The impact of smoking cessation attempts on stress levels

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Abstract

Background: Cigarette smoking is a major health risk, particularly in male South Koreans. Smoking cessation can benefit health; however, the process of quitting smoking is difficult to some smokers and shows its relationship to their stress level. The hypothesis of this study is that who has failed attempts to stop smoking induce more stress than habitual smoking.

Methods: To test this, the analysis on the association between smoking cessation attempts and stress levels in smokers was performed. The Korean Community Health Survey (2011–2016) data with the total of 488,417 participants’ data were used for this study. Survey data were analyzed using the chi-square test and logistic regression. As the dependent variable, self-reported level of stress was selected.

Results: Of the subject population, 78.3% (63.3% males, 81.4% females) felt stressed. Among participants who successfully stopped smoking, 73.0% (72.6% males, 78.1% females) reported feeling stressed. In contrast, of those who failed to stop smoking, 83.3% (83.6% males, 86.3% females) reported high stress levels. Among those who did not attempt smoking cessation, 81.1% (81.2% males, 80.3% females) responded that they experienced stress. Those who failed to stop smoking had higher odds of stress than those who did not attempt smoking cessation [odds ratio (OR) 1.11, 95% confidence interval (CI) 1.09–1.14, p < 0.001]. Those who successfully stopped smoking had lower odds of stress than those who did not attempt smoking cessation (OR 0.87, 95% CI 0.86–0.89, p < 0.001).

Conclusion: The study found an association between unsuccessful smoking cessation and stress level. As the result, people who failed smoking cessation showed higher stress. These data should be considered in health policy recommendations for smokers.

Keywords: Smoking cessation attempt, Stress, Smoking cessation failure, Health policy

Background

Cigarette smoking is a well-characterized underlying cause of cardiovascular and respiratory diseases, neoplasias, and depression [1–3]. Cessation of smoking is therefore recommended and is associated with many advantages. The risk of both smoking-related cancer, such as lung cancer, and other cancers was reduced by about 18–45% in one study that followed the health outcomes of former smokers [4]. Smoking cessation also reduced symptoms of depression and anxiety, while improving the overall quality of life for former smokers [5, 6].

In South Korea, 18.4% of adults smoked daily in 2015, which was slightly lower than the Organization for Economic Co-operation and Development (OECD) average of 18.5% [7]. Smoking rates were 40.7% among males and 6.4% among females in 2016. The male smoking rates have steadily declined from 66.3% in 1998 to 40.7% in 2016. In females, the smoking rates from 1998 to 2016 seemed consistent around 6.4% even though there was a point when it declined to 5.7% in 2014 [8]. The percentage of people who successfully quit smoking was 45.5%, with people who were older, married, or having high incomes demonstrating a better success rate for smoking cessation [9, 10].
The investigations conducted for years regarding the association between socioeconomic factors and smoking [11, 12] show that the prevalence of smoking is higher in low socioeconomic status [12, 13]. The relationship between smoking cessation and socioeconomic group, due to the supportive environment and motivation, they have advantages to succeeding in cessation [14]. Previous study discovered that where there was a less supportive environment for those with low socioeconomic status, they may experience difficulty in quitting [15–17]. As per motivation, the motivation to quit smoking is essential in the process of smoking cessation [14, 18]. The study [19] reported that those who were in low socioeconomic status groups showed low commitment or awareness of smoking cessation [19]. For example, the Hiscock, Judge, and Bauld [20] study highlighted that disadvantages of low socioeconomic level led to low successful cessation. Also, previous study discussed the results of quitting smoking and its correlation with occupational status [21].

Many studies have indicated that stress levels are a barrier for smoking cessation [9, 22] and that people with lower levels of stress have a better chance at successful cessation [9]. Some studies have reported that stress levels are associated with nicotine dependency rather than the smoking frequency, such that people who get stressed cannot easily quit smoking [23, 24]. Because perceived stress compounded with smoking greatly increases cardiovascular and hypothalamic-pituitary-adrenal measures like heart rate and blood pressure, cessation of smoking is critical for good health, despite stress-induced challenges [1].

There was previous research that investigated the mental health between people who had relapsed after quitting smoking and those who had entirely abstained. People who had relapsed displayed starkly increased anxiety when compared to those who had abstained [25]. However, despite the well-known impact of smoking on stress levels, it is hard to find studies investigating the association between stress levels and smoking cessation failure.

