

Oral health inequalities in Italian schoolchildren - a cross-sectional evaluation

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Objective: To evaluate which of the following indicators of socio-economic status (SES) has the strongest association with dental caries status in a 6-year-old population: the educational level of each parent (individual-level); the mean price of housing/m² in the area where the family resides; or the mean per capita income in the area where the family lives (area-level). **Material and Methods:** Dental caries was recorded in 2,040 schoolchildren (42.5% boys, 57.5% girls) using decayed/missed/filled surface index (d₃ level) in primary dentition. Parents filled in a standardised questionnaire regarding nationality, level of education, frequency of dental check-up and perception of child's oral health and child's oral hygiene habits. **Results:** At the individual-level of SES, mothers' educational level was associated with their children's caries severity ($\chi^2_{(9)}=147.51$ p<0.01): as educational level rose the proportion of children with high numbers of carious lesions fell. The two income indicators (area-level SES) were not associated. A multinomial logistic regression model was run for caries risk factors. Caries severity was used as dependent variable and the model was stratified by mothers' educational level. Mothers' perception of child's oral health was the only covariate that was always associated in every caries severity strata and for each level of mothers' education. **Conclusions:** The present study shows that mothers' educational level is a useful individual SES indicator for caries in Italian children living in a low-income population.

Key words: dental caries, socio-economic status, socio-behavioural variables, primary dentition, Italian schoolchildren.

Introduction

In the last 40 years, the prevalence of dental decay across the world was reported to be declining particularly in the developed countries, mainly due to the introduction and widespread use of fluoridated toothpaste (Campus *et al.*, 2007a; 2007b; Marthaler, 2004). However, in populations with a low caries experience, information about the role of the main risk factors is still needed (Marthaler, 2004). Dental caries is a multifactorial disease whose development is influenced by several factors including the previous caries experience, use of fluoride, plaque control, salivary flow rate, medical history and diet. All these are influenced by social factors and it is essential to focus on the non-biological determinants of dental caries, namely socio-behavioural and environmental factors (Holst *et al.*, 2001).

Despite the remarkable reduction in the prevalence of dental caries, it remains one of the most common diseases affecting children especially from socially disadvantaged groups (Ekbäck and Persson, 2012; Sabbah *et al.*, 2007). Socio-economic status (SES) is considered the most powerful predictor of future experience of poor oral health (Vargas and Ronzio, 2006), and behavioural factors may well function as a mediator between social disparities and health outcomes. Children depend on their environment to establish favorable health behaviours and

their dental health banks on the parents' involvement, including family lifestyle habits and support from the National Health Service. Additionally, the influence of social conditions on dental health has been shown to be stronger for preschool children than older children (Christensen *et al.*, 2010). It is quite demanding for health and health policy researchers to obtain reliable individual-level income information. To resolve out this problem, several area-level indicators of SES are commonly used in public health research (Diez-Roux *et al.*, 2001; Geronimus *et al.*, 1996). Among the SES indicators commonly presented in literature are the individual-level educational grading of the parents (Borges *et al.*, 2012), and the area-level SES as mean *per capita* income of the area where the family lives (Braveman *et al.*, 2005). However, area-level SES measures may not be an appropriate proxy for individual-level SES as their use assumes that the indicators are roughly homogeneous across an area.

The mean price/m² of the houses in the area where the family resides might be used as a SES indicator (Fichera and Gathergood, 2013; Mian and Sufi, 2011), and it might be used in countries where most families live in their own homes as in Italy (Campus *et al.*, 2009a; b).

The aim of this cross-sectional study was to determine which of the following indicators of SES has the strongest association with clinical data regarding caries prevalence

in a group of children from a low-income population: the educational level of the parents (individual-level); the mean housing price in the area where the family resides; and that area's mean *per capita* income (area-level).

Methods

The present study was carried out in Sassari county (Sardinia, Italy), under the supervision of the WHO Collaborating Centre for Epidemiology and Community Dentistry of Milan (Italy) and lasted 30 months, from January 2008 to June 2010. According to Eurostat (epp.eurostat.ec.europa.eu), the mean income *per capita* was € 20,627 in 2009. The Sardinian economy is constrained due to high costs of goods trading and electricity and the whole island can be considered a low-income area respect to mean European Union income *per capita*. The study was carried out in Sassari and in nine small surrounding towns. The study group was obtained from children aged 6 years attending primary schools. The study protocol received ethical approval from the Ethics Committee of the University of Sassari (128SS/2007).

