

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-015042
Article Type:	Research
Date Submitted by the Author:	16-Dec-2016
Complete List of Authors:	Lambert, Martijn; Universiteit Gent, Dentistry Vanobbergen, Jacques; Universiteit Gent, Dentistry Martens, Luc; Universiteit Gent, Dentistry De Visschere, Luc; Universiteit Gent, Dentistry
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Public health, Epidemiology
Keywords:	EPIDEMIOLOGY, ORAL MEDICINE, Community child health < PAEDIATRICS, PUBLIC HEALTH

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3 **Socioeconomic inequalities in oral health aspects in primary school**
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5 **children: a cross-sectional survey**
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53 **Key words**
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3 Oral Health (MeSH)

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5 Healthcare disparities (MeSH)

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7 Social class (MeSH)

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9 Pediatric Dentistry

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12 **word count:** 3,380

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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 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.

Strengths and limitations

Strengths:

- 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

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2
3 Although dental caries is largely preventable, it is a major public health problem, since
4 untreated tooth decay remains by far the most common chronic disease worldwide (1).
5
6 International data on childhood caries epidemiology confirm that dental caries remains a
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8 'significant and consequential disease of childhood', being increasingly localized in a
9
10 subgroup of high-risk children, both in developing and developed countries (2).
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14 Dental caries is a multifactorial disease. Consumption of sugary substances and poor oral
15 health practices largely affect the occurrence of tooth decay. Literature provides powerful
16
17 evidence that dental caries is positively correlated to sugar intake (3) and adversely correlated
18
19 to tooth brushing with a fluoridated toothpaste (4). However, all dietary and behavioural
20
21 determinants of caries are influenced by people's social context, resulting in worsened oral
22
23 health outcomes in underprivileged groups. Socio-economic inequalities in pre-school
24
25 children have already been reported nationally and internationally. Van den Branden not only
26
27 highlights the occurrence of early childhood caries in preschool children (3-5 years old), but
28
29 also provides some evidence that a social gradient in early childhood caries can be suggested
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31 (5). This confirms results from earlier national reports and is consistent with international
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33 literature (2,6,7,8). For the Belgian situation however, the mentioned national reports only
34
35 include preschool children. Recent data from children attending school are scarce, but
36
37 certainly needed (9).
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44 The occurrence of dental caries and other oral diseases is not the only domain in which
45
46 inequalities appear. Use of oral health care facilities and regular preventive dental check-up
47
48 are also affected by social variables. In adulthood, it is clear that dental non-attenders rank
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50 significantly more often at the lower end of the socioeconomic scale (10). Regarding the
51
52 financial aspect of oral health care in Belgium a fee-for-service payment method is used,
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54 combined with a compulsory health insurance. In this system a patient pays the entire dental
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56 visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this
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3 sum from his health insurance agency. To reduce inequalities in (oral) health, some national
4
5 government initiatives have been implemented yet. Underprivileged individuals can be
6
7 entitled to an increased allowance for health care interventions when the family income is
8
9 low. In case of excessive medical costs, less fortunate people can also have access to the
10
11 mechanism known as the “Maximum Bill”, calculating a cost limit for medical care. All
12
13 medical costs exceeding this limit will be completely reimbursed. Furthermore, a full
14
15 coverage of regular treatment costs for all children under the age of 18 is guaranteed,
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17 provided that the dentist acceded to the convention between the national health insurance
18
19 agency and dental professional organisations. For 2015-2016 period, 62.64% of Belgian
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21 dentists partially or completely take part in this convention.
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24 25 26 *Objectives*

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28 Objective data on children’s dental non-attendance and health consumption are scarce, not
29
30 only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national
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32 database data on utilization of (oral) health care services, this article provides objective
33
34 information on oral health consumption and dental attendance.
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38 In this study the authors aimed to explore existing oral health inequalities and to assess the
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40 impact of socio-economic factors on oral health, oral health behaviour and dental compliance
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42 of primary schoolchildren.
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49 **Materials and methods**

50 51 52 *Study design, settings and population*

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55 The present survey fits into the context of Glimlachen.be®, a prospective four-year
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57 longitudinal oral health promotion program, visiting primary schools in Flanders (Belgium)
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3 with a mobile dental unit. It is conducted by dentists of the Flemish Dental Association under
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5 the authority of the National Institute for Health and Disability Insurance (NIHDI).
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8 The present cross-sectional study reports on the oral health condition of children in the last
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10 year of primary school, recruited in all schools in Flanders within the three educational
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12 networks (GO – publicly run under the authority of the Flemish Community (15%); OGO
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14 publicly funded and publicly run by local authorities or provincial authorities (15%; VGO
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16 publicly funded and privately run by private non-profit-making organisations, mainly catholic
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18 schools (70%)).
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22 The study population is estimated to be about 68000 children in 2340 schools. The unit of
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24 randomisation was the school. Schools were randomly selected with an oversampling of 2%
25
26 for schools with assistance from special education for disabled children or children with
27
28 learning or educational difficulties. The sample size was determined based on a confidence
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30 level of 95% and a margin of error of 2.5%.
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34 Data were collected in 2014 from a representative sample of 2,216 primary school children in
35
36 105 different schools in Flanders.
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39 *Data collection*

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42 In all participants, oral health condition was recorded by visual inspection with a mobile
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44 dental unit in school premises by 44 well-trained and calibrated dentist-examiners. Calibration
45
46 was undertaken to avoid bias, using a series of full-mouth photographs simulating the clinical
47
48 examination of patients, set up in a PowerPoint presentation. Intra Class Correlation
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50 Coefficient (ICC) for all examiners was 0.86 with a 95% confidence interval of 0.82 to 0.90.
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53 General kappa score was 0.72.
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3 Individual children have been examined for several oral health parameters. DMFT was used
4 as outcome variable to count the number of decayed (D), missing (M) and filled (F) teeth.
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7 Caries detection was based on the International Caries Detection and Assessment System
8 (ICDAS), using six subcategories of caries going from first visible change in enamel (score 1)
9 to extensive cavity with visible dentin possibly reaching the pulp (score 6). Both caries at D1
10 level (score > 0: early enamel lesions and decay into dentine) and D3 level (score ≥ 4 : obvious
11 decay into dentine, excluding early lesions restricted to the enamel) are taken into account.
12
13 The level of provided care has been approached through the restorative index (RI= (Ft/D3Ft)
14 *100), care index (CI= (Ft/D3MFt)*100) and treatment index (TI= (MF/D3MFt)*100), all
15 ranging from 0 to 100%. Restorative and treatment index were also dichotomized to divide
16 subjects into two groups: children without untreated caries (RI = 100%, TI=100%) and
17 children with untreated caries (RI<100%, TI<100%).
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30 Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Loe
31 (11). This index calculates the mean buccal surface plaque score of six reference teeth on a
32 scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).
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38 Both knowledge and attitude were assessed by a validated and reliable questionnaire,
39 answered by the children. An expert panel tested the content validity of the items, after which
40 the questionnaire was pretested in a small subgroup of primary school children on two
41 different time points to check the discriminatory power and reliability (test-retest). A higher
42 score out of ten correlates to more knowledge and a better attitude.
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50 To explore the impact of social environment on oral health and oral health related behaviour,
51 knowledge and attitude, a summary measure was used to characterize the deprivation level.
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53 All parameters have been analysed in children eligible for the “Maximum Bill” for at least
54 one year between 2009 and 2013, compared to those who cannot take profit of this system
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(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

