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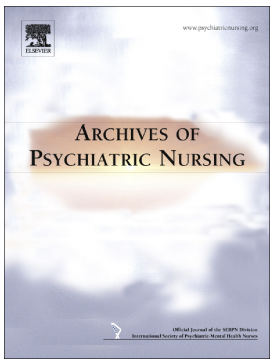

The effects of hardcore smokers' depression and self-esteem on daily smoking amount

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PII: S0883-9417(19)30481-9

DOI: https://doi.org/10.1016/j.apnu.2020.02.006

Reference: YAPNU 51245

To appear in: *Archives of Psychiatric Nursing*

Received date: 3 December 2019

Revised date: 26 January 2020

Accepted date: 8 February 2020

Please cite this article as: J.-W. Han and H. Lee, The effects of hardcore smokers' depression and self-esteem on daily smoking amount, *Archives of Psychiatric Nursing*(2020), https://doi.org/10.1016/j.apnu.2020.02.006

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Title: The Effects of Hardcore Smokers' Depression and Self-Esteem on Daily Smoking Amount

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Conflicts of interest

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The authors have no competing interests to declare.

Ethical consideration

Receiving deliberative process exemption (1040271-201910-HR-034) from the IRB institution of C University.

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TITLE OF THE PAPER

The Effects of Hardcore Smokers' Depression and Self-Esteem on Daily Smoking Amount

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The Effects of Hardcore Smokers' Depression and Self-Esteem on Daily Smoking Amount

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Abstract

Background: This is a secondary data analysis designed as a longitudinal study aimed at investigating the effects of depression and self-esteem on daily smoking amounts among hardcore smokers over time.

Methods: The subjects of this study were 264 hardcore smokers aged 19 years or older who participated in all waves of the 9^{th}–13^{th} Korea Welfare Panel Studies. Self-report questionnaires were used to collect data. Data analyses were performed using SPSS WIN 24.0 and AMOS 18.0, and data were analyzed using a latent growth model.

Results: The intercept of depression and self-esteem among the subjects had statistically significant effects on the intercept of the daily smoking amount. The slope of depression and self-esteem among the subjects also had statistically significant effects on the slope of the daily smoking amount. The slope of depression indirect affected the slope of daily smoking amount via the level of self-esteem.

Conclusion: It is important to determine the initial levels and the rates of change of depression, self-esteem, and daily smoking amount among hardcore smokers. In order to reduce the daily smoking amount among hardcore smokers, interventions for depression and methods to improve self-esteem among hardcore smokers should be considered.

Keywords: depression, longitudinal studies, self-esteem, smoking

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Introduction

The smoking rate among adults aged 19 or older in South Korea has decreased by only 3% over the past 10 years, from 25.3% in 2007 to 22.3% in 2017. The smoking rate among adult males in 2017 remained particularly high at 38.1% (Korea Centers for Disease Control and Prevention, 2019). Despite strong smoking control policies in South Korea, there have been only slight declines in the smoking _rates, which has convincingly been argued to be attributable to hardcore smokers with no intention to quit. In particular, hardcore smokers have become more dependent on smoking over time because of their nicotine addiction, making it difficult for them to comply with smoking control policies (Hughes, 2001). Effectively controlling hardcore smokers has been pointed out as an important issue with regard to controlling the general smoking population (Warner & Burns, 2003; Chaiton, Cohen, & Frank, 2008).

The term "hardcore smoker" has been defined differently by various researchers and there is still no consensus on its definition. However, "hardcore smoker" generally refers to daily smokers who have never quit smoking in the past and are not willing to quit in the future (Lund, Lund, & Kvaavik, 2011). The criteria for this definition may further include smoking more than 15 cigarettes smoked per day or long-term smoking for more than 5 years, which can serve to assess nicotine dependence. In some cases, an age requirement of 20 years or older can also be added to this definition (Lund et al., 2011; Sorg, Xu, Doppalapudi, Shelton, & Harris, 2011). Studies have reported that smokers of higher ages and with lower incomes were more likely to be hardcore smokers (Bommelé et al., 2014, 2015). It has also been reported that smokers with an earlier onset of smoking, a longer duration of smoking, and a greater amount of smoking were more likely to find it difficult to quit smoking due to nicotine dependence and were thus more likely to become hardcore smokers (Lund et al., 2011; Azagba, 2015). In addition, it is reported that if the level of income is low, then there is

a high possibility of becoming a heavy smoker because of limited access to an effective smoking education program. (Hiscock et al., 2012).

The socioeconomic demographic of income level among smokers is associated with the number of smoking cessation attempts and smoking cessation success rates (Haustein, 2006). Compared to smokers in the upper socioeconomic class, smokers in the lower socioeconomic class smoke cheaper cigarettes that are higher in nicotine and tar content, which results in higher addiction rates and the maintenance of smoking habits among the lower socioeconomic class (Kim, Seo, Shin, & Kim, 2013). The lower class also exhibits a higher smoking rate due to the functional role of smoking, which includes mitigating mental stress resulting from issues such as lower socioeconomic status (Graham,1994). Although the absolute level of income of both individuals and households has risen over time, the relative income gap persists and the poverty of the lower socioeconomic class is often connected to individual mental health problems such as increased depression and lower self-esteem (Asthana & Halliday, 2006). However, lower socioeconomic class smokers use cigarettes to regulate mood, reduce stress, and counter depression and hardships resulting from material deprivation, making it more difficult for smokers with lower incomes to quit smoking (Graham, 1994).

Studies in many countries have already confirmed the importance of psychological problems among smokers. According to the National Survey on Drug Use and Health, the use of tobacco products including cigarettes and cigars, as of 2013, was higher among people with mental health problems than those without mental health problems. Specifically, the use of cigarettes diverged greatly at 32.6% and 20.7% respectively for those two groups (Montgomery, 2015). Furthermore, a study examining the trend of smoking rates in England from 1993 to 2010, depending on the presence of persistent mental health problems including depression, found that the group with mental health problems exhibited a smoking rate that

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was not only much higher but also persistent without any decreases (Kulik & Glantz, 2016). According to the results of a previous study (Weinberger et al., 2017), individuals with high levels of depression were more likely to smoke than those with low levels of depression and were more likely to fail to quit even if they attempted to do so. In addition, it was reported that the presence of depression might make it harder to quit smoking, and quitting smoking among those with depression might in fact make their depression worse (Stepankova et al., 2017). Conversely, smoking itself has been reported to be a predictor of depression, and some neurotransmitters during smoking have been reported to be involved in the development and persistence of depression (Hammer & McPhee, 2014). These various findings indicate that individuals with depressive symptoms are more likely to continue smoking over time.