Power analysis was performed using G*Power 3.1.3 for Apple using logistic regression, with an odds ratio of 1.3, an error probability of 0.01 and the total sample size set at 1,803. Data from the Italian National Institute for Statistics for 2008 gave the number of 6 year-olds living in the area as 3,708. Taking into account the anticipated low response rate, all these children were invited to participate. Children's parents were asked to fill in a standardised questionnaire regarding their nationality, level of education, frequency of dental check-up, perception of child's oral health and child's oral hygiene habits. The questionnaires were distributed to the parents through the teachers and were accompanied by a letter explaining the purpose of the study.

The SES of the family was evaluated using the parents' educational levels (Borges *et al.*, 2012), the mean price/m² of the houses in the area where the family resides (Fichera and Gathergood, 2013; Mian and Sufi, 2011) and the mean income *per capita* in that area (Braveman *et al.*, 2005).

Children were examined at school sitting on an ordinary chair, using a mouth mirror and a Community Periodontal Index probe (approved by the WHO) under optimal lighting. Dental caries in primary dentition was assessed using decayed, missed, filling surface index (dmfs) at dentinal level (d_i).

Data from the dental examination and questionnaire were entered in the FileMaker Pro 5.0 Runtime database and then exported to Excel® Microsoft spreadsheet. SES was assessed using three indicators: one at individual-level, the educational grading of the parents and two at area-level, the mean housing price/m² and the mean *per capita* income of the area where the family lives.

The educational level of each parent was classified as follows: none, compulsory education, secondary school and university. Housing price/m² in the area where the family resides is defined as the price at which a house would sell if placed on the market. Mean housing price/m² was classified as: low, <€1,000; medium, <€1,500; and high, ≥€1,500 (INIS). The mean *per capita* incomes of the nine small towns registered in 2010 were similar

to each other (mean €19,468, range €17,831-20,179). So in the data analysis, Sassari (mean income €24,373) was considered an urban area, while the mean income of the nine surrounding towns was considered typical of a non-urban area (INIS).

Descriptive statistics and cross-tabs were calculated to investigate the relationship between dental health and different risk factors: parents' nationality, parental educational level, frequency of dental check-up, previous experience to dental care, parental perception on child's oral health and brushing frequency. Next, multilevel mixed Poisson regression was performed to determine which SES indicator, at individual- or at area-level, fits better with caries disease. A dummy variable as the sum of the mean housing price and the mean *per capita* income was constructed. Finally multinomial logistic regression was performed using caries severity levels as the dependent variable. Caries index (dmfs) was classified as healthy (no decayed surfaces), moderate (1-2 decayed surfaces), severe (3-15 decayed surfaces) and high (>15 surfaces).

All data were analysed using the software STATA® (Mac v10.1). For all analyses the statistical significance level was set at $\alpha=0.05$.

Results

Written consents were obtained from 2,410, 65.0%, of the 3,708 6 year-olds in the area. The reasons for the 1,298 non-responses were failure to return the questionnaire (962, 74.1%) and absence from schools (336, 25.9%). A further 370 children refused to be examined on the day of dental examination.

Overall, 2,040 schoolchildren (55.0% of the population, 84.6% of those with written consent, 42.5% boys and 57.5% girls) were examined at school by *ad hoc* calibrated examiners (GCar SS). The examiners were trained and calibrated by the same epidemiologist (GCam) to reduce inter-examiner variation; a 0.90 Kappa index and an agreement of 94.0% were reached. Observations were duplicated on a random 10% of the children giving agreement and the Kappa index values 99.0% and 0.80, respectively.

The mean age of the enrolled children was 6.65 years (sd 0.13). The results obtained from the dental examinations showed a mean dmfs of 0.60 (sd 0.19) and a high percentage of caries-free children (64.5%).

Association between risk indicators and caries experience

Table 1 displays the proportion of schoolchildren with caries experience (dmfs>0 and dmfs=0) by various background variables. The great majority of the parents were of Italian origin (95.5% of mothers, 96.6% of fathers). Most parents (79.1% of mothers, 80.4% of fathers) were educated to compulsory or secondary level, with only 16.2% (mothers) and 11.5% (fathers) reaching university level. The educational level of the parents was associated with the caries experience of their children ($p<0.01$). The table also presents detailed information on oral health behaviours. Parents are quite equally divided between those that arrange a dental check-up every 6 months (35.0%) and those who do so every 2 years (37.6%).

