the required interval of 0.70<Cronbach's Alpha<0.90.

To explore the impact of social environment on oral health and oral health related behaviour, knowledge and attitude, a summary measure was used to characterize the deprivation level. All parameters have been analysed in children eligible for the "Maximum Bill" for at least one year between 2009 and 2013, compared to those who cannot take part of this system (dichotomous explanatory variable). The Maximum Bill measure is automatically assigned to individuals in order to reimburse medical costs exceeding a certain limit, based on income levels. Accordingly, those who benefit from it correspond to underprivileged individuals. Those without can be considered as middle and high-income subjects. The combined questionnaire and oral health examination data were supplemented with the Intermutual

Agency (IMA) national database data on utilization of (oral) health care services, in order to trace individuals who can make use of the Maximum Bill and to obtain information on participants' frequency of utilization of oral health care services. This includes all attested dental treatments and regular preventive dental check-ups over a period from 2009 to 2013. By consensus, participants are considered as regular dental attenders if IMA database reported at least one dental visit in three different years over a four-year period, excluding urgency treatments. Subsequently, a dichotomous variable has been created to distinguish regular dental attenders from non-regular dental attenders.

Data analysis

Data analysis was carried out in the IBM SPSS Statistics V22.0 (SPSS Inc., Chicago, IL, USA). Independent Sample T-test was used to compare underprivileged and more fortunate individuals for their mean DMFT, DMFS, Plaque index, Care Index, Restorative Index, Treatment Index, knowledge and attitude scores. A parametrical test was used, based on the central limit theorem. Differences in proportions for dichotomous variables (RI100%, TI100% and being a regular dental attender) have been compared in crosstabs, using a Chi Square statistical test. Alpha was set at < 0.05.

The approach used to deal with uncomplete records and so to avoid bias, was to compare the proportion of children eligible for the "Maximum Bill" in both responders and non-responders (no clinical data available), by using the Chi Square statistical test. This social parameter could be determined for all children by using the national registration number of the child and the IMA database.

Ethical aspects

The present study was approved by the Ethics Committee of the University Hospital Ghent (2010/061). All parents signed an informed consent form prior to data collection. All schools

received information about the study protocol and agreed to participate. Children requiring dental treatment or periodic recall were referred to the local dentist.

Results

Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years (SD 0.68). Data analysis was performed in 88.2% (n=1,954). Incomplete records were due to failure to obtain consent and child's absence from school on the day of examination. From these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of responders and non-responders, the proportion of children eligible for the 'Maximum Bill' was equal for both groups (Chi Square Test; p=0.4).

More than 19% (n=374) of the children made use of the Maximum Bill. Being part of this subgroup significantly affected oral health and oral health behaviour, as demonstrated in table 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a higher plaque index and higher DMFt and DMFs scores, both at D1 and D3 level. Overall care level was significantly lower, resulting in a lower care index, treatment index and restorative index. Both knowledge and attitude scores were slightly but significantly lower in low-income children.

Regarding the proportion of participants being completely treated for caries, underprivileged children again differ from their more fortunate counterparts. According to table 2, 78.4% of the low-income children were caries free (DMFT=0), compared to 88.4% for the high income group. From those having a DMFT>0, 55.3% of the Maximum Bill group children were found to have a 100% Treatment index against 65.8% for children of higher social class. The same trend appeared when comparing the 100% Restorative index, resulting in strongly significant differences. Half of the low-income children (50.3%) could be considered as regular dental attenders for the period between 2009 and 2013, whether 12.6% did not have

any dental visit during these five year period. Middle- and high-income children visited the dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only 3.4% of these children did not report any dental visit. All of these differences proved to be statistically significant.

Discussion

Oral health inequalities are clearly visible within the present sample of primary school children. Since 2,216 subjects were randomly selected in 105 different primary schools in Flanders, results can be extrapolated to the entire Flemish region.