In addition to depression levels, self-esteem is regarded as one of the major factors associated with smoking cessation attempts and successful smoking cessation. In Thailand, a smoking cessation program designed to improve self-esteem among male students was found to have reduced smoking (Junnual, Sota, & Chaikoolvatana, 2019). In addition, the results of a study conducted in Finland involving 16-year-old adolescents who were surveyed for self-esteem and smoking behavior and followed up with at the age of 29 showed that the respondents who had lower self-esteem in adolescence had a 1.8-fold increased risk of smoking regularly in adulthood (Saari et al., 2015). Because self-esteem affects individuals' executive ability to attempt to quit smoking, it is necessary to examine self-esteem as a predisposing factor of smoking.

In South Korea, a variety of smoking control policies have been implemented since 1982, including cigarette advertisement and promotion regulations, smoking warning labels, tar and nicotine content marketing regulations, a ban on misleading wording (e.g., "mild"), restrictions on the sale of cigarettes to adolescents, non-smoking areas, and increases in cigarette prices. These have been equally applied to all smokers (Kim, 2014). However, as

mentioned above, smokers are divided into non-hardcore smokers and hardcore smokers, and the relevant smoking control policies applying to non-hardcore smokers have limited applicability to hardcore smokers. This indicates that there is a need for research, policy development, and management for hardcore smokers that consider both the sociodemographic backgrounds and associated psychosocial characteristics of hardcore smokers, beyond the existing smoking control policies suited to the sociodemographic characteristics of smokers in general. In particular, income level, which has been found to be an important factor affecting smoking amounts in many previous studies (Bommelé et al., 2014, 2015; Clare, 2014; Hiscock et al., 2012; Sorg et al., 2011), is related to depression and self-esteem among hardcore smokers (Junnual et al., 2019; Saari, et al., 2015), and such psychological variables can change over time and influence each other. Thus, this study aims to investigate the effects of depression and self-esteem on smoking amounts among hardcore smokers over time using a latent growth model and to provide baseline data for developing policies and programs for hardcore smokers.

Methods

Research Design

This is a secondary data analysis study using the data from the Korea Welfare Panel Studies (KOWEPS) conducted by Korea Institute for Health and Social Affairs (KIHASA) and Seoul National University Institute of Social Welfare. This is designed as a longitudinal, descriptive, causal study aimed at investigating the effects of depression and self-esteem on smoking amounts among hardcore smokers over time.

Research Subjects

The KOWEPS is a longitudinal survey conducted by KIHASA and the Seoul National

University Institute of Social Welfare in South Korea. The 1st wave of the KOWEP in 2006 sampled 517 enumeration districts from 90% of the population census to investigate household income and the economic status of household members. From the first-stage survey data, general households and low-income households were selected as sample households, and a total of 7,072 panel households were then selected using stratified double sampling. In view of the fact that the retention rate of the original sample of households decreased after the 6th KOWEPS, the 7th KOWEPS added 1,800 households and constructed a new panel to maintain the sample size of the 1st KOWEPS. Sampling was performed in the same manner as in the 1st KOWEPS. The KOWEPS was carried out based on direct interviews where surveyors or enumerators visited panel households, met the respective household members, and recorded responses from the respondents in a Computer-Assisted Personal Interview (CAPI). Prior to the field survey, a telephone survey was conducted to ask for survey cooperation and to identify moved households, and surveyors visited offices of small administrative districts of *eup*, *myon*, and *dong* to asked for cooperation with the field survey of panel households in the respective area. However, if it was difficult for surveyors to meet any participant directly during the survey period for unavoidable reasons such as returning home late at night or long-term absence, or if any household member was absent from the household for a certain period of time due to overseas residence, travel and business trips, hospitalization, or military service, telephone surveys or proxy response surveys were restrictively allowed. Surveyors who had experience in panel surveys and large-scale surveys and had excellent performance grades were selected from a pool of surveyors held by the KIHASA. They were educated mainly on the contents of the survey, CAPI, greetings to the respective household members when visiting households, and other precautions related to the survey. The retention rate for the KOWEPS used in this study was 69.23% in the 9th KOWEPS (2014), 67.31 in the 10th KOWEPS (2015), 64.48% in the 11th KOWEPS (2016),

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62.19% in the 12th KOWEPS (2017), and 60.32% in the 13th KOWEPS (2018), based on 7,072 subjects in 2006.

In particular, the subjects of this study were hardcore smokers who were adults aged 19 years or older and were participants in the KOWEPS. Hardcore smokers here are defined as adults aged 19 years or older who continue to smoke, smoke an average of 20 cigarettes or more per day, have smoked for 5 or more years, have not quit smoking in the past one year, and are not willing to quit in the future. According to the data from the KOWEPS, the number of hardcore smokers out of the total smokers was 591 in the 9th wave of the KOWEPS, 443 in its 10th wave, 485 in its 11th wave, 389 in its 12th wave, and 390 in its 13th wave. The final selection of study participants were 264 hardcore smokers who participated in all surveys from the 9th wave to the 13th wave of the KOWEPS (Figure 1).

Measurement

General Characteristics of the Subjects

The general characteristics of the subjects included gender, age, residential area, education level, marital status, presence or absence of religion, job type, subjective health status, presence or absence of chronic disease, average indoor passive smoking time per day, and average alcohol consumption per year.

Depression

In the KOWEPS, depression was measured using the Center for Epidemiologic Studies Depression Scale (CES-D) scale (Hoe, Park, & Bae, 2015). This scale consists of 11 items rated on a 4-point Likert scale (0: *rarely*, 1: *sometimes*, 2: *generally*, 3: *always*). Items 2 and 7 for measuring positive emotions were reverse-scored for data analysis. Perceived depression was calculated as the sum of scores for all items (*20/11) in accordance with the KOWEPS

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guidelines. Higher scores indicate higher levels of perceived depression. The reliability of this scale in this study was indicated by values of Cronbach's α = .85 in the 9th wave, .90 in the 10th wave, .88 in the 11th wave, .76 in the 12th wave, and .85 in the 13th wave.

Self-esteem

In the KOWEPS, self-esteem was measured using the Rosenberg Self-Esteem Scale (Rosenberg, 1965). This scale consists of 10 items, each scored on a 4-point Likert scale (1: *strongly disagree*, 2: *disagree*, 3: *agree*, 4: *strongly agree*). The scores of five negative items were reverse-calculated in data analysis, and higher scores indicate higher self-esteem. The reliability of this scale in this study was shown by values of Cronbach's α = .74 in the 9th wave, .75 in the 10th wave, .79 in the 11th wave, .76 in the 12th wave, and .76 in the 13th wave.

Daily Smoking Amount

The daily smoking amount refers to the number of cigarettes smoked per day as indicated by the respondents to the question, "What is your total number of cigarettes smoked per day?" at the time of the survey.

