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Explaining oral health inequalities in European welfare state regimes: the role of health behaviours

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Keywords:	Oral health, Health inequalities, Europe, Welfare regimes, Adults

Abstract:	Objective: To assess the extent to which behavioural factors, including those related to dental care, account for oral health inequalities in different European welfare state regimes. Methods: Data from the Eurobarometer 2009 survey were analysed. Nationally representative samples of dentate adults aged ≥45 years (n=9,979) from 21 European countries classified into the five welfare regimes (Scandinavian, Anglo-Saxon, Bismarckian, Southern, Eastern) were considered. Inequalities in no functional dentition (having <20 natural teeth) by education and occupation were identified using the Relative and Slope Indices of Inequality (RII and SII, respectively). The percentage reduction in RII and SII was calculated from regression models before and after adjustment for behaviours, first one at a time and then all together. Results: Behaviours explained 21.0% (95% CI 8.7, 31.4) and 13.1% (95% CI 7.9, 33.2) of educational inequalities in no functional dentition (RII) in the Scandinavian and Eastern regimes, respectively. For occupational inequalities, the attenuations in RII in these welfare regimes were 19.3% (95% CI 7.1, 24.2) and 10.5% (95% CI 3.4, 22.5) respectively. Attenuations were weaker and non-significant in the Bismarckian, Anglo-Saxon and Southern regimes. Among the behaviours analysed, alcohol consumption was particularly relevant in explaining inequalities in the Scandinavian regime, and this was confirmed in sensitivity analyses through three-way cross-level interaction terms in multilevel models. Behaviours related to dental care produced similar, consistent attenuations in the Scandinavian and Eastern regimes for both socioeconomic indicators. SII findings showed a similar picture.

	Conclusion: The role of particular behaviours in explaining oral health inequalities could be heterogeneous across European welfare regimes, indicating that their importance might be influenced by the general approach to social policies.

Explaining oral health inequalities in European welfare state regimes: the role of health behaviours

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Running head: Behaviours and inequalities in welfare regimes

Abstract

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Methods: Data from the Eurobarometer 2009 survey were analysed. Nationally representative samples of dentate adults aged ≥45 years (n=9,979) from 21 European countries classified into the five welfare regimes (Scandinavian, Anglo-Saxon, Bismarckian, Southern, Eastern) were considered. Inequalities in no functional dentition (having <20 natural teeth) by education and occupation were identified using the Relative and Slope Indices of Inequality (RII and SII, respectively). The percentage reduction in RII and SII was calculated from regression models before and after adjustment for behaviours, first one at a time and then all together.

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Conclusion: The role of particular behaviours in explaining oral health inequalities could be heterogeneous across European welfare regimes, indicating that their importance might be influenced by the general approach to social policies.

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Introduction

Studies have shown that countries with the most generous and universal welfare policies (that is, those in the Social-democratic or Scandinavian welfare regime) are not consistently exhibiting the lowest health inequalities, including inequalities in oral health.[1-3] Various factors have been suggested to explain this puzzle or paradox, including differences in inequalities in health-related behaviours across welfare regimes.[4,5] Behaviours could play a key role because: (1) health compromising behaviours are not usually the focus of welfare state related policies and non-material resources related to behaviours, such as cultural capital, have been traditionally 'untouched' by welfare state provision;[4,6] (2) large inequalities in behaviours in the most generous welfare states could be related to 'intervention generated inequalities' where universal health promotion interventions are taken up mostly by those of higher socioeconomic position (SEP); [5,7] and (3) in more "advanced" welfare states, extensive welfare benefits such as cash benefits could, paradoxically, have contributed to widen health inequalities by increasing the availability of certain health-damaging goods such as alcohol and tobacco to those of lower SEP.[4,8] If that is the case, behaviours could play a more relevant role in explaining health/oral health inequalities in the Scandinavian regime than in other European welfare regimes.

In general, behaviours can play a role in explaining health inequalities, as evidence has shown that unhealthier behaviours, including those related to oral health, usually cluster among people in less advantaged social groups.[9,10] Smoking, diet, physical activity, alcohol consumption and personal care practices have all been related to socioeconomic circumstances.[9-11] Also, stressful working and living conditions (as well as access to material resources) have an impact on health-related behaviours. Smoking, drug use and comfort eating might be ways of coping with the psychosocial stress and pressures of certain socioeconomic circumstances.[12] In turn, eating habits are associated with economic resources; for example, fruits and vegetables are more expensive than less nutritious food in many countries.[13] Studies have assessed the role of behaviours in explaining oral health inequalities, with mixed findings according to the oral health outcome, SEP measure and

type of behaviour(s)[14-16]. Overall, this evidence suggests that the role of behaviours would be relatively limited, but that it could vary according to the context analysed[14-16].

