Long working hours are associated with unmet dental needs in south Korean male adults who have experienced dental pain

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Abstract

Backgrounds: We explored the association between working hours and unmet dental needs among adults who have experienced dental pain, and how this relationship varied by demographic and lifestyle factors.

Methods: We used the data of 9594 adults who reported dental pain from the Korea National Health and Nutrition Examination Survey (KNHANES) V and VI. We conducted a logistic regression analysis to determine the association between working hours and unmet dental needs, followed by a subgroup analysis and Cochran-Armitage trend tests.

Results: Among the 4203 male subjects, 1661 (39.5%) experienced unmet dental needs. They also showed a significant dose-response relationship between working hours and unmet dental needs (OR 1.21 [95% CI 0.97–1.51], OR 1.30 [95% CI 0.99–1.69], OR 1.33 [95% CI 1.04–1.71], OR 1.58 [95% CI 1.21–2.07] compared to no working hours), whereas female participants did not. The significance of the association was preserved among participants with increased consumption of alcohol, urban residence, and who brushed their teeth at least twice a day. It was also stronger among those who lacked access to dental services or did not perceive the need for dental care.

Conclusion: Among adults who have experienced dental pain, unmet dental needs had higher odds of occurring in males who worked longer, and this relationship appears to be influenced by consumption of alcohol, region of residence, tooth-brushing frequency, and access to and perception of dental care. Accordingly, policies should be drafted to reduce unmet needs by considering these factors.

Keywords: Unmet needs, Dental pain, Unmet dental needs, Working hours, Dose-response relationship, Region, Alcohol

Background

A good society ensures that individuals can readily obtain appropriate medical services when needed. Accordingly, many countries strive to invest in medical facilities [1]. However, improving the medical facilities does not always translate to a better hospital experience for patients. In fact, quantitative expansion in medicine—such as constructing new hospitals and improving medical facilities—appears to have little effect on patients if patients cannot effectively reach a doctor [2].

A variety of obstacles can hinder individuals from reaching or deciding to contact a doctor, even when they might need to [3]. Unmet needs in health care can lead to a range of adverse health outcomes [4]. By identifying and resolving the causes of unmet needs in patients, we can expect an improvement in overall medical services without further investment in medical resources, which are often limited. Canada has noted a number of diverse efforts in considering gender, income, and social integration to alleviate inequalities in unmet dental needs [5].

In South Korea, the ratio of dental expenses to total medical expenses is rising rapidly, which accords with the dangerously high rate of unmet dental needs among
both children and adults (20 and 40%, respectively) [6]. Alarming, the rate of unmet dental needs is almost twice that of other diseases [6]. Thus, it is very important to determine and eliminate the factors that contribute to this high rate of unmet dental needs.

The excessive working hours among Korean adults is a contentious topic in Korean society. Among the Organization for Economic Co-operation and Development (OECD) countries, Korea was ranked third in terms of annual working hours in 2016 [7]. Many studies have pointed out that long working hours can have a range of adverse effects, including a higher incidence of physical problems such as diabetes mellitus and metabolic syndrome, as well as psychological problems such as anxiety and excessive alcohol use [8, 9]. It is similarly possible that longer working hours plays a role in unmet care needs, with overworking leading to less time available for accessing medical services. If this is found, reducing overall working hours might help improve the overall healthcare system.

There are several previous studies on the factors associated with unmet dental needs, conducted in both Western countries and South Korea [10, 11]. However, few of these studies utilized dental pain as an index of unmet dental needs, and most were limited to Western countries and child populations [10]. One study in the United States of America (USA) examined adults to find out factors of unmet dental needs, but they did not look for associations [12]. Also, studies examining the association between working hours and unmet dental needs among people who have experienced dental pain were generally unfound. This suggests the need for such study within this specific Korean population. By utilizing an objective index of illness (i.e., dental pain), we might be able to resolve the subjectivity of the unmet needs variable [13], which is often mentioned as a limitation in former studies [14, 15]. These objective indicators could certify the actual demands of patients, and more precisely detect health inequity. Therefore, we chose a sample exclusively comprised of subjects who have experienced dental pain, given that toothache is an unbiased index of the need for dental care [16].

We hypothesized that longer working hours will be associated with greater unmet needs among workers who have experienced dental pain. Furthermore, we performed a subgroup analysis with demographic and behavioral variables to examine which factors influence this association. Factors such as region of residence can affect the relationship, due to different accessibility to medical facilities.