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3 could be determined for all children by using the national registration number of the child and
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5 the IMA database.
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10 11 *Ethical aspects*

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14 The present study was approved by the Ethics Committee of the University Hospital Ghent
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16 (2010/061). All parents signed an informed consent form prior to data collection. All schools
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18 received information about the study protocol and agreed to participate. Children requiring
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20 dental treatment or periodic recall were referred to the local dentist.
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27 **Results**

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30 Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years
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32 (± 0.68). Data analysis could be performed in 88.2% (n=1,954). Uncomplete records are due to
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34 failure to obtain consent and child's absence from school on the day of examination. From
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36 these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of
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38 responders and non-responders, there was no relationship between the missingness of data and
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40 the distribution of the social indicator (p=0.4).
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45 More than 19% (n=374) of the children made use of the Maximum Bill. Being part of this
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47 subgroup significantly affected oral health and oral health behaviour, as demonstrated in table
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49 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a
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51 higher plaque index and higher DMFt and DMFs scores, both at D1 and D3 level. Overall
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53 care level was significantly lower, resulting in a lower care index, treatment index and
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55 restorative index. Both knowledge and attitude scores were slightly but significantly lower in
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57 low-income children.
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3 Regarding the proportion of participants being completely treated for caries, underprivileged
4 children again differ from their more fortunate counterparts. According to table 2, 78.4% of
5 the low-income children was caries free (DMFT=0), compared to 88.4% for the high income
6 group. From those having a DMFT>0, 55.3% of the Maximum Bill group children were
7 found to have a 100% Treatment index against 65.8% for children of higher social class. The
8 same trend appeared when comparing the 100% Restorative index, resulting in strongly
9 significant differences. Half of the low-income children (50.3%) could be considered as
10 regular dental attenders for the period between 2009 and 2013, whereas 12.6% did not have
11 any dental visit during these five year period. Middle- and high-income children visited the
12 dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only
13 3.4% of these children did not report any dental visit. All of these differences proved to be
14 statistically significant.
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33 Discussion

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36 Oral health inequalities are clearly visible within the present sample of primary school
37 children. Since 2,216 subjects were randomly selected in 105 different primary schools in
38 Flanders, results can be extrapolated to the entire Flemish region.
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43 All oral health related parameters are strongly and significantly affected by participants'
44 social class. Not only caries experience, by means of DMFT and DMFs, proves to be higher in
45 underprivileged groups, but also oral hygiene (plaque index) and the level of care seems to
46 depend on families' social context. A 10% gap emerges when comparing Care index,
47 Treatment index and Restorative index for middle/high-income and low income children, in
48 disadvantage of the latter group. Statistical analysis clearly demonstrates underprivileged
49 children to visit less frequently the dental practitioner. One out of eight low-income children
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3 (12.6%) did not see a dentist one single time during the five years prior to data collection.
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5 This dental absenteeism is almost four times higher in underprivileged groups compared to
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7 the more fortunate subgroups.
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10 The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon,
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12 but are in accordance with global findings. International literature is overloaded with recent
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14 evidence demonstrating social inequalities in oral health. A systematic review by Scwendicke
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16 shows that low social class is associated with an increased risk of dental caries, especially in
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18 more developed countries (12). Childhood financial hardship not only has a main impact on
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20 individuals oral health during childhood, but also in later life. Poulton et al. (13) revealed that
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22 low childhood socio-economic status (SES) contributes to increased adult levels of caries and
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24 periodontal disease, even after adjusting for adult SES. Listl et al. (14) confirmed these
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26 findings, showing the long-term adverse effects of financial problems in childhood on oral
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28 health in middle and later adulthood.
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33 The today's persistence of social inequalities, both in Flanders and in the entire world, is food
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35 for thought. From the most negative point of view, one could state that all previous oral health
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37 promotion campaigns, health promoting schools and governmental interventions simply failed
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39 to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not
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41 able to uncover a specific reason for this failure. What needs to be considered and further
42
43 investigated, is the key role played by the family and environmental context in children's
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45 dental adherence. It is clear that 12-year old children cannot be taken fully responsible for
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47 being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that
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49 parental oral health habits affects children's oral health. For this reason, the authors of this
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51 review state that oral health promotion programs need to put emphasis on the entire family
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53 context, concerning their lifestyle and oral health behaviour.
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3 Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for
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5 all children under the age of 18, so in fact differences in utilization of health care services for
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7 financial reasons are not expected. However, in most dental practices, the often high dental
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9 fee needs to be paid first by the client, to get it reimbursed by the health insurance agency
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11 afterwards. Third party payment is allowed for minors, but not well established. Further,
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13 37.36% of the Belgian dentists did not take part in the fee convention, bearing a risk of
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15 potentially increased dental costs. Further research is needed to evaluate the effects of
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17 different provider payment methods on social inequalities.
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21 Although oral health inequalities have always existed and are still remaining, society cannot
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23 simply acquiesce in its existence. Dental caries is largely preventable, but still remains the
24
25 most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16).
26
27 Dental treatment is expensive, absorbing a considerable part of overall health care budget
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29 (17). Focussing on prevention and tackling oral health inequalities not only improve
30
31 individuals' oral health and quality of life, but can also help in reducing governmental costs.
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33 Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream
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35 public health approach, targeting the deeper social, political and economic causes of oral
36
37 health inequalities. They advocate new multidisciplinary preventive strategies at local,
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39 regional, national and international levels, based on a common risk factor approach. Quoting
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41 the authors, "collaborative efforts among researchers, policy makers, public health
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43 practitioners, clinical teams, and the public are urgently required". So, decisions on oral health
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45 promotion and tackling oral health inequalities should not exclusively be made by
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47 policymakers, but also involve dentists and intermediate partner organizations.
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53 The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by
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55 introducing the method of 'proportionate universalism'. Interventions don't need to focus
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3 only on the most disadvantaged individuals, but should be universal and contain a scale and
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5 intensity in accordance with subgroups' level of disadvantage.
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8 **Conclusion**

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10 Oral health inequalities are an undeniable reality in primary school children in
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12 Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance
13
14 patterns are strongly negatively affected by children's social class.
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17 **Acknowledgement**

18
19 The research presented in this report is part of the 'Glimlachen.be' project
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21 (www.glimlachen.be), commissioned and financed by the 'Insurance Committee for Health
22
23 Care' of the 'Belgian National Institute for Health and Disability Insurance'.
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28 The authors thank the Flemish Dental Association (VVT), the dentist examiners and dental
29
30 assistants and the school for their collaboration. All authors do not declare any potential
31
32 conflict of interest.
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35 **Contributorship statement**

36
37 All authors declare to have had substantial contributions to the conception and design of the
38
39 work, to have drafted and revised the work for important intellectual content. All authors gave
40
41 final approval of the version to be published; and agreement to be accountable for all aspects
42
43 of the work.
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47
48 The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University,
49
50 department of Community Dentistry and Oral Public Health. His task was to analyze data and
51
52 write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L.
53
54 Martens are the PhD supervisors of drs. Lambert. They are all participating in the
55
56 'Glimlachen.be' project from its very beginning. In that way, they could provide essential
57
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1
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3 information on data collection procedure and other methodological aspects of the present
4
5 study. Their expertise was indispensable to realize this publication.
6
7

