

## GIS and areal variation in dental caries – contribution of socio-economic factors among 6-year-olds in Kemi, Finland

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### Abstract

The aim was to study the area-based variation of factors related to oral health among 6-year-olds in Kemi, Finland. The areal factors included were: percentage of unemployed, annual gross income, number of persons economically dependent on one employed person and percentage of household-dwelling units with poor standard of equipment. Numbers of decayed, filled or missing deciduous teeth, emergency care visits for tooth-ache, missed appointments and appointments where the child had reported to be uncooperative were collected for each patient from 1998 records retrospectively since birth. No associations between oral health and areal factors were observed.

### Introduction

In Finland, oral health care services have been provided free of charge to all children and adolescents under 17 and 19 years of age since 1976 and 1979, respectively (Widström and Hiiri 1998). These systematic and comprehensive services, provided by local municipalities and financed by general and local taxation, have included regular oral health examinations, preventive care such as oral hygiene instruction and fluoride applications, and all necessary treatment. The oral

health services are partly integrated with the mother and child health care (MCH) activities, which are used by virtually all families in Finland and strongly emphasise health promotion. The oral health of Finnish children and adolescents has improved markedly since the 1970's (Nordblad *et al.* 2004, Vehkalahti *et al.* 1997). The average numbers of decayed, filled or missing permanent teeth (DMFT) per child in Finland in 2000 were 0.2, 1.2 and 2.6 among 6-, 12- and 15-year-olds, respectively (Nordblad *et al.* 2004). These figures are similar to those

reported in other industrialised countries. In the 1990's Denmark, Iceland, Norway, Sweden and UK reported DMFT levels of 1.2–1.5 among 12-year-olds (Marthaler 1996).

As the caries rates have declined, the occurrence of caries has polarised. In 1993, in Helsinki, 78% of the five-year-olds had no history of caries i.e. were caries free, whereas 8% of the children accounted for 76% of all decayed teeth (Vehkalahti et al. 1997). Among 15-year-olds 26% were caries free and 10% of the children accounted for 55% of decayed teeth (Vehkalahti et al. 1997). In 1992–1998 25% of the children in Jyväskylä and Kuopio with the highest DMFS (S=tooth surfaces) values accounted for 79% and 67% of the affected surfaces for 12-year-olds and 15-year-olds, respectively (Seppä et al. 2000). Even though caries occurrence has declined it continues to affect also those who previously have been caries-free. In the Finnish City of Vantaa, almost half of the children who were caries-free by age of 12-years got caries by the time they are 15-year-olds (Hausen 2003).

Due to the uneven distribution of caries in child populations it is tempting to try to identify those individuals at greater risk for caries and target preventive oral health measures to them. In addition, the currently available screening methods for caries risk are fairly inaccurate (Hausen 1997; Hausen 2003), and none of them meets the criteria suggested in the literature (Kingman 1990). Identification of high-risk children with reasonable accuracy seems to be possible only among toddlers (Alaluusua 1993; Jokela 1997). Besides problems in identifying the high-risk children it is also difficult to help them within oral health services. In Finnish circumstances, intensive pre-

vention for high risk children does not seem to be effective in preventing dental caries (Hausen et al. 2000).

Means other than individual, to reach the children at increased risk for caries have been suggested (Prendergast et al. 1997). In international studies, area-based measures have been proposed (Locker 1993) and used (Sweeney et al. 1999; Watt and Sheiham 1999; Tickle et al. 2000a, 2000b, 2000c; Morgan and Treasure 2001) to identify groups at risk. In Finland, such measures have been used in studies related to mortality (Rytönen et al. 2001), diabetes (Ranta et al. 1996, Karvonen et al. 1997) and health related factors like milk consumption (Gang et al. 1996). However, reports on the areal distribution of dental caries within municipalities in Finland have not been published. Our aim was to study among 6-year-olds the area-based variation of the percentage of caries free children in 5 major regions and 15 statistical regions in the City of Kemi, in Northern part of Finland. In addition, we wanted to study the areal distribution of emergency care visits due to tooth-ache, missed appointments and appointments where the child had reported to be uncooperative.

## Material and methods

All (N=247) 6-year-olds that in 1998 were residents in the City of Kemi, a middle size city with about 24 thousand inhabitants, were included in the study. Oral health data were obtained from patient records. Number of decayed, filled or missing deciduous teeth (dmft) and number of decayed deciduous teeth (dt) were collected for each patient from 1998 records. Numbers of emergency care visits due to tooth-ache, missed appointments and appoint-

ments where the child had reported to be uncooperative were collected retrospectively since birth.

The following areal factors were considered: percentage of unemployed, annual gross income, number of persons economically dependent on one employed person (economic dependency ratio) and percentage of household-dwelling units with poor standard of equipment. Individual oral health data were combined to the already existing socio-economical GIS data set by using the social security numbers that indicate the present area of residence. Areal

observations were conducted in 5 major regions and 15 statistical regions of the City of Kemi. The study was approved by the ethical committee of the University of Oulu.