**Methods**

**Study design and participants**

We used the data from the Korea National Health and Nutrition Examination Survey (KNHANES) V and VI, a nationwide cross-sectional study conducted from 2010 to 2015 by the Korean Ministry of Health and Welfare. The research population is homogeneous and unbiased, and represents non-institutionalized Korean civilians [17]. For this study, we selected adults older than 19 years old with valid responses to all items and had experienced dental pain. Among the 39,518 participants, after excluding participants with missing values and adolescents, we chose 10,118 respondents who reported the experience of dental pain. After further eliminating participants with invalid answers to regular dental checkups (n = 104), national health insurance (n = 85), drinking habits (n = 27), occupation (n = 305), and education (n = 3), 9594 respondents were analyzed.

**Working hours**

Respondents were asked about their weekly working hours with the question “How long do you work per week, including extra work/night shift and excluding mealtimes?” The Labor Standards Act of Korea states that standard working hours must not exceed 40 h per week; work up to 48–60 h is defined as “extra work” and is given extra wages [18]. Studies have reported that people who work longer than 60 h per week tend to suffer from health problems such as higher cardiovascular mortality rates [19]. Accordingly, we classified participants’ answers to this question into four groups: 40 h or less, 41–48, 49–60, and 61 or more.

**Unmet needs**

Unmet dental needs were assessed with two questions. First, they were asked “Have you ever wanted to visit a dentist but could not?”. Those who answered ‘yes’ were then asked why, and the answers were classified into three groups. Firstly, ‘Lack of ability to pay’ was classified as ‘economic reasons’. Second, ‘Dental clinic is too far away,’ ‘could not leave workplace or school,’ ‘mobility or health problems,’ and ‘had to take care of children’ were classified as ‘lack of access’. Finally, ‘did not consider it a serious problem’ and ‘afraid to visit a dentist’ were classified as ‘perceptual barriers’ [20].

**Other variables**

Demographic variables included gender, age (20–29, 30–39, 40–49, 50–59, 60–65, and >65 years), and region of residence (urban or rural areas). The socioeconomic variables included level of education (middle school or lower, high school, and college or higher), occupation type (office, labor, and service), and household income (high, moderately high, moderately low, and low). Household income was divided into quartiles using the monthly average equivalent household income (i.e., monthly household income divided by the square root of the number of household members) [17]. The health-
related variables considered were smoking (non-smoker, past smoker, and present smoker), drinking habits (non-drinker, light drinker, and heavy drinker), possession of private insurance, health insurance type (national health insurance (NHI)-local, NHI-employee’s, and medical aid), self-rated oral health status (good, moderate, bad). Heavy drinkers were defined as those who drank >2 times a week, light drinkers as those who drank less than twice per week, and non-drinkers as those who never drank or drank less than once per month. Finally, the dental care indicators included usage of dental care tools, number of times of teeth brushing per day, and dental checkup within the last year. Unless otherwise mentioned, the above variables were binary variables (yes or no).

Statistical analysis
Because average workload, occupation, and physical abilities differ considerably according to gender [21], we stratified all analysis by gender. For binary variables, we calculated the frequency and proportions of each variable and compared them using chi-square tests. The association was quantified using logistic regression analyses after adjusting for demographic, socioeconomic, health-related, and dental care indicators. Additionally, we performed subgroup analyses according to drinking habits, region of residence, and tooth-brushing habit. Cochran–Armitage trend tests were used to determine the p for trend between working hours and unmet dental needs. For this test, working hours were defined as a continuous variable (with an interval of 1 h) and unmet dental needs as a binary variable. All analyses were conducted using SAS 9.4 (SAS Inc., Cary, NC, USA). There were no human subjects involved in this study.

Results
Table 1 displays the general characteristics of the gender-stratified study population. Of the 4203 (43.8%) male participants and 5391 (56.2%) female participants, 1661 (39.5%) and 2376 (44.1%) had experienced unmet dental needs, respectively. Among both males and females, the percentage of unmet dental needs increased with working hours (p < 0.001 in males, p = 0.017 in female). Specifically, among males, the proportions of unmet dental needs were 32.3, 38.5, 40.9, 41.7, and 46.9% in the 0, < 40, 41–48, 49–60, and > 60 h groups, respectively; among females, the proportions of unmet dental needs were 41.3, 45.2, 46.2, 46.3, and 48.2%, respectively.

Table 2 presents the logistic regression analysis results adjusted with confounding factors for both males and females. We observed a dose-response relationship between working hours and unmet need only in male participants. Specifically, the odds ratios (ORs) and 95% confidence intervals (CI) for the working hour groups (vs. the 0-h group) were as follows: OR = 1.21 [95% CI 0.97–1.51] for < 40 h; OR = 1.30 [95% CI 0.99–1.69] for 41–48 h; OR = 1.33 [95% CI 1.04–1.71] for 49–60 h; and OR = 1.58 [95% CI 1.21–2.07] for > 60 h. In other words, the odds ratios increased with working hours among males. Among females, the ORs showed a bell-shaped pattern (OR = 1.24 [95% CI 1.08–1.42] for < 40 h; OR = 1.27 [95% CI 1.02–1.58] for 41–48 h; OR = 1.24 [95% CI 1.00–1.54] for 49–60 h; OR = 1.21 [95% CI 0.95–1.55] for > 60 h).

