RESEARCH REPORTS
Clinical

S. Listl

University of Heidelberg, Department of Conservative Dentistry, and University of Mannheim, Mannheim Research Institute for the Economics of Aging (MEA); stefan.listl@med.uni-heidelberg.de

J Dent Res 90(6):717-723, 2011

Income-related Inequalities in Dental Service Utilization by Europeans Aged 50+

ABSTRACT

The purpose of this study was to describe income-related inequalities in dental service utilization by the elderly populations residing in different European countries. We used data from the Survey of Health, Ageing, and Retirement in Europe (SHARE Wave 2), which contains information on utilization of dental services by 33,358 individuals aged 50+ years from 14 different countries. We assessed income-related inequalities in dental attendance and preventive and/or operative dental treatment by means of Concentration Indices (CI) and Slope Indices of Inequality (SII). We could identify a disproportionate concentration of access to treatment among the rich elderly populations in all 14 countries (relative inequality according to CI), as well as significantly higher access to treatment by individuals located in the highest in relation to the lowest income group for all countries except Italy and the Czech Republic (absolute inequality according to SII). Such differential utilization appears mainly attributable to inequalities in preventive dental visits, either alone or in combination with operative treatment. Persons' oral health status explains substantial proportions of absolute but not of relative inequalities. Overall, there is considerable income-related inequality in dental service utilization by several elderly populations residing in Europe. More research is needed to identify the exact causes of such disparities.

KEY WORDS: health services research, geriatric dentistry, dental public health.

DOI: 10.1177/0022034511399907

Received October 4, 2010; Last revision January 12, 2011; Accepted January 13, 2011

A supplemental appendix to this article is published electronically only at http://jdr.sagepub.com/supplemental.

INTRODUCTION

In recent years, elderly populations have increasingly received attention from health policy and clinical decision-makers (United Nations Population Fund, 2002; Harford, 2009). This is mainly due to economic considerations that identify population aging as one factor for steadily increasing expenditures for dental (Grytten, 1990; Kleinman *et al*., 2009) and health care (Reinhardt, 2003; Caley and Sidhu, 2011). Despite its relevance for the planning of future treatment needs and the development of an accordingly shaped allocation of resources [*e.g*., workforce planning, see Brown and Lazar (1999)], little is known about socio-economic inequalities in the utilization of dental services by the elderly populations within European countries. Such information, however, may enable us to gain a better understanding of dental attendance patterns of different socio-economic groups, and, ultimately, to provide guidance for decision-makers in dental services.

It has been well documented that there exists a socio-economic gradient in oral health, *i.e*., individuals from the lower end of the socio-economic scale usually have a worse oral health status than do individuals with higher socio-economic status (Watt and Sheiham, 1999; Locker, 2000; Gilbert *et al*., 2003; Enjary *et al*., 2006; Jamieson and Thomson, 2006; López *et al*., 2006; Makhija *et al*., 2006; Sanders *et al*., 2006; Tellez *et al*., 2006; Armfield, 2007; Watt, 2007; Holst, 2008; Du *et al*., 2009; Tsakos *et al*., 2009; Do *et al*., 2010; Ståhlnacke *et al*., 2010; Bernabé and Marcenes, 2010). While there is disagreement about the exact explanation for such a socio-economic gradient in oral health (Petersen, 2005; Brunner and Marmot, 2006; Sisson, 2007), it has frequently been suggested that dental attendance patterns are one pathway through which differences in oral health may emerge. In particular, regular and frequent dental attendance has been shown to be associated with better oral health and to be more common among individuals with higher socio-economic status, and *vice versa* (Unell *et al*., 1999; McGrath and Bedi, 2001; Petersen *et al*, 2004; Dye and Selwitz, 2005; Krustrup and Petersen, 2006; Sanders *et al*., 2006; Donaldson *et al*., 2008; Pavi *et al*., 2010).

To the best of our knowledge, socio-economic inequalities in the elderly population's dental attendance in European countries have never been investigated. The purpose of this paper is, therefore, to describe such inequalities in the utilization of dental services by persons aged 50 and above from different European countries.

DATASET AND MEASUREMENT OF SOCIO-ECONOMIC INEQUALITY

The analysis presented here is based on data from Wave 2 of the Survey of Health, Ageing, and Retirement in Europe (SHARE). These data were collected in 2006-2007. A detailed description of the process of data collection has been published previously (Börsch-Supan *et al*., 2008). The survey is modeled closely after the US Health and Retirement Study (HRS) and is the first

Table 1. Incidence of Dental Treatment within Preceding 12 Months and Net Monthly Household Income by Country of Residence

