

ORIGINAL RESEARCH

The longitudinal relationship between changes in smoking and depression in older male adults

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Abstract

In this study, we investigated the relationship between smoking habits and the development of depression among elderly males in South Korea. We used the Korean Longitudinal Study of Aging (KLoSA) data from 2006 to 2020 to analyze the longitudinal relationship between daily cigarette consumption and depression levels in elderly Korean men over 65 years-of-age, as measured on the Center for Epidemiological Studies-Depression (CES-D)-10 scale. Data analysis was conducted using SPSS 28.0 and M-plus 8.0, with Latent Growth Modeling to determine the changes and relationships over time. Analysis revealed a declining average daily smoking rate from 4.50 cigarettes in 2006 to 0.85 in 2020, while depression scores exhibited fluctuations over this duration of time. Using a linear growth model, we identified that as the initial smoking rate was higher, the increase in depression was steeper over time (Coefficient = 0.016, $p < 0.001$). Furthermore, as smoking decreased progressively, the rise in depression was sharper, highlighting a potential relationship between decreasing smoking habits and increasing depression in elderly men (Coefficient = 0.030, $p < 0.001$). In conclusion, the reduction of smoking by elderly Korean men over time is associated with a notable increase in depression. This relationship suggests a complex interplay between mental health and lifestyle changes, emphasizing the importance of holistic approaches when addressing health issues in the aging population. Our findings suggest that policies targeting elderly men should address this potential relationship, and that comprehensive interventions now need to manage both smoking cessation and mental health simultaneously.

Keywords

Depression; Mental health; Older adults; Public health policy; Smoking

1. Introduction

Every year, over 8 million people die worldwide due to smoking [1]. The issue of smoking has long occupied a prominent place in public health, and at the national level, various efforts are being made to reduce the smoking population, including regulating tobacco advertisements, expanding no-smoking zones, increasing the price of cigarettes, and mandating adult verification [2]. Traditionally, smoking has been perceived as a culture that predominates in men, and even in modern society, the rate of smoking in men is significantly higher than that among women. In Korea, the rate of smoking in elderly people over 65 years-of-age is almost eight-fold higher in men (20.2%) than in women (2.3%) [3] and as of 2021, the smoking rate of men was 26.3%, ranking second among the Organization for Economic Cooperation and Development (OECD) countries [4].

Smoking in the elderly often begins in the earlier stages of life, and prolonged smoking has been shown to affect not only physical health, such as oral health [5], cardiovascular diseases, and metabolic syndrome [6], but also mental health,

including depression [7]. While previous studies have found that smoking exerts negative effects on physical health, it sometimes has positive effects on mental health; however, high rates of smoking are often detected in groups experiencing mental health issues [8]. In particular, depression has been demonstrated to be a significant factor in predicting suicidal thoughts in the elderly [9–11]. Therefore, it is necessary to identify methods to reduce depression by specifically investigating the effects of smoking on depression.

Smoking and depression are positively correlated. In data collected from St. Louis, MO, USA in the 1980s, regular smoking habits were more frequently observed in groups experiencing depressive disorders [12]. The neurotransmitter system is known to be affected by smoking and plays a role in the biological mechanisms underlying depression [13]. Therefore, smoking could influence the onset of depression [14]. This corresponds with previous research, which has shown a clear decline in smoking rates as age increases, suggesting that the aging process may contribute to the development of new chronic conditions or the worsening of existing ones [15]. Smoking arising from depression has been observed as a self-

defensive coping behavior [16]. Collectively, these studies indicate that the relationship between smoking and depression is reciprocal and not unilateral [17]. In this study, we investigated the relationship between smoking and depression from a longitudinal perspective to provide a more comprehensive form of analysis.

Research on the effect of smoking on health in the elderly has tended to focus on different age groups [5, 18] or specific administrative districts [7, 19]. However, since the smoking population is predominantly male, and attempts to quit smoking are decreasing [3], the health status of men who smoke is likely to be at a higher risk, thus necessitating a specific focus on men's smoking. Therefore, in this study, we specifically investigated the relationship between smoking and depression in elderly men over 65 years-of-age in Korea.

