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Caries in five different socio-economic clusters in Örebro county

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Aim: This study assessed the prevalence of socio-demographic clusters in a Swedish county and the relationship of socio-demographic clusters and caries. ***Methods:*** All 2-19-year-olds (n=58,573) who attended a routine check-up in Örebro County in 2005-2007 were involved in this study. Initially, two-stage cluster analyses were used to identify outliers. Secondly, the Ward method which is a hierarchical clustering method was used to conduct the final analysis. Bivariate logistic regression was also used to study the relationship between cluster membership and caries. The smallest study unit used in the initial analysis for geographical area is known as key code area, which is a geographical entity defined by the municipalities themselves. Decayed surface (DS/ds) has been used as a measure of dental caries. ***Results:*** The county of Örebro clustered in five different socioeconomic clusters. Each cluster was defined by proportion of people over 75 years, native-born, single parents, and those with low incomes and low level of education. Odds ratio (OR) for having DS/ds>0 in the last dental check-up during 2005-2007 was 1.5 (cluster 1), 1.3 (cluster 2), 1.4 (cluster 3) and 3.8 (cluster 4) compared with the most socioeconomically favoured cluster (cluster 5). ***Conclusion:*** Cluster analysis of socioeconomic data is a useful tool to identify neighbourhoods with different socio-economic conditions.

Key words: *socioeconomic factors, oral health, child, adolescent, dental caries, Sweden*

Introduction

There is fairly strong evidence for an inverse relationship between Socio Economic Status (SES) and the prevalence of caries (Freire *et al*., 1996; Pereraa and Ekanayakeb, 2008; Reisine and Psoter, 2001; Treasure and Dewer, 1994) despite a lack of consensus on measures of both caries and SES. Some authors have stated that SES explains up to half the variance in dental caries (Hobdell *et al*., 2003). Despite this, Reisine and Psoter (2001) stated in a literature review that due to the relatively small number of studies and methodological limitations, the evidence for this relationship is weaker for those older than twelve. She also recommended that future studies should include variables that provide opportunities for effective interventions in order to reduce risk (Reisine and Psoter, 2001). Since his literature-review there have been a number of papers about oral health and SES, and some of these have used conceptual models and multi-level analysis to find and discuss moderating and mediating factors which hide the effect of SES (Ekbäck *et al*., 2009; Telford *et al*., 2011). But even if there is a general understanding of associations between caries and socio-demographic conditions this understanding tends to be very diffuse and still there are few studies with a large number of participants showing differences in decayed surfaces (DS/ds) between clearly defined socio-demographic areas. Only in the last several years have systematic epidemiological and socioeconomic register data become available to facilitate research in this field.

Equitably financed universal dental care for children and adolescents has a long tradition in the Nordic countries (Helöe, 1988). Since 1938, the Public Dental Health Services (PDHS) in Sweden have had a responsibility to provide dental care (including specialist care) free of charge to children and adolescents (Sundberg, 1986). The counties are responsible for financing and providing this service, and allow a free choice of caregivers, including both public and private practitioners. All counties have a responsibility to invite children and adolescents for a dental check-up and monitor their oral health (Sundberg, 1986) with epidemiological data being routinely collected by the PDHS and private practitioners in terms of clinical measures, like decayed surfaces, for the purpose of estimating oral health status and treatment needs. Socio-economic data are less readily available for planning despite poverty status often being suggested as an important factor for planning and monitoring future national oral health objectives (Dye and Thornton-Evans, 2010). In the county of Örebro two such analyses have been carried out and this study is based on the last one (Persson *et al*., 2009).

In line with the suggestions from Reisine and Psoter (2001) that future studies should include variables that provide opportunities for effective interventions to reduce caries risk from SES this study has used five different socio-economic clusters, well described, to measure caries differences. From the description of these five socio-economic clusters, it is possible to create specific programs to intervene with the purpose of reducing the caries-incidence in specific areas.