The subgroup analysis is shown in Table 3, separately for males and females. For alcohol consumption, males defined as heavy drinkers showed significantly higher ORs (for the 41–48, 49–60, and > 60 h) and maintained the dose-response relationship. Among females, the ORs increased with working hours in the light drinking group particularly, although significance was found only for the 1–40, 41–48, and 49–60 h groups. As for region of residence, males continued to show a dose-response relationship in urban areas (OR = 1.17 [95% CI 0.90–1.51] for < 40 h; OR = 1.39 [95% CI 1.02–1.90] for 41–48 h; OR = 1.52 [95% CI 1.14–2.03] for 49–60 h; OR = 1.65 [95% CI 1.21–2.25] for > 60 h), but not in rural areas. As for times tooth-brushing habit, both males and females showed a stronger positive relationship between working hours and unmet dental need when they brushed at least twice a day.

Table 4 shows the associations between working hours and unmet dental needs for each reason group. For both males and females, participants who lacked access to dental care and had perceptual barriers for dental care showed higher ORs than did those who lacked the ability to pay. Furthermore, among participants who lacked access, the relationship between working hours and unmet dental needs remained positive; in contrast, the relationship was negative among those who had perceptual barriers for dental care.

Discussion
The purpose of this study was to examine the association between working hours and unmet dental needs in a specific population of Koreans—those with experience of dental pain. We also conducted subgroup analyses by alcohol consumption level, region of residence, tooth-brushing frequency, and the major reasons for unmet dental needs.

We observed a dose-response relationship between working hours and unmet dental needs in the male group. In order to interpret effect sizes of odds ratios, the odds ratios were converted into Cohen’s d, or the standardized mean difference between two group means [22]. While the effect size of the odds ratio of the > 60 h group (OR = 1.54, or Cohen’s d = 0.2) is considered small, it is nevertheless reflective of a continued stepwise
Table 1 General characteristics by unmet dental need