All included oral health parameters were strongly significantly affected by participants' social class. Not only caries experience, by means of DMFt and DMFs, proved to be higher in underprivileged groups, but also oral hygiene (plaque index) and the level of care seemed to depend on families' social context. This level of care was assessed by means of the restorative index, care index and treatment index. These indices could only be calculated for children having a DMFT > 0. This was mathematically declared in the methodological section, by explaining that it is impossible to divide by "0", which would be the case for those having a DMFT =0. Also clinically, this would be irrelevant, because the indices aim to calculate the proportion of the decayed teeth which have been restored or extracted. If there is no caries experience at all (DMFT=0), these indices are not applicable.

An arithmetic gap of 11.87, 8.34 and 9.96 emerges when comparing Care index, Treatment index and Restorative index for middle/high-income and low income children, in disadvantage of the latter group. The three indices do not all have the same meaning. Restorative index (RI= (Ft/(D3+Ft)) *100) does not consider the missing teeth, because there can be doubts whether teeth were removed due to caries or due to other factors (trauma,

periodontal infection). Care index (CI= (Ft/(D3+M+Ft))*100) partially involves the missing teeth, but the index does not consider a tooth extraction as a 'solution', but as part of the problem. Children are literally 'missing' a tooth, so tooth extraction it is seen as a 'lost chance'. On the other hand, Treatment Index (TI= ((M+Ft)/(D3+M+Ft))*100) proposes tooth extraction as part of the solution, because it removes a (potential) focus of infection. It gives the same value to fillings and extractions. None of these indices can be considered as 'all-embracing', so it is good to compare them. When two subgroups differ significantly in restorative index, but not in treatment index, this means that one of the groups received more tooth extractions, which can be relevant to explore the severity of the disease and the way of treating it. The present findings suggest that the low-income children had more teeth being extracted, although it is hard to determine the clinical relevance of a 1% difference between treatment index and restorative index.

Statistical analysis clearly demonstrates underprivileged children to visit less frequently the dental practitioner. One out of eight low-income children (12.6%) did not see a dentist one single time during the five years prior to data collection. This dental absenteeism is almost four times higher in underprivileged groups compared to the more fortunate subgroups.

The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon, but are in accordance with global findings. International literature is overloaded with recent evidence demonstrating social inequalities in oral health. A systematic review by Schwendicke shows that low social class is associated with an increased risk of dental caries, especially in more developed countries (12). Childhood financial hardship not only has a main impact on individuals oral health during childhood, but also in later life. Poulton et al. (13) revealed that low childhood socio-economic status (SES) contributes to increased adult levels of caries and periodontal disease, even after adjusting for adult SES. Listl et al. (14)

confirmed these findings, showing the long-term adverse effects of financial problems in childhood on oral health in middle and later adulthood.

The todays' persistence of social inequalities, both in Flanders and in the entire world, is food for thought. From the most negative point of view, one could state that all previous oral health promotion campaigns, health promoting schools and governmental interventions simply failed to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not able to uncover a specific reason for this failure. What needs to be considered and further investigated, is the key role played by the family and environmental context in children's dental adherence. It is clear that 12-year old children cannot be taken fully responsible for being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that parental oral health habits affects children's oral health. For this reason, the authors of this review state that oral health promotion programs need to put emphasis on the entire family context, concerning their lifestyle and oral health behaviour.

Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for all children under the age of 18 without distinction, so in fact differences in utilization of health care services for financial reasons are not expected. However, in most dental practices, the often high dental fee needs to be paid first by the client "out of pocket", to get it reimbursed by the health insurance agency afterwards. Third party payment, in which the health insurance agency pays the dental fee directly to the dental practitioner instead of the client, is allowed for all minors, but not well established. Further, 37.36% of the Belgian dentists did not take part in the fee convention, bearing a risk of potentially increased dental costs. The authors cannot draw conclusions in this respect, but want to express the need to determine the principal cause(s) of oral health inequalities. The specific provider payment method can be one of the factors, but probably not the only one. Regarding knowledge and attitude of the children in this study, there are statistically significant differences between both

social subgroups. However, a mean difference of 0.27 in attitude (on a score out of ten) might be of little clinical relevance to explain the existing inequalities. For children's knowledge, this gap is bigger, with a mean difference of 0.80 in knowledge scores. Differences in knowledge and health literacy, attitude and lifestyle need further investigated, not only for children, but also for the parents.