Ordinary Income

Ordinary income refers to each subject's regular and predictable income, which is the sum of his/her labor income, business and sideline income, property income, and private and public transfer income as reported in the KOWEPS.

Data Analysis

After signing up, logging in on the homepage of the KOWEPS (https://www.koweps.re.kr), and entering the information on the purpose and methods of using the data, we obtained the

data for use in this study. The data were provided without personally identifiable information on the participants. The welfare panel survey team provided raw data after the deletion of key items of personal identification information including name, resident registration number, and date of birth, and further protected the identities of individuals by assigning survey participants with unique IDs. In addition, this study was conducted after receiving approval from the institutional review board at C University.

In order to investigate the relationships between depression and self-esteem and their effects on smoking amounts among hardcore smokers, this study used a combination of the data on households and the data on householder members from the 9^{th} – 13^{th} waves of the KOWEPS. Data entry and data analysis were performed using the SPSS WIN 24.0 software program (SPSS Korea Data Solution Inc.), and the AMOS 18.0 software program (SPSS Korea Data Solution Inc.). The missing values were processed using the FIML (full information maximum likelihood) estimation method. The general characteristics of the subjects were analyzed as real numbers, percentages, means, and standard deviations. Depression, self-esteem, and daily smoking amount at each measurement time were analyzed by means and standard deviations. Correlations between the measurement variables were analyzed using Pearson's correlation coefficient analysis. In addition, this study used a latent growth model to examine the relationships between depression, self-esteem, and daily smoking amount among hardcore smokers over time.

The latent growth model used in this study is intended to investigate the degree of change up to the last level using the intercept (initial value) and the slope (rate of change). In particular, the latent growth model is divided into an unconditional model and a conditional model. In the unconditional model, depression, self-esteem, and daily smoking amount were measured five times per year; a non-change model, a linear change model, and a quadratic function model were then set up to select the most adequate model. The following is the non-

change model, which hypothesizes that depression, self-esteem, and daily smoking amount of the subject may not change over time.

Level 1: $Y_{ti} = \pi_{0i} + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + r_{0i}$

The linear change model is as follows.

Level 1: $Y_{ti} = \pi_{0i} + \pi_{1i} Time_{ti} + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

In this model, y_{ti} indicates the score for the y variable for an individual i at time t, π_{0i} indicates the initial state (intercept) of an individual i, π_{1i} indicates the rate of change (slope) for an individual i, t indicates the encoded value of the measurement of time, and e_{ti} indicates error. Such a model is called a level 1 model. In addition, in an interpersonal model, or a level 2 model, β_{00} and β_{10} indicate the group means of intercept and slope, respectively; r_{0i} indicates the degree to which an individual i deviates from a group; and r_{1i} indicates the degree to which an individual i deviates from the slope.

The quadratic function model is as follows.

Level 1: $Y_{ti} = \pi_{0i} + \pi_{1i} Time_{ti} + \pi_{2i} Time^2_{ti} + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

$\pi_{2i} = \beta_{20} + r_{2i}$

In this model, β_{20} indicates how the slope of daily smoking amount among the participants accelerates or decelerates as a quadratic function. Finally, in this study, the best-fitting model for the trend change of the variable over time was selected by comparing the goodness-of-fit between the unconditional model and the conditional model using ordinary income as a control, which was reported to affect depression and self-esteem among smokers (Figure 2).

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The goodness-of-fit of the model was evaluated using chi-square values, Tucker Lewis Index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). In addition, bootstrapping was performed to confirm the direct and indirect effects between the variables.

Results

General Characteristics of the Participants

Table 1 presents the general characteristics of the participants. With regard to gender, 258 participants (97.7%) were male and 6 (2.3%) were female. Their mean age was 46.03 years old. In terms of education level, 59 (22.4%) were middle school graduates or below, 129 (48.9%) were high school graduates, and 76 (28.7%) were junior college graduates or above. In terms of job type, 158 (59.9%) were wage workers, 68 (25.8%) were self-employed or employers, 2 (0.8%) were unpaid family workers, and 36 (13.6%) were unemployed. In terms of average time per day of indoor passive smoking, 136 (51.5%) engaged in passive smoking for less than one hour per day and 128 (48.5%) for more than one hour per day. In terms of average alcohol consumption per year, 25 (9.5%) drank less than once per month, 60 (22.7%) drank 2–4 times per month, 74 (28.0%) drank 2–3 times per week, 65 (24.6%) drank more than 4 times per week, and 40 (15.2%) were non-drinkers.

Correlations and Changes in Each Factor over Time

Table 2 presents the correlations and changes in each factor over time. The skewness for variables such as depression, self-esteem, daily smoking amount, and ordinary income by year all had absolute values less than 3; kurtosis values all had absolute value of less than 10, which met the normality assumptions. In addition, the analysis of measurement variables showed significant correlations between variables at all time points.

Latent Growth Model for Each Factor and its Goodness-of-Fit Verification

Table 3 presents the latent growth model for each factor and its goodness-of-fit verification. In order to verify whether the trend of change by factor among the subjects was statistically significant and to identify the best-fitting model for this change tendency, we evaluated the goodness-of-fit of the unconditional model (e.g., non-change, linear, and quadratic function models) and the conditional model with the ordinary income in the respective year controlled for each factor. The results showed that the conditional model had the best fit for depression (χ^2 = 54.00, *df* = 24, TLI = 0.96, CFI = 0.98, RMSEA = 0.06) and self-esteem (χ^2 = 42.75, *df* = 24, TLI = 0.97, CFI = 0.99, RMSEA = 0.05).

Estimation of Development Trajectory by Factor

Table 4 presents the estimation of development trajectory by factor. The means of depression, self-esteem, and daily smoking amount intercepts among the participants were 20.35 ($p < .05$), 27.22 ($p < .05$), and 22.37 ($p < .05$), respectively. The variance of depression, self-esteem, and daily smoking amount intercepts among the participants were 0.40 ($p < .05$), 0.12 ($p < .05$), and 0.08 ($p < .05$), respectively, rejecting the hypothesis that the intercepts' mean of each factor may have been 0. Accordingly, there were statistically significant individual differences in the intercept by each factor. The means of the depression and daily smoking amount slopes were −0.94 (< .05) and −1.00 (< .05), respectively, showing that depression and daily smoking amount both decreased over time from the 1st year. The variance of depression and daily smoking amount slopes were 0.09 (< .05) and 0.66 (< .05), respectively, showing that there also were individual differences in the slopes. In addition, the covariance of both the intercept and slope of depression with the daily smoking amount were negative. Therefore, depression and daily smoking amount were found to decrease gradually

among participants with higher intercepts of depression and daily smoking amount, whereas depression and daily smoking amount were found to decrease relatively rapidly among those with lower intercepts of depression and daily smoking amount. The mean of the self-esteem slope was 0.27 (< .05) and self-esteem increased over time from the 1st year; the variance of the slope of self-esteem was 0.47 (< .05), indicating that there was an individual difference in the slope. In addition, both the intercept of self-esteem and the covariance of slope of self-esteem were negative. Therefore, self-esteem was found to gradually increase among subjects with a high intercept of self-esteem, but to increase relatively rapidly among those with a low intercept of self-esteem.