Country (observations)	Any Treatment	Preventive Only	Operative Only	Preventive & Operative	Equalized Income (OECD) (Std. Dev.)
Austria (n = 1322)	50.23%	20.92%	15.79%	13.44%	1277.26 (573.37)
Germany (n = 2520)	73.25%	33.77%	10.21%	29.10%	3941.41 (7116.51)
Sweden (n = 2701)	81.23%	39.69%	11.21%	29.95%	2419.01 (3785.22)
Netherlands (n = 2593)	65.83%	34.11%	5.63%	25.61%	2924.51 (5527.36)
Spain (n = 2169)	26. 28%	9.92%	9.46%	6.80%	1970.29 (4456.90)
Italy (n = 2914)	36.41%	13.25%	14.69%	8.39%	4389.61 (5992.78)
France (n = 2804)	48.57%	15.43%	22.23%	9.88%	2961.65 (5561.28)
Denmark (n = 2518)	79.67%	47.39%	3.96%	28.01%	4019.59 (7759.93)
Greece (n = 3072)	38.61%	10.46%	13.51%	14.55%	1987.11 (3976.66)
Switzerland (n = 1414)	72.70%	33.59%	9.72%	29.08%	4758.15 (8723.37)
Belgium (n = 3079)	49.98%	20.46%	12.97%	16.47%	2359.69 (4288.90)
Czech Republic (n = 2742)	54.49%	18.13%	13.45%	22.55%	1936.87 (3177.70)
Poland (n = 2415)	23.77%	3.17%	13.30%	7.16%	618.90 (1396.20)
Ireland (n = 1095)	42.37%	22.60%	8.32%	11.03%	4261.42 (7773.34)

European dataset to combine extensive cross-national information on socio-economic status, health, and family conditions of the elderly population. Wave 2 contains information on utilization of dental services by 33,358 individuals from 14 different countries. The latter represent Europe's economic, social, institutional, and cultural diversity from Scandinavia to the Mediterranean.

Our data source provides information on access to dental services ("any treatment") and utilization of preventive (*i.e.*, routine dental check-ups and scaling/polishing) and/or operative treatment, the latter including restorative, endodontic, periodontal, and prosthodontic interventions. Table 1 presents incidence rates of dental treatment within the 12 mos preceding the survey, by respondents' country of residence, and suggests substantive differences in utilization of dental treatment; *e.g.*, about 81% of Swedish but only about 24% of Polish respondents reported having seen a dentist within the preceding year. Table 1 also shows summary statistics for respondents' average net monthly equivalence income (in €), which is our measure of socio-economic status. It is specified according to the so-called OECD-modified equivalence scale (Hagenaars *et al*., 1994). This discount scale takes into account household size and age of household members, *i.e*., children aged 14 yrs or younger are assumed to contribute less to household consumption than do other household members who are older than 14 yrs and, particularly, the household head (Appendix, formula F.1).

We identified socio-economic inequality in dental service utilization using the Concentration Index (CI) (Kakwani, 1977, 1980) and the Slope Index of Inequality (SII). The SII (Appendix, formula F.2) quantifies the degree of absolute socio-economic inequality in a health variable (Pamuk, 1985). It has been used, *e.g*., to measure socio-economic inequalities in dental caries among adolescents (Perera and Ekanayake, 2008). In our study, it describes the difference in dental utilization when moving from the lowest to the highest decile of equalized income. The CI (Appendix, formula F.3) quantifies the degree of relative socio-economic inequality in a health variable and is derived from the "concentration curve" (Kakwani *et al*., 1997). It has been used, *e.g*., to measure the degree of socio-economic-related inequality in childhood caries (Do *et al*., 2010) and oral health care utilization (Somkotra and Detsomboonrat, 2009; Somkotra and Vachirarojpisan, 2009). The definition of the CI in our study is as follows: If the CI is zero, it indicates that there is no income-related inequality regarding utilization of dental services; a positive (negative) value of the CI indicates a disproportionate concentration of the utilization variable among the rich (poor). In other words, a positive (negative) value of the Concentration Index means that utilization is higher among the rich (poor). This is also referred to as "pro-rich" ("pro-poor") income-related inequality. Note that the Index is bounded between -1 and 1. Interpreting CIs is not straightforward; however, multiplying the

Table 2a. Concentration Indices (CI) for Income-related Inequalities in Dental Service Utilization (values in bold indicate statistical significance at the 5% level; age-and sex-adjusted results)

