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Association between childhood socioeconomic position and periodontitis in Korean adults

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Objective: To examine the relationship of early life socioeconomic position (SEP) and adulthood periodontitis in the middle aged Korean representative sample. ***Methods:*** The 4th Korea National Health and Nutrition Examination Survey data were used. Multivariate logistic regression analyses were conducted on adults aged 30-59 years to estimate the association between parental SEP (education, occupation) and periodontitis and assess the relative impacts of own SEP (education, income and occupation) on periodontitis. Periodontitis (Community Periodontal Index) was dependent variable and parental SEPs were independent variables. ***Results:*** Own SEP was associated with periodontitis (OR of own education=1.94, OR of own occupation=1.67; OR of the lowest income=1.52). Income was associated with periodontitis after adjustment for own SEPs and parental SEPs simultaneously (adjusted OR of the lowest income=1.68). Parental SEP was associated with periodontitis (OR of father's education=1.66, OR of mother's education=1.64; OR of father's occupation=1.38, OR of mother's occupation=1.44). ***Conclusions:*** Early-life socioeconomic disadvantages were significantly associated with adulthood periodontitis in the representative Korean sample ($p<0.05$). The results also indicated that systematic oral health program and oral education would be needed from early childhood throughout the whole life time to improve periodontal health in adulthood.

Key words: *childhood, epidemiology, socioeconomic position, periodontitis, Korea*

Introduction

Periodontal disease is the sixth-most prevalent condition in the world (Kassebaum *et al.*, 2014), and the global burden of severe periodontitis increases with age to become the most predominant cause of disability-adjusted life years in individuals from 35 to 59 years old (Marcenes *et al.*, 2013). In Korea, the prevalence of periodontitis was reported to be 33% among adults (Kwon *et al.*, 2011).

The risk of periodontitis in adulthood tends to be linked to socioeconomic position (SEP) (Buchwald *et al.*, 2013; Hobdell *et al.*, 2003; Levine *et al.*, 2013; Poulton *et al.*, 2002; Thomson *et al.*, 2004). However, the evidence on socioeconomic inequalities in adult oral health has been mostly limited to adult SEP. Moreover, it was not considered that adverse socioeconomic circumstances may influence oral health at critical or different stages in life and have accumulative effects in lifetime. The life-course approach is explains the effects of factors at different stages of an individual's life influencing the risk of disease in adulthood (Darnton-Hill *et al.*, 2004; Delgado-Angulo and Bernabé, 2015; Gliksman *et al.*, 1995). Lower SEP is generally associated with the higher rate of smoking and obesity in later life (Fontaine *et al.*, 2011). The results could be explained with the hypothesis that children's experience of socioeconomic disadvantage was associated with a wide range of health risk factors and outcomes in adult life (Poulton *et al.*, 2002; Wamala *et al.*, 2001).

A few life course studies on the relationship between SEP and adult periodontitis have been provided (Nicolau *et al.*, 2007; Poulton *et al.*, 2002; Shin *et al.*, 2015; Thomson *et al.*, 2004). The ongoing Dunedin Multidisciplinary Health and Development Study in New Zealand has found that parental occupation was related to plaque score, gingival bleeding, periodontal disease and dental caries at the age 26 years old after controlling for current occupation (Thomson *et al.*, 2004). A life-course approach among Brazilian middle-aged women found that paternal education was related to adulthood periodontal disease, independent of own education (Nicolau *et al.*, 2007). However, there have been controversial findings. A recent Korean study found that periodontitis was associated with socioeconomic disadvantage in adulthood but not from childhood (Shin *et al.*, 2015).

Many studies have been considered the relationship of periodontitis to early life SEP (parental education/occupation) or current SEP (education, income and occupation), one Korean study with atypical findings. However, the Dunedin Multidisciplinary Health and Development Study focused on young adults who are too young to have sufficient periodontitis. Therefore, we intend to examine which factor of parents' SEP in early life was associated more strongly with adulthood periodontitis. In addition, our study aims to investigate the impact of own SEP for periodontitis in life-course model with adjusting for adulthood SEP among the middle-aged Korean representative sample.