The Latent Growth Model for Depression, Self-Esteem, and Daily Smoking Amount among Hardcore Smokers

Table 5 presents the latent growth model for depression, self-esteem, and daily smoking amount among hardcore smokers. The results of testing the latent growth model for depression, self-esteem, and daily smoking amount among hardcore smokers showed that the model fit indices (χ^2 = 407.95, *df* = 148, TLI = 95, CFI = 99, RMSEA = .04) were all adequate. The intercept of depression among the participants had statistically significant effects on the intercept of self-esteem (β = −.32, p < .001) and the slope of self-esteem (β = −.64, p = .008), while the slope of depression had statistically significant effects on the slope of self-esteem (β = −.31, p = .002). In addition, the intercept of depression among the subjects had statistically significant effects on the intercept of daily smoking amount (β = .20, p < .001), while the slope of depression among the participants had statistically significant effects on the slope of the daily smoking amount (β = .11, p=.030). In addition, the intercept of depression had indirect effects on the intercept of daily smoking amount (β = .20, p= .040) and the slope of depression had indirect effects on the slope of daily smoking amount (β = .30,

p = .003). The intercept of self-esteem in the subject had statistically significant effects on the intercept of daily smoking amount (β = −.38, p < .001), while the slope of self-esteem had statistically significant effects on the slope of daily smoking amount (β = −.12, p = .048).

Discussion

This study aimed to examine the effects of depression and self-esteem on smoking amount among Korean hardcore smokers, and to provide preliminary data for the development of interventions for hardcore smokers in South Korea. Based on the results of this study, the implications are discussed as follows.

First, there were individual differences in the means and variances of the intercepts of depression, self-esteem, and daily smoking amount among the subjects. In other words, early depression, self-esteem, and daily smoking amount varied widely between individuals, and the rate of change for each variable, in accordance with the passage of time, also varied widely between individuals. Since it has been reported that smoking-related characteristics such as individual mental health status, self-esteem, age of onset of smoking, and daily smoking amount are closely related to successful smoking cessation (Stepankova et al., 2017; Weinberger et al., 2017; Nichter, Nichter, Carkoglu, Lloyd-Richardson, & Tobacco Etiology Research Network, 2010), it is thought that the approach of accurately identifying the initial levels of such factors may be an important approach to achieving smoking cessation among hardcore smokers. In addition, the means and variances of the slope of these factors were also statistically significant. Depression and daily smoking amount were found to decrease over time, and the rates of change in depression and daily smoking were different among individuals. These results are similar to the results of a study regarding the longitudinal patterns of smoking behaviors in adult smokers using the data from the KOWEPS over 9 years, in which 14% of male adults changed from smoking to smoking cessation (Park, 2017).

These results are similar to those from a longitudinal study (Joly, D'Athis, Gerbaud, Hazart, Perriot, & Quantin, 2016) of smokers in France, in which smokers with mental health problems like depression also exhibited a level of cigarette addiction severe enough for them to be labelled as hardcore smokers. Level of depression varies between individuals, and for smokers with a high level of depression, it is relatively more likely that they began smoking due to the antidepressant effect of nicotine and therefore exhibit a relatively higher smoking rate. In addition to an increased release of dopamine, nicotine increases the bioavailability of serotonin, which is a mechanism similar to the effect of some antidepressants (Schnoll & Lerman, 2006). Ultimately, level of depression is a factor that contributes to the disparity in daily smoking amounts and the disparity in persistence for hardcore smokers. Medical professionals therefore need to accurately assess and manage depression early on during the management of hardcore smokers, with mental health management programs for hardcore smokers developed and applied at the government level. In particular, considering the fact that preceding studies confirm the effectiveness of mental health management for smoking cessation (Taylor, McNeill, Girling, Farley, Lindson-Hawley, & Aveyard, 2016), it is assumed that hardcore smokers who received treatment from medical professionals for their mental health problems including depression would have experienced effects similar to those of smoking cessation.

Furthermore, as an important predictive variable that changes or maintains individual behavior (Strecher, Devellis, Becker, & Rosenstock, 1997), self-esteem is regarded by existing studies as a key factor that determines the number of smoking cessation attempts and ultimate success (Abernathy, Massad, & Romano-Dwyer, 1995). Simply put, a high level of self-esteem is regarded as increasing the success rate of smoking cessation attempts by impacting the individual capability to attempt to stop smoking. Because the level of self-esteem is not the same but varies between individuals, ultimately, smokers who fall under the

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category of being a hardcore smoker can vary in the level of intention and motivation toward smoking cessation in accordance with their level of self-esteem. Therefore, it is assumed that, by increasing self-esteem in order to reinforce the motivation to stop smoking, the various smoking cessation policies that are effective for regular smokers could be applied effectively to hardcore smokers as well. Furthermore, because smoking functions as a solution for mental stress caused by issues such as material deprivation experienced by the lower socioeconomic classes (Graham, 1994), it is necessary to seek healthier alternative methods to resolve mental stressors like depression caused by relative poverty when managing hardcore smokers.

Second, depression and daily smoking amount were found to decrease gradually among the participants with high intercepts of depression and daily smoking amount, whereas depression and daily smoking amount were found to decrease relatively rapidly in subjects with low intercepts of depression and daily smoking amount. This finding is consistent with the results of a study (Weinberger et al., 2017) showing that individuals with high levels of depression were more likely to smoke than those with low levels of depression, and that individuals with higher levels of depression were more likely to fail even if they attempted to quit smoking. As reported in the results of a study that having depression could itself make it more difficult to quit smoking, and conversely, quit attempts could make individuals more depressed (Stepankova et al., 2017), this study found that smoking and depression might have a strong influence on the initial values of depression and smoking amount. In particular, when the initial values of depression and daily smoking amount were high, depression and daily smoking amount were found to decrease gradually over time. Therefore, close attention should be given to individuals with high initial values of depression and daily smoking amount.