Country	Any Treatment (95% Conf. Int.)	Preventive Only (95% Conf. Int.)	Operative Only (95% Conf. Int.)	Preventive & Operative (95% Conf. Int.)
Austria	**0.0932** (0.0600; 0.1265)	**0.0745** (0.0090; 0.1399)	0.0578 (–0.0190; 0.1348)	**0.1667** (0.0818; 0.2516)
Germany	**0.0254** (0.0100; 0.0409)	0.0161 (–0.0193; 0.0515)	–0.0216 (–0.0995; 0.0563)	**0.0508** (0.0128; 0.0888)
Sweden	**0.0434** (0.0309; 0.0559)	**0.0434** (0.0157; 0.0712)	–0.0163 (–0.0818; 0.0871)	**0.0655** (0.0313; 0.0996)
Netherlands	**0.0756** (0.0573; 0.0941)	**0.0798** (0.0450; 0.1147)	–0.0924 (–0.1902; 0.0055)	**0.0999** (0.0589; 0.1409)
Spain	**0.1207** (0.0697; 0.1720)	**0.1634** (0.0638; 0.2630)	**0.1226** (0.0333; 0.2120)	0.0677 (–0.0379; 0.1734)
Italy	**0.0427** (0.0133; 0.0722)	0.0396 (–0.0154; 0.0946)	0.0110 (–0.0423; 0.0642)	**0.0996** (0.0265; 0.1727)
France	**0.0657** (0.0414; 0.0900)	**0.1512** (0.0973; 0.2051)	–0.0101 (–0.0524; 0.0323)	**0.0979** (0.0297; 0.1660)
Denmark	**0.0677** (0.0543; 0.0812)	**0.0816** (0.0564; 0.1068)	**–0.1746** (–0.2885; –0.0607)	**0.0791** (0.0433; 0.1149)
Greece	**0.0679** (0.0355; 0.1002)	0.0312 (–0.0517; 0.1141)	**0.0752** (0.0140; 0.1365)	**0.0852** (0.0221; 0.1483)
Switzerland	**0.0561** (0.0359; 0.0764)	**0.0729** (0.0263; 0.1194)	0.0242 (–0.0864; 0.1348)	0.0443 (–0.0058; 0.0946)
Belgium	**0.0839** (0.0614; 0.1063)	**0.1118** (0.0679; 0.1556)	0.0088 (–0.0478; 0.0655)	**0.1096** (0.0629; 0.1562)
Czech Republic	**0.0321** (0.0107; 0.05334)	**0.1442** (0.0971; 0.1912)	–0.0261 (–0.0838; 0.0316)	–0.0299 (–0.0747; 0.0149)
Poland	**0.1304** (0.0853; 0.1755)	**0.3092** (0.1760; 0.4423)	**0.1089** (0.0447; 0.1731)	**0.0905** (0.0016; 0.1795)
Ireland	**0.0665** (0.0191; 0.1140)	0.0655 (–0.0071; 0.1380)	0.0987 (–0.0430; 0.2405)	0.0457 (–0.0664; 0.1578)

value of the Concentration Index by 75 gives the percentage of utilization that would need to be redistributed from the richer to the poorer half of the population (in the case of pro-rich inequality) to obtain a CI equal to zero (Koolman and van Doorslaer, 2004).

We first provide CIs and SIIs for the full sample. To identify potential causes of income-related inequalities in dental service utilization, we then additionally provide separate measures of inequality according to (1) individual's denture status and (2) individual's retirement status. The rationale for splitting the sample according to denture status is to adjust for oral health status. Within SHARE, denture-wearing is the only objective measure of oral health and is reported as a binary variable (respondent wears a denture or not). Similarly, the rationale for splitting the sample according to retirement status is to control for 'dislike dental utilization' patterns by those still working and those who are retired (see Appendix Table 1 for descriptive statistics). Statistically significant differences between subsamples are identified by means of pairwise *t* tests, with no adjustment made for multiple testing. All data analysis was carried out with the software package STATA/SE 10.1 (StataCorp, College Station, TX, USA). The level of statistical significance was generally set at 5%.

RESULTS

Relative Inequalities

Table 2a shows CIs for the full sample. Inequalities in access to dental treatment are identified in column 1. For all countries, the CI is positive and statistically significant, indicating pro-rich inequality in accessing dental services. In decreasing order of inequality, the countries rank as follows (in parentheses: required redistribution of utilization from the richer to the poorer half of the population, to obtain zero inequality): Poland (9.78%), Spain (9.05%), Austria (6.99%), Belgium (6.30%), Netherlands (5.67%), Greece (5.09%), Denmark (5.08%), France (4.93 %), Ireland (4.91%), Switzerland (4.21%), Sweden (3.26%), Italy (3.21%), the Czech Republic (2.41%), and Germany (1.91%). Column 2 of Table 2a shows CIs for preventive dental visits. For all countries except Germany, Italy, Greece, and Ireland, the parameter estimates are positive and statistically significant, *i.e.*, indicating pro-rich inequality in utilization of preventive treatment. Similarly, column 4 shows positive significant CIs for all countries except Spain, Switzerland, the Czech Republic, and Ireland, which indicates pro-rich inequality in joint utilization of preventive and operative treatment. For operative treatment alone, and unlike other columns of Table 2a, column 3 shows

Table 2b. Slope Indices of Inequality (SII) for Income-related Inequalities in Dental Service Utilization (values in bold indicate statistical significance at the 5% level; age- and sex-adjusted results)