Stress is strongly related to smoking cessation and smoking relapse [26–28]. Smoking cessation can reduce stress, but before successful smoking cessation, it can contribute to stress to patients who are unsuccessful at quitting smoking. Cohen and Lichtenstein investigated the changes in stress levels in accordance with the status of smoking. The study reported that people who did not succeed in smoking cessation maintained the higher level of stress [27]. Also, the research conducted by Parrott discussed the reduced stress level after succeeding in smoking cessation. At this point, there is no adverse effect caused by acute nicotine depletion [28].

This study hypothesized that the stress associated with the experience of attempted smoking cessation could be detrimental; therefore, analysis of the association between attempted smoking cessation and stress levels was conducted.

**Methods**

This study has used data from the Korean Community Health Survey (CHS) between 2011 and 2016, which is a national survey conducted by the Korean Centers for Disease Control and Prevention. The survey aims to establish a community health care plan, assess the viability of the plan, and produce comparable community health statistics. As representative data of the Korean population, trained surveyors conducted the survey in the computer-assisted personal interviewing method. A total of 253 households was chosen after multistage, stratified, and random selection of the local Korean communities by the resident registration. Each local community included around 900 participants. CHS survey included 229,226 people in 2011; 228,921 people in 2012; 228,781 people in 2013; 228,712 people in 2014; 228,558 people in 2015; and 228,452 people in 2016. CHS data are the secondary data available for public research.

Of the 1,372,650 subjects in the dataset (males: 618,051; females: 754,599), our study has included 506,396 people who were smokers (males: 465,177; females: 41,219) from 2011 to 2016. Of those, 488,417 subjects were included in the data analysis (males: 448,976; females: 39,441) and 17,979 subjects were excluded because of missing variables.

The variable of interest, that is smoking cessation is formed by the combination of two questions “Are you a current smoker?” and “Have you ever tried to quit smoking more than 24 hours?”. These questions express the smoking cessation attempt and its outcome. The variable is categorized into three groups: succeed (past-smoker and succeeded in cessation), failed (current-smoker and failed in cessation), and did not attempt (current-smoker and didn’t attempt smoking cessation).

The dependent variable was the stress levels, i.e., the existence of self-reported stress. The CHS inquiry regarding stress levels was “How much stress do you feel in your daily life?” and the response was multiple choice-based with 4 answers which are “I feel very much”, “I feel a lot”, “I feel a little bit” and “I hardly feel it”. The response was transformed into a binary response (High: I feel very much, I feel a lot, I feel a little bit; Low: I hardly feel it).

The independent variables included age, gender, family income, family members, marital status, education level, job, alcohol use, self-reported health, underlying chronic disease, and survey year.

Age was used as a categorized variable (6 groups: less than 20 years of age; 20 to 30 years of age; 30 to 40 years of age; 40 to 50 years of age; 50 to 60 years of age; and
over 60 years of age). Family income variable was categorized into four groups (low: under 1,000,000 South Korean won/month; low-intermediate: 1,000,000-3,000,000 South Korean won/month; upper-intermediate: 3,000,000-5,000,000 South Korean won/month; high: over 5,000,000 South Korean won/month). The marital status variable was divided into three groups (marriage with cohabitation; single; else: other types of marriage). The education level variable was also categorized into four groups (under graduation from elementary school; dropout or graduation from middle school; dropout or graduation from high school; dropout or graduation from university or more). The job variable was categorized into three groups (office worker; site worker; unemployed or homemaker). The alcohol use variable was categorized into two groups (Yes: have drunk alcohol in the recent year; No: have not drunk alcohol in the recent year). The self-reported health status was divided into two categories (good; bad). The underlying chronic disease variable was determined based on whether the subject had experienced hypertension, diabetes, dyslipidemia, and arthritis diagnosed by doctors or not.

The data analysis was performed using multi logistic regression and chi-square tests. The analysis was performed on the fully adjusted model. Data analysis was performed with all subjects and then stratified by sex. The additional analyses were conducted on further levels of stress: high, mid, and low by sex (Additional file 1). Also, the sensitivity analysis on different level of stress was performed (Additional file 2). Subgroup analysis was done using stratification such variables as family income, family members, age, and marital status. Results were considered significant if \( p \)-value <.05. SAS 9.2 (SAS Institute Inc., Cary, NC) was used for data analysis.