2. Methods

2.1 Data acquisition

In this study, we analyzed the rounds one to eight of the Korean Longitudinal Study of Aging (KLoSA) conducted between 2006 and 2020 to identify the relationship between changes in smoking and depression in elderly men. The KLoSA is a representative panel study on the elderly in Korea and aims to produce basic data that can be used to formulate effective socio-economic policies by measuring and understanding the social, economic, psychological, demographic composition, and health status of the elderly population. The Aging Research Panel Survey began in 2006 and is conducted every two years; the survey takes place between August and December. The target population for the Aging Research Panel Survey consists of citizens aged 45 years and considers residents on a national scale. In the initial survey, a total of 10,254 individuals were surveyed. The survey method uses a computer-assisted personal interviewing (CAPI) method and a laptop computer, and sampling is performed using the stratified two-stage cluster sampling method. In this study, elderly men aged 65 years and over were targeted based on the first-year criteria, and 1308 people who reported smoking and depression for more than three years between 2006 (the first round) and 2020 (the eighth round) were selected as the final subjects for analysis.

The sociodemographic characteristics of the study participants are shown in Table 1. In terms of education, 625 people (47.8%) had an educational level of elementary school or below, and 683 people (52.2%) had an educational level of middle school or above, thus exhibiting a similar ratio. The residential areas were represented by 880 individuals (67.3%) who resided in urban areas and 428 individuals (32.7%) residing in rural areas. With regards to marital status, 110 individuals (8.4%) were without a spouse, while 1198 individuals (91.6%) had a spouse. Mean subject age was 71.51 ± 5.23 years (mean \pm standard deviation), and the mean household income $8880.92 \pm 15,482.83$ US dollars.

2.2 Variables

2.2.1 Independent variables

The smoking variable in this study refers to the number of cigarettes smoked per day.

2.2.2 Dependent variables

Depression was analyzed using The Center for Epidemiological Studies-Depression (CES-D10) scale. The CES-D scale was first developed by Randolff [20] and is utilized in the Korean Longitudinal Study of Aging, which uses a Korean version of the CES-D-10 scale consisting of 10 abbreviated items to measure depression. In this scale, depression is structured on a 4-point scale (1 = briefly think or do not think about it; 2 = occasionally think about it; 3 = often think about it; 4 = always think about it). A higher score on this scale implies a higher level of depression. Total depression is calculated by summing up the 10 items to a maximum score of 40 points. If the score is 20 points or above, the individual is considered to suffer from depression. In this study, the reliability (Cronbach's α) of the depression scale was 0.837 in 2006, 0.851 in 2008, 0.825 in 2010, 0.833 in 2012, 0.893 in 2014, 0.819 in 2016, 0.839 in 2018 and 0.842 in 2020.

2.3 Statistical analysis

Data analysis was conducted using SPSS 28.0 (IBM, New York, NY, USA) and M-plus 8.0 (Mplus, Los Angeles, CA, USA) software. First, we conducted descriptive statistical analysis to identify the sociodemographic characteristics and the main characteristics of the variables. Secondly, to identify

TABLE 1. Sociodemographic characteristics of the study participants (N = 1308).

Variable	Categories	N	%
Education	Elementary School or below	625	47.8
	Middle School or above	683	52.2
Residential Area	Urban Areas	880	67.3
	Rural Areas	428	32.7
Marital Status	No Spouse	110	8.4
	With Spouse	1198	91.6
Age (Mean (SD))		71.51 (5.23)	
Household Annual Income (Mean (SD)) in USD		8880.92 (15,482.83)	

SD: standard deviation.

the changes in smoking and depression in elderly men over time and to verify the longitudinal relationship between smoking and depression, we utilized latent growth modeling. The suitability of the latent growth model was determined using the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA).

3. Results

3.1 Descriptive statistics

Based on the descriptive statistical analysis of the main variables (Table 2), we found that the highest mean smoking rate occurred in 2006 with a mean of 4.50 ± 8.01 cigarettes per day, and the lowest was in 2020 with 0.85 ± 3.73 cigarettes per day. This data demonstrated that the mean smoking rate decreased continuously from 2006 to 2020. With regards to depression, the depression score was lowest in 2006 with a mean of 1.66 ± 0.49 points and was highest in 2010 with a mean score of 1.83 ± 0.58 points. Thus, the mean depression score fluctuated over time, alternating between increases and decreases from 2006 to 2020.