Considering the psychosocial aspect of health behaviours, one would expect certain differences in their role in explaining general/oral health inequalities across welfare regimes. Since the provision of welfare benefits and services could address some of the stressors experienced by people at lower socioeconomic levels, differences across welfare regimes in the coverage, generosity and ways of delivering welfare benefits could have a differential impact on levels of psychosocial stress and their related unhealthy behaviours. Variation across regimes would also be expected when differences in health promotion policies are taken into account (since promoting healthy behaviours is at the core of these policies). A policy analysis found that the approach to these policies was in line with the broader 'ideology' of the regimes, emphasising individual choices and targeted interventions in the Liberal and Bismarckian regimes, while highlighting structural measures and a clear commitment towards reducing inequalities in the Scandinavian.[17] Finally, there is considerable variation across European countries and welfare regimes in both the prevalence of behaviours and their role in explaining health inequalities.[6,15,18,19]

We previously found significant occupational and educational inequalities in all welfare regimes in Europe[3] but the pattern of inequalities across regimes varied according to the socioeconomic measure used, oral health outcome and nature of the inequalities (absolute or relative).[3,20] In line with the health inequalities evidence, oral health inequalities were not smaller in the Scandinavian regime. However, no study has yet analysed the extent to which oral health inequalities in different European welfare regimes may be attributable to potentially modifiable behaviours. Given the considerable variation in health-related behaviours and inequalities in those behaviours across Europe[10,19,21] and that oral health behaviours are significantly associated with SEP,[9,11] the role of behaviours in explaining oral health inequalities may vary between welfare state regimes in Europe. Accordingly, this study aimed to assess the potential role of sugar intake, alcohol consumption, smoking and dental attendance to explain socioeconomic inequalities in oral health in different European welfare regimes.

Methods

Data source and study sample

We analysed cross-sectional data from the Eurobarometer 72.3, a survey carried out in 2009 on nationally representative samples of adults in European countries. We used data from the 21 countries which are classified in one of the five European welfare regimes based on Ferrera's typology[22] and the additional Eastern type. The survey employed a multi-stage random sampling design using sampling points within administrative regional units in each country. From the selected sampling points, households were randomly selected and a household member was approached to complete the questionnaire. The analytical sample for this study consisted of dentate adults aged ≥45 years with complete information on the study variables (n=9,979 for analysis by education, n=8,802 for analysis by occupation). From the initial eligible sample of 10,435 adults, 456 were excluded due to missing data. In addition, the unemployed, homemakers, students and people who had never done any paid job, were excluded from analyses by occupation.

Variables

Outcome measure

The oral health outcome for this analysis was no functional dentition (defined as having fewer than 20 natural teeth). This is a measure of life-time oral health since it captures the cumulative effect of different determinants of health and also reflects the experience of dental treatment.[23,24] Having fewer than 20 natural teeth has been associated with poorer chewing ability[25,26] and lower consumption of fruits and vegetables.[27] In the present study, no functional dentition was self-reported and derived from a question about the number of natural teeth, with five response options: all; 20 or more, but not all; 10-19; 1-9; no natural teeth. The variable was dichotomised, with '10-19' and '1-9' responses categorised as 'no functional dentition'. Respondents answering 'no natural teeth' were not included in analyses which referred to dentate persons only. Since the prevalence of this state is very low among young adults, only persons aged 45 years and over were considered.

Socioeconomic position measures

We analysed inequalities by education and occupational social class. Education was measured as age at completion of full-time education and categorized into three groups: up

to 15 years; 16-19 years; and 20 years and older. Occupational social class was classified into: managerial and professional; intermediate; and routine-manual. Retired participants were allocated to an occupational class based on their last job.

Behavioural factors

The behaviours analysed in this study included sugar intake, alcohol consumption, smoking and dental attendance. Sugar intake was assessed by asking respondents how often they consume biscuits, cakes, sweets, soft drinks, jam and chewing gum containing sugar (response options: 'Never', 'Rarely', 'From time to time' and 'Often'). A binary variable for frequent sugar consumption was derived including those participants reporting 'Often' on one or more sugary food or drink items. Two separate measures of alcohol consumption were used. Frequency was assessed by a question on the number of times the respondent had consumed alcohol during the last month. We distinguished between respondents who drank alcohol more than once a week, once a week or less often, and those who never drank alcohol.[10,19] The quantity of alcohol consumed was measured by a question about how much respondents drank on a single occasion. We distinguished between respondents who drank less than 1 drink, those who drank 1 or more drinks but did not have excessive drinking (1-4 drinks on a single occasion), and those reporting risky single-occasion drinking (5+ drinks).[28] Smoking was measured by a three-category variable identifying current smokers, former smokers, and those who had never smoked. Two dental care variables were considered. The first captured whether a participant had had a dental check-up in the previous year (vs. otherwise). The second measured the time since the last visit to the dentist, with response categories of less than one year ago, one to less than two years ago, and two or more years ago.

Welfare state regimes

Five European welfare regimes were considered: Scandinavian, Anglo-Saxon, Bismarckian, Southern and Eastern. The first four regimes are based upon Ferrera's typology,[22] which clustered countries according to their eligibility criteria for welfare benefits, coverage, funding regulations and administrative processes of the social security systems.[29] The Scandinavian welfare regime (Sweden, Finland, and Denmark in our study) has universal, generous welfare benefits provided by the State with social security programs designed to

have a redistributive impact. In the Bismarckian regime (Austria, Belgium, France, Germany, Luxemburg and Netherlands), the State provides some earnings-related welfare benefits; the family plays an important role in welfare provision, and the market participation in social services and benefits is minimal. Unlike the Scandinavian regime, the Bismarckian does not have welfare provision with significant redistributive effects. The Anglo-Saxon regime (the UK and Ireland) is characterised by minimal State-provided benefits and services, and a significant role of the market in the provision of goods and services. The Southern regime (Greece, Italy, Portugal and Spain) exhibits a fragmented welfare system combining generous and weak provisions, a strong public-private mix, and a scheme of cash subsidies prone to corruption.[22] Finally, the Eastern European welfare regime (Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia) groups together former Communist countries that have experienced severe changes in social policies since the 1990s and moved from a communist welfare state to welfare schemes characterised by decentralization and marketization.[30,31]