**Results**

Table 1 displays stress levels by independent variables and sex. Of the eligible respondents, 78.3% (63.3% of males and 81.4% of females) respond that they felt stressed daily. Of those who succeed in smoking cessation, 73.0% (72.6% of males and 78.1% of females) respond that they have experienced stress, while 83.8% of people who have failed in smoking cessation, (83.6% of male and 86.3% of female) respond that they have experienced stress. People who have used alcohol in the past year and have had higher education levels report that they have experienced stress. (Table 1).

Table 2 shows the adjusted stress odds ratio of independent variables by sex. People who have succeed in smoking cessation decrease odds of stress compared to those who have even not tried to stop smoking [odds ratio (OR) 0.87, 95% confidence interval (CI) 0.86–0.89, \( p < 0.001 \)]. When stratified by sex, both males (OR 0.88, 95% CI 0.86–0.90, \( p < 0.001 \)) and females (OR 0.80, 95% CI 0.75–0.86, \( p < 0.001 \)) continue to show significance.

(Table 2) People who have failed in smoking cessation increase odds of stress compared to those who have even not tried to stop smoking (OR 1.11, 95% CI 1.09–1.14, \( p < 0.001 \)). When they were stratified by sex, this significance remained for both males (OR 1.10, 95% CI 1.08–1.13, \( p < 0.001 \)), and for females (OR 1.18, 95% CI 1.09–1.27, \( p < 0.001 \)). Based on the adjusted variables’ results, people who have self-reported that their health are bad have higher odds for stress compared to those who have self-reported that their health are good (OR 1.84, 95% CI 1.81–1.88, \( p < 0.001 \)). The highest family income group has significantly lower odds for stress compared to the lowest family income group (OR 0.91, 95% CI 0.89–0.94, \( p < 0.001 \)). When comparing with the number of household members, the group with more than 4 family members shows the highest odds for high stress levels. The odds ratio for stress is 0.94 (95% CI 0.91–0.95, \( p < 0.001 \) for the group whose number of family members is 2), 1.18 (95% CI 1.14–1.22, \( p < 0.001 \) for the group whose number of family members is 3), 1.25 (95% CI 1.20–1.29, \( p < 0.001 \) for the group whose number of family members is 4), compared to the group whose family number is 1. Based on these results, people who have underlying chronic disease have higher odds for stress than people who have not self-reported chronic disease (OR 1.07, 95% CI 1.05–1.08, \( p < 0.001 \)). People who are current drinkers also have higher odds for stress than people who are not (OR 1.15, 95% CI 1.13–1.17, \( p < 0.001 \)). The result of adjusted analysis on the stress level among those people who have attempted smoking cessation shows that when men have failed the cessation, the odds ratio of stress level is at 1.79 (95% CI 1.72–1.86, \( p < 0.001 \)) and it is at 1.66 (95% CI 1.52–1.81, \( p < 0.001 \)) in women (Additional file 3).

Figure 1 displays the logistic regression results for associated stress in those who have attempted to quit smoking compared to those who have failed in smoking cessation after adjustment for all variables. When stratified by marital status, in the ‘else’ group, people who have failed in smoking cessation have significantly higher odds of stress than people who have even not attempted to stop smoking (for both sexes: OR 1.21, 95% CI 1.14–1.28, \( p < 0.001 \); males: OR 1.19, 95% CI 1.11–1.28, \( p < 0.001 \); females: OR 1.25, 95% CI 1.13–1.38, \( p < 0.001 \). (Fig. 1).