8 **Competing interests**

9
10 All co-authors declare no competing interests
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12

13 **Funding**

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15
16
17 There was no funding to analyze data or to report this paper. The only funding corresponds to
18
19 data collection (see acknowledgement).
20
21

22 **Data sharing statement**

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25 Patient leveled data or full data set and statistical code book are available from the
26
27 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 (missing = 1)	No	1602	0.41	0.48	<0.001
	Yes	351	0.59	0.58	
DMFt (D1-level) (missing = 1)	No	1601	1.68	2.05	<0.001
	Yes	352	2.79	2.43	
DMFt (D3-level) (missing = 2)	No	1600	0.78	1.42	<0.001
	Yes	352	1.25	1.68	
DMFs (D1-level) (missing = 0)	No	1602	2,30	3.25	<0.001
	Yes	352	4,02	4.07	
DMFs (D3-level) (missing = 0)	No	1602	1,18	2.51	<0.001
	Yes	352	2,00	3.16	
Care index* (missing = 0)	No	544	70.33	42.14	<0.001
	Yes	170	58.46	45.17	
Treatment index* (missing = 0)	No	544	73.13	40,83	0.02
	Yes	170	64.79	43,75	
Restorative index* (missing = 0)	No	537	72.18	41.57	0.01
	Yes	164	62.22	44,79	
Knowledge (missing = 183)	No	1483	7.58	2.12	<0.001
	Yes	288	6.78	2.49	
Attitude (missing = 183)	No	1482	8.37	1.32	0.002
	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

Variable	Maximum Bill		p-value
	No	Yes	
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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants Page 6 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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

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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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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 Strengths 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)
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*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

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

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-015042.R1
Article Type:	Research
Date Submitted by the Author:	04-May-2017
Complete List of Authors:	Lambert, Martijn; Universiteit Gent, Dentistry Vanobbergen, Jacques; Universiteit Gent, Dentistry Martens, Luc; Universiteit Gent, Dentistry De Visschere, Luc; Universiteit Gent, Dentistry
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Public health, Epidemiology
Keywords:	EPIDEMIOLOGY, ORAL MEDICINE, Community child health < PAEDIATRICS, PUBLIC HEALTH

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3 **Socioeconomic inequalities in caries experience, care level and dental**
4 **attendance in primary school children in Belgium: a cross-sectional survey**
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53 word count: 4,389
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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

1
2
3 financial aspect of oral health care in Belgium a fee-for-service payment method is used,
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5 combined with a compulsory health insurance. In this system a patient pays the entire dental
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7 visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this
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9 sum from his health insurance agency. To reduce inequalities in (oral) health, some national
10
11 government initiatives have been implemented. Underprivileged individuals can be entitled to
12
13 an increased allowance for health care interventions when the family income is low. In case of
14
15 excessive medical costs, people can also have access to the mechanism known as the
16
17 “Maximum Bill”, calculating a cost limit for medical care for every individual. The higher the
18
19 family income, the higher the cost limit. When medical costs exceed this limit, they will be
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21 entirely and automatically reimbursed. Furthermore, a full coverage of regular treatment costs
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23 for all children under the age of 18 is guaranteed, provided that the dentist acceded to the
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25 convention between the national health insurance agency and dental professional
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27 organisations. For 2015-2016 period, 62.64% of Belgian dentists partially or completely took
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29 part in this convention.
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33 34 35 *Objectives*

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37 Objective data on children’s dental non-attendance and health consumption are scarce, not
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39 only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national
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41 database data on utilization of (oral) health care services, this article provides objective
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43 information on oral health consumption and dental attendance.
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48 In this study the authors aimed to explore existing oral health inequalities and to assess the
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50 impact of socio-economic factors on oral health, oral health behaviour and dental compliance
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52 of primary schoolchildren.
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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%).

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3 Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Løe
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5 (11). This index calculates the mean buccal surface plaque score of six reference teeth on a
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7 scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).
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10 Both knowledge and attitude were assessed by a validated and reliable questionnaire,
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12 answered by the children. A higher score out of ten correlates to more knowledge and a better
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14 attitude. An expert panel tested the content validity of the items, after which the questionnaire
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16 was pretested in a class of 25 primary school children (convenience sample) on two different
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18 time points (test-retest). Internal consistency was analysed by means of the Cronbach's Alfa,
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20 resulting in a score of 0.75, which fits into the required interval of $0.70 < \text{Cronbach's}$
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22 $\text{Alpha} < 0.90$.
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26 To explore the impact of social environment on oral health and oral health related behaviour,
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28 knowledge and attitude, a summary measure was used to characterize the deprivation level.
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30 All parameters have been analysed in children eligible for the "Maximum Bill" for at least
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32 one year between 2009 and 2013, compared to those who cannot take part of this system
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34 (dichotomous explanatory variable). The Maximum Bill measure is automatically assigned to
35
36 individuals in order to reimburse medical costs exceeding a certain limit, based on income
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38 levels. Accordingly, those who benefit from it correspond to underprivileged individuals.
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40 Those without can be considered as middle and high-income subjects. The combined
41
42 questionnaire and oral health examination data were supplemented with the Intermutual
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44 Agency (IMA) national database data on utilization of (oral) health care services, in order to
45
46 trace individuals who can make use of the Maximum Bill and to obtain information on
47
48 participants' frequency of utilization of oral health care services. This includes all attested
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50 dental treatments and regular preventive dental check-ups over a period from 2009 to 2013.
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52 By consensus, participants are considered as regular dental attenders if IMA database reported
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54 at least one dental visit in three different years over a four-year period, excluding urgency
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3 treatments. Subsequently, a dichotomous variable has been created to distinguish regular
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5 dental attenders from non-regular dental attenders.
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8 *Data analysis*

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10 Data analysis was carried out in the IBM SPSS Statistics V22.0 (SPSS Inc., Chicago, IL,
11
12 USA). Independent Sample T-test was used to compare underprivileged and more fortunate
13
14 individuals for their mean DMFT, DMFS, Plaque index, Care Index, Restorative Index,
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16 Treatment Index, knowledge and attitude scores. A parametrical test was used, based on the
17
18 central limit theorem. Differences in proportions for dichotomous variables (RI100%,
19
20 TI100% and being a regular dental attender) have been compared in crosstabs, using a Chi
21
22 Square statistical test. Alpha was set at < 0.05 .
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27 The approach used to deal with uncomplete records and so to avoid bias, was to compare the
28
29 proportion of children eligible for the “Maximum Bill” in both responders and non-responders
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31 (no clinical data available), by using the Chi Square statistical test. This social parameter
32
33 could be determined for all children by using the national registration number of the child and
34
35 the IMA database.
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38 *Ethical aspects*

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40 The present study was approved by the Ethics Committee of the University Hospital Ghent
41
42 (2010/061). All parents signed an informed consent form prior to data collection. All schools
43
44 received information about the study protocol and agreed to participate. Children requiring
45
46 dental treatment or periodic recall were referred to the local dentist.
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50 **Results**

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52 Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years
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54 (SD 0.68). Data analysis was performed in 88.2% (n=1,954). Incomplete records were due to
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3 failure to obtain consent and child's absence from school on the day of examination. From
4
5 these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of
6
7 responders and non-responders, the proportion of children eligible for the 'Maximum Bill'
8
9 was equal for both groups (Chi Square Test; $p=0.4$).
10