Statistical analysis

First, relative educational and occupational inequalities in having no functional dentition were identified by estimating the relative index of inequality (RII) using a base model (age, gender and marital status adjusted). The RII is a measure of relative inequalities that summarises the association between the SEP measure and the outcome with one single value considering all socioeconomic groups at once.[32] For this, categories of education and occupational social class were organized hierarchically and, based on the distribution of participants in these categories, values between 1 and 0 were assigned to each category, creating a weighted score for each SEP measure. The RII was obtained by regressing (robust Poisson) this score on the outcome, adjusting for covariates. Then, this model was further adjusted for behavioural factors, one at a time and then all together. The percentage reduction in the RII coefficient was used to calculate the mediation proportion (attenuation) for each adjustment based on the formula: $100*(\beta_0 - \beta_1)/ \beta_0$, where β_0 is the SEP variable coefficient in the initial base model and β_1 is the SEP variable coefficient in a model adjusting for behaviour(s). The confidence interval for the percentage attenuation in the RII was obtained using a bias-corrected bootstrap method, with 1000 re-samplings. Identical analyses were conducted using the slope index of inequality (SII) as a measure of absolute

inequality. As a sensitivity analysis to examine whether significant differences existed in the role of behaviours in explaining inequalities across welfare regimes, we fitted multilevel models (two-level random intercept models) that included three-way cross-level interaction terms between welfare regimes, SEP and each behaviour.

Results

Estimates of the base model showed significant educational and occupational inequalities in all welfare regimes, with a higher prevalence of no functional dentition among those in lower socioeconomic levels, as indicated by values of RII larger than one (Tables 1 and 2). Given that the magnitude of inequalities may differ according to age[33], we estimated inequalities by age group (45-59 years, 60-74 years and 75 years and over), but did not find a consistent pattern of age differences across regimes. Most of the stratified RII estimates showed non-significant differences by age groups (Appendix).

Educational inequalities

Overall, behaviours explained 21.0% and 13.1% of educational inequalities in the Scandinavian and Eastern regimes, respectively (Table 1 and Figure 1). In the Anglo-Saxon regime, behaviours explained 11.4% of educational inequalities, but the reduction in RII was not significant. Behaviours did not explain educational inequalities in the Bismarckian and Southern regimes. When only dental care behaviours were considered, educational inequalities were lower by 10.7% in the Scandinavian and Eastern regimes. In other regimes, those factors explained up to 4% of the RII but the reductions were not significant. Other behavioural factors (sugar intake, alcohol consumption and smoking) were particularly relevant in explaining educational inequalities in the Scandinavian regime (15.1% lower RII), mainly due to the contribution of alcohol consumption. Sugar intake alone did not show a significant role in explaining educational inequalities in any welfare regime (Table 1).

Occupational inequalities

Relative occupational inequalities were larger in magnitude than educational inequalities in all welfare regimes except the Bismarckian (Table 2). Overall, 19.3% and 10.5% of occupational inequalities were accounted for by behavioural factors in the Scandinavian and

Eastern regimes, respectively. In the Anglo-Saxon regime, behaviours explained 11.1% of occupational inequalities, but the reduction was not significant. Similar to findings for education, behaviours were less relevant in explaining occupational inequalities in the Bismarckian and Southern welfare regimes. Dental care behaviours reduced occupational inequalities by 8.5% in the Scandinavian and Eastern regimes, while, in other regimes, the reductions were lower and not significant. Other behavioural factors explained a larger proportion of occupational inequalities in the Scandinavian regime with a reduction of 14.2%, with alcohol consumption alone explaining 10.9%. Again, sugar intake did not have a significant role in explaining occupational inequalities.

Results for absolute inequalities, using the SII, showed a similar picture. However, the behavioural factors explained a larger proportion of absolute inequalities in the Eastern regime compared with the Scandinavian, mainly due to the contribution of dental care behaviours (Appendix). The three-way cross-level interaction terms in the multilevel model showed a significant interaction between education, welfare regime and alcohol consumption, thereby confirming differences in the role of alcohol in explaining educational inequalities across welfare regimes (results not shown).

Discussion

After identifying significant educational and occupational inequalities in functional dentition in different European welfare regimes, we assessed the contribution of behavioural factors in explaining those inequalities. Our findings showed a general picture of relatively larger significant reductions in inequalities after accounting for behaviours in the Scandinavian and Eastern regimes, smaller and non-significant reductions in the Anglo-Saxon and very small non-significant attenuations in the Bismarckian and Southern regimes. These differences across welfare regimes should be, nonetheless, viewed with caution, because there was a large overlap in the confidence intervals of percentage attenuations. Such observed wide confidence intervals, leading to overlap, are common in this type of analysis.[34,35] In addition, larger reductions in inequalities in the Scandinavian and Eastern regimes could be partly explained by their larger baseline inequalities. Despite this, our findings would suggest that behaviours could play a role in the Scandinavian regime, with dental care behaviours in

particular having a considerable role in both the Scandinavian and Eastern regimes. However, in other regimes (particularly in the Bismarckian), the behavioural factors analysed did not explain much of the inequalities.