When stratified by the number of family members, the odds of stress in those who have failed in smoking cessation is significantly higher in the ‘living alone’ group (for both sexes: OR 1.18, 95% CI 1.19, \( p < 0.001 \); males: OR 1.19, 95% CI 1.11–1.27, \( p < 0.001 \); females: OR 1.20, 95%
|                                                                 | Total                   | Male                   | Female                  |
|-----------------------------------------------------------------|-------------------------|------------------------|-------------------------|
| **Smoking cessation**                                           |                         |                        |                         |
| Succeed                                                        | 226,030 46.3 73.0 27.0 <0.001 | 208,903 46.5 72.6 27.4 <0.001 | 17,127 43.4 78.1 21.9 <0.001 |
| Failed                                                          | 175,039 35.8 83.8 16.2 | 161,413 36.0 83.6 16.4 | 13,626 34.6 86.3 13.7 |
| Did not attempt                                                 | 87,348 17.9 81.1 18.9 | 78,660 17.5 81.2 18.8 | 8,688 22.0 80.3 19.8 |
| **Age**                                                        |                         |                        |                         |
| ~20                                                             | 2269 0.5 809 19.1 <0.001 | 1965 0.4 791 20.9 <0.001 | 304 0.8 924 7.6 <0.001 |
| 20 ~ 30                                                         | 35,201 7.2 868 13.2 | 30,728 6.8 85.9 14.1 | 4,473 11.3 92.4 7.6 |
| 30 ~ 40                                                         | 76,086 15.6 911 8.9 | 69,099 15.4 91.0 9.0 | 7,987 17.7 91.9 8.1 |
| 40 ~ 50                                                         | 102,336 21.0 885 11.5 | 95,655 21.3 88.5 11.5 | 6,681 16.9 87.9 12.1 |
| 50 ~ 60                                                         | 104,658 21.4 804 19.6 | 98,092 21.9 80.1 19.9 | 6,566 16.7 84.2 15.8 |
| 60 ~                                                            | 167,867 34.4 633 36.7 | 153,437 34.2 62.8 37.2 | 14,430 36.6 68.5 31.6 |
| **Sex**                                                        |                         |                        |                         |
| Male                                                            | 448,976 91.9 78.1 22.0 <0.001 |                       |                         |
| Female                                                          | 39,441 8.1 81.4 18.6 |                         |                         |
| **Family income**                                               |                         |                        |                         |
| High                                                            | 125,653 25.7 81.6 18.4 <0.001 | 119,466 26.6 81.5 18.5 <0.001 | 6,187 15.7 83.0 17.1 <0.001 |
| Upper-intermediate                                              | 119,326 24.4 83.9 16.2 | 111,949 24.9 83.8 16.3 | 7,377 18.7 85.4 14.7 |
| Low-intermediate                                                | 162,073 33.2 77.5 22.5 | 147,703 32.9 76.8 23.2 | 14,370 36.4 85.1 14.9 |
| Low                                                             | 81,365 16.7 668 33.2 | 69,858 15.6 65.7 34.3 | 11,507 29.2 73.5 26.5 |
| **Family number**                                               |                         |                        |                         |
| 1                                                               | 48,956 10.0 75.8 24.2 <0.001 | 38,300 8.5 76.2 23.8 <0.001 | 10,656 27.0 74.2 25.8 <0.001 |
| 2                                                               | 174,336 35.7 700 30.0 | 162,257 36.1 691 30.9 | 12,079 30.6 82.5 17.5 |
| 3                                                               | 103,766 21.3 822 17.8 | 96,017 21.4 82.0 18.0 | 7,749 19.7 85.1 14.9 |
| 4 and more                                                      | 161,359 33.0 856 14.4 | 152,402 33.9 85.6 14.4 | 8,957 22.7 85.4 14.6 |
| **Marital status**                                              |                         |                        |                         |
| Cohabitating marriage                                           | 363,908 74.5 775 22.5 <0.001 | 346,873 77.3 771 22.9 <0.001 | 17,035 43.2 86.2 13.8 <0.001 |
| Other types of marriage                                         | 55,057 11.3 739 26.1 | 38,742 8.6 74.3 25.7 | 16,315 41.4 72.9 27.1 |
| Single                                                          | 69,452 14.2 860 14.0 | 63,361 14.1 85.5 14.5 | 6,091 15.4 91.0 9.0 |
| **Education level**                                             |                         |                        |                         |
| University or more                                              | 167,768 34.4 853 14.8 <0.001 | 160,001 35.6 85.1 14.9 <0.001 | 7,767 19.7 89.0 11.0 <0.001 |
| High school                                                     | 167,016 34.2 813 18.7 | 153,622 34.2 80.7 19.4 | 13,394 34.0 88.8 11.2 |
| Middle school                                                   | 61,343 12.6 720 28.0 | 57,169 12.7 71.1 28.9 | 4,174 10.6 84.3 15.7 |
| Under Elementary school                                         | 92,290 18.9 645 35.5 | 78,184 17.4 636 36.4 | 14,106 35.8 69.5 30.6 |
| **Job**                                                         |                         |                        |                         |
| Office worker                                                   | 99,546 20.4 885 11.6 <0.001 | 95,257 21.2 88.3 11.7 <0.001 | 4,289 10.9 91.4 8.6 <0.001 |
| Site worker                                                     | 272,149 55.7 792 20.8 | 257,838 57.4 78.8 21.2 | 14,311 36.3 85.9 14.1 |
| Unemployed or homemaker                                         | 116,722 23.9 676 32.4 | 95,881 21.4 65.7 34.3 | 20,841 52.8 76.3 23.7 |
| **Alcohol use**                                                 |                         |                        |                         |
| Yes                                                             | 389,832 79.8 806 19.5 <0.001 | 363,894 81.1 80.2 19.8 <0.001 | 25,938 65.8 85.3 14.7 <0.001 |
| No                                                              | 98,585 20.2 695 30.5 | 85,082 19.0 68.8 31.2 | 13,503 34.2 73.9 26.1 |
Table 1 Association of stress, demographics, and clinical characteristics compared by sex (unit: individual, %) (Continued)