11
12 More than 19% ($n=374$) of the children made use of the Maximum Bill. Being part of this
13
14 subgroup significantly affected oral health and oral health behaviour, as demonstrated in table
15
16 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a
17
18 higher plaque index and higher DMFt and DMFs scores, both at D1 and D3 level. Overall
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20 care level was significantly lower, resulting in a lower care index, treatment index and
21
22 restorative index. Both knowledge and attitude scores were slightly but significantly lower in
23
24 low-income children.
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28 Regarding the proportion of participants being completely treated for caries, underprivileged
29
30 children again differ from their more fortunate counterparts. According to table 2, 78.4% of
31
32 the low-income children were caries free ($DMFT=0$), compared to 88.4% for the high income
33
34 group. From those having a $DMFT>0$, 55.3% of the Maximum Bill group children were
35
36 found to have a 100% Treatment index against 65.8% for children of higher social class. The
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38 same trend appeared when comparing the 100% Restorative index, resulting in strongly
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40 significant differences. Half of the low-income children (50.3%) could be considered as
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42 regular dental attenders for the period between 2009 and 2013, whether 12.6% did not have
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44 any dental visit during these five year period. Middle- and high-income children visited the
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46 dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only
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48 3.4% of these children did not report any dental visit. All of these differences proved to be
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50 statistically significant.
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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

1
2
3 the same value to fillings and extractions. None of these indices can be considered as ‘all-
4 embracing’, so it is good to compare them. When two subgroups differ significantly in
5 restorative index, but not in treatment index, this means that one of the groups received more
6 tooth extractions, which can be relevant to explore the severity of the disease and the way of
7 treating it. The present findings suggest that the low-income children had more teeth being
8 extracted, although it is hard to determine the clinical relevance of a 1% difference between
9 treatment index and restorative index.
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19 Statistical analysis clearly demonstrates underprivileged children to visit less frequently the
20 dental practitioner. One out of eight low-income children (12.6%) did not see a dentist one
21 single time during the five years prior to data collection. This dental absenteeism is almost
22 four times higher in underprivileged groups compared to the more fortunate subgroups.
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29 The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon,
30 but are in accordance with global findings. International literature is overloaded with recent
31 evidence demonstrating social inequalities in oral health. A systematic review by
32 Schwendicke shows that low social class is associated with an increased risk of dental caries,
33 especially in more developed countries (12). Childhood financial hardship not only has a main
34 impact on individuals oral health during childhood, but also in later life. Poulton et al. (13)
35 revealed that low childhood socio-economic status (SES) contributes to increased adult levels
36 of caries and periodontal disease, even after adjusting for adult SES. Listl et al. (14)
37 confirmed these findings, showing the long-term adverse effects of financial problems in
38 childhood on oral health in middle and later adulthood.
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51 The today's persistence of social inequalities, both in Flanders and in the entire world, is food
52 for thought. From the most negative point of view, one could state that all previous oral health
53 promotion campaigns, health promoting schools and governmental interventions simply failed
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3 to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not
4
5 able to uncover a specific reason for this failure. What needs to be considered and further
6
7 investigated, is the key role played by the family and environmental context in children's
8
9 dental adherence. It is clear that 12-year old children cannot be taken fully responsible for
10
11 being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that
12
13 parental oral health habits affects children's oral health. For this reason, the authors of this
14
15 review state that oral health promotion programs need to put emphasis on the entire family
16
17 context, concerning their lifestyle and oral health behaviour.
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19

20
21 Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for
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23 all children under the age of 18 without distinction, so in fact differences in utilization of
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25 health care services for financial reasons are not expected. However, in most dental practices,
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27 the often high dental fee needs to be paid first by the client "out of pocket", to get it
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29 reimbursed by the health insurance agency afterwards. Third party payment, in which the
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31 health insurance agency pays the dental fee directly to the dental practitioner instead of the
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33 client, is allowed for all minors, but not well established. Further, 37.36% of the Belgian
34
35 dentists did not take part in the fee convention, bearing a risk of potentially increased dental
36
37 costs. The authors cannot draw conclusions in this respect, but want to express the need to
38
39 determine the principal cause(s) of oral health inequalities. The specific provider payment
40
41 method can be one of the factors, but probably not the only one. Regarding knowledge and
42
43 attitude of the children in this study, there are statistically significant differences between both
44
45 social subgroups. However, a mean difference of 0.27 in attitude (on a score out of ten) might
46
47 be of little clinical relevance to explain the existing inequalities. For children's knowledge,
48
49 this gap is bigger, with a mean difference of 0.80 in knowledge scores. Differences in
50
51 knowledge and health literacy, attitude and lifestyle need further investigated, not only for
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53 children, but also for the parents.
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3 Although oral health inequalities have always existed and are still remaining, society cannot
4 simply acquiesce in its existence. Dental caries is largely preventable, but still remains the
5 most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16).
6
7 Dental treatment is expensive, absorbing a considerable part of overall health care budget
8 (17). Focussing on prevention and tackling oral health inequalities not only improve
9 individuals' oral health and quality of life, but can also help in reducing governmental costs.
10
11 Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream
12 public health approach, targeting the deeper social, political and economic causes of oral
13 health inequalities. They advocate new multidisciplinary preventive strategies at local,
14 regional, national and international levels, based on a common risk factor approach. Quoting
15 the authors, "collaborative efforts among researchers, policy makers, public health
16 practitioners, clinical teams, and the public are urgently required". So, decisions on oral health
17 promotion and tackling oral health inequalities should not exclusively be made by
18 policymakers, but also involve dentists and intermediate partner organizations.
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35 The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by
36 introducing the method of 'proportionate universalism'. Interventions don't need to focus
37 only on the most disadvantaged individuals, but should be universal and contain a scale and
38 intensity in accordance with subgroups' level of disadvantage.
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44 **Strenghts and limitations**

45 **Strenghts:**

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48 The authors understand that the oral health status of Belgian children might be of less
49 relevance in international literature. Although, this survey describes a very relevant theme:
50 social inequalities in health. Off course, many other authors did research on this topic.
51
52 However, the present study certainly has an added value. What pleads in favour, is the large
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3 sample of children with the same age, but more important, the objective and reliable link that
4
5 was provided between children's oral health, their social status and their oral health care
6
7 utilization. Oral health was investigated by calibrated and blinded dentists. Afterwards, these
8
9 findings were linked to people's social class, not by interviewing the patients or their parents,
10
11 but by exploring data of the national health institute. In this way, dental examiners were
12
13 blinded, and people could not 'hide' their social status for the researchers. Furthermore, the
14
15 same database revealed the most reliable information on oral health care utilization. Mostly,
16
17 dental attendance is assessed by means of a questionnaire, inevitably leading to bias. In this
18
19 survey, every single dental visit of a child could be linked to its corresponding record. It is
20
21 obvious that this kind of survey requires a strict procedure, to ensure children's medical data
22
23 and privacy. Because of the sensitive character of the information, studies with the same
24
25 setting are very rare. A short literature search on Pubmed with the following string "Oral
26
27 Health"[Mesh] AND "health care utilization"[All Fields]" resulted in only 7 hits. Two
28
29 Nigerian surveys reported on almost the same subject, but both of them used a self-
30
31 administered questionnaire (20-21).
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37 **Limitations:**