Country	Any Treatment (95% Conf. Int.)	Preventive Only (95% Conf. Int.)	Operative Only (95% Conf. Int.)	Preventive & Operative (95% Conf. Int.)
Austria	**0.4456** (0.2853; 0.6059)	**0.1379** (0.0070; 0.2688)	0.0991 (–0.0202; 0.2185)	**0.2101** (0.1003; 0.3198)
Germany	**0.1287** (0.049; 0.2075)	0.0434 (–0.0425; 0.1292)	–0.0166 (–0.0714; 0.0381)	**0.1023** (0.0183; 0.1862)
Sweden	**0.3366** (0.2488; 0.4245)	**0.1763** (0.0688; 0.2838)	–0.0077 (–0.0761; 0.0606)	**0.1685** (0.0684; 0.2685)
Netherlands	**0.3339** (0.2444; 0.4234)	**0.1835** (0.0953; 0.2717)	–0.0333 (–0.0769; 0.0102)	**0.1697** (0.0866; 0.2528)
Spain	**0.1345** (0.0561; 0.2129)	**0.0645** (0.0155; 0.1135)	**0.0685** (0.0136; 0.1235)	0.0017 (–0.0442; 0.0476)
Italy	0.0500 (–0.0099; 0.1099)	0.0018 (–0.0397; 0.0433)	0.0013 (–0.0427; 0.0453)	**0.0471** (0.0117; 0.0825)
France	**0.2205** (0.1381; 0.3029)	**0.1554** (0.0972; 0.2137)	–0.0118 (–0.0803; 0.0566)	**0.0702** (0.0194; 0.1211)
Denmark	**0.5188** (0.4323; 0.6053)	**0.3680** (0.2591; 0.4769)	**–0.0681** (–0.1115; –0.0246)	**0.2169** (0.1175; 0.3163)
Greece	**0.1352** (0.0521; 0.2183)	0.0285 (–0.0236; 0.0807)	0.0580 (–0.0041; 0.1201)	0.0472 (–0.0121; 0.1064)
Switzerland	**0.2485** (0.1375; 0.3595)	**0.1626** (0.0441; 0.2812)	0.0065 (–0.0661; 0.0792)	0.0720 (–0.0433; 0.1874)
Belgium	**0.2944** (0.2062; 0.3826)	**0.1588** (0.0888; 0.2288)	0.0101 (–0.0504; 0.0705)	**0.1228** (0.0564; 0.1891)
Czech Republic	–0.0448 (–0.1236; 0.0339)	0.0562 (–0.0079; 0.1204)	–0.0160 (–0.0736; 0.0416)	**–0.0860** (–0.1528; –0.0192)
Poland	**0.1213** (0.0472; 0.1954)	**0.0605** (0.0304; 0.0906)	**0.0607** (0.0014; 0.1200)	–0.0010 (–0.0454; 0.0434)
Ireland	**0.1704** (0.0581; 0.2826)	**0.1025** (0.0075; 0.1975)	0.0388 (–0.0241; 0.1018)	0.0294 (–0.0397; 0.0986)

positive significant CIs for only three countries (Spain, Greece, and Poland) and one negative significant CI for Denmark.

Absolute Inequalities

Table 2b shows SIIs for the full sample. Inequalities in access to dental treatment are identified in column 1. For all countries except Italy and the Czech Republic, the SII is positive and statistically significant, indicating an increase in dental access when moving from the lowest to the highest income groups. In decreasing order of inequality, the countries rank as follows (in parentheses: absolute difference between lowest and highest income groups): Denmark (52% points difference), Austria (45% points), Sweden (34% points), the Netherlands (34% points), Belgium (29% points), Switzerland (25% points), France (22% points), Ireland (17% points), Greece (14% points), Spain (13% points), Germany (13% points), and Poland (12% points). Column 2 of Table 2b shows SIIs for preventive dental visits. For all countries except Germany, Italy, Greece, and the Czech Republic, the parameter estimates are positive and statistically significant, which indicates increasing rates of preventive treatment alongside increasing income groups. For joint preventive and operative treatment, column 4 shows significant SIIs for all countries except Spain, Greece, Switzerland, Poland, and Ireland. All significant parameter estimates have a positive sign, with the only exception being the Czech Republic. Unlike the other columns of Table 2b, column 3 shows significant SIIs for only three countries. With increasing income classes, this identifies an increase in utilizing operative treatment for Spain and Poland, but a decrease for Denmark.

The Influence of Denture-wearing

Fig. 1 shows pairwise *t* statistics for differences in CIs according to denture status. For dental attendance, it illustrates that CIs differ significantly between denture-wearers and their peers without dentures only in Denmark (higher inequality among denture-wearers). For preventive treatment, CIs differ significantly only in France (higher inequality among denture-wearers) as well as Poland (lower inequality among denture-wearers). For operative treatment, CIs differ significantly only in Sweden and Belgium (higher inequalities among denture-wearers). For joint preventive and operative treatment, finally, Fig. 1 shows significant differences for Germany and Denmark (higher inequalities among denture-wearers) as well as Spain (lower inequality among denture-wearers).