| Variable                          | N   | %   | Male (n = 4173) | Female (n = 5355) | p-value | N   | %   | Male (n = 4173) | Female (n = 5355) | p-value |
|-----------------------------------|-----|-----|----------------|-------------------|---------|-----|-----|----------------|-------------------|---------|
| Total                             | 9528| 100.0 | 2524 | 60.5 | 1649 | 39.5 | 2995| 55.9 | 2360 | 44.1 | 0.030 |
| Working hours per week            | < 0.001 | < 0.001 | | 1208 | 58.6 | 853 | 41.4 | 1083 | 54.8 | 892 | 45.2 | |
| No work                           | 2816 | 29.6 | 510 | 67.5 | 245 | 32.5 | 1208 | 58.6 | 853 | 41.4 | |
| < 40                              | 3346 | 35.1 | 844 | 61.6 | 527 | 38.4 | 1083 | 54.8 | 892 | 45.2 | |
| 41–48                             | 1100 | 11.5 | 365 | 9.1 | 253 | 40.9 | 259 | 53.7 | 223 | 46.3 | |
| 49–60                             | 1366 | 14.3 | 516 | 82.2 | 371 | 18.8 | 258 | 53.9 | 221 | 46.1 | |
| > 60                              | 900  | 9.4  | 289 | 33.3 | 253 | 46.7 | 187 | 52.2 | 171 | 47.8 | |
| Age                               | < 0.001 | 0.160 | | 353 | 53.2 | 310 | 46.8 | 537 | 54.0 | 458 | 46.0 | 0.160 |
| 20–29                             | 1076 | 11.3 | 245 | 59.3 | 168 | 40.7 | 353 | 53.2 | 310 | 46.8 | 310 | 46.8 |
| 30–39                             | 1678 | 17.6 | 370 | 54.2 | 313 | 45.8 | 537 | 54.0 | 458 | 46.0 | 458 | 46.0 |
| 40–49                             | 1692 | 17.8 | 448 | 59.7 | 303 | 40.3 | 539 | 57.3 | 402 | 42.7 | 402 | 42.7 |
| 50–59                             | 2019 | 21.2 | 527 | 56.4 | 407 | 43.6 | 595 | 54.8 | 490 | 45.2 | 490 | 45.2 |
| 60–65                             | 1058 | 11.1 | 311 | 64.8 | 169 | 35.2 | 335 | 58.0 | 243 | 42.0 | 243 | 42.0 |
| > 65                              | 2005 | 21.0 | 623 | 68.3 | 289 | 31.7 | 636 | 58.2 | 457 | 41.8 | 457 | 41.8 |
| Health insurance type             | 5977 | 73.2 | 1813 | 60.1 | 1204 | 39.9 | 2236 | 66.5 | 1724 | 33.5 | 0.404 |
| No                                | 2551 | 26.8 | 711 | 51.5 | 445 | 48.5 | 759 | 54.4 | 636 | 45.6 | 0.184 |
| Yes                               | 6977 | 73.2 | 1813 | 60.1 | 1204 | 39.9 | 2236 | 66.5 | 1724 | 33.5 | 0.184 |
| Region of residence               | < 0.001 | < 0.001 | | 921 | 52.6 | 830 | 47.4 | 1966 | 58.3 | 1407 | 41.7 | 0.736 |
| Urban                             | 7417 | 77.8 | 2005 | 61.8 | 1239 | 38.2 | 2339 | 56.1 | 1834 | 43.9 | 1834 | 43.9 |
| Rural                             | 2111 | 22.2 | 519 | 55.9 | 410 | 44.1 | 656 | 55.5 | 526 | 44.5 | 526 | 44.5 |
| Occupation type                   | 0.035 | 0.035 | | 564 | 51.5 | 532 | 48.5 | 764 | 54.1 | 648 | 45.9 | 0.035 |
| Office                            | 3417 | 35.9 | 919 | 62.8 | 544 | 37.2 | 1108 | 56.7 | 846 | 43.3 | 846 | 43.3 |
| Labor                             | 5181 | 54.4 | 1464 | 59.1 | 1015 | 40.9 | 1514 | 56.0 | 1188 | 44.0 | 1188 | 44.0 |
| Service                           | 930  | 9.8  | 141 | 61.0 | 90  | 39.0 | 373  | 53.4 | 326 | 46.6 | 326 | 46.6 |
| Self-assessment of dental health   | < 0.001 | < 0.001 | | 286 | 79.4 | 74  | 20.6 | 1226 | 66.8 | 608 | 33.2 | 608 | 33.2 |
| Good                              | 716  | 7.5  | 297 | 83.4 | 59  | 16.6 | 286 | 79.4 | 74  | 20.6 | 74  | 20.6 |
| Moderate                          | 3071 | 32.2 | 890 | 71.9 | 347 | 28.1 | 1226 | 66.8 | 608 | 33.2 | 608 | 33.2 |
| Bad                               | 5741 | 60.3 | 1337 | 51.8 | 1243 | 48.2 | 1483 | 46.9 | 1678 | 53.1 | 1678 | 53.1 |
| Reason for unmet dental needs*     | 0.001 | 0.001 | | 2995 | 100.0 | 0  | 0.0 | 2995 | 100.0 | 0  | 0.0 | 0.001 |
| No unmet need                     | 5519 | 57.9 | 2524 | 100.0 | 0  | 0.0 | 2995 | 100.0 | 0  | 0.0 | 0.001 |
| Lack of ability to pay            | 0    | 0.0  | 590 | 35.8 | 0  | 0.0 | 931  | 39.4 |   |     | 0.034 |
| Lack of ability to reach          | 0    | 0.0  | 543 | 32.9 | 0  | 0.0 | 617  | 43.2 |   |     | 0.034 |
| Lack of ability to perceive       | 0    | 0.0  | 516 | 31.3 | 0  | 0.0 | 812  | 28.1 |   |     | 0.034 |
| Variable                        | Male (n = 4173) |                   | Female (n = 5355) |                   |
|--------------------------------|----------------|------------------|-------------------|------------------|
|                                | N   | %   | No unmet need | N   | %   | Unmet need | p-value | N   | %   | No unmet need | N   | %   | Unmet need | p-value |
| Number of family members       | 0.018 | 0.063 |                   |                   |
| More than one                  | 8654 | 90.8 | 2367 | 61.0 | 1515 | 39.0 | 2690 | 56.4 | 2082 | 43.6 |                   |                   |
| Alone                          | 874  | 9.2  | 157  | 54.0 | 134  | 46.0 | 305  | 52.3 | 278  | 47.7 |                   |                   |