|                          | Total  | Male                  | Female                 |
|--------------------------|--------|-----------------------|------------------------|
|                          | Total  | Yes | No | p-value | Total  | High | Low | p-value | Total  | High | Low | p-value |
|                          | N    | %  | %  | %       | N    | %   | %  | %       | N    | %   | %  | %       |
| Self-reported health condition |          |      |    |        |      |    |    |        |      |    |    |        |
| Good                     | 393,605 | 80.6 | 78.7 | 21.3 | < 0.001 | 367,593 | 81.9 | 78.5 | 21.5 | < 0.001 | 26,012 | 66.0 | 81.9 | 18.1 | < 0.001 |
| Bad                      | 94,812  | 19.4 | 76.7 | 23.3 |          | 81,383  | 18.1 | 76.1 | 23.9 |          | 13,429 | 34.1 | 80.4 | 19.6 |          |
| Underlying Chronic Disease |          |      |    |        |      |    |    |        |      |    |    |        |
| Yes                      | 184,916 | 37.9 | 73.4 | 26.6 | < 0.001 | 168,407 | 37.5 | 73.2 | 26.8 | < 0.001 | 16,509 | 41.9 | 76.1 | 23.9 | < 0.001 |
| No                       | 303,501 | 62.1 | 81.3 | 18.7 |          | 280,569 | 62.5 | 81.0 | 19.0 |          | 22,932 | 58.1 | 85.3 | 14.7 |          |
| Survey year              |          |      |    |        |      |    |    |        |      |    |    |        |
| 2011                     | 78,725  | 16.1 | 79.3 | 20.7 | < 0.001 | 72,530  | 16.2 | 79.1 | 20.9 | < 0.001 | 6195   | 15.7 | 82.0 | 18.0 | 0.211  |
| 2012                     | 79,762  | 16.3 | 79.3 | 20.7 |          | 73,486  | 16.4 | 79.1 | 20.9 |          | 6276   | 15.9 | 82.1 | 17.9 |          |
| 2013                     | 81,503  | 16.7 | 78.5 | 21.6 |          | 74,908  | 16.7 | 78.3 | 21.7 |          | 6595   | 16.7 | 80.6 | 19.4 |          |
| 2014                     | 82,859  | 17.0 | 78.1 | 21.9 |          | 76,278  | 17.0 | 77.8 | 22.2 |          | 6581   | 16.7 | 81.3 | 18.7 |          |
| 2015                     | 82,275  | 16.9 | 77.8 | 22.2 |          | 75,486  | 16.8 | 77.5 | 22.5 |          | 6789   | 17.2 | 81.1 | 18.9 |          |
| 2016                     | 83,293  | 17.1 | 77.1 | 22.9 |          | 76,288  | 17.0 | 76.7 | 23.3 |          | 7005   | 17.8 | 81.6 | 18.4 |          |
| Total                    | 488,417 | 100.0 | 78.3 | 21.7 |          | 448,976 | 100.0 | 78.1 | 22.0 |          | 39,441 | 100.0 | 81.4 | 18.6 |          |
CI 1.05–1.36, p = 0.007), and the odds of stress for people who have succeed in smoking cessation is significantly lower in the 'living alone' group (for both sexes: OR 0.87, 95% CI 0.82–0.92, p < 0.001; for males: OR 0.91, 95% CI 0.85–0.97, p = 0.005; for females: OR 0.75, 95% CI 0.67–0.84, p < 0.001).