Third, the mean of the self-esteem slope was found to increase over time from the 1st year,

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and there was an individual difference in the mean of self-esteem slope. Self-esteem was found to increase gradually in the subjects with high initial values of self-esteem, whereas self-esteem was found to increase relatively rapidly in the subjects with low initial values of self-esteem. Self-esteem is one of the major factors in quit attempts and successful smoking cessation (Chaiton et al., 2016; Abernathy et al., 1995). A high level of self-esteem is considered a factor strengthening individuals' ability to attempt to quit and thus increase the success of quit attempts. Based on the results of a study (Saari et al., 2015) showing that individuals with low levels of self-esteem were more likely to smoke regularly, this study suggests that it may be effective to identify initial levels of self-esteem and proceed with intervention programs suited to the individual's self-esteem. In particular, the results of this study showed a rapid increase over time in self-esteem in the subjects with low initial values of self-esteem. Therefore, self-esteem-related interventions may be greatly effective in the subjects with low initial values of self-esteem. In particular, because smokers aged 25 years or younger have yet to harden into hardcore smokers, it is thought that intervention programs designed to enhance self-esteem in smokers of this age group will have greater effects on the success rate of quit attempts.

Fourth, the results of verifying the indirect effects of depression on daily smoking amounts among the participants showed that the intercept and slope of depression had indirect effects on the intercept and slope of daily smoking amount via self-esteem. This finding is consistent with the results of a study (Saari et al., 2015) showing that individuals with low levels of self-esteem were more likely to smoke regularly. The results of this study suggest that it may be effective to identify the initial levels of depression, self-esteem, and smoking amount before proceeding with related intervention programs.

As a previous study on depression and self-esteem reported that low self-esteem lead to a negative belief in self, which caused depression (Orth, Robins, & Roberts, 2008), it is thought

that worsened depression may further increase smoking amount. In addition, severe depression was reported to affect self-esteem (Burwell & Shirk, 2006; Shahar & Davidson, 2003; Shahar & Henrich, 2010). Self-esteem and depression are variables that affect each other, and thus it may be effective to consider them together. Therefore, when implementing smoking cessation programs for hardcore smokers, strategies to present the association between depression and self-esteem, to enhance self-esteem, and to manage depression so as to quit smoking may be considered.

Conclusion

This study aimed to examine the effects of depression and self-esteem on smoking amount in hardcore smokers over time using a latent growth model, and to provide basic data for developing policies and intervention programs for hardcore smokers. The present study is significant in that it provides preliminary data for developing smoking cessation policies and community smoking cessation programs for hardcore smokers. The results indicate the importance for hospital medical professionals to approach the development of smoking cessation programs for hardcore smokers with a focus on mental health problems. The limitations of this study are as follows. Data were analyzed on the assumption that there were no differences in the changing patterns of potential smoking behaviors among hardcore smokers according to age, social class, or education level. Further studies are needed to investigate whether there are differences in the changing patterns of smoking behavior among hardcore smokers according to these factors.

Declarations

Acknowledgements

Not applicable.

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Ethical Considerations

Data were provided after deliberation and the research was conducted after receiving deliberative process exemption (1040271-201910-HR-034) from the IRB institution of Changwon University.

Consent for publication

Not applicable.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

HJW developed a hypothesis, searched the literature, reviewed the relevant articles, analyzed the data, interpreted the findings, and wrote a manuscript. LH developed the hypothesis, reviewed the relevant article, and wrote the manuscript. All authors have read and approved the manuscript.

Availability of data and materials

Not applicable.

Declaration of competing interest

The authors declare that they have no competing interests.

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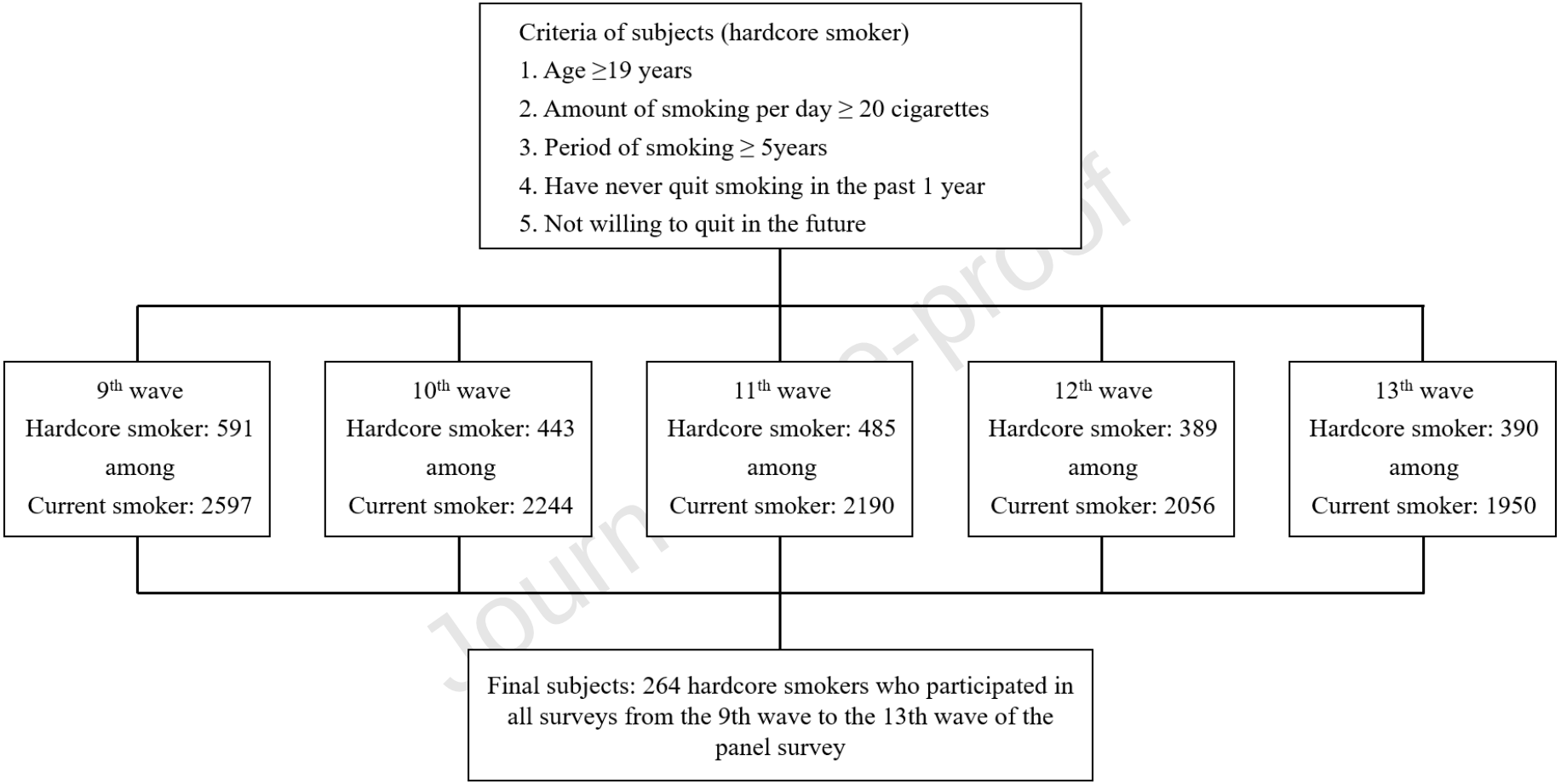