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Method

The data were a subset of the 4th Korea National Health and Nutritional Examination (KNHANES) which was conducted from 2007 to 2009 by the Korea Center for Disease Control and Prevention (KCDC) performed by the Korean Ministry of Health (Kweon *et al.*, 2014) The sample protocol for KNHANES was designed to involve a complex, stratified, multistage and probability-cluster survey of representative sample of the non-institutionalized civilian population in South Korea. The KNHANES sampling unit was based on the 2005 national Census Registry household giving a final sample set of 13,810 households, 24,871 participants of which 10,416 were aged 30-59 years. Because tooth loss prevents periodontal examination those older than 59 years were excluded from the analyses. Among the 10,416 30-59 year-olds, only 9,281 (89%) of the subjects participated in both general measurements and periodontal examination. Participants ages ranged from 30 to 59 years (58% were female) and they consented prior to participation.

Periodontal status was assessed using the Community Periodontal Index (CPI), as recommended by the criteria of the WHO (World Health Organization). This index scale is nominal and ordinal (0, healthy; 1, bleeding; 2, calculus; 3, shallow periodontal pocket; 4, deep periodontal pocket). Periodontitis was defined as a CPI greater than or equal to "code 3", which indicates that more than one site had a 3.5 mm pocket or larger in the index teeth. The mouth is divided into six sextants, and two index teeth per sextant were examined. For each sextant, the worst score was recorded. The number of dentists in each survey year was 13 (2007), 20 (2008), and 13 (2009). Calibration training of dentists was conducted each year and compared to the reference dentist. The mean k-values (range) for inter-examiner reliabilities for periodontitis were 0.711 (0.686-0.772), 0.890 (0.548-1.000), and 0.747 (0.531-0.937), respectively.

For childhood SEP, both parents' education levels and their job titles were gathered via interviews: "What was your father's education level when you were 14 years old?" and "What was your father's job when you were 14 years old?" with the questions repeated for the maternal data. Education reflected the highest completed grade/level of school which was dichotomized as more than middle school and more (≥9 years) or below middle school (<9 years). Occupation was based on South Korean standard for classifying occupations that is derived from International Standard Classification of Occupation of the International Labour Organization dichotomized as white-collared (legislator, senior officials, managers, professionals, technicians, associate professionals, clerks, service workers and market sale workers) or blue-collared (agricultural and fishery workers, craft and related workers, plant/machine operators and elementary occupations). Housewives were excluded from the analyses. If the subjects were not certain of their parents' SEP, they were excluded from the analysis. The number of excluded participants of parental SEP variables were father's education, 332; mother's education, 289; father's occupation, 1,259; and mother's occupation, 3,547.

For own SEP, participants' own education, income and occupation were included: education level again determined as the highest completed grade/level dichotomized as high school and more (≥12 years) or below high school (<12 years). Occupation was again classified as white- or and blue-collar. If subjects were housewives or were without occupation or unknown, they were excluded from the analysis. Monthly household income was adjusted for the number of household members and was categorized into four different groups: <25%, 25-<50%, 50-75% and 75-100%. Socio-demographic variables were included in data analysis: age, survey year, gender, marital status (married/single) and residence (urban/ rural).

The conceptual model of this study was adapted from another study (Thomson *et al.,* 2004). Low SEP in early life, can be associated with low SEP in adulthood and so with periodontitis in adulthood. Among indicators of an individual's own SEP, their education level considered ahead of their income and occupation because education level was generally achieved in early adulthood.

Separate analyses were planned for men and women because life course effects on adult health have previously been suggested differ by gender (Lamont *et al.*, 2000; Parker *et al.*, 2003). The characteristics of the study subjects by periodontal status were presented with the frequency distributions and Chi-square tests were used to assess the associations of periodontitis with other variables. In our analysis, we used complex sample designs including primary sampling units, stratification, and sample weights from the KNHANES. A series of logistic regression analyses estimated the adjusted odds ratio of periodontitis according to the own SEP measures and early life SEP measures after sequential adjustment. The base model was unadjusted (Model 1), Model 2 adjusted for demographic factors, Model 3 adjusted for concurrent measures (other early life or other own SEP measures) and Model 4 adjusted for all SEP measures simultaneously. These analyses were undertaken using SPSS v15.0 with significance set at <0.05 to assess the relative importance of childhood SEP measures.