TABLE 2. Descriptive statistics of the key variables (N = 1308).

Year	Smoking	Depression
	M (SD)	M (SD)
2006	4.50 (8.01)	1.66 (0.49)
2008	4.03 (7.53)	1.75 (0.54)
2010	3.22 (6.40)	1.83 (0.58)
2012	3.10 (6.38)	1.81 (0.55)
2014	2.44 (5.72)	1.75 (0.57)
2016	1.64 (4.82)	1.71 (0.57)
2018	1.12 (4.05)	1.77 (0.59)
2020	0.85 (3.73)	1.69 (0.55)

M: mean; SD: standard deviation.

Next, correlation analysis was conducted to determine the specific relationship between smoking and depression (Table 3). Generally, the correlation between smoking and depression was not significant. However, the sixth round of data for smoking and the sixth round of data for depression ($r = 0.070, p < 0.05$), and the fourth round of data for smoking and the seventh round of data for depression ($r = 0.074, p < 0.05$) were significantly and positively correlated.

3.2 Research model analysis

In this study, the latent growth model was performed two stages. In the first stage, the initial values and rates of change of smoking in elderly men depression were estimated using an unconditional model, and in the second stage, the relationship between changes in smoking and changes in depression was examined based on the initial values and rates of change found in the first stage; this utilized a conditional model.

3.2.1 The unconditional model

Before proceeding with the conditional model, we performed the unconditional model to investigate the changes in smoking and depression among elderly men. To identify the optimal change patterns with the unconditional model, both the no-growth model and the linear growth model were performed separately. Analysis showed that the fit of the linear growth models for smoking ($\chi^2 = 589.936, p < 0.001, CFI = 0.909, TLI = 0.919, RMSEA = 0.087$) and depression ($\chi^2 = 249.385, p < 0.001, CFI = 0.919, TLI = 0.925, RMSEA = 0.073$) were better at explaining the changes in smoking and depression than the no-growth model; thus the linear growth model was adopted for subsequent analysis (Table 4).

By applying the final linear growth model, the patterns of change and individual differences in smoking and depression were confirmed (Table 5). The mean initial value of smoking within the cohort of elderly men was 4.485 ($p < 0.001$) with a variance of 49.759 ($p < 0.001$); thus, there was a significant difference in the initial values of smoking among the study participants. The mean rate of change in the smoking activity of elderly men was -0.542 ($p < 0.001$) with a variance of 0.867 ($p < 0.001$); thus, over time, there was a tendency for smoking in elderly men to decrease, although the rate of change varied between study participants. The covariance between the initial value and rate of change of smoking in elderly men was -4.760 ($p < 0.001$), thus indicating that the higher the initial value of smoking in elderly men, the more significantly it decreased over time. In other words, the lower the initial value of smoking in elderly men, the more gradually it decreased over time.

The mean initial score for depression in elderly men was 1.718 ($p < 0.001$) with a variance of 0.129 ($p < 0.001$), thus indicating that there was a significant difference in the initial values of depression among the study participants. The mean rate of change in the depression scores of elderly men was 0.022 ($p < 0.001$) with a variance of 0.005 ($p < 0.001$), thus indicating that as time passes, there was a tendency for the depression score of elderly men to increase significantly, but also that the rate of change varied between study participants. The covariance between the initial value and the rate of change in depression score in elderly men was 0.486 ($p < 0.01$), thus indicating that the higher the initial value of depression in elderly men, the more significantly it increases over time. In other words, the lower the initial value of depression in elderly men, the more gradually it increases over time.

3.2.2 The conditional model

In the conditional model analysis, we investigated the influence of the initial values and rates of change in the smoking habits of elderly individuals on the initial values and rates of change of depression. The results of the conditional model fit analysis showed that there were no issues in analyzing the model ($\chi^2 = 898.552, p < 0.001$), $CFI = 0.905, TLI = 0.907$ and $RMSEA = 0.069$. The initial value of smoking did not have a significant impact on the initial depression score (Table 6). On the other hand, the initial value of smoking had a significant influence on the rate of change in depression (Coefficient = 0.016, $p < 0.001$) (Table 5). Analysis showed that when

TABLE 3. Correlation analysis between smoking and depression.