There are different potential explanations for the lack of larger reductions in inequalities after accounting for behaviours. It is possible that other pathways (including psychosocial, materialist and social relational ones) play a more relevant role than behaviours in explaining oral health inequalities in European countries. The findings could also reflect some limitations of the data. For example, information on oral hygiene practices was not available; sugar consumption was not measured thoroughly; and the categorisation of behavioural variables might have influenced the findings. However, we conducted additional analyses using slightly different cut points for the categorisation, and the findings were very similar. Finally, the nature of the outcome could partially explain the limited role of behaviours in explaining oral health inequalities. A functional dentition is an established measure of oral health, reflecting oral function primarily and providing a cumulative account of the effect of oral diseases and treatments across the life course. As such, the role of current health behaviours could be expected to be rather limited for this outcome.

Our findings suggest a potential variation in the explanatory power of behavioural factors across European welfare state regimes. The higher contribution of behaviours in the Scandinavian regime than in other regimes gives support to the idea that the traditional welfare provision in those countries might have paradoxically contributed to higher socioeconomic inequalities in health behaviours.[4,8] Previous analyses have identified a substantial contribution of behavioural factors, including those related to dental care, in explaining oral health inequalities in Scandinavian countries. Educational inequalities in dental caries among Finnish adults were fully explained by dental attendance, tooth brushing with fluoride toothpaste, sugar consumption and smoking.[16] Moreover, studies of Swedish adults have found that more than 60% of the socioeconomic differences in self-rated oral health were explained by lack of access to oral health care,[36] and that people from lower SEP groups refrained from seeking dental services for financial reasons despite perceived need.[37,38] Our findings are not in agreement, since the proportion of inequalities explained in our study was much lower and dental attendance factors were less relevant

than other health behaviours in Scandinavian countries. In addition, the contribution of dental attendance in our analysis could be due to the stronger association observed between that behaviour and the outcome, rather than by inequalities in dental attendance, which were not particularly high in the Scandinavian regime. These differences between our findings and those of previous studies could be explained by the dissimilar outcomes, SEP and behaviour measurements, as well as the population groups included in the analyses. More in-depth studies of the role of different behaviours are needed to fully understand the complex picture of oral health inequalities in contexts of low socioeconomic inequality.

In line with our findings, recent analyses have shown considerable cross-national variation in the extent to which behavioural and dental care factors explain socioeconomic inequalities in general and oral health.[6,15] Research on adults aged 50 years and over in 14 European countries showed that considerable proportions of socioeconomic inequalities in the number of teeth were attributable to dental attendance in only half of these countries.[15] Furthermore, those countries were spread across welfare regimes, indicating also considerable variation within welfare regimes and highlighting the necessity to also investigate other macro-level determinants and their influence on both oral health inequalities and behaviours. In addition, an analysis on educational inequalities in self-reported health revealed that material and psychosocial factors were more relevant in the UK and Ireland, whereas occupational and behavioural factors were the leading explanations of inequalities in Nordic countries.[6] These and our findings suggest that European countries should consider different strategies to reduce health (and oral health) inequalities, prioritising specific mediating pathways that are more relevant in different contexts and also expanding their strategies rather than focusing solely on behaviours.

In addition to the above-mentioned limitations of the behavioural data (including the non-availability of other oral health behaviours), this study has other caveats. First, the cross-sectional nature of the data makes it impossible to establish a temporal sequence in the hypothesised SEP-behaviours-oral health relationship. Second, our analyses were limited to one oral health outcome (having no functional dentition). It is possible that behaviours analysed in this study may play a different role in explaining inequalities in other oral health outcomes. For example, the unequal distribution of current behaviours could be more

strongly related to inequalities in decay. Unfortunately, data on decay or other (more current) oral health indicators were not available in the survey. Third, our outcome was self-reported and so it may be influenced by health perceptions and cultural background.[39] However, this is unlikely to occur as this outcome reports on the number of teeth rather than requires reflection on perceptions of function. In addition, self-reported health measures are suitable for cross-national analyses and have strong associations with clinical indicators of morbidity and mortality.[40,41] Self-reported oral health indicators have also shown associations with clinical conditions and are valid oral health outcomes.[42,43] Fourth, information on water fluoridation and fluoridated toothpaste consumption in each country was not included in the analysis due to its non-availability. These two factors could act as confounders of the associations of interest. Finally, the welfare regime approach has limitations related to the homogeneity assumed in different social policy areas within each regime and the changes in social welfare policies observed during the last decades.[1,44] However, clusters of countries which are very similar to the welfare regime typology have been identified in international comparisons of particular areas of the welfare provision (e.g., labour market, health care and family)[44,45] and in analyses of social 'outcomes' like poverty and income inequality.[46,47] Although welfare regimes have blurred over time, some evidence suggests that they could still play a role as macro-level determinants of health inequalities,[48] including those in oral health.[49] Future studies should explore whether that will remain the case in years to come, along with examining more specific features of welfare provision and characteristics of the dental health systems.

It is possible that the welfare regime approach could be less relevant for oral health than for other health outcomes since, in many countries, dental care is not fully integrated into the health care system. Furthermore, it has been argued that the role of the welfare state is not only to create overall general equality, but also improve the situation of those at the bottom of the socioeconomic hierarchy.[5] Our findings on the age-standardized prevalence estimates are in line with this view, since those in the lowest socioeconomic levels were better off in functional dentition terms in the Scandinavian regime than in the other regimes.

This study also has considerable strengths. It examined five different oral health-related behaviours and oral health inequalities using two indicators that capture different SEP

dimensions. We also ran analyses using both relative and absolute measures of inequalities. This is the first study to investigate the contribution of behaviours in explaining oral health inequalities in five European welfare regimes (in 21 countries) using a comparable data source that employed the same questions for all countries.