Results

Table 1 shows the characteristics of participants. Significant differences were found in the distribution of periodontitis in regards to all variables except place of residence (Table 1). Periodontitis worsened as age increased. Periodontal health improved with education level and income. The less educated, low income group and blue collar workers had more periodontitis. Those whose parents are less educated and blue collar workers showed more periodontitis. Separate analyses by gender are not reported because interactions between own/parental SEPs were not significant ($p>0.05$).

As seen in Table 2, significant associations of own SEPs with periodontitis were found (OR=1.94 for education, 1.67 for occupation, and 1.52 for income). In a series of adjustment, own education was related to periodontitis after adjustment for demographic factors (OR=1.30), but the association was disappeared after adjustment for own SEP measures simultaneously.

Occupation was associated with periodontitis after adjustment for own SEP measures simultaneously (OR=1.25), but the association disappeared after adjustment for all own SEP and parental SEP measures simultaneously. However, income retained this association throughout those adjustments (OR=1.68).

Table 3 showed the association between parental SEP and periodontitis. Father's educational status during childhood was related to periodontal disease as an adult (OR=1.66) in the unadjusted model. The association was attenuated but remained significant after adjustment for own education, income and occupation (OR=1.16). Simultaneous adjustment for all SEP variables made the relationship un-significant. Father's occupational status during childhood was related to periodontal disease as an adult (OR=1.38) in the unadjusted model. However, the association was attenuated and non-significant after adjustment for own education, income and occupation. Mother's educational status during childhood was related to periodontal disease as an adult (OR=1.64) in the unadjusted model. The association was attenuated but remained significant after adjustment for own education, income and occupation (OR=1.21). Simultaneous adjustment for all SEP variables made the relationship insignificant. Mother's occupational status during childhood was related to periodontal disease as an adult (OR=1.44) in the unadjusted model. However, the association was attenuated and insignificant after adjustment for own education, income and occupation.

Table 1. Characteristics of subjects by periodontitis

Variables	*Healthy, n (weighted %)*	*Periodontitis, n (weighted %)*	*P, by χ^2test*
Age group			
30-39 years	2,318 (79.4)	553 (20.6)	**<0.001**
40-49 years	1,771 (60.8)	1,020 (39.2)	
50-59 years	1,230 (49.5)	1,172 (50.5)	
Gender			
Male	1,739 (57.0)	1,372 (43.0)	**<0.001**
Female	3,580 (72.4)	1,373 (27.6)	
Marital status			
Married	5,016 (63.9)	2,645 (36.1)	**<0.001**
Single	297 (74.9)	96 (25.1)	
Place of residence			
Urban	4,193 (65.2)	2,071 (34.8)	0.129
Rural	1,126 (61.9)	674 (38.1)	
Education			
≥12 years	4,151 (68.3)	1,751 (31.7)	**<0.001**
<12 years	1,168 (52.7)	994 (47.3)	
Income			
IV (highest)	1,453 (69.7)	599 (30.3)	**<0.001**
III (high)	1,419 (67.5)	626 (32.5)	
II (low)	1,254 (60.5)	740 (39.5)	
I (lowest)	1,193 (60.1)	780 (39.9)	
Occupation			
White-collar	2,166 (66.9)	987 (33.1)	**<0.001**
Blue-collar	1,258 (54.7)	991 (45.3)	
Paternal education			
≥9 years	2,781 (70.4)	1,134 (29.6)	**<0.001**
<9 years	2,367 (59.0)	1,492 (41.0)	
Maternal education			
≥9 years	1,863 (72.0)	683 (28.0)	**<0.001**
<9 years	3,318 (61.1)	1,959 (38.9)	
Paternal occupation			
White-collar	1,489 (70.0)	591 (30.0)	**<0.001**
Blue-collar	3,137 (62.9)	1,745 (37.1)	
Maternal occupation			
White-collar	744 (68.4)	302 (31.6)	**<0.001**
Blue-collar	2,452 (60.0)	1,520 (40.0)	

Table 2. Odds ratio (95% confidence interval) of periodontitis by own socioeconomic position in the series of adjusted models