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40 The authors also have to report some limitations of the study. Although oral health figures can
41
42 be comparable with other western countries, the present sample only included Belgian
43
44 subjects. Further, the cross-sectional study design does not allow the authors to identify
45
46 specific causes for inequalities in oral health and dental non-attendance, only associations.
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48

49
50 Since Glimlachen.be® is a four-year longitudinal program visiting schools, most of the
51
52 subjects will have received previous dental screenings before the present data collection.
53

54 These screenings might have positively influenced the oral health and oral health behaviour of
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3 all children, resulting in an underestimation of oral health related problems. However, this
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5 influence should be equal for both compared groups.
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7

8 **Conclusion**

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10 Oral health inequalities are an undeniable reality in primary school children in
11
12 Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance
13
14 patterns are negatively affected by children's social class.
15
16

17 **Acknowledgement**

18
19 The research presented in this report is part of the 'Glimlachen.be' project
20
21 (www.glimlachen.be), commissioned and financed by the 'Insurance Committee for Health
22
23 Care' of the 'Belgian National Institute for Health and Disability Insurance'.
24
25
26

27
28 The authors thank the Flemish Dental Association (VVT), the dentist examiners and dental
29
30 assistants and the school for their collaboration. All authors do not declare any potential
31
32 conflict of interest.
33
34

35 **Contributorship statement**

36
37 All authors declare to have had substantial contributions to the conception and design of the
38
39 work, to have drafted and revised the work for important intellectual content. All authors gave
40
41 final approval of the version to be published; and agreement to be accountable for all aspects
42
43 of the work.
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47
48 The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University,
49
50 department of Community Dentistry and Oral Public Health. His task was to analyze data and
51
52 write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L.
53
54 Martens are the PhD supervisors of drs. Lambert. They are all participating in the
55
56 'Glimlachen.be' project from its very beginning. In that way, they could provide essential
57
58
59
60

1
2
3 information on data collection procedure and other methodological aspects of the present
4
5 study. Their expertise was indispensable to realize this publication.
6
7

8 **Competing interests**

9
10
11 All co-authors declare no competing interests
12

13 **Funding**

14
15
16
17 There was no funding to analyze data or to report this paper. The only funding corresponds to
18
19 data collection (see acknowledgement).
20
21

22 **Data sharing statement**

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25 Patient leveled data or full data set and statistical code book are available from the
26
27 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 (missing = 1)	No	1602	0.41	0.48	-0.17	[-0.23; -0.12]	<0.001
	Yes	351	0.59	0.58			
DMFt (D1-level) (missing = 1)	No	1601	1.68	2.05	-1.12	[-1.36; -0.87]	<0.001
	Yes	352	2.79	2.43			
DMFt (D3-level) (missing = 2)	No	1600	0.78	1.42	-0.47	[-0.64; -0.30]	<0.001
	Yes	352	1.25	1.68			
DMFs (D1-level) (missing = 0)	No	1602	2.30	3.25	-1.72	[-2.11; -1.32]	<0.001
	Yes	352	4.02	4.07			
DMFs (D3-level) (missing = 0)	No	1602	1.18	2.51	-0.83	[-1.13; -0.52]	<0.001
	Yes	352	2.00	3.16			
Care index* (missing = 0)	No	544	70.33	42.14	11.87	[4.47; 19.27]	<0.001
	Yes	170	58.46	45.17			
Treatment index* (missing = 0)	No	544	73.13	40.83	8.34	[1.18; 15.51]	0.02
	Yes	170	64.79	43.75			
Restorative index* (missing = 0)	No	537	72.18	41.57	9.96	[2.54; 17.38]	0.01
	Yes	164	62.22	44.79			
Knowledge (missing = 183)	No	1483	7.58	2.12	0.80	[0.52; 1.07]	<0.001
	Yes	288	6.78	2.49			
Attitude (missing = 183)	No	1482	8.37	1.32	0.27	[0.10; 0.44]	0.002
	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

Variable	Maximum Bill		p-value
	No	Yes	
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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants Page 6 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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

For peer review only

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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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 Strengths 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)
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*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

1
2 <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is
3 available at www.strobe-statement.org.
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BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-015042.R2
Article Type:	Research
Date Submitted by the Author:	01-Jun-2017
Complete List of Authors:	Lambert, Martijn; Universiteit Gent, Dentistry Vanobbergen, Jacques; Universiteit Gent, Dentistry Martens, Luc; Universiteit Gent, Dentistry De Visschere, Luc; Univ Ghent, Community Dentistry and Oral Public Health
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Public health, Epidemiology
Keywords:	EPIDEMIOLOGY, ORAL MEDICINE, Community child health < PAEDIATRICS, PUBLIC HEALTH

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3 **Socioeconomic inequalities in caries experience, care level and dental**
4 **attendance in primary school children in Belgium: a cross-sectional survey**
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8 Martijn J. Lambert¹, Jacques SN Vanobbergen², Luc C. Martens³, Luc M.J. De Visschere⁴
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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.

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3 Conclusion: Oral health, oral hygiene, oral health care level and dental attendance patterns are
4 negatively affected by children's social class, leading to oral health inequalities in Belgian
5 primary school children.
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10 11 12 13 **Introduction**

14 15 *Background*

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17 Although dental caries is largely preventable, it is a major public health problem, since
18 untreated tooth decay remains by far the most common chronic disease worldwide (1).
19 International data on childhood caries epidemiology confirm that dental caries remains a
20 'significant and consequential disease of childhood', being increasingly localized in a
21 subgroup of high-risk children, both in developing and developed countries (2).
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25 Dental caries is a multifactorial disease. Consumption of sugary substances and poor oral
26 health practices largely affect the occurrence of tooth decay. Literature provides powerful
27 evidence that dental caries is positively correlated to sugar intake (3) and adversely correlated
28 to tooth brushing with a fluoridated toothpaste (4). However, all dietary and behavioural
29 determinants of caries are influenced by people's social context, resulting in worsened oral
30 health outcomes in underprivileged groups. Socio-economic inequalities in pre-school
31 children have already been reported nationally and internationally. Van den Branden not only
32 highlights the occurrence of early childhood caries in preschool children (3-5 years old), but
33 also provides some evidence that a social gradient in early childhood caries can be suggested
34 (5). This confirms results from earlier national reports and is consistent with international
35 literature (2,6,7,8). For the Belgian situation however, the mentioned national reports only
36 include preschool children. Recent data from children attending school are scarce, but
37 certainly needed (9).
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3 The occurrence of dental caries and other oral diseases is not the only domain in which
4 inequalities appear. Use of oral health care facilities and regular preventive dental check-up
5 are also affected by social variables. In adulthood, it is clear that dental non-attenders rank
6 significantly more often at the lower end of the socioeconomic scale (10). Regarding the
7 financial aspect of oral health care in Belgium a fee-for-service payment method is used,
8 combined with a compulsory health insurance. In this system a patient pays the entire dental
9 visit cost to the dentist at first hand, in order to recover at second hand the biggest part of this
10 sum from his health insurance agency. To reduce inequalities in (oral) health, some national
11 government initiatives have been implemented. Underprivileged individuals can be entitled to
12 an increased allowance for health care interventions when the family income is low. In case of
13 excessive medical costs, people can also have access to the mechanism known as the
14 “Maximum Bill”, calculating a cost limit for medical care for every individual. The higher the
15 family income, the higher the cost limit. When medical costs exceed this limit, they will be
16 entirely and automatically reimbursed. Furthermore, a full coverage of regular treatment costs
17 for all children under the age of 18 is guaranteed, provided that the dentist acceded to the
18 convention between the national health insurance agency and dental professional
19 organisations. For 2015-2016 period, 62.64% of Belgian dentists partially or completely took
20 part in this convention.
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43 *Objectives*