Table 1. Socio-demographic variables and oral health behaviour in the study group across caries experience (dmfs=0; dmfs>0)

	<i>dmfs>0</i> <i>n (%)</i>	<i>dmfs=0</i> <i>n (%)</i>	<i>OR</i> <i>95% CI</i>	χ^2 for trend of odds	<i>p</i>
Nationality of the mother				$\chi^2_{(1)} 0$	0.59
Italian	612 (33.79)	1,118 (61.74)	0.49-0.60		
Other	31 (1.71)	50 (2.76)	0.39-0.97		
Nationality of the father				$\chi^2_{(1)} 0$	0.99
Italian	605 (33.90)	1,120 (62.74)	0.49-0.59		
Other	21 (1.17)	39 (2.19)	0.32-0.91		
Educational level mother				$\chi^2_{(3)} 94$	<0.01
None	53 (2.94)	32 (1.78)	1.06-2.57		
Compulsory education	309 (17.16)	380 (21.10)	0.69-0.94		
Secondary school	223 (12.38)	512 (28.43)	0.37-0.51		
University	57 (3.16)	235 (13.05)	0.18-0.32		
Educational level father				$\chi^2_{(3)} 92$	<0.01
None	81 (4.58)	62 (3.50)	0.94-1.82		
Compulsory education	345 (19.50)	495 (27.98)	0.61-0.79		
Secondary school	163 (9.21)	419 (23.69)	0.32-0.46		
University	30 (1.70)	174 (9.84)	0.12-0.25		
Frequency of parent's check-up				$\chi^2_{(3)} 38$	<0.01
Pain presence	85 (4.85)	168 (9.59)	0.39-0.65		
Each 6 months	266 (15.18)	347 (19.81)	0.65-0.89		
Once a year	49 (2.80)	179 (10.22)	0.19-0.37		
Once in 2 years	221(12.61)	437 (24.94)	0.43-0.59		
Frequency of child's check-up				$\chi^2_{(3)} 19$	p<0.01
Pain presence	226 (17.04)	257 (19.38)	0.73-1.05		
Each 6 months	36 (2.71)	87 (6.56)	0.28-0.61		
Once a year	183 (13.80)	295 (22.25)	0.51-0.74		
Once in 2 years	84 (6.34)	158 (11.91)	0.40-0.69		
Previous experience to the dentist				$\chi^2_{(1)} 23$	<0.01
No	236 (13.00)	567 (31.24)	0.35-0.48		
Yes	408 (22.48)	604 (33.28)	0.59-0.76		
Parents' perception of child's oral health				$\chi^2_{(1)} 450$	0.01
Good health	280 (15.60)	1047 (58.33)	0.23-0.30		
Poor health	354 (19.72)	114 (6.35)	2.51-3.83		
Child's brushing frequency				$\chi^2_{(2)} 2$	0.28
Once a day	129 (7.1)	199 (11)	0.52-0.81		
Twice a day	382 (21.1)	699 (38.6)	0.48-0.61		
More than twice a day	137 (7.5)	267 (14.7)	0.42-0.63		

Parents' dental attendance was significantly associated with the children's caries experience ($p<0.01$). More than a third (36.4%) of the children only visited a dentist when a dental emergency occurred; a similar 36.1% were regularly examined once a year. Parents had a correct perception of their child's oral status; more than three quarters of parents (78.1%) estimated it accurately ($p<0.01$). Some 1,081 children (59.7%) brushed their teeth twice a day, but brushing frequency was not related to caries experience ($p=0.28$).

Association between SES indicators and caries severity

A high collinearity was observed between mothers' and fathers' educational level ($\chi^2_{(9)}=921.93$ $p<0.01$). Fathers' educational level was less associated with caries prevalence and so it was dropped from succeeding analyses. Mothers' educational level was associated with their children's caries level ($\chi^2_{(9)}=147.51$, $p<0.01$): the higher the educational level, the lower the incidence of high numbers of carious lesions.

Mean *per capita* income of the area where the family lives was not associated with the distribution of carious lesion ($\chi^2_{(3)}=5.97$ $p=0.11$). Children's distribution across caries severity scores was similar in the two income levels; only in the high caries level group, the percentage of children living in (affluent) urban area was higher than in non-urban areas (4.1 vs 1.8). Also the mean housing price/m² in the area where the family resides was not associated with carious lesion severity ($\chi^2_{(9)}=5.97$, $p=0.09$), with similar figures to mean *per capita* income.

Table 2 shows the outcomes of the multilevel Poisson regressions for the distribution of caries severity among the three chosen SES indicators. Random effects were evaluated on the gender of the subjects. Mothers' education was the only indicator significantly associated with the caries level.