**Table 2** Adjusted binary logistic regressions to examine the association between stress, demographics and clinical characteristics compare by sex

| Variable                  | Total          | Male          | Female         |
|---------------------------|----------------|---------------|----------------|
| Smoking cessation         |                |               |                |
| Succeed                   | 0.87 (0.86–0.89, < 0.001) | 0.88 (0.86–0.90, < 0.001) | 0.80 (0.75–0.86, < 0.001) |
| Failed                    | 1.11 (1.09–1.14, < 0.001) | 1.10 (1.08–1.13, < 0.001) | 1.18 (1.09–1.27, < 0.001) |
| Did not attempt           | 1.00           | 1.00          | 1.00           |
| Age                       |                |               |                |
| ~ 20                      | 1.00           | 1.00          | 1.00           |
| 20–30                     | 1.37 (1.23–1.53, < 0.001) | 1.42 (1.26–1.59, < 0.001) | 0.99 (0.64–1.55, 0.975) |
| 30–40                     | 1.74 (1.55–1.94, < 0.001) | 1.86 (1.66–2.09, < 0.001) | 0.96 (0.62–1.50, 0.869) |
| 40–50                     | 1.27 (1.13–1.41, < 0.001) | 1.37 (1.22–1.54, < 0.001) | 0.58 (0.37–0.90, 0.015) |
| 50–60                     | 0.75 (0.67–0.84, < 0.001) | 0.80 (0.71–0.90, < 0.001) | 0.44 (0.28–0.69, < 0.001) |
| 60~                       | 0.40 (0.36–0.45, < 0.001) | 0.43 (0.38–0.48, < 0.001) | 0.23 (0.15–0.37, < 0.001) |
| Family income             |                |               |                |
| High                      | 0.91 (0.89–0.94, < 0.001) | 0.93 (0.91–0.96, < 0.001) | 0.70 (0.63–0.78, < 0.001) |
| Upper-intermediate        | 1.01 (0.98–1.04, 0.556) | 1.03 (1.00–1.06, 0.033) | 0.76 (0.69–0.84, < 0.001) |
| Low-intermediate          | 1.02 (1.00–1.05, 0.041) | 1.03 (1.01–1.06, 0.007) | 0.92 (0.85–1.00, 0.041) |
| Family number             |                |               |                |
| 1                         | 1.00           | 1.00          | 1.00           |
| 2                         | 0.94 (0.91–0.95, < 0.001) | 0.92 (0.89–0.95, < 0.001) | 1.23 (1.13–1.33, < 0.001) |
| 3                         | 1.18 (1.14–1.22, < 0.001) | 1.17 (1.13–1.22, < 0.001) | 1.38 (1.26–1.52, < 0.001) |
| 4 and more                | 1.25 (1.20–1.29, < 0.001) | 1.24 (1.19–1.29, < 0.001) | 1.42 (1.29–1.57, < 0.001) |
| Marital status            |                |               |                |
| Cohabiting marriage       | 1.19 (1.15–1.23, < 0.001) | 1.19 (1.15–1.23, < 0.001) | 1.06 (0.94–1.20, 0.327) |
| Other types of marriage   | 1.14 (1.10–1.19, < 0.001) | 1.21 (1.16–1.26, < 0.001) | 0.79 (0.70–0.90, < 0.001) |
| Single                    | 1.00           | 1.00          | 1.00           |
| Education level           |                |               |                |
| University or more        | 1.00           | 1.00          | 1.00           |
| High school               | 1.00 (0.98–1.02, 0.8395) | 0.99 (0.97–1.02, 0.529) | 1.10 (0.99–1.21, 0.071) |