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46 Objective data on children’s dental non-attendance and health consumption are scarce, not
47 only in Belgium, but worldwide. By involving the Intermutual Agency (IMA) national
48 database data on utilization of (oral) health care services, this article provides objective
49 information on oral health consumption and dental attendance.
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3 In this study the authors aimed to explore existing oral health inequalities and to assess the
4 impact of socio-economic factors on oral health, oral health behaviour and dental compliance
5 of primary schoolchildren.
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10 11 12 13 14 15 16 **Materials and methods**

17 *Study design, settings and population*

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20 The present survey fits into the context of Glimlachen.be®, a prospective four-year
21 longitudinal oral health promotion program, visiting primary schools in Flanders (Belgium)
22 with a mobile dental unit. It is conducted by dentists of the Flemish Dental Association under
23 the authority of the National Institute for Health and Disability Insurance (NIHDI).
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32 The present cross-sectional study reports on the oral health condition of children in the last
33 year of primary school, recruited in all schools in Flanders within the three educational
34 networks (GO – publicly run under the authority of the Flemish Community (15%); OGO
35 publicly funded and publicly run by local authorities or provincial authorities (15%; VGO
36 publicly funded and privately run by private non-profit-making organisations, mainly catholic
37 schools (70%)).
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46 Data were collected in 2014 from a representative sample of 2,216 primary school children in
47 105 different schools in Flanders. The total study population is estimated to be about 68000
48 children in 2340 schools. Schools were randomly selected, based on a two-step stratification.
49 In the first step, a stratified randomisation was executed at school-level, based on three strata:
50 number of pupils, region and educational network. In the next step, randomisation occurred at
51 the individual level. There was an oversampling of 2% for schools with assistance from
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3 special education for disabled children or children with learning or educational difficulties.
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5 The sample size was determined based on a confidence level of 95% and a margin of error of
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7 2.5%. There were several sample size estimations, depending on the variability of the
8
9 different outcome variables. The authors decided to include as many children as practically
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11 possible, based on the availability of three mobile dental units and the number of school days.
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14 15 16 17 18 *Data collection* 19

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21 In all participants, oral health condition was recorded by visual inspection with a mobile
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23 dental unit in school premises by 44 well-trained and calibrated dentist-examiners. All
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25 examiners were blinded to the socioeconomic status of the children they examined.
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27 Calibration was undertaken to avoid bias, using a series of full-mouth photographs simulating
28
29 the clinical examination of patients, set up in a PowerPoint presentation. Intra Class
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31 Correlation Coefficient (ICC) for all examiners was 0.86 with a 95% confidence interval of
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33 0.82 to 0.90. General kappa score was 0.72.
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37 Individual children have been examined for several oral health parameters. DMFT was used
38
39 as outcome variable to count the number of decayed (D), missing (M) and filled (F) teeth.
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41 Caries detection was based on the International Caries Detection and Assessment System
42
43 (ICDAS), using six subcategories of caries going from first visible change in enamel (score 1)
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45 to extensive cavity with visible dentin possibly reaching the pulp (score 6). Both caries at D1
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47 level (score > 0: early enamel lesions and decay into dentine) and D3 level (score \geq 4: obvious
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49 decay into dentine, excluding early lesions restricted to the enamel) were taken into account.
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51 The level of provided care has been approached through the restorative index (RI=
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53 $(Ft/(D3+Ft)) * 100$), with Ft standing for “filled teeth”, care index (CI= $(Ft/(D3+M+Ft))*100$)
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55 and treatment index (TI= $((M+Ft)/(D3+M+Ft))*100$), all ranging from 0 to 100%. These
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3 indices can only be calculated for those children having a DMFT score > 0 . For the other
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5 children (DMFT=0), it is mathematically impossible to calculate RI, CI and TI, since the
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7 formula should request to divide by "0". Restorative and treatment index were also
8
9 dichotomized to divide subjects into two groups: children without untreated caries (RI =
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11 100%, TI=100%) and children with untreated caries (RI<100%, TI<100%).
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15 Clinical amount of dental plaque was measured using the Plaque Index of Sillness and Loe
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17 (11). This index calculates the mean buccal surface plaque score of six reference teeth on a
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19 scale from 0 (no plaque) to 3 (visible plaque on more than one third of the buccal surface).
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23 Both knowledge and attitude were assessed by a validated and reliable questionnaire,
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25 answered by the children. A higher score out of ten correlates to more knowledge and a better
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27 attitude. An expert panel tested the content validity of the items, after which the questionnaire
28
29 was pretested in a class of 25 primary school children (convenience sample) on two different
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31 time points (test-retest). Internal consistency was analysed by means of the Cronbach's Alfa,
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33 resulting in a score of 0.75, which fits into the required interval of $0.70 < \text{Cronbach's}$
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35 $\text{Alpha} < 0.90$.
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39 To explore the impact of social environment on oral health and oral health related behaviour,
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41 knowledge and attitude, a summary measure was used to characterize the deprivation level.
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43 All parameters have been analysed in children eligible for the "Maximum Bill" for at least
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45 one year between 2009 and 2013, compared to those who cannot take part of this system
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47 (dichotomous explanatory variable). The Maximum Bill measure is automatically assigned to
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49 individuals in order to reimburse medical costs exceeding a certain limit, based on income
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51 levels. Accordingly, those who benefit from it correspond to underprivileged individuals.
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53 Those without can be considered as middle and high-income subjects. The combined
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55 questionnaire and oral health examination data were supplemented with the Intermutual
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3 Agency (IMA) national database data on utilization of (oral) health care services, in order to
4 trace individuals who can make use of the Maximum Bill and to obtain information on
5 participants' frequency of utilization of oral health care services. This includes all attested
6 dental treatments and regular preventive dental check-ups over a period from 2009 to 2013.
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8 By consensus, participants are considered as regular dental attenders if IMA database reported
9 at least one dental visit in three different years over a four-year period, excluding urgency
10 treatments. Subsequently, a dichotomous variable has been created to distinguish regular
11 dental attenders from non-regular dental attenders.
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20 21 *Data analysis*

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24 Data analysis was carried out in the IBM SPSS Statistics V22.0 (SPSS Inc., Chicago, IL,
25 USA). Independent Sample T-test was used to compare underprivileged and more fortunate
26 individuals for their mean DMFT, DMFS, Plaque index, Care Index, Restorative Index,
27 Treatment Index, knowledge and attitude scores. A parametrical test was used, based on the
28 central limit theorem. Differences in proportions for dichotomous variables (RI100%,
29 TI100% and being a regular dental attender) have been compared in crosstabs, using a Chi
30 Square statistical test. Alpha was set at < 0.05 .
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41 The approach used to deal with uncomplete records and so to avoid bias, was to compare the
42 proportion of children eligible for the "Maximum Bill" in both responders and non-responders
43 (no clinical data available), by using the Chi Square statistical test. This social parameter
44 could be determined for all children by using the national registration number of the child and
45 the IMA database.
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51 52 *Ethical aspects*