Figure 1. Selection of subjects in the study

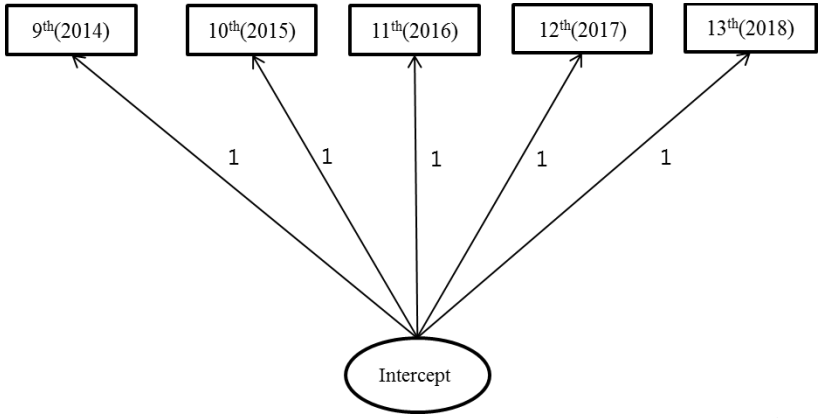


Figure 1-A. Unconditional model(changeless)

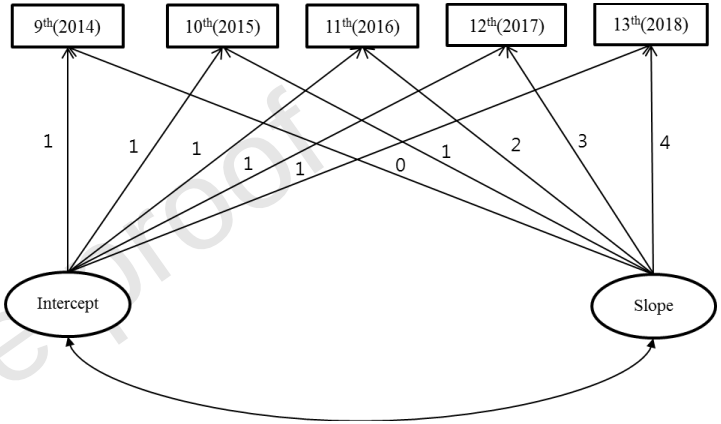
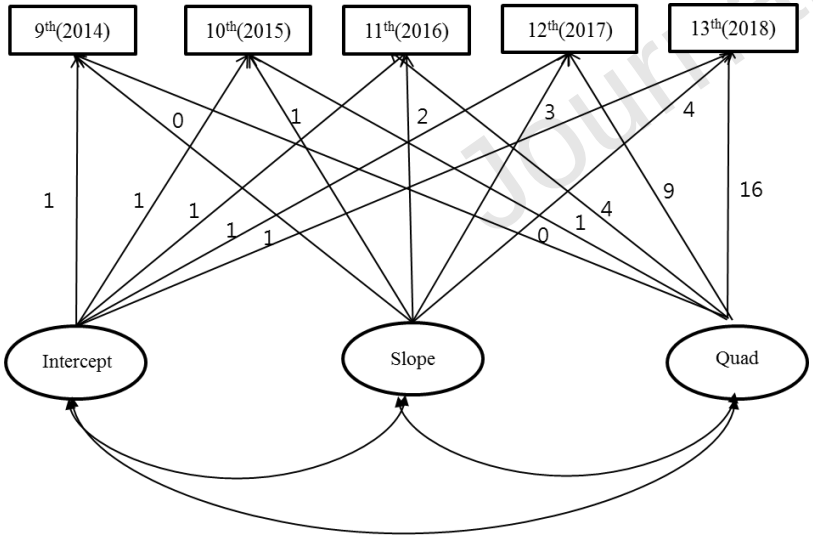


Figure 1-B. Unconditional model(linear)



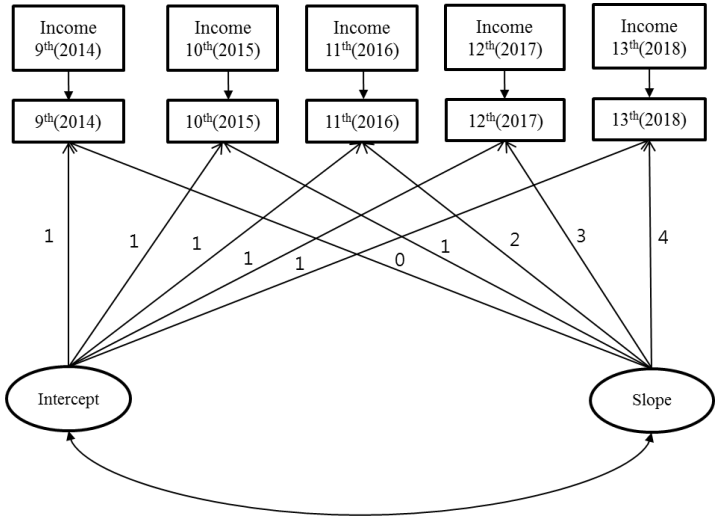


Figure 1-C. Unconditional model(quadrie)

Figure 1-D. Conditional model

Figure 2. Structure of latent growth model

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Table 1. General characteristics of the subjects

Variables	Category	n	%
Sex	Male	258	97.7
	Female	6	2.3
Age (year)	< 40	3	1.1
	41-49	59	22.4
	50-59	102	38.6
	60-69	86	32.6
	≥ 70	14	5.3
Marriage	Married	175	66.3
	Single	54	20.5
	Others	35	13.2
Residential area	Seoul	33	12.5
	Metropolitan city	67	25.4
	City	111	42.1
	Gun and urban-rural complex areas	53	20.0
Education	Middle school graduate	59	22.4
	High school graduate	129	48.9
	Above college graduation	76	28.7
Religious	No	180	68.2
	Yes	84	31.8
Occupation	Wage workers	158	59.9
	Self-employed or employers	68	25.8
	Unpaid family workers	2	0.8
	Unemployed	36	13.6
Subjective health status	Very healthy	46	17.4
	Healthy	153	58.0
	Moderate	42	15.9
	Unhealthy	20	7.6
	Very unhealthy	3	1.1
Chronic disease status	No chronic disease	158	59.9
	Medication for less than 3 months	18	6.8
	Medication for less than 3 months	88	33.3
Passive smoking exposure time per day	less than 1 hour	136	51.5
	more than 1 hour	128	48.5
Alcohol consumption per year	less than once a month	25	9.5
	2–4 times a month	60	22.7