Fig. 2 shows pairwise *t* statistics for differences in SIIs according to denture status. Except for operative treatment, all SIIs have a negative value, indicating lower absolute inequality among denture-wearers. For dental attendance, statistical significance is corroborated for Austria, Sweden, the Netherlands, Denmark, Greece,

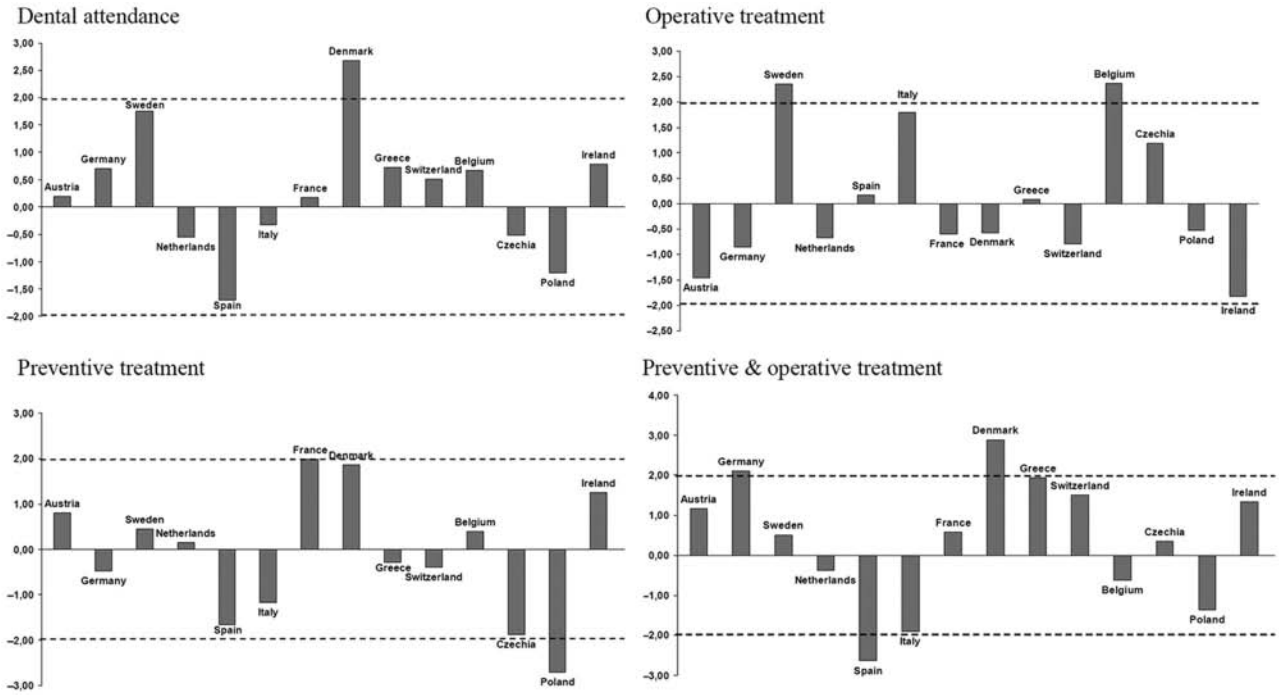

Figure 1. Pairwise *t* statistics for differences in CIs according to denture status and for dental attendance, preventive treatment, operative treatment, and preventive & operative treatment.