| Middle school             | 0.94 (0.92–0.97, < 0.001) | 0.93 (0.91–0.96, < 0.001) | 1.10 (0.97–1.26, 0.148) |
| Under Elementary school   | 0.79 (0.77–0.81, < 0.001) | 0.80 (0.78–0.82, < 0.001) | 0.72 (0.64–0.82, < 0.001) |
| Job                       |                |               |                |
| Office worker             | 1.90 (1.85–1.96, < 0.001) | 1.89 (1.84–1.95, < 0.001) | 1.69 (1.49–1.92, < 0.001) |
| Site worker               | 1.39 (1.37–1.42, < 0.001) | 1.38 (1.36–1.41, < 0.001) | 1.48 (1.39–1.58, < 0.001) |
| Unemployed or homemaker   | 1.00           | 1.00          | 1.00           |
| Alcohol use               |                |               |                |
| Yes                       | 1.15 (1.13–1.17, < 0.001) | 1.15 (1.13–1.17, < 0.001) | 1.17 (1.10–1.24, < 0.001) |
| No                        | 1.00           | 1.00          | 1.00           |
| Self-reported health condition |            |               |                |
| Good                      | 1.00           | 1.00          | 1.00           |
| Bad                       | 1.84 (1.81–1.88, < 0.001) | 1.81 (1.78–1.85, < 0.001) | 2.12 (1.99–2.26, < 0.001) |
| Underlying Chronic Disease|                |               |                |
| Yes                       | 1.07 (1.05–1.08, < 0.001) | 1.06 (1.04–1.08, < 0.001) | 1.17 (1.10–1.25, < 0.001) |
| No                        | 1.00           | 1.00          | 1.00           |
| Survey year               |                |               |                |
| 2011                      | 1.00           | 1.00          | 1.00           |
| 2012                      | 1.02 (1.00–1.05, 0.101) | 1.02 (1.00–1.05, 0.083) | 1.00 (0.90–1.10, 0.933) |
| 2013                      | 1.00 (0.98–1.03, 0.8472) | 1.01 (0.98–1.04, 0.493) | 0.91 (0.83–1.01, 0.062) |
| 2014                      | 0.94 (0.92–0.97, < 0.001) | 0.95 (0.92–0.97, < 0.001) | 0.86 (0.78–0.95, 0.002) |
| 2015                      | 0.97 (0.94–0.99, 0.0112) | 0.98 (0.95–1.00, 0.083) | 0.85 (0.78–0.94, < 0.001) |
| 2016                      | 0.94 (0.92–0.97, < 0.001) | 0.95 (0.92–0.97, < 0.001) | 0.87 (0.79–0.96, 0.005) |
Discussion
The study analyzed the association between smoking cessation experience and stress. The prevalence of stress in people who have failed to stop smoking was 1.11-fold higher than in those who have even not tried to stop smoking. Prevalence of stress in people who have successfully stopped smoking was 0.87-fold lower than in those who have even not tried to stop smoking. This association was stronger in females than in males. It might be one reason why the two genders had variable smoking cessation success rates. Variables such as income, family member number, and marital status were stratified for analyses. The result represented the trend that people who have failed to stop smoking had a higher risk of stress in most of the strata, especially among males. The results showed that smoking cessation reduced stress when they have succeeded. Smoking cessation can be harmful and elicit stress if the attempt fails.