Although oral health inequalities have always existed and are still remaining, society cannot simply acquiesce in its existence. Dental caries is largely preventable, but still remains the most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16). Dental treatment is expensive, absorbing a considerable part of overall health care budget (17). Focussing on prevention and tackling oral health inequalities not only improve individuals' oral health and quality of life, but can also help in reducing governmental costs. Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream public health approach, targeting the deeper social, political and economic causes of oral health inequalities. They advocate new multidisciplinary preventive strategies at local, regional, national and international levels, based on a common risk factor approach. Quoting the authors, "collaborative efforts among researchers, policy makers, public health practitioners, clinical teams, and the public are urgently required". So, decisions on oral health promotion and tackling oral health inequalities should not exclusively be made by policymakers, but also involve dentists and intermediate partner organizations.

The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by introducing the method of 'proportionate universalism'. Interventions don't need to focus only on the most disadvantaged individuals, but should be universal and contain a scale and intensity in accordance with subgroups' level of disadvantage.

The authors understand that the oral health status of Belgian children might be of less relevance in international literature. Although, this survey describes a very relevant theme: social inequalities in health. Off course, many other authors did research on this topic. However, the present study certainly has an added value. What pleads in favour, is the large sample of children with the same age, but more important, the objective and reliable link that was provided between children's oral health, their social status and their oral health care utilization. Oral health was investigated by calibrated and blinded dentists. Afterwards, these findings were linked to people's social class, not by interviewing the patients or their parents, but by exploring data of the national health institute. In this way, dental examiners were blinded, and people could not 'hide' their social status for the researchers. Furthermore, the same database revealed the most reliable information on oral health care utilization. Mostly, dental attendance is assessed by means of a questionnaire, inevitably leading to bias. In this survey, every single dental visit of a child could be linked to its corresponding record. It is obvious that this kind of survey requires a strict procedure, to ensure children's medical data and privacy. Because of the sensitive character of the information, studies with the same setting are very rare. A short literature search on Pubmed with the following string "Oral Health"[Mesh] AND "health care utilization"[All Fields]" resulted in only 7 hits. Two Nigerian surveys reported on almost the same subject, but both of them used a self-administered questionnaire (20-21).

The authors also have to report some limitations of the study. Although oral health figures can be comparable with other western countries, the present sample only included Belgian subjects. Further, the cross-sectional study design does not allow the authors to identify specific causes for inequalities in oral health and dental non-attendance, only associations.

Since Glimlachen.be® is a four-year longitudinal program visiting schools, most of the subjects will have received previous dental screenings before the present data collection.

These screenings might have positively influenced the oral health and oral health behaviour of all children, resulting in an underestimation of oral health related problems. However, this influence should be equal for both compared groups.

Conclusion

Oral health inequalities are an undeniable reality in primary school children in Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance patterns are negatively affected by children's social class.

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Contributorship statement

All authors declare to have had substantial contributions to the conception and design of the work, to have drafted and revised the work for important intellectual content. All authors gave final approval of the version to be published; and agreement to be accountable for all aspects of the work.

The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University, department of Community Dentistry and Oral Public Health. His task was to analyze data and write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L. Martens are the PhD supervisors of drs. Lambert. They are all participating in the

‘Glimlachen.be’ project from its very beginning. In that way, they could provide essential information on data collection procedure and other methodological aspects of the present study. Their expertise was indispensable to realize this publication.

Competing interests

All co-authors declare no competing interests

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Data sharing statement

Patient leveled data or full data set and statistical code book are available from the corresponding author on request.

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Table 1: Oral health and oral health behaviour between children from low income (utilizing the 'Maximum Bill') and middle-to-high income families.