To conclude, we have shown that the role of behaviours in explaining socioeconomic inequalities in oral health is not universal across European welfare regimes, suggesting that their relevance is influenced by the broader political context. This highlights the importance of tackling socioeconomic inequalities in health-related behaviours, even in contexts of relatively low social inequality. Further research considering different mediating pathways to inequalities will shed light on how the mechanisms leading to oral health inequalities operate under diverse political contexts.

References

1. Brennenstuhl S, Quesnel-Vallée A, McDonough P. Welfare regimes, population health and health inequalities: a research synthesis. *J Epidemiol Community Health*. 2012;66:397-409.
2. Bergqvist K, Yngwe MA, Lundberg O. Understanding the role of welfare state characteristics for health and inequalities -an analytical review. *BMC Public Health*. 2013;13:1234.
3. Guarnizo-Herreno CC, Watt RG, Pikhart H, Sheiham A, Tsakos G. Socioeconomic inequalities in oral health in different European welfare state regimes. *J Epidemiol Community Health*. 2013;67:728-35.
4. Mackenbach JP. The persistence of health inequalities in modern welfare states: The explanation of a paradox. *Soc Sci Med*. 2012;75:761-9.
5. Bambra C. Health inequalities and welfare state regimes: theoretical insights on a public health 'puzzle'. *J Epidemiol Community Health*. 2011;65:740-5.
6. Balaj M, McNamara CL, Eikemo TA, Bambra C. The social determinants of inequalities in self-reported health in Europe: findings from the European social survey (2014) special module on the social determinants of health. *Eur J Public Health*. 2017;27:107-14.
7. Victora CG, Vaughan JP, Barros FC, Silva AC, Tomasi E. Explaining trends in inequities: evidence from Brazilian child health studies. *Lancet*. 2000;356:1093-8.
8. Pega F, Blakely T, Carter K, Sjoberg O. The explanation of a paradox? A commentary on Mackenbach with perspectives from research on financial credits and risk factor trends. *Soc Sci Med*. 2012;75:770-3.
9. Kino S, Bernabe E, Sabbah W. Socioeconomic inequality in clusters of health-related behaviours in Europe: latent class analysis of a cross-sectional European survey. *BMC Public Health*. 2017;17:497.
10. Huijts T, Gkiouleka A, Reibling N, Thomson KH, Eikemo TA, Bambra C. Educational inequalities in risky health behaviours in 21 European countries: findings from the European social survey (2014) special module on the social determinants of health. *Eur J Public Health*. 2017;27:63-72.
11. Singh A, Rouxel P, Watt RG, Tsakos G. Social inequalities in clustering of oral health related behaviors in a national sample of British adults. *Prev Med*. 2013;57:102-6.
12. Emmons KM. Health behaviors in a social context. In: Berkman LF, Kawachi I, editors. Social Epidemiology: Oxford University Press, USA; 2000.
13. Turrell G, Hewitt B, Patterson C, Oldenburg B, Gould T. Socioeconomic differences in food purchasing behaviour and suggested implications for diet-related health promotion. *J Hum Nutr Diet*. 2002;15:355-64.
14. Sanders AE, Spencer AJ, Slade GD. Evaluating the role of dental behaviour in oral health inequalities. *Community Dent Oral Epidemiol*. 2006;34:71-9.
15. Shen J, Listl S. Investigating social inequalities in older adults' dentition and the role of dental service use in 14 European countries. *Eur J Health Econ*. 2018;19:45-57.
16. Sabbah W, Suominen AL, Vehkalahti MM, Aromaa A, Bernabe E. The role of behaviour in inequality in increments of dental caries among Finnish adults. *Caries Res*. 2015;49:34-40.

17. Fosse E. Different welfare states-different policies? An analysis of the substance of national health promotion policies in three European countries. *Int J Health Serv*. 2011;41:255-72.
18. Listl S, Moeller J, Manski R. A multi-country comparison of reasons for dental non-attendance. *Eur J Oral Sci*. 2014;122:62-9.
19. Huijts T, Stornes P, Eikemo TA, Bambra C. The social and behavioural determinants of health in Europe: findings from the European Social Survey (2014) special module on the social determinants of health. *Eur J Public Health*. 2017;27:55-62.
20. Guarnizo-Herreno CC, Watt RG, Pikhart H, Sheiham A, Tsakos G. Inequalities in oral impacts and welfare regimes: analysis of 21 European countries. *Community Dent Oral Epidemiol*. 2014;42:517-25.
21. Grosse Frie K, Eikemo TA, von dem Knesebeck O. Education and self-reported health care seeking behaviour in European welfare regimes: results from the European Social Survey. *Int J Public Health*. 2010;55:217-20.
22. Ferrera M. The 'southern model' of welfare in social Europe. *J Eur Soc Policy*. 1996;6:17-37.
23. Aida J, Kondo K, Kondo N, Watt RG, Sheiham A, Tsakos G. Income inequality, social capital and self-rated health and dental status in older Japanese. *Soc Sci Med*. 2011;73:1561-8.
24. Celeste RK, Nadanovsky P, Ponce de Leon A, Fritzell J. The individual and contextual pathways between oral health and income inequality in Brazilian adolescents and adults. *Soc Sci Med*. 2009;69:1468-75.
25. Hsu K-J, Yen Y-Y, Lan S-J, Wu Y-M, Chen C-M, Lee H-E. Relationship between remaining teeth and self-rated chewing ability among population aged 45 years or older in Kaohsiung City, Taiwan. *Kaohsiung J Med Sci*. 2011;27:457-65.
26. Sheiham A, Steele JG, Marcenes W, Finch S, Walls AW. The impact of oral health on stated ability to eat certain foods; findings from the National Diet and Nutrition Survey of Older People in Great Britain. *Gerodontology*. 1999;16:11-20.
27. Ervin RB, Dye BA. The effect of functional dentition on Healthy Eating Index scores and nutrient intakes in a nationally representative sample of older adults. *J Public Health Dent*. 2009;69:207-16.
28. Gmel G, Kuntsche E, Rehm J. Risky single-occasion drinking: bingeing is not bingeing. *Addiction*. 2011;106:1037-45.
29. Arts W, Gelissen J. Three worlds of welfare capitalism or more? A state-of-the-art report. *J Eur Soc Policy*. 2002;12:137-58.
30. Bambra C, Netuveli G, Eikemo TA. Welfare state regime life courses: the development of western European welfare state regimes and age-related patterns of educational inequalities in self-reported health. *Int J Health Serv*. 2010;40:399-420.
31. Kim IH, Muntaner C, Vahid Shahidi F, Vives A, Vanroelen C, Benach J. Welfare states, flexible employment, and health: A critical review. *Health Policy*. 2012;104:99-127.
32. Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. *Soc Sci Med*. 1997;44:757-71.
33. Celeste RK, Fritzell J. Do socioeconomic inequalities in pain, psychological distress and oral health increase or decrease over the life course? Evidence from Sweden over 43 years of follow-up. *J Epidemiol Community Health*. 2018;72:160-7.