		Model 1	*Model 2*	*Model 3*	*Model 4*
Education (Ref: ≥12 years)		**1.94 (1.70, 2.20)**	**1.30 (1.11, 1.52)**	1.01 (0.83, 1.23)	1.14 (0.89, 1.47)
Occupation (Ref: white-collar)		**1.67 (1.47, 1.90)**	**1.35 (1.17, 1.55)**	**1.25 (1.08, 1.44)**	1.00 (0.83, 1.21)
Income (Ref: IV highest)	I (lowest)	**1.52 (1.28, 1.81)**	**1.66 (1.39, 1.99)**	**1.53 (1.24, 1.88)**	**1.68 (1.27, 2.23)**
	II (low)	**1.50 (1.27, 1.77)**	**1.54 (1.29, 1.84)**	**1.57 (1.27, 1.93)**	**1.58 (1.20, 2.08)**
	III (high)	1.10 (0.94, 1.30)	1.14 (0.96, 1.36)	1.16 (0.95, 1.41)	1.21 (0.92, 1.59)

Model 1 Unadjusted ; Model 2 Adjusted for age, survey year, marital status, and residence; Model 3 Adjusted as for Model 2 plus income, education and occupation; Model 4 Adjusted as for Model 3 plus father's education, father's occupation, mother's education, and mother's occupation; **Bold** denotes statistical significance at P<0.05

Table 3. Odds ratio (95% confidence intervals) of periodontitis by childhood socioeconomic position in the series of four adjusted models

		Model 1	*Model 2*	*Model 3*	*Model 4*
Father's Education	(Ref: ≥9 yr)	**1.66 (1.48, 1.85)**	**1.32 (1.17, 1.48)**	**1.16 (1.00, 1.33)**	1.06 (0.84, 1.34)
Father's Occupation	(Ref: white-collar)	**1.38 (1.19, 1.60)**	**1.22 (1.05, 1.42)**	1.03 (0.86, 1.22)	1.22 (0.84, 1.78)
Mother's Education	(Ref: ≥9 yr)	**1.64 (1.45, 1.85)**	**1.30 (1.14, 1.48)**	**1.21 (1.03, 1.42)**	1.22 (0.92, 1.64)
Mother's Occupation	(Ref: white-collar)	**1.44 (1.21, 1.71)**	1.18 (0.98, 1.41)	1.15 (0.92, 1.45)	1.12 (0.79, 1.59)

Model 1 Unadjusted ; Model 2 Adjusted for age, survey year, marital status, and residence; Model 3 Adjusted as for Model 2 plus income, education and occupation; Model 4 Adjusted as for Model 3 plus father's education, father's occupation, mother's education, and mother's occupation; **Bold** denotes statistical significance at P<0.05

Discussion

The results of this study suggest that the periodontal health status of Koreana was associated with their parental education, and that the impact of parental education remained after taking into account own education, occupation, and income. Additionally, income was related to periodontitis regardless of parental SEP measures.

The results from this study are compatible with earlier studies which reported that fathers' education were associated with greater loss of periodontal attachment and that early socioeconomic inequalities in periodontal health appear to persist well into the third decade of life (Nicolau *et al*., 2007; Thomson *et al*., 2004). This means that childhood disadvantage has an enduring effect on periodontal health. However, the lack of association between parental SEP and periodontal disease was reported in two previous studies (Bernabe *et al*. 2011; Shin *et al*. 2015). This may be explained by differences between study populations, the socioeconomic measure used or the type of periodontal outcome assessed. Although Shin *et al*. (2015) used a similar KNHANES dataset for lifecourse approach of periodontal disease, the early life SEP measure was parental occupation rather than parental education. Education as a SEP indicator has some strength. Education is comparatively easy to measure in self-administered questionnaires, garners a high response rate, and is relevant to people regardless of age or working circumstances, unlike many other SEP indicators (Liberatos *et al*., 1988). In addition, the collection of information on education may be less contentious in some contexts than other SEP indicators such as income or occupation. However, the most important limitation of occupational indicators is that they cannot be readily assigned to people who are not currently employed. As a result, if used as the only source of information on SEP, socioeconomic differentials may be underestimated through the exclusion of some of the population (Martikainen and Valkonen, 1999). Groups commonly excluded are retired people, people whose work is inside the home (mainly affecting women), the unemployed, students, and people working in unpaid, informal, or illegal jobs (Galobardes *et al*., 2006). In our study, parental education had stronger association with periodontitis than parental occupation. The reason why education level is important for evaluating health is that higher education is accompanied with economic advantage and opportunities to choose one's health behaviors, solve problems and handle disease.