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55 The present study was approved by the Ethics Committee of the University Hospital Ghent
56 (2010/061). All parents signed an informed consent form prior to data collection. All schools
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3 received information about the study protocol and agreed to participate. Children requiring
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5 dental treatment or periodic recall were referred to the local dentist.
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8 **Results**

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10 Sample consisted of 2,216 Flemish primary school children with a mean age of 11.25 years
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12 (SD 0.68). Data analysis was performed in 88.2% (n=1,954). Incomplete records were due to
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14 failure to obtain consent and child's absence from school on the day of examination. From
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16 these 1,954 children, 1,771 completed the questionnaire. Comparing the social status of
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18 responders and non-responders, the proportion of children eligible for the 'Maximum Bill'
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20 was equal for both groups (Chi Square Test; p=0.4).
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25 More than 19% (n=374) of the children made use of the Maximum Bill. Being part of this
26
27 subgroup significantly affected oral health and oral health behaviour, as demonstrated in table
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29 1. Underprivileged children showed worse outcomes for all explanatory variables. They had a
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31 higher plaque index and higher DMFT and DMFs scores, both at D1 and D3 level. Overall
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33 care level was significantly lower, resulting in a lower care index, treatment index and
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35 restorative index. Both knowledge and attitude scores were slightly but significantly lower in
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37 low-income children.
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41 Regarding the proportion of participants being completely treated for caries, underprivileged
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43 children again differ from their more fortunate counterparts. According to table 2, 78.4% of
44
45 the low-income children were caries free (DMFT=0), compared to 88.4% for the high income
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47 group. From those having a DMFT>0, 55.3% of the Maximum Bill group children were
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49 found to have a 100% Treatment index against 65.8% for children of higher social class. The
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51 same trend appeared when comparing the 100% Restorative index, resulting in strongly
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53 significant differences. Half of the low-income children (50.3%) could be considered as
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55 regular dental attenders for the period between 2009 and 2013, whereas 12.6% did not have
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3 any dental visit during these five year period. Middle- and high-income children visited the
4 dentist on a more regular base, resulting in a 77.7% rate for regular dental attendance. Only
5 3.4% of these children did not report any dental visit. All of these differences proved to be
6 statistically significant.
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11 **Discussion**

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13 Oral health inequalities are clearly visible within the present sample of primary school
14 children. Since 2,216 subjects were randomly selected in 105 different primary schools in
15 Flanders, results can be extrapolated to the entire Flemish region.
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19 All included oral health parameters were strongly significantly affected by participants' social
20 class. Not only caries experience, by means of DMFT and DMFs, proved to be higher in
21 underprivileged groups, but also oral hygiene (plaque index) and the level of care seemed to
22 depend on families' social context. This level of care was assessed by means of the restorative
23 index, care index and treatment index. These indices could only be calculated for children
24 having a DMFT > 0. This was mathematically declared in the methodological section, by
25 explaining that it is impossible to divide by "0", which would be the case for those having a
26 DMFT =0. Also clinically, this would be irrelevant, because the indices aim to calculate the
27 proportion of the decayed teeth which have been restored or extracted. If there is no caries
28 experience at all (DMFT=0), these indices are not applicable.
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49 An arithmetic gap of 11.87, 8.34 and 9.96 emerges when comparing Care index, Treatment
50 index and Restorative index for middle/high-income and low income children, in
51 disadvantage of the latter group. The three indices do not all have the same meaning.
52 Restorative index ($RI = (Ft / (D3 + Ft)) * 100$) does not consider the missing teeth, because there
53 can be doubts whether teeth were removed due to caries or due to other factors (trauma,
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3 periodontal infection). Care index ($CI = (Ft / (D3 + M + Ft)) * 100$) partially involves the missing
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5 teeth, but the index does not consider a tooth extraction as a 'solution', but as part of the
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7 problem. Children are literally 'missing' a tooth, so tooth extraction it is seen as a 'lost
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9 chance'. On the other hand, Treatment Index ($TI = ((M + Ft) / (D3 + M + Ft)) * 100$) proposes tooth
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11 extraction as part of the solution, because it removes a (potential) focus of infection. It gives
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13 the same value to fillings and extractions. None of these indices can be considered as 'all-
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15 embracing', so it is good to compare them. When two subgroups differ significantly in
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17 restorative index, but not in treatment index, this means that one of the groups received more
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19 tooth extractions, which can be relevant to explore the severity of the disease and the way of
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21 treating it. The present findings suggest that the low-income children had more teeth being
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23 extracted, although it is hard to determine the clinical relevance of a 1% difference between
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25 treatment index and restorative index.
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30 Statistical analysis clearly demonstrates underprivileged children to visit less frequently the
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32 dental practitioner. One out of eight low-income children (12.6%) did not see a dentist one
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34 single time during the five years prior to data collection. This dental absenteeism is almost
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36 four times higher in underprivileged groups compared to the more fortunate subgroups.
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40 The present Flemish/Belgian results on oral health inequalities are not a unique phenomenon,
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42 but are in accordance with global findings. International literature is overloaded with recent
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44 evidence demonstrating social inequalities in oral health. A systematic review by
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46 Schwendicke shows that low social class is associated with an increased risk of dental caries,
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48 especially in more developed countries (12). Childhood financial hardship not only has a main
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50 impact on individuals oral health during childhood, but also in later life. Poulton et al. (13)
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52 revealed that low childhood socio-economic status (SES) contributes to increased adult levels
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54 of caries and periodontal disease, even after adjusting for adult SES. Listl et al. (14)
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3 confirmed these findings, showing the long-term adverse effects of financial problems in
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5 childhood on oral health in middle and later adulthood.
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8 The today's persistence of social inequalities, both in Flanders and in the entire world, is food
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10 for thought. From the most negative point of view, one could state that all previous oral health
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12 promotion campaigns, health promoting schools and governmental interventions simply failed
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14 to close the social gap in oral health. Unfortunately, the present cross-sectional survey is not
15
16 able to uncover a specific reason for this failure. What needs to be considered and further
17
18 investigated, is the key role played by the family and environmental context in children's
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20 dental adherence. It is clear that 12-year old children cannot be taken fully responsible for
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22 being a dental non-attender. A systematic review of Freire de Castilho (15) reveals that
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24 parental oral health habits affects children's oral health. For this reason, the authors of this
25
26 review state that oral health promotion programs need to put emphasis on the entire family
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28 context, concerning their lifestyle and oral health behaviour.
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33 Regarding the financial aspect, basic dental costs are completely reimbursed in Belgium for
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35 all children under the age of 18 without distinction, so in fact differences in utilization of
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37 health care services for financial reasons are not expected. However, in most dental practices,
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39 the often high dental fee needs to be paid first by the client "out of pocket", to get it
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41 reimbursed by the health insurance agency afterwards. Third party payment, in which the
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43 health insurance agency pays the dental fee directly to the dental practitioner instead of the
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45 client, is allowed for all minors, but not well established. Further, 37.36% of the Belgian
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47 dentists did not take part in the fee convention, bearing a risk of potentially increased dental
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49 costs. The authors cannot draw conclusions in this respect, but want to express the need to
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51 determine the principal cause(s) of oral health inequalities. The specific provider payment
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53 method can be one of the factors, but probably not the only one. Regarding knowledge and
54
55 attitude of the children in this study, there are statistically significant differences between both
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3 social subgroups. However, a mean difference of 0.27 in attitude (on a score out of ten) might
4
5 be of little clinical relevance to explain the existing inequalities. For children's knowledge,
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7 this gap is bigger, with a mean difference of 0.80 in knowledge scores. Differences in
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9 knowledge and health literacy, attitude and lifestyle need further investigated, not only for
10
11 children, but also for the parents.
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14 Although oral health inequalities have always existed and are still remaining, society cannot
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16 simply acquiesce in its existence. Dental caries is largely preventable, but still remains the
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18 most prevalent chronic disease worldwide, mainly affecting high-risk subgroups (1,16).
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20 Dental treatment is expensive, absorbing a considerable part of overall health care budget
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22 (17). Focussing on prevention and tackling oral health inequalities not only improve
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24 individuals' oral health and quality of life, but can also help in reducing governmental costs.
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26 Watt et al. (18) call in the "London Charter on Oral Health Inequalities" for a more upstream
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28 public health approach, targeting the deeper social, political and economic causes of oral
29
30 health inequalities. They advocate new multidisciplinary preventive strategies at local,
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32 regional, national and international levels, based on a common risk factor approach. Quoting
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34 the authors, "collaborative efforts among researchers, policy makers, public health
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36 practitioners, clinical teams, and the public are urgently required". So, decisions on oral health
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38 promotion and tackling oral health inequalities should not exclusively be made by
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40 policymakers, but also involve dentists and intermediate partner organizations.
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46 The 'Marmot Review' (19) provides a guidance to assess the social gradient in health, by
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48 introducing the method of 'proportionate universalism'. Interventions don't need to focus
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50 only on the most disadvantaged individuals, but should be universal and contain a scale and
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52 intensity in accordance with subgroups' level of disadvantage.
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3 The authors understand that the oral health status of Belgian children might be of less
4
5 relevance in international literature. Although, this survey describes a very relevant theme:
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7 social inequalities in health. Of course, many other authors did research on this topic.
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9 However, the present study certainly has an added value. What pleads in favour, is the large
10
11 sample of children with the same age, but more important, the objective and reliable link that
12
13 was provided between children's oral health, their social status and their oral health care
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15 utilization. Oral health was investigated by calibrated and blinded dentists. Afterwards, these
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17 findings were linked to people's social class, not by interviewing the patients or their parents,
18
19 but by exploring data of the national health institute. In this way, dental examiners were
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21 blinded, and people could not 'hide' their social status for the researchers. Furthermore, the
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23 same database revealed the most reliable information on oral health care utilization. Mostly,
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25 dental attendance is assessed by means of a questionnaire, inevitably leading to bias. In this
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27 survey, every single dental visit of a child could be linked to its corresponding record. It is
28
29 obvious that this kind of survey requires a strict procedure, to ensure children's medical data
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31 and privacy. Because of the sensitive character of the information, studies with the same
32
33 setting are very rare. A short literature search on Pubmed with the following string "Oral
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35 Health"[Mesh] AND "health care utilization"[All Fields]" resulted in only 7 hits. Two
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37 Nigerian surveys reported on almost the same subject, but both of them used a self-
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39 administered questionnaire (20-21).
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46 The authors also have to report some limitations of the study. Although oral health figures can
47
48 be comparable with other western countries, the present sample only included Belgian
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50 subjects. Further, the cross-sectional study design does not allow the authors to identify
51
52 specific causes for inequalities in oral health and dental non-attendance, only associations.
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56 Since Glimlachen.be® is a four-year longitudinal program visiting schools, most of the
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58 subjects will have received previous dental screenings before the present data collection.
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3 These screenings might have positively influenced the oral health and oral health behaviour of
4
5 all children, resulting in an underestimation of oral health related problems. However, this
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7 influence should be equal for both compared groups.
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10 **Conclusion**