| Level of education             | 0.020 | 0.644 |                   |                   |
| Middle school                  | 3457 | 36.3 | 758  | 60.8 | 488  | 39.2 | 1223 | 55.3 | 988  | 44.7 |                   |                   |
| High school                    | 3049 | 32.0 | 829  | 57.8 | 606  | 42.2 | 902  | 55.9 | 712  | 44.1 |                   |                   |
| ≥ college                      | 3022 | 31.7 | 937  | 62.8 | 555  | 37.2 | 870  | 56.9 | 660  | 43.1 |                   |                   |
| Usage of dental care tools     | < 0.001 | < 0.001 |                   |                   |
| No                             | 5363 | 56.3 | 1481 | 56.9 | 1120 | 43.1 | 1423 | 51.5 | 1339 | 48.5 |                   |                   |
| Yes                            | 4165 | 43.7 | 1043 | 66.3 | 529  | 33.7 | 1572 | 60.6 | 1021 | 39.4 |                   |                   |
| Number of times brushing teeth per day | 0.004 | 0.069 |                   |                   |
| 0–1                            | 1240 | 13.0 | 419  | 55.9 | 331  | 44.1 | 255  | 52.0 | 235  | 48.0 |                   |                   |
| ≥ 2                            | 8288 | 87.0 | 2105 | 61.5 | 1318 | 38.5 | 2740 | 56.3 | 2125 | 43.7 |                   |                   |
| Dental checkup within last one year | < 0.001 | < 0.001 |                   |                   |
| No                             | 6546 | 68.7 | 1596 | 56.9 | 1207 | 43.1 | 1900 | 50.8 | 1843 | 49.2 |                   |                   |
| Yes                            | 2982 | 31.3 | 928  | 67.7 | 442  | 32.3 | 1095 | 67.9 | 517  | 32.1 |                   |                   |
| Smoke                          | < 0.001 | < 0.001 |                   |                   |
| No                             | 5424 | 56.9 | 500  | 67.1 | 245  | 32.9 | 2666 | 57.0 | 2013 | 43.0 |                   |                   |
| Current smoker                 | 2104 | 22.1 | 947  | 53.7 | 815  | 46.3 | 162  | 47.4 | 180  | 52.6 |                   |                   |
| Past smoker                    | 2000 | 21.0 | 1077 | 64.6 | 589  | 35.4 | 167  | 50.0 | 167  | 50.0 |                   |                   |
| Drink                          | 0.148 | 0.938 |                   |                   |
| No drink                       | 3579 | 37.6 | 444  | 61.5 | 278  | 38.5 | 1110 | 56.2 | 864  | 43.8 |                   |                   |
| Light drink                    | 2363 | 24.8 | 1135 | 61.7 | 704  | 38.3 | 1594 | 55.8 | 1263 | 44.2 |                   |                   |
| Heavy drink                    | 2136 | 22.4 | 945  | 58.6 | 667  | 41.4 | 291  | 55.5 | 233  | 44.5 |                   |                   |
| Average hours of sleep per week| 0.036 | < 0.001 |                   |                   |
| < 5                            | 478  | 5.0  | 86   | 55.1 | 70   | 44.9 | 159  | 49.4 | 163  | 50.6 |                   |                   |
| 5–6                            | 3772 | 39.6 | 980  | 58.4 | 698  | 41.6 | 1125 | 53.7 | 969  | 46.3 |                   |                   |
| 7–8                            | 4588 | 48.2 | 1297 | 62.5 | 777  | 37.5 | 1474 | 58.6 | 1040 | 41.4 |                   |                   |
| > 8                            | 690  | 7.2  | 161  | 60.8 | 104  | 39.2 | 237  | 55.8 | 188  | 44.2 |                   |                   |
| BMI                            | 0.113 | 0.130 |                   |                   |
| ≤ 25                           | 4275 | 44.9 | 1552 | 59.6 | 1054 | 40.4 | 2087 | 56.6 | 1599 | 43.4 |                   |                   |
| > 25                           | 3236 | 34.0 | 972  | 62.0 | 595  | 38.0 | 908  | 54.4 | 761  | 45.6 |                   |                   |
| Year                           | < 0.001 | < 0.001 |                   |                   |
| 2010                           | 1489 | 15.6 | 357  | 54.0 | 304  | 46.0 | 419  | 50.6 | 409  | 49.4 |                   |                   |
| 2011                           | 1335 | 14.0 | 329  | 57.1 | 247  | 42.9 | 408  | 53.8 | 351  | 46.2 |                   |                   |
| 2012                           | 1789 | 18.8 | 459  | 57.2 | 329  | 41.8 | 530  | 52.9 | 471  | 47.1 |                   |                   |
| 2013                           | 1769 | 18.6 | 486  | 62.6 | 290  | 37.4 | 589  | 59.3 | 404  | 40.7 |                   |                   |
| 2014                           | 1529 | 16.0 | 448  | 67.4 | 217  | 32.6 | 497  | 57.5 | 367  | 42.5 |                   |                   |
| 2015                           | 1617 | 17.0 | 445  | 62.9 | 262  | 37.1 | 552  | 60.7 | 358  | 39.3 |                   |                   |