Two main pathways have been proposed to explain the association between socioeconomic variables and periodontal disease. The first is behavioral pathway, in which poor health behavior, such as smoking, poor oral hygiene and irregular dental checkup, are affected by socioeconomic circumstances (Sheiham and Nicolau, 2005). In detail, those with low SEP in early life period are more likely to smoke and have physically sedentary lifestyle (Poulton *et al.*, 2002). The second pathway is psycho-physiological pathway (Friedman and Herd, 2010), in which social stress leads to an array of endocrine, neural and immune changes. The hormones which are secreted in stress situation induce the production of pro-inflammatory cytokine secretion, known as contributors to periodontitis (Genco *et al.*, 1998). Exposure to stress during sensitive periods of immune maturation in early life can alter immune function, leading to increased susceptibility to infectious or inflammatory disease later in life (Coe and Lubach, 2003). It can be suggested that exposures to low socioeconomic status, such as parental education, lead to a cumulative damage to the biological systems and so to more periodontal disease. Both pathways are influenced by early life experience.

The similarity of our findings to previous studies that tested the life-course approach suggests that the pathways outlined above are also important for periodontal disease. Periodontal disease is more common in subjects from low socioeconomic backgrounds, those with low levels of education and those adolescents whose parents reported low levels of marital quality (Marcenes and Sheiham, 1992; Sheiham and Nicolau, 2005).

In the life-course model, material and psychosocial factors contribute to socioeconomic disparity with ill-health behavior and ill-health related practices. As described earlier, it is not sufficient to understand periodontitis based on contemporary risk factors, but considering from early life SEP throughout adult SEP needs to be considered. Determinant factors for periodontitis, such as behavioral and psychosocial ones, may develop during early lifetime and into adulthood (Thomson *et al.,* 2004; Nicolau *et al.,* 2007). Hygiene practice behavior and dietary practice are established in early life (Lynch *et al.*, 1997). In addition, early-life SEP influences nutritional development and immune maturation (Nicolau *et al.,* 2007).

The life-course concept appears to be well suited to periodontitis. Early-life SEP in childhood can affect oral health risk factors during childhood, which could worsen over time. Another way is that low SEP in early life can be associated with low SEP in adulthood, which is itself related to periodontitis. This social trajectories model depicts chains of risk by which one negative exposure increases the subsequent risk of another negative exposure (Delgado-Angulo and Bernabé, 2015; Buchwald *et al.,* 2013; Thomson *et al.,* 2004). Similarly, though Korean education has recently developed greatly (Sorensen, 1994), paternal educational inequality measured by SEP remains a serious social problem (Park, 2007) associated with health inequality. Thus, it seems to be important in understanding disease progression to consider early life SEP in a life course model.

The strength of our study was that data was obtained from a nationwide population with a high response, which provided representative information on the Korean population. Nevertheless, several study limitations should be considered. First, we used unvalidated, self-reported, retrospective data on parental education, which could be subject to memory bias, potentially greater measurement error and an underestimation of the association (Galobardes *et al.*, 2004; Kauhanen *et al.*, 2006). Though, some studies have found that childhood SEP could be accurately recalled in adulthood, especially when using temporal references (Berney and Blane, 1997). Secondly, we cannot infer causal relationship between periodontitis and childhood socioeconomic status in this cross-sectional study and thus a temporal relationship between the variables cannot be established. Thirdly, we could not measure cumulative or interaction SEP, but used data for a single age (when the child was 14 years old). Finally, due to the limitation of the occupational indicator, the several aforementioned categories of participants and their parents were excluded from some analyses. Therefore the interpretation of this study should be cautious. Further well-designed prospective studies are needed to assess the association between early life SEP and periodontitis.

In summary, socioeconomic disadvantages in early lifetime were significantly associated with adulthood periodontitis in a representative Korean sample. The results also indicate that systematic oral health program and oral education would be needed from early childhood throughout the whole life course to improve periodontal health in adulthood.

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