34. Giesinger I, Goldblatt P, Howden-Chapman P, Marmot M, Kuh D, Brunner E. Association of socioeconomic position with smoking and mortality: the contribution of early life circumstances in the 1946 birth cohort. *J Epidemiol Community Health*. 2014;68:275-9.
35. Hiyoshi A, Fukuda Y, Shipley MJ, Brunner EJ. Health inequalities in Japan: the role of material, psychosocial, social relational and behavioural factors. *Soc Sci Med*. 2014;104:201-9.
36. Wamala S, Merlo J, Bostrom G. Inequity in access to dental care services explains current socioeconomic disparities in oral health: the Swedish National Surveys of Public Health 2004-2005. *J Epidemiol Community Health*. 2006;60:1027-33.
37. Nordenram G. Dental health: Health in Sweden: The National Public Health Report 2012. Chapter 16. *Scand J Public Health*. 2012;40:281-6.
38. Molarius A, Engstrom S, Flink H, Simonsson B, Tegelberg A. Socioeconomic differences in self-rated oral health and dental care utilisation after the dental care reform in 2008 in Sweden. *BMC Oral Health*. 2014;14:134.
39. Zimmer Z, Natividad J, Lin HS, Chayovan N. A cross-national examination of the determinants of self-assessed health. *J Health Soc Behav*. 2000;41:465-81.
40. Robine JM, Jagger C. Creating a coherent set of indicators to monitor health across Europe: the Euro-REVES 2 project. *Eur J Public Health*. 2003;13:6-14.
41. Thomson WM, Mejia GC, Broadbent JM, Poulton R. Construct validity of Locker's global oral health item. *J Dent Res*. 2012;91:1038-42.
42. Kojima A, Ekuni D, Mizutani S, Furuta M, Irie K, Azuma T, et al. Relationships between self-rated oral health, subjective symptoms, oral health behavior and clinical conditions in Japanese university students: a cross-sectional survey at Okayama University. *BMC Oral Health*. 2013;13:62.
43. Silva AE, Menezes AM, Assuncao MC, Goncalves H, Demarco FF, Vargas-Ferreira F, et al. Validation of self-reported information on dental caries in a birth cohort at 18 years of age. *PLoS One*. 2014;9:e106382.
44. Bambra C. Cash versus services: 'Worlds of welfare' and the decommodification of cash benefits and health care services. *J Soc Policy*. 2005;34:195-213.
45. Bambra C. The worlds of welfare: illusory and gender blind? *Soc Policy Soc*. 2004;3:201-11.
46. Kammer A, Niehues J, Peichl A. Welfare regimes and welfare state outcomes in Europe. *J Eur Public Policy*. 2012;22:455-71.
47. Fritzell J, Bäckman O, Ritakallio V. Income inequality and poverty: do the Nordic countries still constitute a family of their own? In: Kvist J, Fritzell J, Hvinden B, Kangas O, editors. Changing social equality: the Nordic welfare model in the 21st century. Bristol: Policy Press; 2012.
48. Muntaner C, Davis O, McIsaack K, Kokkinen L, Shankardass K, O'Campo P. Retrenched welfare regimes still lessen social class inequalities in health: a longitudinal analysis of the 2003-2010 EU-SILC in 23 European countries. *Int J Health Serv*. 2017;47:410-31.
49. Guarnizo-Herreno CC, Watt RG, Stafford M, Sheiham A, Tsakos G. Do welfare regimes matter for oral health? A multilevel analysis of European countries. *Health & Place*. 2017;46:65-72.

Table 1 - Educational inequalities in no functional dentition and effect of adjustment for oral health related behaviours.