## Results

In the entire Kemi, the percentage of caries free 6-year-olds was 64.3%, the mean dmft was 1.04 and the mean dt was 0.63. Table 1 presents the percentages of children with no history of caries (caries-free, dmft=0), no current cavities (decayed teeth,

Table 1. The percentages of 6-year-olds with no history of caries (caries-free), no current cavities (decayed teeth), at least one emergency care visit due to tooth-ache (tooth-ache), at least one missed appointment and at least one reported visit with uncooperative behaviour, and the percentage of unemployed persons, annual gross income, number of persons economically dependent on one employed person (economic dependency ratio) and percentage of household-dwelling units with poor standard of equipment in the entire Kemi and in the five major regions (MR1-5)

	<b>Kemi</b>	<b>MR1</b>	<b>MR 2</b>	<b>MR 3</b>	<b>MR 4</b>	<b>MR 5</b>
tooth-ache % <sup>1</sup>	20.2	25.8	21.0	16.3	19.2	17.2
missed appointments % <sup>1</sup>	30.3	35.5	25.8	28.6	24.7	34.5
cooperation behavior % <sup>1</sup>	55.1	54.8	41.9	55.1	54.8	58.6
caries-free (dmft=0)% <sup>1</sup>	64.3	45.2	64.5	61.2	65.8	62.1
no cavities (dt=0)% <sup>1</sup>	71.3	58.1	74.2	61.2	71.2	72.4
economic dependency ratio <sup>2</sup>	1.99	1.90	1.99	1.99	2.02	1.98
annual gross income <sup>3</sup>	14 931	15 111	14 974	15 053	14 510	15 749
unemployment % <sup>3</sup>	25.6	23.8	26.0	23.3	28.2	24.3
household-dwelling units with poor standard of equipment% <sup>1</sup>	5.0	3.0	5.6	7.0	4.9	4.8

<sup>1</sup>=1998 information, <sup>2</sup>=1997 information, <sup>3</sup>=1996 information

dt=0), at least one emergency care visit due to tooth-ache, at least one missed appointment and at least one reported visit with uncooperative behaviour, and the percentage of unemployed persons, annual gross income, number of persons economically dependent on one employed person (economic dependency ratio) and percentage of household-dwelling units with poor standard of equipment in the entire Kemi and in the five major regions of Kemi. Table 2 presents the same information in the two

statistical regions that ranked highest and poorest according to at least four aspects of oral health.

Major region 1 that ranked poorest according to the percentage of caries-free children, visits for tooth-ache and missed appointments did not rank poorest according to the areal socio-economic variables. Major region 4 that ranked poorest according to areal socio-economic variables had the highest percentage of caries-free chil-

Table 2. The percentages of 6-year-olds with no history of caries (caries-free), no current cavities (decayed teeth), at least one emergency care visit due to tooth-ache (tooth-ache), at least one missed appointment and at least one reported visit with uncooperative behaviour, and the percentage of unemployed persons, annual gross income, number of persons economically dependent on one employed person (economic dependency ratio) and percentage of household-dwelling units with poor standard of equipment in the entire Kemi and in the the two statistical regions (SR) that ranked highest (H1-2) and poorest (P1-2) according to at least four variables related to oral health.

	<b>Kemi</b>	<b>SR-H1</b>	<b>SR-H2</b>	<b>SR-P1</b>	<b>SR-P2</b>
tooth-ache % <sup>1</sup>	20.2	9.1	15.2	28.6	18.2
missed appointments % <sup>1</sup>	30.3	18.2	18.2	35.7	25.0
cooperation behavior % <sup>1</sup>	55.1	36.3	48.4	50.0	41.6
caries-free (dmft=0)% <sup>1</sup>	64.3	77.3	72.7	42.9	33.3
no cavities (dt=0)% <sup>1</sup>	71.3	81.2	75.8	42.9	50.0
economic dependency ratio <sup>2</sup>	1.99	1.97	2.20	1.79	2.61
annual gross income <sup>3</sup>	14 924	15 424	14 171	15 551	12 422
unemployment % <sup>3</sup>	25.6	24.5	29.8	20.0	41.9
household-dwelling units with poor standard of equipment% <sup>1</sup>	5.0	4.0	1.7	5.0	1.5

<sup>1</sup>=1998 information, <sup>2</sup>=1997 information, <sup>3</sup>=1996 information

dren and the lowest percentage of missed appointment.

The statistical region with the lowest percentage of caries-free children ranked poorest according to annual gross income, percentage of unemployed and economic dependency ratio but ranked highest according to household-dwelling units with standard of equipment. The statistical region that ranked second poorest according to the percentage of caries-free children ranked most favorable according to annual gross income, percentage of unemployed and economic dependency ratio. The two areas that ranked highest with regard to the percentage of caries-free children showed no consistent pattern with regard to the areal socio-economic variables.

## Discussion

In previous studies, widening areal inequalities in oral health have been found simultaneously with the improvement of average oral health (Watt and Sheiham 1999). Poor oral health has been associated with areal deprivation and poor socio-economic status in several studies (Sweeney *et al.* 1999; Watt and Sheiham 1999; Tickle *et al.* 2000a, 2000b, 2000c; Morgan and Treasure 2001). However, in Kemi such association was not found. On the contrary, in statistical regions, some contradicting associations between oral health and areal socio-economic variables were found. This diverging finding may be due to the rather equal income distribution in Finland and especially in Kemi, that belongs to the lowest income difference quintile within the country (Rusanen *et al.* 2001a, 2001b).

This analysis did not include other socio-demographic variables, such as level of the parents' education that has been found to

be one of the most powerful forces affecting oral health related knowledge, attitudes and behavior (Gift 1993). On the other hand, education level and income correlate strongly. In Kemi, paper and pulp industry are the major sources of living and the percentage of employees in that area is high. Within paper and pulp industry wages are higher than in other occupations that require the same level of education. This might have contributed to the lack of association between socio-economic variables and oral health related factors and would be worth further studies. Even though no association between areal socio-economic variables and oral health was found areas where oral health was poor according to several measures could be identified. Thus, oral health promotion activities, including both community based approaches and oral health services, could be planned and targeted to those areas.

## Conclusion

In Kemi, the poor areal socio-economic living standards were not associated with poor oral health as reported elsewhere. This could be explained by the fairly homogeneous structure of the Finnish society but needs to be studied further.

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