	Maximum Bill	N	Mean	SD	Mean diff.	95%CI	p-value
Mean Plaque index	No	1602	0.41	0.48	-0.17	[-0.23;-0.12]	**<0.001**
(missing = 1)	Yes	351	0.59	0.58			
DMFt (D1-level)	No	1601	1.68	2.05	-1.12	[-1.36; -0.87]	**<0.001**
(missing = 1)	Yes	352	2.79	2.43			
DMFt (D3-level)	No	1600	0.78	1.42	-0.47	[-0.64; -0.30]	**<0.001**
(missing = 2)	Yes	352	1.25	1.68			
DMFs (D1-level)	No	1602	2,30	3.25	-1.72	[-2.11; -1.32]	**<0.001**
(missing = 0)	Yes	352	4,02	4.07			
DMFs (D3-level)	No	1602	1,18	2.51	-0.83	[-1.13; -0.52]	**<0.001**
(missing = 0)	Yes	352	2,00	3.16			
Care index*	No	544	70.33	42.14	11.87	[4.47; 19.27]	**<0.001**
(missing = 0)	Yes	170	58.46	45.17			
Treatment index*	No	544	73.13	40,83	8.34	[1.18; 15.51]	**0.02**
(missing = 0)	Yes	170	64.79	43,75			
Restorative index*	No	537	72.18	41.57	9.96	[2.54; 17.38]	**0.01**
(missing = 0)	Yes	164	62.22	44,79			
Knowledge	No	1483	7.58	2.12	0.80	[0.52; 1.07]	**<0.001**
(missing = 183)	Yes	288	6.78	2.49			
Attitude	No	1482	8.37	1.32	0.27	[0.10; 0.44]	**0.002**
(missing = 183)	Yes	289	8.10	1.44			

*of those having DMFt>0

Table 2: Dental Compliance and Caries Free proportions between children from low income (using the "Maximum Bill") and middle-to-high income families

	Maximum Bill		
Variable	No	Yes	p-value
Treatment index (TI=100%)^	65.8% (n=358)	55.3% (n=94)	**0.01**
Restorative index (RI=100%)^	65.4% (n=351)	53.7% (n=88)	**0.008**
Regular dental attender*	77.7% (n=1344)	50.3% (n=188)	**<0.001**
No dental visit between 2009 and 2013	3.4% (n=59)	12.6% (n=47)	**<0.001**
Caries free proportion	88.4% (n=1414)	78.4% (n=276)	**<0.001**

^ Dichotomous explanatory variable

* at least one dental visit in three different years over a four-year period, excluding urgency treatments

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	*(*a) Indicate the study's design with a commonly used term in the title or the abstract **Cross-sectional survey (title page)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **Page 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **Background (page 4)**
Objectives	3	State specific objectives, including any prespecified hypotheses **Objectives (page 5)**
Methods		
Study design	4	Present key elements of study design early in the paper **Page 6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Page 6**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **Page 6**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Data collection (page 6-7)**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **(Page 7)**
Bias	9	Describe any efforts to address potential sources of bias **Calibration of examiners (Page 6-7)**
Study size	10	Explain how the study size was arrived at **Study design, settings and population (Page 6)**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Page 7-8**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Data analysis (page 8)**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 8**
		(*c*) Explain how missing data were addressed **Page 9**

	(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **Page 6**
	(*e*) Describe any sensitivity analyses **Not applicable**

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Page 9**
		(b) Give reasons for non-participation at each stage **Page 10**
		(c) Consider use of a flow diagram **Not applicable (cross-sectional design)**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Page 10**
		(b) Indicate number of participants with missing data for each variable of interest **Table 1 (Page 18)**
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **Tables page 17-18**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized **Table 2 (Page 19)**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **Not applicable**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Not applicable**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Page 10**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Strenghts and limitations (page 3)**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Page 10-11**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 10**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Acknowledgement (page 13)**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.