	Scandinavian (n= 1,760)		Anglo-Saxon (n= 1,011)		Bismarckian (n= 2,825)		Southern (n= 1,650)		Eastern (n= 2,733)	
	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)
Base model	3.38 (2.38, 4.80)		2.02 (1.28, 3.19)		2.20 (1.70, 2.84)		1.77 (1.19, 2.62)		1.91 (1.56, 2.33)	
Behaviours related to Dental care										
Dental check-up	3.14 (2.21, 4.46)	7.1 (0.5, 11.7)	1.94 (1.23, 3.05)	3.5 (-7.5, 18.8)	2.14 (1.65, 2.77)	2.7 (-0.9, 7.3)	1.76 (1.18, 2.63)	0.6 (-17.4, 18.3)	1.75 (1.43, 2.15)	8.4 (5.3, 21.7)
Time since last visit	3.03 (2.14, 4.29)	10.4 (2.3, 15.7)	1.95 (1.24, 3.07)	3.5 (-7.9, 17.5)	2.17 (1.67, 2.81)	1.4 (-2.8, 6.3)	1.72 (1.16, 2.56)	2.8 (-12.7, 22.8)	1.71 (1.39, 2.11)	10.5 (6.5, 27.2)
All dental care	3.02 (2.13, 4.28)	10.7 (2.2, 16.3)	1.94 (1.23, 3.04)	4.0 (-8.1, 20.2)	2.16 (1.67, 2.80)	1.8 (-2.9, 7.2)	1.74 (1.17, 2.59)	1.7 (-14.1, 20.5)	1.71 (1.39, 2.10)	10.5 (6.6, 28.2)
Other Behaviours										
Sugar intake	3.37 (2.37, 4.78)	0.3 (-1.1, 1.9)	2.03 (1.28, 3.21)	-0.5 (-7.0, 5.4)	2.19 (1.70, 2.83)	0.5 (-1.7, 2.3)	1.76 (1.19, 2.61)	0.6 (-6.1, 8.2)	1.91 (1.57, 2.34)	0.0 (-2.8, 2.7)
Alcohol consumption	3.04 (2.12, 4.35)	10.0 (1.8, 17.1)	1.98 (1.25, 3.12)	2.0 (-9.4, 20.5)	2.20 (1.70, 2.84)	0.0 (-3.0, 5.1)	1.72 (1.16, 2.57)	2.8 (-16.8, 38.1)	1.84 (1.50, 2.25)	3.7 (-1.4, 10.5)
Smoking	3.24 (2.29, 4.60)	4.1 (-0.7, 7.5)	1.89 (1.19, 2.98)	6.4 (-10.7, 30.0)	2.20 (1.71, 2.83)	0.0 (-5.7, 5.3)	1.81 (1.22, 2.69)	-2.3 (-17.7, 9.3)	1.89 (1.56, 2.30)	1.1 (-3.6, 6.8)
All other behaviours	2.87 (2.00, 4.13)	15.1 (4.2, 23.7)	1.84 (1.17, 2.92)	8.9 (-15.4, 45.5)	2.18 (1.70, 2.80)	0.9 (-5.8, 10.1)	1.76 (1.18, 2.62)	0.6 (-14.2, 29.6)	1.81 (1.49, 2.21)	5.2 (-1.3, 14.2)
All Factors	2.67 (1.87, 3.81)	21.0 (8.7, 31.4)	1.79 (1.14, 2.82)	11.4 (-51.2, 89.2)	2.14 (1.67, 2.76)	2.7 (-4.1, 12.8)	1.74 (1.16, 2.61)	1.7 (-17.4, 36.3)	1.66 (1.35, 2.04)	13.1 (7.9, 33.2)
Prevalence of no functional dentition by educational level[a] - Weighted percentage % (95% CI)										
High	15.53 (13.43, 17.90)		23.97 (16.76, 33.05)		28.17 (24.12, 32.61)		28.67 (21.15, 37.59)		51.84 (45.88, 57.75)	
Intermediate	21.59 (18.12, 25.53)		28.65 (23.44, 34.49)		34.18 (30.74, 37.78)		30.61 (25.63, 36.10)		63.30 (60.18, 66.30)	
Low	38.41 (31.77, 45.51)		41.43 (33.31, 50.05)		48.93 (43.81, 54.08)		39.99 (36.48, 43.59)		82.78 (76.67, 87.56)	

[a] Age-standardized prevalence

Table 2 - Occupational inequalities in no functional dentition and effect of adjustment for oral health related behaviours.