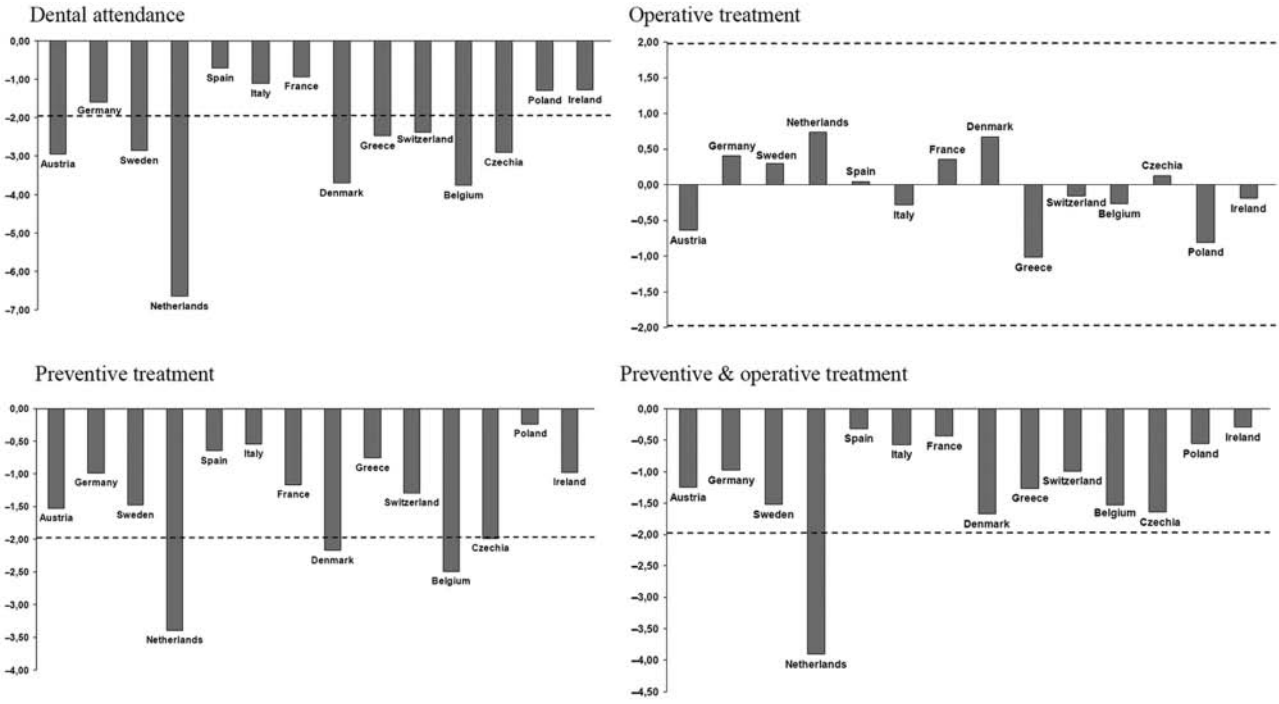

Figure 2. Pairwise *t* statistics for differences in SIIs according to denture status and for dental attendance, preventive treatment, operative treatment, and preventive & operative treatment.

Switzerland, Belgium, and the Czech Republic. For preventive treatment, significance is found for the Netherlands, Denmark, Belgium, and the Czech Republic, while for joint preventive and operative treatment, significance is corroborated only for the Netherlands. For operative treatment, finally, the *t* statistics have comparably inhomogenous signs and are never significant.

The Influence of Retirement Status

Appendix Fig. 1 shows pairwise *t* statistics for differences in CIs according to retirement status. For overall dental attendance, it depicts no significant differences in CIs between retired and non-retired persons. For preventive treatment, CIs differ significantly only in France and Greece (higher inequalities among retired individuals). For operative treatment, CIs differ significantly only in France and Denmark (higher inequalities among non-retired persons) as well as in the Czech Republic and Poland (higher inequalities among retired individuals). For joint preventive and operative treatment, finally, Appendix Fig. 1 shows significant differences for CIs in Germany and Sweden (higher inequalities among retired persons), but higher inequalities among the non-retired in Spain.

Appendix Fig. 2 shows pairwise *t* statistics for differences in SIIs according to retirement status. Statistically significant *t* statistics are indicated for dental attendance only in the Netherlands and Poland, *i.e.*, in these two countries, the absolute income-related inequality in dental attendance is higher among non-retired in comparison with retired individuals.

DISCUSSION

On the basis of data from SHARE Wave 2, this paper describes income-related inequalities in utilization of dental services by Europeans aged 50 yrs and above. In terms of relative inequality, our findings indicate a disproportionate concentration of access to treatment among the rich elderly populations in all countries included in our study. In terms of absolute inequality, we similarly observe significantly higher access to treatment by individuals located in the highest income group compared with peers located in the lowest income group within all countries except Italy and the Czech Republic. While the magnitude of both relative and absolute inequalities varies across countries, there is no clear association (neither uniform nor diametrical) between the ranking of countries according to absolute and relative indices. For both measures of inequality, however, a huge proportion of differential utilization appears to be attributable to inequalities in preventive treatment either alone or in combination with operative treatment, but not to differential utilization of operative treatment alone. Overall, our study gives strong evidence for income-related inequalities in the utilization of dental services by several elderly populations residing in Europe.

There are many pathways through which such utilization patterns could materialize. First, there may exist cross-country differences in oral health status. For a majority of countries in our study, we observed reduced absolute inequalities for individuals wearing a denture, whereas relative inequalities proved independent of denture status. Even if denture-wearing may be considered only a proxy for oral health status, our results suggest that pro-rich inequalities persist despite reduced utilization margins due to deteriorated oral health. Second, there may be cross-country differences in treatment use between those still working and those who have retired. In this respect, our study provides some, albeit mixed, evidence: While absolute inequalities in dental attendance are reduced only for the retired in the Netherlands and Poland, differences in relative inequalities are never significant with respect to overall attendance. There are significant differences in relative inequalities regarding preventive and/or operative treatment in various countries. However, in some cases, such inequalities are higher among those still working, whereas in other cases they are higher among the retired.

Third, inequalities in utilization may be due to dissimilar dental insurance coverage inherent in different health care systems: Austria, Belgium, Germany, the Netherlands, France, the Czech Republic, and Poland finance health care mainly through social insurance contributions; Ireland, Denmark, Spain, Sweden, and Italy through taxation; Greece and Switzerland through out-of-pocket payments (Kaiser Family Foundation, 2009; Thomson *et al*., 2009). However, there is no obvious association between these different financing arrangements and the inequalities found in our study. Identification of further explanations for inequalities among elderly populations in Europe is, therefore, left open for future research.