2–3 times a week	74	28.0
more than 4 times a week	65	24.6
non-drinkers	40	15.2

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Table 2. The correlation of factors

(N=264)

Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X1:Depression_9th	1																			
X2:Depression_10th	.31	1																		
X3:Depression_11th	.40	.21	1																	
X4:Depression_12th	.46	.40	.32	1																
X5:Depression_13th	.35	.25	.34	.40	1															
X6:Self-esteem_9th	-.59	-.28	-.38	-.33	-.32	1														
X7:Self-esteem_10th	-.31	-.46	-.25	-.25	-.31	.37	1													
X8:Self-esteem_11th	-.35	-.23	-.53	-.17	-.21	.38	.37	1												
X9:Self-esteem_12th	-.30	-.27	-.25	-.56	-.41	.28	.38	.30	1											
X10:Self-esteem_13th	-.33	-.22	-.30	-.28	-.50	.42	.40	.34	.44	1										
X11: Daily smoking amount _9th	.29	.26	.17	.16	.15	-.19	-.17	-.15	-.10	-.14	1									
X12: Daily smoking amount _10th	.16	.38	.13	.13	.14	-.13	-.17	-.18	-.19	-.17	.34	1								
X13: Daily smoking amount _11th	.16	.22	.15	.15	.18	-.11	-.18	-.12	-.15	-.12	.43	.45	1							
X14: Daily smoking amount _12th	.35	.26	.16	.13	.13	-.16	-.15	-.20	-.23	-.14	.41	.37	.38	1						
X15: Daily smoking amount _13th	.38	.26	.12	.12	.12	-.12	-.14	-.14	-.23	-.12	.35	.38	.45	.43	1					
X16: Ordinary income_9^{th} (10,000 won)	-.38	-.30	-.21	-.23	-.33	.40	.38	.20	.31	.35	-.11	-.19	-.17	-.15	-.12	1				
X17: Ordinary income _10^{th} (10,000 won)	-.39	-.29	-.23	-.23	-.33	.38	.37	.22	.35	.37	-.16	-.14	-.11	-.17	-.10	.70	1			
X18: Ordinary income _11^{th} (10,000 won)	-.34	-.23	-.18	-.22	-.30	.39	.34	.26	.36	.38	-.12	-,12	-.17	-.14	-.17	.73	.76	1		
X19: Ordinary income _12^{th} (10,000 won)	-.45	-.30	-.25	-.29	-.35	.43	.39	.32	.41	.40	-.28	-.19	-.15	-.13	-.14	.66	.76	.72	1	
X20: Ordinary income _13^{th} (10,000 won)	-.39	-.33	-.21	-.24	-.34	.43	.36	.27	.40	.41	-.14	-.14	-.14	-.19	-.13	.66	.74	.76	.76	1

The correlation of factors is statistically significant at the $p < .05$

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Table 3. Latent growth model and goodness of fit

(N=264)

Model	x2	df	TLI	CFI	RMSEA(95% CI)
Depression_unconditional model(changeless)	50.23	9	.81	.84	.13(.11-.19)
Depression_unconditional model (linear)	42.29	14	.86	.88	.08(.05-.11)
Depression_unconditional model (quadric)	35.87	11	.85	.89	.09(.06-.12)
Depression_conditional model (control of income)	54.00	24	.96	.98	.06(.04-.09)
Self-esteem_unconditional model(changeless)	28.68	9	.93	.93	.05(.01-.09)
Self-esteem_unconditional mode(linear)	25.75	14	.95	.95	.05(.02-.09)
Self-esteem_unconditional model (quadric)	22.00	11	.94	.96	.05(.02-.09)
Self-esteem_conditional model (control of income)	42.75	24	.97	.99	.05(.02-.08)
Daily smoking amount _unconditional model(changeless)	13.96	9	.98	.98	.04(.01-.09)
Daily smoking amount _unconditional model (linear)	49.86	14	.91	.88	.05(.03-.09)
Daily smoking amount _unconditional model (quadric)	46.01	11	.89	.88	.06(.04-.10)
Daily smoking amount _conditional model (control of income)	34.17	24	.96	.99	.04(.01-.06)

TLI=Tucker Lewis Index, CFI=comparative fit index, RMSEA=root mean square error of approximation, 95% CI=95% confidence interval

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Table 4. Estimates of the trajectory of variables

(N=264)

Variables	Mean (p)	SE	Variance (p)	SE	Covariance (p)	SE
Depression intercept	20.35(.004)	1.23	0.40(<.001)	0.09	-0.07(<.001)	0.04
Depression slope	-0.94(.008)	0.04	0.09(.015)	0.28		
Self-esteem intercept	27.22(.002)	1.59	0.12(.001)	0.07	-0.72(<.001)	0.06
Self-esteem slope	0.27(.001)	0.06	0.47(.002)	0.30		
Daily smoking amount intercept	22.37(.009)	1.52	0.08(<.001)	0.06	-0.34(.005)	0.02
Daily smoking amount slope	-1.00(.001)	0.07	0.66(<.001)	0.21		

SE=-Standard error

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Table 5. The result of latent growth model on the depression, self-esteem and daily smoking amount

Independent variables		Dependent variables	β	B	S.E	C.R	*p*	Direct effect	(p)	Indirect effect	(p)	Total effect	(p)
Depression intercept	---->	Self-esteem intercept	-.32	-.23	.03	-6.52	<.001	-.32	(<.001)	-		-.32	(<.001)
Depression intercept	---->	Self-esteem slope	-.64	-.54	.20	-2.63	.008	-.64	(.008)	-		-.64	(.008)
Depression slope	---->	Self-esteem slope	-.31	-.18	.69	-3.15	.002	-.31	(.002)	-		-.31	(.002)
Depression intercept	---->	Daily smoking amount intercept	.20	.38	.11	3.37	<.001	.20	(<.001)	.20	(.40)	.40	(<.001)
Depression intercept	---->	Daily smoking amount slope	.34	.78	.68	0.29	.769	.34	(.769)	.17	(.001)	.41	(.321)
Depression slope	---->	Daily smoking amount slope	.11	.15	.59	2.24	.030	.11	(.030)	.30	(.003)	.41	(<.001)
Self-esteem intercept	---->	Daily smoking amount intercept	-.38	-.14	.03	-3.63	<.001	-.38	(<.001)	-		-.38	(<.001)
Self-esteem intercept	---->	Daily smoking amount slope	-.01	-.01	.86	-0.01	.996	-.01	(.996)	-		-.01	(.996)
Self-esteem slope	---->	Daily smoking amount slope	-.12	-.22	.41	-2.01	.048	-.12	(.048)	-		-.12	(.048)