	Scandinavian (n= 1,710)		Anglo-Saxon (n= 826)		Bismarckian (n= 2,466)		Southern (n= 1,251)		Eastern (n= 2,549)	
	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)	RII (95% CI)	% attenuation (95% CI)
Base model	3.93 (2.74, 5.63)		2.80 (1.74, 4.53)		1.52 (1.18, 1.96)		2.04 (1.32, 3.15)		2.10 (1.68, 2.61)	
Behaviours related to Dental care										
Dental check-up	3.71 (2.59, 5.31)	5.6 (0.3, 8.0)	2.72 (1.67, 4.42)	2.9 (-8.0, 14.0)	1.48 (1.15, 1.91)	2.6 (-4.4, 15.9)	2.02 (1.31, 3.13)	0.56 (-8.0, 10.1)	1.94 (1.55, 2.43)	8.4 (3.1, 18.0)
Time since last visit	3.62 (2.54, 5.17)	7.9 (0.9, 11.0)	2.77 (1.70, 4.51)	1.1 (-9.6, 11.8)	1.47 (1.14, 1.90)	3.3 (-6.3, 20.1)	1.99 (1.27, 3.10)	2.5 (-12.1, 19.5)	1.93 (1.54, 2.45)	8.1 (3.4, 18.8)
All dental care	3.60 (2.53, 5.14)	8.4 (1.05, 11.6)	2.75 (1.69, 4.48)	1.8 (-9.5, 13.3)	1.48 (1.14, 1.91)	2.6 (-7.4, 20.4)	1.99 (1.28, 3.10)	2.5 (-9.1, 16.3)	1.92 (1.53, 2.41)	8.6 (3.7, 20.5)
Other Behaviours										
Sugar intake	3.95 (2.76, 5.66)	-0.5 (-1.8, 1.0)	2.82 (1.74, 4.57)	-0.7 (-4.5, 3.2)	1.53 (1.18, 1.97)	-0.7 (-8.1, 4.4)	2.03 (1.31, 3.13)	0.5 (-3.9, 5.4)	2.10 (1.69, 2.62)	0.0 (-1.7, 1.0)
Alcohol consumption	3.50 (2.43, 5.03)	10.9 (2.4, 14.5)	2.61 (1.60, 4.28)	6.8 (-7.7, 22.6)	1.53 (1.18, 1.98)	-0.7 (-13.5, 13.1)	2.05 (1.32, 3.18)	-0.5 (-23.1, 26.0)	2.06 (1.65, 2.56)	1.9 (-1.4, 7.0)
Smoking	3.77 (2.63, 5.41)	4.1 (-0.5, 6.5)	2.71 (1.67, 4.42)	3.2 (-8.7, 15.0)	1.53 (1.19, 1.97)	-0.7 (-17.3, 11.6)	2.03 (1.32, 3.13)	0.5 (-7.1, 8.2)	2.06 (1.65, 2.56)	1.9 (-2.1, 7.1)
All other behaviours	3.37 (2.34, 4.85)	14.2 (4.1, 18.3)	2.52 (1.52, 4.16)	10.0 (-8.5,30.8)	1.54 (1.20, 1.98)	-1.3 (-26.2, 21.0)	2.02 (1.31, 3.14)	1.0 (-15.3, 21.1)	2.01 (1.61, 2.51)	4.3 (-1.3, 12.1)
All Factors	3.17 (2.21, 4.54)	19.3 (7.1, 24.2)	2.49 (1.49, 4.16)	11.1 (-10.2, 34.8)	1.51 (1.17, 1.94)	0.7 (-17.4, 24.0)	2.01 (1.29, 3.12)	1.5 (-11.9, 20.4)	1.88 (1.50, 2.36)	10.5 (4.7, 25.0)
Prevalence of no functional dentition by occupational level[a] - Weighted percentage % (95% CI)										
Managerial/ professional	13.75 (11.26, 16.70)		22.07 (16.39, 29.03)		29.62 (25.80, 33.74)		26.06 (19.79, 33.49)		48.64 (42.46, 54.86)	
Intermediate	17.66 (14.31, 21.59)		30.06 (23.34, 37.76)		39.47 (34.80, 44.35)		34.36 (28.02, 41.31)		55.80 (51.16, 60.34)	
Routine-manual	29.88 (26.84, 33.12)		41.97 (35.79, 48.42)		39.29 (35.83, 42.86)		40.44 (36.19, 44.83)		71.33 (67.92, 74.51)	

[a] Age-standardized prevalence

Figure 1 - Educational inequalities in no functional dentition (RII) at baseline and after adjustment for oral health related behaviours

Figure 2 - Occupational inequalities in no functional dentition (RII) at baseline and after adjustment for oral health related behaviours

Figure 1 - Educational inequalities in no functional dentition (RII) at baseline and after adjustment for oral health related behaviours

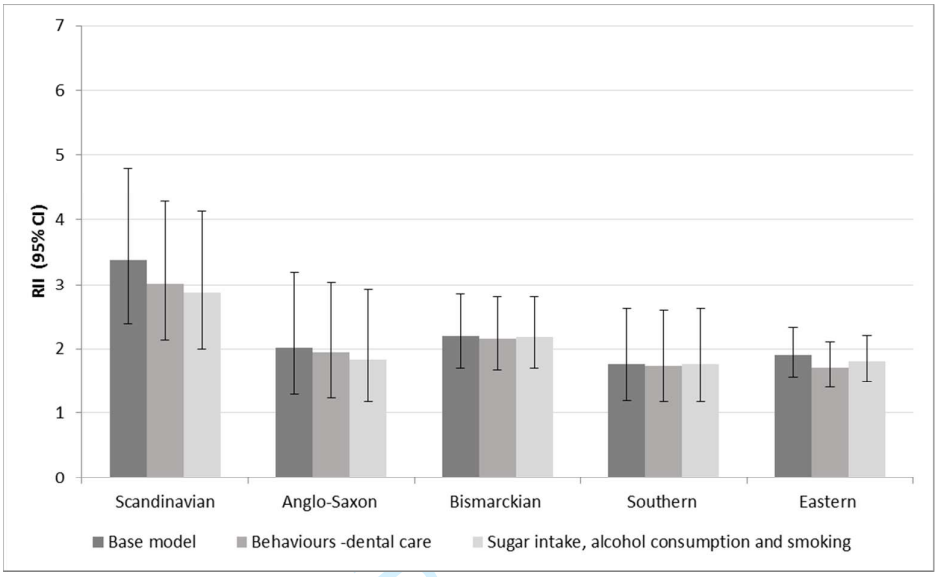

Figure 2 - Occupational inequalities in no functional dentition (RII) at baseline and after adjustment for oral health related behaviours