There are many studies reporting results that are consistent with this study pertaining to the results about lower stress levels in the group that successfully quit smoking. Previous studies support the data that there is significant change in stress levels after and during smoking cessation. Pawalina et al. analyzed stress levels during smoking cessation treatment and found that the percentage of people who felt stress decreased from 62.68% before the start of program to 51.41% after the program [29]. There was a decrease in mean stress levels in the smoking cessation group (4.4 points, 95% CI 4.1–4.8) compared to the current-smoker group (5.2 points, 95% CI 4.9–5.6) in a study by Hajek et al. [30]. However, it was hard to find data about stress levels in the smoking-relapsed group in published reports.

Assessment of stress levels is important for those who have a smoking cessation plan. Incorporating a stress-coping skills program increase the success rates of smoking cessation (smoking cessation rate: 44% in the stress-coping skills program group; 27.5% in the control group) [31]. The stress is thought to be associated with nicotine dependency [23, 24], and nicotine dependency is related to higher rates of relapse and lower rates of smoking cessation [32]. Additionally, perceived stress determines smoking behavior [24]. For these reasons, increased stress levels for smoking cessation failure in our study have to be accounted for.

There are many factors that influence the perceived stress of smokers. Our results show that smoking cessation failure could impact the perceived stress of smokers. Skov-Ettrup et al. reported that people who had previously attempted to quit smoking got more stressed when they had stopped smoking [33]. People who have relapsed from attempted smoking cessation might therefore need more effort to quit smoking.

These stresses can impinge upon smoking addiction [34]. There are five stages of change during smoking cessation: pre-contemplation, contemplation, preparation, action, and maintenance [35]. Stress can impact the action and maintenance stages and result in relapse to cigarette smoking. This relationship between stress and smoking may be a result of the impact of stress on hypothalamic-pituitary-adrenal axis function and the autonomic nervous system [34].

Besides stress, many mental health problems are related to smoking [6]. Adults with serious psychological distress are likely to be smokers and to smoke heavily [36]. Smokers with any mental illness have lower self-reported
quit rates and higher current- and lifetime-smoking rates compared to those without any mental illness [37]. However, depression is not associated with smoking cessation failure [38]. These mental health problems are usually rectified upon smoking cessation. Taylor et al. conducted a systematic review and reported the association between smoking cessation and mental health [5]. There were 4 studies about anxiety, 10 studies about depression, 5 studies about mixed anxiety and depression, 8 studies about the psychological quality of life, and 3 studies about stress after smoking cessation [5]. Regarding studied mental health elements, quitting smoking led to lowering the risk of mental health issues significantly [5]. Future studies will include these additional mental health parameters as variables for smoking cessation studies because no data on their association is currently available.

There are some limitations in this study. First, the study was based on the cross-sectional data that there was no causal relationship between smoking cessation and stress level and data that were collected at one point in time. Second, the period after the smoking cessation experience was not included in the analysis. Furthermore, data on the duration of smoking cessation attempts was lacking. Importantly, there were no standards measurement such as duration regarding smoking cessation. Therefore, the categorization of smoking cessation was placed into three categories for those attempting smoking cessation, and those completely succeeding in smoking cessation. Additionally, all data are computed based on self-reported variables and unconscious biases could be introduced. Thirdly, smoking cessation methods were not included in our analysis. Different cessation methods could lead to variable outcomes. Indeed, higher levels of behavioral counseling sessions resulted in higher rates of smoking cessation, but nicotine replacement therapy did not [39]. Individualized treatment also resulted in successful cessation [17].

**Conclusion**
The study compares people who have succeeded in smoking cessation, have failed in smoking cessation, and have never attempted smoking cessation. The results show that people who have failed in quitting smoking experience more stress. Our study focuses on not only smoking cessation experience, but also the outcome of smoking cessation. Several reports have demonstrated that stress in smokers is associated with lower rates of smoking cessation and increased rates of cardiovascular and other diseases. Health policy and smoking cessation treatments should therefore be customized based on an individual’s past attempts to quit smoking to improve the success of cessation and associated health outcomes for former smokers.

**Additional files**

**Additional file 1:** Appendix 1a Adjusted logistic regression to examine the association between stress levels (male). Appendix 1b Adjusted logistic regression to examine the association between stress levels (female). (DOCX 24 kb)

**Additional file 2:** Appendix 2 Binary logistic regression on stress: high level compare to mid-and low level. (DOCX 16 kb)

**Additional file 3:** Appendix 3 Comparison of the result of smoking cessation and stress level. (DOCX 15 kb)

**Abbreviations**
CHS: Community Health Survey; OR: Odds ratio

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**Availability of data and materials**
Data and materials are opened for public research by Korea Centers for Disease Control and Prevention. https://chs.cdc.go.kr/

**Authors’ contributions**
S.J.K, W.J.C, and S.I.J. designed the research and developed the overall research plan. S.J.K, W.J.C, W.H.P, and M.H.P. analyzed the data and wrote the manuscript. E.C.P and S.I.J. provided intellectual input for the manuscript. S.I.J supervised the study. All members read and approved the final manuscript for quality assurance of the study.

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Not applicable.

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