Finally a multinomial logistic regression model was run for caries risk factors. Caries severity was used as dependent variable and the model was stratified by mothers' educational level. The category with the highest frequency of subjects in each caries level was used

Table 2. Outcome of the multilevel (mixed effects) Poisson regression

	Coefficient (SE)	95% CI	p-value
Mothers' educational level (<i>University</i>)	-0.93 (0.40)	0.62, 1.14	<0.01
Mean <i>per capita</i> income (<i>Urban area</i>)	0.47 (0.35)	-0.20, 1.15	0.17
Mean housing price (<i>High</i>)	0.34 (0.21)	0.06, 1.08	0.74
Income/housing	-0.26 (0.15)	-0.58, 0.04	0.10
Gender	-0.24 (0.17)	-0.59, 0.60	0.11
Constant	2.10 (0.22)	1.67, 2.53	<0.01
<i>Random-effects parameters: Independent</i>			
sd(gender)	-0.93 (0.40)	0.62, 1.14	<0.01
sd(constant)	0.47 (0.35)	-0.20, 1.15	0.17

Note: Caries severity was used as the dependent variable with values: dmfs(0) being the reference level; dmfs(1-2); dmfs(3-15); dmfs(>15), across the SES indicators: mothers' educational level, mean cost of the housing price and mean *per capita* income of area where the family lives. Random effects were evaluated on the gender of the subjects.

Table 3. Multinomial logistic regression estimates for significantly associated caries risk factors.

Mothers' education	dmfs	Coefficient	95% CI	Log likelihood	$\chi^2_{(12)}$	p
None (n=61)	0 ¹ Parents' perception of child's oral health (poor)	-1.50	-2.90, -0.09	-70	21	0.05
	1-2 ¹ Parents' perception of child's oral health (poor)	-2.01	-3.69, -0.33			0.02
	Compulsory (n=489)					-495
Secondary (n=515)	1-2 Parents' perception on child's oral health (poor)	0.65	0.05, 1.25	-396	150	0.03
	3-15 Parents' perception on child's oral health (poor)	2.33	1.81, 2.85			<0.01
	Frequency of child's check-up (pain presence)	-0.29	-0.54, -0.04			0.02
	>15 Parents' perception on child's oral health (poor)	5.22	3.19, 7.25			<0.01
	Frequency of child's check-up (pain presence)	-0.44	-0.83, -0.05			0.02
	1-2 Parents' perception on child's oral health (poor)	1.67	1.06, 2.27			<0.01
University (n=204)	3-15 Parents' perception on child's oral health (poor)	2.95	2.35, 3.56	-113	52	<0.01
	Frequency of child's check-up (pain presence)	-0.33	-0.62, -0.03			0.03
	>15 Parents' perception on child's oral health (poor)	4.05	1.84, 6.25			<0.01
	Frequency of child's check-up (pain presence)	-0.88	-1.56, -0.20			0.01
	1-2 Parents' perception on child's oral health (poor)	1.86	0.76, 2.95			<0.01
3-15 Parents' perception on child's oral health (poor)	3.60	2.37, 4.81	<0.01			

Note: Caries severity was used as dependent variable with values: dmfs(0); dmfs(1-2); dmfs(3-15); dmfs(>15). The model was stratified by mothers' educational level. The category with the highest frequency of subjects in each caries level was used as reference namely dmfs(>15) for mothers' educational level "none"¹ and dmfs(0) for the other mothers' educational levels.

as a reference, namely dmfs>15 for mothers with no education and dmfs=0 for the other levels. The parents' perception of child's oral health was the only covariate that was always associated in each caries severity stratum and for all levels of mothers' education. The frequency of child dental check-up, namely the presence of tooth pain, was statistically associated with the highest caries figures in two levels of mothers' education: compulsory and secondary.

Discussion

Dental caries remains an important childhood disease, affecting a considerable proportion of children worldwide. In the Italian islands, caries prevalence in pre-school

children seems low (18.3%) (Campus *et al.*, 2009b), but at age 12 years this prevalence increases significantly, reaching nearly 40% with a quite high percentage of untreated teeth (Campus *et al.*, 2007b). An association between caries prevalence and the socioeconomic status of the population has been postulated: people living in Southern Italy and Islands, where mean *per capita* income is lower than in other parts of Italy, have less access to dental care and consequently a higher level of disease (Campus *et al.*, 2007b).

The aim of this study was to determine which indicator of SES among the educational level of the parents (individual-level SES) and two income indicators, the mean housing price in the area where the family resides and the mean *per capita* income of that area (area-

level SES), fits better with clinical data regarding caries prevalence and severity in a population of 6-year olds in a low-income area of Italy. Findings show that the individual-level indicator (mother's educational level) was statistically significant associated with caries severity of the children, while the two income area-level indicators were not associated.