Some limitations surrounding our study should be noted. First, our analysis relies on cross-sectional data only and, thus, does not facilitate causal inferences (Flanders *et al*., 1992). Therefore, it is not possible to disentangle the exact causes for and consequences of the income-related inequalities as observed in our study. As soon as further waves of SHARE become available in the future, this may better enable us to investigate how changes in institutional, economic, or cultural circumstances determine variations in dental treatment. Second, no adjustment was made for multiple testing. This may be relevant because the use of such statistical methods could—to some extent—challenge the interpretation of statistical significance (at the 5% level), specifically when considering comparisons between subsamples. Third, the data used are survey-based and thus may be affected somewhat by reporting bias. Nevertheless, since there is currently no comparable source of administrative data available, the Survey of Health, Ageing and Retirement in Europe provides a unique source for comparing inequalities in utilization of dental treatment.

In conclusion, this study is the first to investigate income-related inequalities in dental utilization of elderly populations residing in 14 European countries. Our findings suggest a considerably disproportionate concentration of access to treatment among the rich elderly populations in all countries (relative inequality according to CI), as well as significantly higher access to treatment by individuals located in the highest in comparison with the lowest income groups for all countries except Italy and the Czech Republic (absolute inequality according to SII). Such differential utilization appears mainly attributable to inequalities in preventive dental visits, either alone or in combination with operative treatment. More research is needed to identify the exact causes of such disparities.

ACKNOWLEDGMENTS

This work was funded through a Post-doctoral Fellowship by the Medical Faculty of the University of Heidelberg. The author thanks Hendrik Jürges for his advice during preparation of this manuscript. This paper uses data from SHARE Wave 2 (Release 2.3.1, published July 29, 2010). The SHARE data collection was primarily funded by the European Commission through its 5th and 6th framework programs (project numbers QLK6-CT-2001-00360; RII-CT-2006-062193; CIT5-CT-s005-028857). Additional funding

by the US National Institute on Aging (grant numbers U01 AG09740-13S2; P01 AG005842; P01 AG08291; P30 AG 12815; Y1-AG-4553-01; OGHA 04-064; R21 AG025169) as well as by various national sources is gratefully acknowledged (see www.share-project.org for a full list of funding institutions).

REFERENCES

Armfield JM (2007). Socioeconomic inequalities in child oral health: a comparison of discrete and composite area-based measures. *J Public Health Dent* 67:119-125.

Bernabé E, Marcenes W (2010). Periodontal disease and quality of life in British adults. *J Clin Periodontol* 37:968-972.

Börsch-Supan A, Brugiavini A, Juerges H, Kapteyn A, Mackenbach J, Siegrist J, *et al*., editors (2008). Health, ageing and retirement in Europe (2004-2007) — Starting the longitudinal dimension. Mannheim: MEA.

Brown LJ, Lazar V (1999). Trends in the dental health work force. *J Am Dent Assoc* 130:1743-1749.

Brunner E, Marmot MG (2006). Social organization, stress, and health. In: *Social determinants of health*. 2nd ed. Marmot MG, Wilkinson RG, editors. Oxford: Oxford University Press, pp. 6-30.

Caley M, Sidhu K (2011). Estimating the future healthcare costs of an aging population in the UK: expansion of morbidity and the need for preventative care. *J Public Health* [Epub ahead of print, June 9, 2010] (in press).

Do LG, Spencer AJ, Slade GD, Ha DH, Roberts-Thomson KF, Liu P (2010). Trend of income-related inequality of child oral health in Australia. *J Dent Res* 89:959-964.

Donaldson AN, Everitt B, Newton T, Steele J, Sherriff M, Bower E (2008). The effects of social class and dental attendance on oral health. *J Dent Res* 87:60-64.

Du M, Jiang H, Tai B, Zhou Y, Wu B, Bian Z (2009). Root caries patterns and risk factors of middle-aged and elderly people in China. *Community Dent Oral Epidemiol* 37:260-266.

Dye BA, Selwitz RH (2005). The relationship between selected measures of periodontal status and demographic and behavioural risk factors. *J Clin Periodontol* 32:798-808.

Enjary C, Tubert-Jeannin S, Manevy R, Roger-Leroi V, Riordan PJ (2006). Dental status and measures of deprivation in Clermont-Ferrand, France. *Community Dent Oral Epidemiol* 34:363-371.

Flanders WD, Lin L, Pirkle JL, Caudill SP (1992). Assessing the direction of causality in cross-sectional studies. *Am J Epidemiol* 135:926-935.

Gilbert GH, Duncan RP, Shelton BJ (2003). Social determinants of tooth loss. *Health Serv Res* 38(6 Pt 2):1843-1862.

Grytten J (1990). How age influences expenditure for dental services in Norway. *Community Dent Oral Epidemiol* 18:225-229.

Hagenaars A, de Vos K, Zaidi MA (1994). Poverty statistics in the late 1980s: research based on micro-data. Luxembourg: Office for Official Publications of the European Communities.

Harford J (2009). Population ageing and dental care. *Community Dent Oral Epidemiol* 37:97-103.

Holst D (2008). Oral health equality during 30 years in Norway. *Community Dent Oral Epidemiol* 36:326-334.