This study: 1, assessed the prevalence of socio-demographic clusters in the county of Örebro; 2, assessed the prevalence of caries, measured by DS as reported by dentists in the county of Örebro; and, 3, examined the relationship between socio-demographic clusters and caries.

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Material and methods

These analyses use socio-demographic data from the Statistics Sweden (SCB) and epidemiological data from the Örebro county council. The socio-demographic data from SCB were initially used to investigate whether there were socio-economic clusters of geographical key-code (postcode) areas in the county which could clearly be described both theoretically and geographically. They were used together with the epidemiological data to compare oral health in terms of active caries between these clusters. Data were supplied by SCB in such a manner that it was not possible to identify individuals. The study population comprised 1,367 small administrative geographical areas, key-codes, each with more than 25 inhabitants in 2007 (initial analysis) and all 2–19-year-olds who were invited for routine check-ups in Örebro County in 2005–2007 (secondary analysis). Data were collected during 2008. The study base for the secondary analysis is presented in Table 1.

Caries status from the last visit has been used when participants have visited the dentist for clinical examinations more than once during the period 2005–2007. Some 58,573 children and adolescents are included in the study and 65% of them have dental status recorded in 2007. These 58,573 children and adolescents account for 99.3% of the 58,969 inhabitants aged 2–19 years, registered in the county in December 2007. More detailed information of this study has been published elsewhere (Persson *et al*., 2009).

The ethical considerations employed in this study were in accordance with the principles of the declaration of Helsinki (WHO, 1964). All data were registered anonymously. The project did not include research which requires ethical approval in Sweden (SFS 2007:1069).

The smallest study unit used in the initial analysis is known as a key-code area with at least 25 residents, which is a geographic administrative entity defined by the municipalities themselves. Socio-demographic variables that were used in the main analysis were as follows; proportion aged 75 and older, proportion born in Sweden, proportion of single parent families, proportion of residents 20 years or older with low disposable income and proportion of population aged 20–64 years with comprehensive school or equivalent education for twelve years or less. These measures were selected because they were valid and reliable and are often used to indicate socio-demographic differences. Number of decayed surface has been widely used as a measure of dental caries. Decayed surfaces were measured only in primary teeth between ages 2-7 and only for permanent teeth for the remaining age groups.

Data were analysed using the SPSS v16 & 17 (Chicago, USA). Initially, two-step cluster analyses were used to identify outliers. One key-code area was identified as an outlier and was excluded from the analysis. Since all available information is not used in the two-step cluster method, a hierarchical agglomerative clustering method, Ward's method (with squared Euclidian distance) was used, to conduct the final analysis. Number of iterations was set to 200 million and number of items in the data-matrix was 1,366. No adjustment was made for any effect of the multiplicity of statistical tests made.

The two datasets, 1,366 geographical key-code areas and 58,573 individuals with dental status, were matched by key-codes. Bivariate logistic regression was used to study the relationship between cluster membership and dental status.

Results

Table 2 shows the final number of clusters and their characteristics. Of the inhabitants, 49% were in cluster 1, 24% in cluster 2, 6% in cluster 3, 6% in cluster 4 and 15% in cluster 5. All addresses in Örebro County could be linked to one of these five clusters apart from a few exceptional cases such as industrial areas. Figure 1 shows the geographical distribution of the clusters.

The statistical effect by cluster for having DS/ds>0 is illustrated with Odds Ratios (OR) in Table 3. The results for the younger groups are similar but not shown in table. These differences in the number of new caries lesions by cluster can also be illustrated by calculating the mean number of new caries-damaged tooth surfaces (mean DS/ds) and such analysis again reveals that those in cluster 5 had the best oral health and those of cluster 4 the worst.

Discussion

This study had two main purposes. The first objective was to determine whether there were clearly identifiable geographical areas in a normal Swedish county council which can be classified based on well-defined socio-demographic characteristics. The second objective was to determine differences in decayed surface between these clusters. The main finding of the study was that five well described distinct SES areas had measurable differences in decayed surface.