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12 Oral health inequalities are an undeniable reality in primary school children in
13
14 Flanders/Belgium. Oral health, oral hygiene, oral health care level and dental attendance
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16 patterns are negatively affected by children's social class.
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20 **Acknowledgement**

21
22 The research presented in this report is part of the 'Glimlachen.be' project
23
24 (www.glimlachen.be), commissioned and financed by the 'Insurance Committee for Health
25
26 Care' of the 'Belgian National Institute for Health and Disability Insurance'.
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30 The authors thank the Flemish Dental Association (VVT), the dentist examiners and dental
31
32 assistants and the school for their collaboration. All authors do not declare any potential
33
34 conflict of interest.
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38 **Contributorship statement**

39
40 All authors declare to have had substantial contributions to the conception and design of the
41
42 work, to have drafted and revised the work for important intellectual content. All authors gave
43
44 final approval of the version to be published; and agreement to be accountable for all aspects
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46 of the work.
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50 The corresponding author is drs. Martijn Lambert, dentist and researcher of Ghent University,
51
52 department of Community Dentistry and Oral Public Health. His task was to analyze data and
53
54 write the present article. Prof. Dr. J. Vanobbergen, Prof. Dr. L. De Visschere and Prof. Dr. L.
55
56 Martens are the PhD supervisors of drs. Lambert. They are all participating in the
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3 'Glimlachen.be' project from its very beginning. In that way, they could provide essential
4
5 information on data collection procedure and other methodological aspects of the present
6
7 study. Their expertise was indispensable to realize this publication.
8
9

10 **Competing interests**

11
12 All co-authors declare no competing interests
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14

15 **Funding**

16
17
18 There was no funding to analyze data or to report this paper. The only funding corresponds to
19
20 data collection (see acknowledgement).
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24 **Data sharing statement**

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27 Patient leveled data or full data set and statistical code book are available from the
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29 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 (missing = 1)	No	1602	0.41	0.48	-0.17	[-0.23; -0.12]	<0.001
	Yes	351	0.59	0.58			
DMFt (D1-level) (missing = 1)	No	1601	1.68	2.05	-1.12	[-1.36; -0.87]	<0.001
	Yes	352	2.79	2.43			
DMFt (D3-level) (missing = 2)	No	1600	0.78	1.42	-0.47	[-0.64; -0.30]	<0.001
	Yes	352	1.25	1.68			
DMFs (D1-level) (missing = 0)	No	1602	2.30	3.25	-1.72	[-2.11; -1.32]	<0.001
	Yes	352	4.02	4.07			
DMFs (D3-level) (missing = 0)	No	1602	1.18	2.51	-0.83	[-1.13; -0.52]	<0.001
	Yes	352	2.00	3.16			
Care index* (missing = 0)	No	544	70.33	42.14	11.87	[4.47; 19.27]	<0.001
	Yes	170	58.46	45.17			
Treatment index* (missing = 0)	No	544	73.13	40.83	8.34	[1.18; 15.51]	0.02
	Yes	170	64.79	43.75			
Restorative index* (missing = 0)	No	537	72.18	41.57	9.96	[2.54; 17.38]	0.01
	Yes	164	62.22	44.79			
Knowledge (missing = 183)	No	1483	7.58	2.12	0.80	[0.52; 1.07]	<0.001
	Yes	288	6.78	2.49			
Attitude (missing = 183)	No	1482	8.37	1.32	0.27	[0.10; 0.44]	0.002
	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

Variable	Maximum Bill		p-value
	No	Yes	
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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants Page 6 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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

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(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

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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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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 Strengths 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)
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*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

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<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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