Area-level indicators showed weaker associations with health outcomes than individual-level ones (Geronimus *et al.*, 1996; Pardo-Crespo *et al.*, 2013). However, in public health the use of area-level SES as a proxy measure for individual SES may be acceptable if carefully used and depending on the setting (Sin *et al.*, 2001). Overall, area-level SES indicators had different patterns of association with health outcomes from individual-level indicators; a multilevel approaches taking into account both individual-level and area-level SES measures is needed when public health strategies are planning (Pardo-Crespo *et al.*, 2013).

Parental SES may impact on the health of both parents and their children. The level of education is an individual-level indicator that has a strong correlation with parents' and children's health; in particular, higher levels of mothers' education seems to have a positive impact on child health (van Doorslaer *et al.*, 2006) and on the future health in adulthood (Currie and Moretti, 2003). The knowledge, personal and social skills provided through education may better endow individuals to access, to maintain and improve their own and their family's health (Case *et al.*, 2005). Nevertheless, individual-level SES cannot be considered as a univocal parameter, since SES includes many aspects, not just a single one, all related to health in different ways (Cutler and Lleras-Muney, 2010). Positive short-term modifications of income might affect health, while long-term economic well-being is correlated with a better health status. Educational level instead remains quite stable after the school-years and during adulthood so it has a stable impact on health (Currie and Moretti, 2003). However, income levels are often central to health research. Among many potential risk factors, income can be considered a non-medical determinant of health and an important factor for having access to health care services (van Doorslaer *et al.*, 2006). Nevertheless, it is often difficult to obtain individual-level income data. Income measures at area-level, such as the local mean housing price/m² and the mean *per capita* income of that area, may be used as indicators of SES, assuming that the incomes will be reasonably homogeneous within small residential areas (Hanley and Morgan, 2008). The market price of the houses in an area might be an indicator especially in country where most families lives in their own home as Italy (Campus *et al.*, 2009a; b). The results of this study indicate that the area level SES indicator, mean housing price/m² used in the present investigation, was weakly related to the recorded data on caries severity.

In the present study, mothers' educational level was the only SES indicator associated with caries experience and severity in children aged six years. This result might be linked to several factors. The main one, as reported above, is related to the greater stability of this individual-level SES indicator and to its large influence on behaviours and habits related to health. Moreover, the mothers' education level in this study varied con-

siderably from no school attendance to university degree with all divisions represented. The two area-level income indicators did not fit in the same way for this population. The mean housing price for square/meter, divided in three degrees (low, medium and high) and the mean *per capita* income, divided in two degrees (urban and sub-urban) are probably not suitable ways to sub-divide a low-income population. The economic disparities measured at area-level are probably too small to produce significant differences in term of access to dental care and to caries preventive programs in a quite homogeneous population. Area-level SES indicators are probably more suitable to assess health status when wide income disparities are present in the studied population (Pardo-Crespo *et al.*, 2013).

A recent literature review aiming to provide evidence of the association between dental caries in adults and socioeconomic indicators showed that educational level was the most frequently used socioeconomic indicator: lower educational level resulted statistically associated with greater severity of dental caries in most of the multivariate analyses considered (Costa *et al.*, 2012). The same review reported that all studies that analysed income of the subjects as proxy for caries level, found that a lower income was significantly associated with greater severity of disease. Although the criteria for the assessment of income differed between studies, the ranges of income were wider than those recorded in the present population. The area-level SES measures are usually based on the census data; however these data are not easily available due to privacy legislation. Results from the present survey show that all parents have a proper and correct perception of their child's oral health, regardless the parental education and the severity of children's caries. Even if more than three-quarters of parents have a correct perception of child's oral status, little more than a third of the children were regularly brought to the dentist once a year. The probable reason of this finding is related to the difficulty to enter to public dental care system. Dental services are a weakness of the Italian national health system. The primary dental health service is based on private health care providers; thus, oral care is mainly financed by direct payment by the family or, to a lesser extent, through private insurance schemes. In addition, preventive caries programs provided by the public dental health services are scarce or inconsistent, although the Italian national health system should provide dental care, included caries treatment and prevention, to all children until the fourteenth year of life (France *et al.*, 2005).

Conclusions

The present study shows that the individual-level indicator of SES, mother's educational level, is a useful SES measure of caries in children in a low-income population; meanwhile area-level income indicators have not proved useful when economic disparities in the population are quite reduced.

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