Table1. Number and percentage of participants aged 2-19 years-old in Örebro County by year of their dental check-up

Year	*n*	*Proportion (%)*
2005	2,287	4
2006	18,301	31
2007	37,985	65
2005–2007	58,573	100

Table 2. Percentage of cluster inhabitants distributed by socio-economic variables

Cluster	*Proportion aged 75 years and older*	*Proportion native born*	*Proportion with single status and having children*	*Proportion with low income*	*Proportion with low level of education*
1	9	91	4	40	80
2	7	91	5	33	65
3	31	91	6	34	68
4	3	57	10	64	80
5	7	93	3	30	47

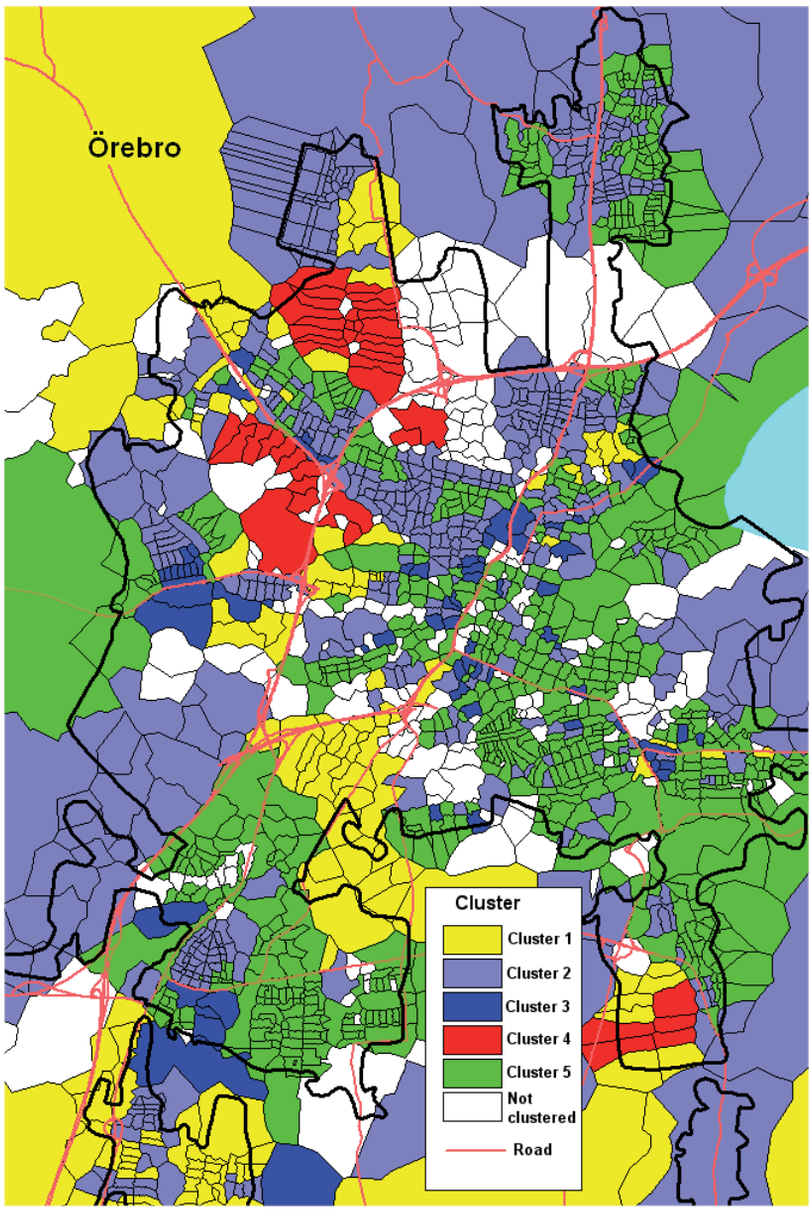

Figure 1. *Map of the five socio-economic clusters in the municipality of Örebro*

Table 3. Unadjusted odds ratios (OR) with 95% confidence intervals for decayed surfaces>0 at the last dental check-up during 2005-2007