* The ratios of each reason represents the percentage compared to the number of people who showed unmet needs
No association between working hours and unmet dental needs was observed for females. The potential cause of this relationship in males is the early closing time of hospitals in South Korea. In other words, when a salaried worker visits the hospital after work (usually at 5 pm), there is little time for them to see the dentist.

### Table 2 Adjusted odds ratios for factors associated with unmet dental need

| Variable                          | Male (p < 0.001)* | Female (p = 0.001)* |
|-----------------------------------|-------------------|---------------------|
|                                  | Unmet need        | Unmet need          |
|                                  | OR    | 95% CI    | OR    | 95% CI    |
| Working hours per week            |       |           |       |           |
| no work                           | 1.00  | 1.00      | 1.00  | 1.00      |
| < 40                              | 1.21  | 0.97      | 1.51  | 1.23      |
| 41–48                             | 1.29  | 0.98      | 1.68  | 1.26      |
| 49–60                             | 1.32  | 1.03      | 1.71  | 1.22      |
| > 60                              | 1.54  | 1.17      | 2.02  | 1.16      |
| Age                               |       |           |       |           |
| 20–29                             | 1.00  | 1.00      | 1.00  | 1.00      |
| 30–39                             | 1.24  | 0.94      | 1.64  | 1.04      |
| 40–49                             | 0.92  | 0.70      | 1.21  | 0.90      |
| 50–59                             | 1.00  | 0.76      | 1.31  | 0.99      |
| 60–65                             | 0.73  | 0.53      | 1.00  | 0.78      |
| 65+                               | 0.57  | 0.42      | 0.78  | 0.63      |
| Private insurance                 |       |           |       |           |
| No                                | 1.00  | 1.00      | 1.00  | 1.00      |
| Yes                               | 0.97  | 0.81      | 1.17  | 1.00      |
| Health insurance type             |       |           |       |           |
| NHI (local)                       | 1.00  | 1.00      | 1.00  | 1.00      |
| NHI (employee’s)                  | 0.90  | 0.78      | 1.04  | 0.86      |
| Medical aid                       | 1.33  | 0.86      | 2.06  | 1.16      |
| Household income                  |       |           |       |           |
| Low                               | 1.00  | 1.00      | 1.00  | 1.00      |
| low - moderate                    | 0.85  | 0.68      | 1.07  | 0.89      |
| Moderate - High                   | 0.89  | 0.70      | 1.12  | 0.81      |
| High                              | 0.76  | 0.59      | 0.97  | 0.79      |
| Region of residence               |       |           |       |           |
| Urban                             | 1.00  | 1.00      | 1.00  | 1.00      |
| Rural                             | 1.26  | 1.07      | 1.48  | 0.95      |
| Occupation type                   |       |           |       |           |
| Office                            | 1.00  | 1.00      | 1.00  | 1.00      |
| Labor                             | 0.93  | 0.78      | 1.10  | 0.84      |
| Service                           | 0.84  | 0.61      | 1.16  | 0.95      |
| Self-assessment of dental health  |       |           |       |           |
| Good                              | 1.00  | 1.00      | 1.00  | 1.00      |
| Moderate                          | 1.80  | 1.31      | 2.46  | 1.94      |
| Bad                               | 4.22  | 3.14      | 5.68  | 4.41      |
| Number of family members          |       |           |       |           |
| More than one                     | 1.00  | 1.00      | 1.00  | 1.00      |
| Alone                             | 1.21  | 0.93      | 1.58  | 1.11      |
| Level of education                |       |           |       |           |
| Middle school                     | 1.00  | 1.00      | 1.00  | 1.00      |

* These p-values represent the result of the Cochran-Armitage trend test for each subgroup.

No association between working hours and unmet dental needs was observed for females. The potential cause of this relationship in males is the early closing time of hospitals in South Korea. In other words, when a salaried worker visits the hospital after work (usually at 5 pm), there is little time for them to see the dentist.
Table 3 Association between work hours and unmet need by different factors