SE=Standard error, C.R=Critical ratio

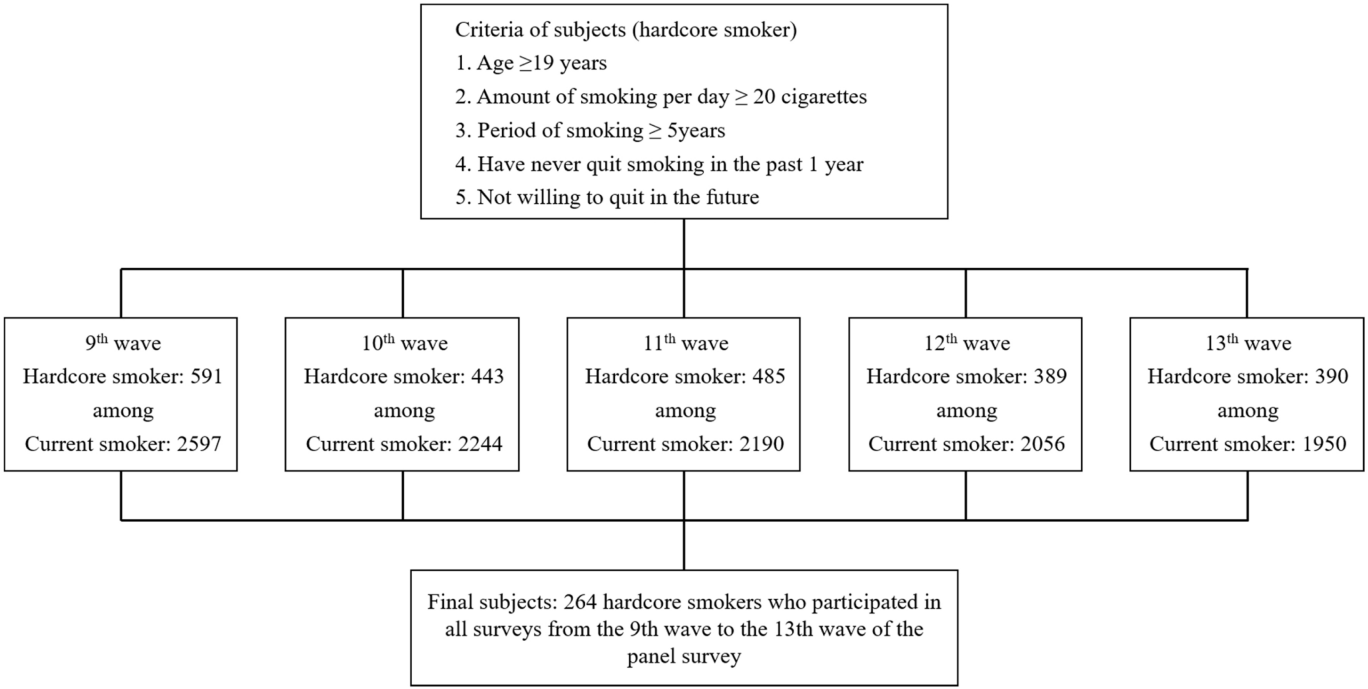
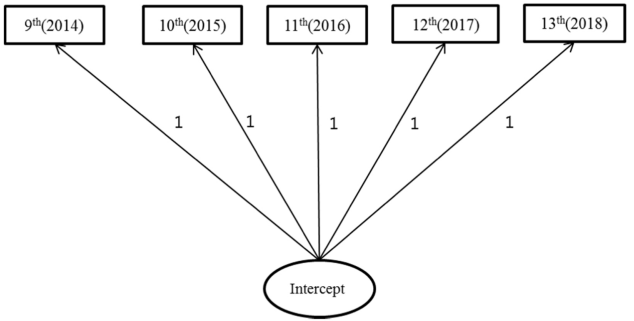
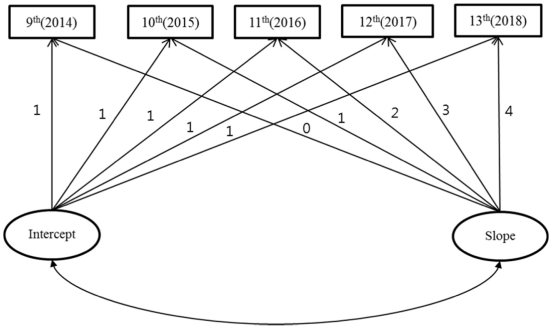

Criteria of subjects (hardcore smoker)
1. Age ≥19 years
2. Amount of smoking per day ≥ 20 cigarettes
3. Period of smoking ≥ 5years
4. Have never quit smoking in the past 1 year
5. Not willing to quit in the future
9th wave
Hardcore smoker: 591
among
Current smoker: 2597
10th wave
Hardcore smoker: 443
among
Current smoker: 2244
11th wave
Hardcore smoker: 485
among
Current smoker: 2190
12th wave
Hardcore smoker: 389
among
Current smoker: 2056
13th wave
Hardcore smoker: 390
among
Current smoker: 1950
Final subjects: 264 hardcore smokers who participated in all surveys from the 9th wave to the 13th wave of the panel survey

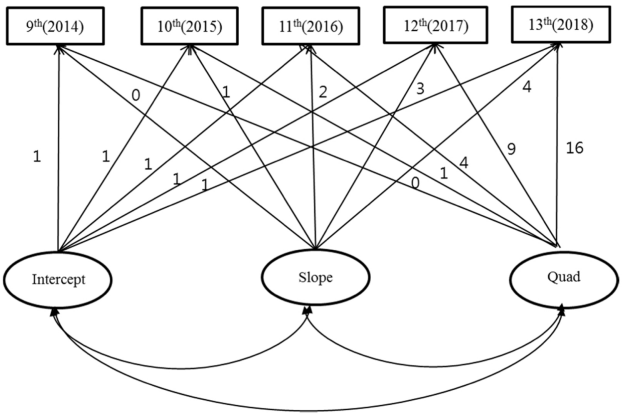
Figure 1



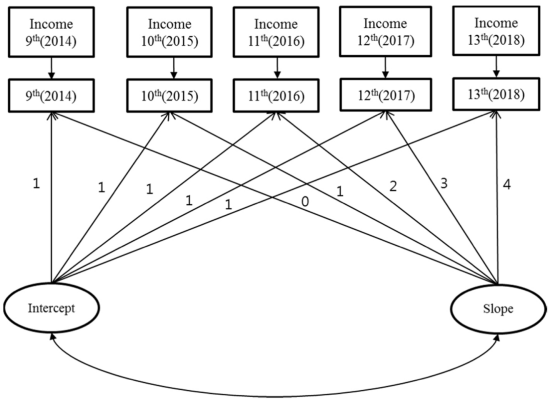
A



B



C



D

Figure 2