Age group	*Cluster 1 OR (95% CI)*	*Cluster 2 OR (95% CI)*	*Cluster 3 OR (95% CI)*	*Cluster 4 OR (95% CI)*
7-9 years	1.4 (1.09-1.82)	1.0 (0.74-1.32)	1.3 (0.78-2.33)	4.1 (3.06-5.43)
10-12 years	1.4 (1.08-1.74)	1.1 (0.84-1.43)	1.0 (0.55-1.70)	3.9 (2.98-5.17)
13-15 years	1.7 (1.37-2.16)	1.3 (1.05-1.73)	1.0 (0.56-1.62)	4.3 (3.32-5.69)
16-19 years	1.6 (1.32-1.82)	1.4 (1.16-1.64)	1.5 (1.16-2.04)	3.7 (3.00-4.47)
7-19 years	1.5 (1.38-1.70)	1.3 (1.12-1.41)	1.4 (1.12-1.70)	3.8 (3.38-4.33)

Data from bivariate logistic regression for different age-groups with Cluster 5 as the reference group.

Other studies found similar relationships, though with considerable variation, and seldom with caries differences related to such detailed mapping supported by advanced technological tools (Freire *et al*., 1996; Pereraa and Ekanayakeb, 2008; Reisine and Psoter, 2001; Walter and Eriksson, 2008).

Sweden is a country whose social politics ensure that even the least favoured social groups have a decent material standard of living. Despite this, there is a clear difference in active caries between different social clusters and perhaps indicating that material living standards are no longer the main determinant of individuals' health but rather income disparity between families (Wilkinson and Marmot, 2003). Contrary to some previous research this study does not find clinical important differences in the correlation between caries and socio-economic status in different age groups (Christensen *et al.*, 2010).

Nordic countries like many others have used both individual approaches and collective approaches for both health prevention and health promotion. In the West, despite generally good levels of oral health, there remain groups with poor oral health and increased attention is being given to programmes specifically targeted at these groups. (Truin *et al.,* 1998). To reach these groups it is important to use both individual and population health strategies. Tellez *et al*. (2006) stated that determinants of individual health can differ from the determinants of population health, and dental researchers have not yet linked macro social forces, such as neighbourhood characteristics with patterns of oral health status and oral disease in populations. So a good knowledge of the neighbourhoods concerned is important to identify links to the epidemiological results. Great differences in oral health (caries), like those in this study, between different socio-economic groups have been presented earlier and the reasons have been discussed by a number of researchers and many explanations have been presented (Berkman and Kawachi, 2000; Frohlich *et al.*, 2001; Tellez *et al.,* 2006).

Because the clusters in this study are both socioeconomically and geographically well-defined it is possible to use the findings to plan specific local oral health interventions focused on special target groups. Based on these socio-demographic areas it is also possible to study lifestyle diseases other than dental caries in this way, for example heart attacks and diabetes (Walter and Eriksson, 2008). Actions based on socio-economic maps are suitable primarily for promotion activities at group level and are specially designed according to the specific cluster appearance with respect to age, sex, language, etc.

We have identified no other studies using such large and detailed geographical SES databases to assess differences in the mean DS/ds The clinically significant findings provide opportunities for planning the deployment of resources recognising that neighbourhoods contribute something unique in connection with oral health (Tellez *et al*., 2006).

There are some limitations in this study. Firstly, the cross-sectional nature of the data used in this analysis did not allow the investigation of the directionality of the associations. Risk factors for dental caries like many other diseases are cumulative and may have occurred earlier when people lived elsewhere. Further, some SCB data could be less than optimal for identifying socio-economic differences. Finally, the choice of five clusters is not the only possible statistical solution and the technique of hierarchical cluster analysis cannot identify the optimal number of clusters. However, the method used, Ward's method, is regarded as fairly robust after controlling for outliers and the final cluster solution corresponded well with previously known areas of different socio-demographic status (Everitt *et al.,* 2001).

To summarise, the present study has shown that it is possible to distinguish clearly defined socio-economic areas with significant differences in their caries activity.

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