Jamieson LM, Thomson WM (2006). Adult oral health inequalities described using area based and household-based socioeconomic status measures. *J Public Health Dent* 66:104-109.

Kaiser Family Foundation (2009). Cost sharing for health care: France, Germany, and Switzerland. Menlo Park, CA: The Henry J. Kaiser Family Foundation.

Kakwani NC (1977). Measurement of tax progressivity: an international comparison. *Economic J* 87:71-80.

Kakwani NC (1980). Income inequality and poverty: methods of estimation and policy applications. London: Oxford University Press.

Kakwani NC, Wagstaff A, Van Doorslaer E (1997). Socioeconomic inequalities in health: measurement, computation and statistical inference. *J Econometrics* 77:87-104.

Kleinman ER, Harper PR, Gallagher JE (2009). Trends in NHS primary dental care for older people in England: implications for the future. *Gerodontology* 26:193-201.

Koolman X, van Doorslaer E (2004). On the interpretation of a concentration index of inequality. *Health Econ* 13:649-656.

Krustrup U, Petersen PE (2006). Periodontal conditions in 35-44 and 65-74-year-old adults in Denmark. *Acta Odontol Scand* 64:65-73.

Locker D (2000). Deprivation and oral health: a review. *Community Dent Oral Epidemiol* 28:161-169.

López R, Fernández O, Baelum V (2006). Social gradients in periodontal diseases amongst adolescents. *Community Dent Oral Epidemiol* 34:184-196.

Makhija SK, Gilbert GH, Boykin MJ, Litaker MS, Allman RM, Baker PS, *et al*. (2006). The relationship between sociodemographic factors and oral health-related quality of life in dentate and edentulous community-dwelling older adults. *J Am Geriatr Soc* 54:1701-1712.

McGrath C, Bedi R (2001). Can dental attendance improve quality of life? *Br Dent J* 190(5):262-265.

Pamuk ER (1985). Social class inequality in mortality from 1921 to 1972 in England and Wales. *Popul Stud (Camb)* 39:17-31.

Pavi E, Karampli E, Zavras D, Dardavesis T, Kyriopoulos J (2010). Social determinant of dental health services utilisation of Greek adults. *Community Dent Health* 27:145-150.

Perera I, Ekanayake L (2008). Social gradient in dental caries among adolescents in Sri Lanka. *Caries Res* 42:105-111.

Petersen PE (2005). Sociobehavioural risk factors in dental caries—international perspectives. *Community Dent Oral Epidemiol* 33:274-279.

Petersen PE, Kjøller M, Christensen LB, Krustrup U (2004). Changing dentate status of adults, use of dental health services, and achievement of national dental health goals in Denmark by the year 2000. *J Public Health Dent* 64:127-135.

Reinhardt U (2003). Does the ageing of the population really drive the demand for health care? *Health Aff* 22:27-39.

Sanders AE, Slade GD, Turrell G, Spencer AJ, Marcenes WS (2006). The shape of the socioeconomic-oral health gradient: implications for theoretical explanations. *Community Dent Oral Epidemiol* 34:310-319.

Sisson KL (2007). Theoretical explanations for social inequalities in oral health. *Community Dent Oral Epidemiol* 35:81-88.

Somkotra T, Detsomboonrat P (2009). Is there equity in oral healthcare utilization: experience after achieving universal coverage. *Community Dent Oral Epidemiol* 37:85-96.

Somkotra T, Vachirarojpisan T (2009). Inequality in dental care utilisation among Thai children: evidence from Thailand where universal coverage has been achieved. *Int Dent J* 59:349-357.

Ståhlnacke K, Unell L, Söderfeldt B, Ekbäck G, Ordell S (2010). Self-perceived oral health among 65 and 75 years old in two Swedish counties. *Swed Dent J* 34:107-119.

Tellez M, Sohn W, Burt BA, Ismail AI (2006). Assessment of the relationship between neighborhood characteristics and dental caries severity among low-income African-Americans: a multilevel approach. *J Public Health Dent* 66:30-36.

Thomson S, Foubister T, Mossialos E (2009). Financing health care in the European Union—challenges and policy responses. European Observatory on Health Systems and Policies Series 17:1-224. Geneva: WHO.

Tsakos G, Sheiham A, Iliffe S, Kharicha K, Harari D, Swift CG, *et al*. (2009). The impact of educational level on oral health-related quality of life in older people in London. *Eur J Oral Sci* 117:286-292.

Unell L, Söderfeldt B, Halling A, Birkhed D (1999). Explanatory models for clinically determined and symptom-reported caries indicators in an adult population. *Acta Odontol Scand* 57:132-138.

United Nations Population Fund (2002). Population ageing and development: social, health and gender issues. Population and development strategies series. Report No. 3. New York: United Nations Population Fund.

Watt RG, Sheiham A (1999). Inequalities in oral health: a review of the evidence and recommendations for action. *Br Dent J* 187(1):6-12.

Watt RG (2007). From victim blaming to upstream action: tackling the social determinants of oral health inequalities. *Community Dent Oral Epidemiol* 35:1-11.