| Variable | Male | | Female | | |
|----------|-----|-----|--------|-----|-----|
| Drink    | Unmet need | OR | 95% CI | Unmet need | OR | 95% CI |
| No drink | 0 h  | 1.00 | | p = 0.011* | p = 0.066 |
|          | 1–40 h | 0.99 | 0.62 | 1.58 | 1.19 | 0.95 | 1.48 |
|          | 40–48 h | 1.32 | 0.70 | 2.50 | 1.06 | 0.72 | 1.58 |
|          | 48–60 h | 1.10 | 0.61 | 1.98 | 1.00 | 0.66 | 1.51 |
|          | ≥61 h  | 1.71 | 0.91 | 3.24 | 1.42 | 0.93 | 2.19 |
| Light drink | 0 h  | 1.00 | | p = 0.002 | p = 0.007 |
|          | 1–40 h | 1.15 | 0.82 | 1.62 | 1.27 | 1.05 | 1.54 |
|          | 40–48 h | 1.12 | 0.75 | 1.68 | 1.38 | 1.03 | 1.85 |
|          | 48–60 h | 1.23 | 0.84 | 1.80 | 1.44 | 1.07 | 1.93 |
|          | ≥61 h  | 1.56 | 1.02 | 2.39 | 1.11 | 0.78 | 1.56 |
| Heavy drink | 0 h  | 1.00 | | p = 0.001 | p = 0.204 |
|          | 1–40 h | 1.44 | 0.97 | 2.15 | 1.19 | 0.74 | 1.91 |
|          | 40–48 h | 1.61 | 1.01 | 2.57 | 1.43 | 0.73 | 2.81 |
|          | 48–60 h | 1.69 | 1.08 | 2.65 | 1.07 | 0.55 | 2.08 |
|          | ≥61 h  | 1.63 | 1.03 | 2.59 | 0.84 | 0.40 | 1.76 |
| Region of residence | | | | | | |
| Urban    | 0 h  | 1.00 | | p < 0.001 | p = 0.002 |
|          | 1–40 h | 1.16 | 0.90 | 1.51 | 1.20 | 1.02 | 1.40 |
|          | 40–48 h | 1.37 | 1.01 | 1.87 | 1.22 | 0.95 | 1.55 |
|          | 48–60 h | 1.53 | 1.14 | 2.04 | 1.31 | 1.01 | 1.70 |
|          | ≥61 h  | 1.60 | 1.17 | 2.18 | 1.12 | 0.83 | 1.51 |
| Rural    | 0 h  | 1.00 | | p = 0.114 | p = 0.215 |
|          | 1–40 h | 1.35 | 0.86 | 2.13 | 1.47 | 1.08 | 1.98 |
|          | 40–48 h | 1.00 | 0.57 | 1.74 | 1.54 | 0.95 | 2.50 |
|          | 48–60 h | 0.83 | 0.49 | 1.42 | 1.28 | 0.83 | 1.96 |
|          | ≥61 h  | 1.39 | 0.79 | 2.45 | 1.44 | 0.90 | 2.29 |
| Number of times brushing teeth per day | | | | | | |
| 0–1      | 0 h  | 1.00 | | p = 0.019 | p = 0.362 |
|          | 1–40 h | 1.41 | 0.89 | 2.23 | 1.01 | 0.64 | 1.59 |
|          | 40–48 h | 1.17 | 0.62 | 2.20 | 0.85 | 0.33 | 2.18 |
|          | 48–60 h | 1.20 | 0.67 | 2.16 | 0.78 | 0.36 | 1.68 |
|          | ≥61 h  | 1.67 | 0.93 | 3.00 | 1.37 | 0.65 | 2.89 |
| ≥2       | 0 h  | 1.00 | | p = 0.001 | p = 0.001 |
|          | 1–40 h | 1.18 | 0.91 | 1.52 | 1.26 | 1.09 | 1.46 |
|          | 40–48 h | 1.30 | 0.96 | 1.76 | 1.30 | 1.04 | 1.63 |
|          | 48–60 h | 1.37 | 1.03 | 1.83 | 1.30 | 1.03 | 1.63 |
|          | ≥61 h  | 1.56 | 1.14 | 2.13 | 1.15 | 0.88 | 1.50 |

* Bolded numbers represent the p-value of the Cochran-Armitage trend test for each subgroup.
dose–response relationship. Despite the proximity of hospitals in urban regions, urban residents’ lack of time might lead to greater unmet needs [15].

Interestingly, participants with a higher frequency of tooth brushing showed greater ORs and stronger relationship between working hours and unmet dental needs. This contradicts the commonsense notion that regular tooth brushing improves oral health [32]. However, in this study, more brushing might imply greater effort to improve health status, since all participants had experienced dental pain. These individuals might have higher expectations in their health, thus elevating their demand and strengthening the relationship between working hours and dental unmet need. Past studies support this idea, where privately insured people showed greater unmet needs [33].

In this study, lack of access and perceptual barriers for dental care were significant moderators of the relationship between working hours and unmet dental need. These results are consistent with previous papers demonstrating that a lack of time is a major reason for unmet needs [15, 33]. The negative relationship between working hours and unmet needs in those who had perceptual barriers for dental care can be explained by the subjectivity of unmet needs, which are highly personal [34]. Specifically, when an unmet need is not perceived as a need by the person—for instance, when individuals perceive working is more important than visiting the doctor—the actual demand will decrease, thus leading to the negative association between working hours and unmet needs. The fact that unmet needs are not solely the result of economic burden supports the idea that society itself must do more to improve overall healthcare quality than mere financial investment.

Our results have several policy implications. First, the association between working hours and unmet dental needs, and the fact that lack of access (including time) is a major reason for unmet, indicate the importance of time in health care. To ensure adequate health care access, policies should be put in place to reduce time-related barriers, such as extending sick-leave breaks or changing hospital hours. Region should also be considered in these policies. Previous studies in Canada and South Ethiopia evaluating differences along the rural–urban continuum have sought to utilize primary health care systems to reduce unmet needs [35, 36]. These former findings suggest feasible strategies for urban areas with long working hours. Lastly, this study is also likely to support the field of preventive dentistry by precluding unmet dental needs in advance.

This study has several limitations. First, cross-sectional data cannot infer any causal relationships. Therefore, caution is required in interpreting our results. Second, this study excluded relevant occupation-related variables: the sample was stratified according to working hours (including non-working group) but did not account for nightshift work or wage type due to collinearity. Further research should include these variables as confounders.

### Table 4 Association by different reasons of unmet need

| Variable             | Male Unmet need | Female Unmet need |
|----------------------|-----------------|------------------|
|                      | OR   | 95% CI     | OR   | 95% CI     |
| Lack of ability to pay |      |            |      |            |
| 0 h                  | 1.00 | < 0.001*   | 1.00 | < 0.001   |
| 1–40 h               | 1.08 | 0.74     | 1.58 | 1.08       |
| 40–48 h              | 1.26 | 0.80     | 1.98 | 1.08       |
| 48–60 h              | 0.89 | 0.57     | 1.37 | 0.69       |
| ≥61 h                | 1.26 | 0.81     | 1.97 | 0.84       |
| Lack of ability to reach |     |            |      |            |
| 0 h                  | 1.00 | < 0.001   | 1.00 | < 0.001   |
| 1–40 h               | 1.43 | 0.91     | 2.24 | 1.14       |
| 40–48 h              | 1.68 | 1.02     | 2.76 | 2.12       |
| 48–60 h              | 2.80 | 1.75     | 4.48 | 3.21       |
| ≥61 h                | 2.36 | 1.45     | 3.84 | 2.30       |
| Lack of ability to perceive |     |            |      |            |
| 0 h                  | 1.00 | 0.004     | 1.00 | < 0.001   |
| 1–40 h               | 0.70 | 0.48     | 1.03 | 0.81       |
| 40–48 h              | 0.53 | 0.34     | 0.83 | 0.45       |
| 48–60 h              | 0.40 | 0.26     | 0.62 | 0.43       |
| ≥61 h                | 0.35 | 0.22     | 0.56 | 0.54       |

* Bolded numbers represent the p-value of the Cochran-Armitage trend test for each subgroup.
Third, we did not include all possible oral health-related factors, such as history of dental diseases, oral health education and medication, because these specific variables were not included in KNHANES questionnaire. Lastly, our manipulation of the occupation variable might disturb the validity of the results; while it preserved 30% of the population, further studies are needed to prove its validity.

Nevertheless, this study endeavored to remain nationally representative by utilizing 6 years of longitudinal data and a large sample. In addition, the sample contained non-workers and all had experience of dental pain, meaning that the population was refined. Furthermore, plausible mechanisms for obscure issues were demonstrated by taking advantage of up-to-date evidence.

Conclusion

Only male subjects showed significant dose-response relationships between working hours and unmet dental needs. In addition, increased consumption of alcohol, residing in urban areas, brushing teeth at least twice a day, and lacking access and perception of the need for dental care significantly moderated the relationships between working hours and unmet dental needs. Future research controlling for other occupation variables would further solidify our results and offer more practical implications for workplaces in South Korea.

Abbreviations

CI: Confidence Interval; h, hr.: hour; KNHANES: Korea National Health and Nutrition Examination Survey; NHI: National Health Insurance; OECD: Organization for Economic Co-operation and Development; OR: Odds Ratio; USA: United States of America

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Authors’ contributions

YTK, SWL, and JYK contributed to the research design, data analysis, and interpretation of data. YTK, SWL, SJ, and JYK carried out the interpretation of data. ECP reviewed the article. YTK and SWL wrote the article. All authors have read and approved the manuscript.

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Availability of data and materials

KNHANES V and VI data can be accessed from the KNHANES homepage (URL: https://knhanes.cdc.go.kr/knhanes/eng/index.do).

Ethics approval and consent to participate

KNHANES is openly published. Thus, ethical approval was not required for this study. This study did not require informed consent from the participants, as their information was fully anonymized and unidentified prior to analysis. KNHANES data was approved by the Institutional Review Board of the Korean Centers for Disease Control and Prevention (IRB No. 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, 2013-07CON-03-4C, 2013-12EXP-03-5C).

Consent for publication

Not applicable.

Competing interests

The authors report no conflicts of interest in this work.

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