Category	Smoking 1st round	Smoking 2nd round	Smoking 3rd round	Smoking 4th round	Smoking 5th round	Smoking 6th round	Smoking 7th round	Smoking 8th round
Depression 1st round	0.058							
Depression 2nd round	0.016	-0.017						
Depression 3rd round	0.046	0.023	-0.004					
Depression 4th round	-0.032	-0.022	-0.027	-0.029				
Depression 5th round	0.024	0.041	0.002	0.004	-0.023			
Depression 6th round	0.019	0.051	0.026	0.010	-0.007	0.070*		
Depression 7th round	-0.003	0.042	0.060	0.074*	0.031	-0.014	-0.030	
Depression 8th round	0.010	0.032	0.042	0.047	-0.002	-0.063	-0.033	-0.066

* $p < 0.05$.

TABLE 4. Model fit for the unconditional model.

Model	χ^2	df	CFI	TLI	RMSEA
Smoking					
No Growth Model	2282.545***	34	0.595	0.667	0.225
Linear Growth Model	589.936***	31	0.909	0.919	0.087
Depression					
No Growth Model	551.809***	34	0.802	0.837	0.108
Linear Growth Model	249.385***	31	0.916	0.925	0.073

*** $p < 0.001$.

Key: TLI: Tucker-Lewis index; CFI: comparative fit index; RMSEA: root mean square error of approximation.

TABLE 5. Mean and variance of the initial score and the rate of change in the unconditional model.

Variables	Mean		Variance		Covariance
	Estimate	S.E.	Estimate	S.E.	
Smoking					
Initial Score	4.485***	0.209	49.759***	2.253	-4.760***
Rate of Change	-0.542***	0.032	0.867***	0.052	-4.760***
Depression					
Initial Score	1.718***	0.013	0.129***	0.008	0.486**
Rate of Change	0.022***	0.003	0.005***	0.000	0.486**

S.E.: standard error.

** $p < 0.01$, *** $p < 0.001$.

TABLE 6. Path coefficients as calculated by the study model.

Path between Variables	Coefficient	S.E.
Initial smoking value → Initial depression value	0.002	0.001
Initial smoking value → Depression change rate	0.016***	0.006
Smoking change rate → Depression change rate	0.030***	0.008

S.E.: standard error.

*** $p < 0.001$.

the initial value of smoking was higher, depression increased significantly over time. In other words, when the initial value of smoking was lower, the increase in depression over time was more gradual. The rate of change in smoking had a significant impact on the rate of change in depression (Coefficient = 0.030, $p < 0.001$) (Table 5). As smoking decreased gradually over time, depression increased significantly. In other words, as smoking decreased sharply over time, the increase in depression was more gradual.

4. Discussion

In this study, we analyzed the relationship between changes in smoking habits and depression in elderly males using data from the Korean Longitudinal Study of Aging. Based on the first phase of the survey in 2006, a total of 1308 males aged 65 years and above, who were available for the estimation of smoking and depression patterns from the first (2006) to the eighth phase (2020) for over three years, were selected as the final subjects of analysis. Descriptive statistics and latent growth models were employed to identify the longitudinal relationship between variable characteristics and the changes in smoking and depression.

First, we found that smoking in elderly males decreased over time, while depression increased as time progressed. This aligns with the context of previous studies that have investigated changes in the health behaviors of adults and the elderly in that smoking rates decreased as age increased [21]. Our data also corresponded with previous research results showing that the levels of depression in the elderly increased over time [22].

Second, we found that elderly males with higher initial values of smoking showed a sharp decline in smoking over time. This corresponds with previous research indicating a pronounced decrease in smoking rates with increasing age and can be attributed to the emergence of new chronic conditions or the exacerbation of existing ones as individuals grow older [2].

Third, elderly males with higher initial depression scores experienced a more rapid increase in depression over time, whereas those with lower initial scores showed a relatively gradual rise in depression levels. This aligns with previous research [23] indicating that the level of depression in the elderly tends to increase over time. Therefore, in cases of high levels of depression, it underscores the need for swift intervention by categorizing them into a separate group. This suggests that a rapid and proactive response is needed for groups at higher risk of depression, categorized by the degree of initial depression levels.

Fourth, while the initial value of smoking did not significantly affect the initial value of depression, it did have a significant effect on the rate of change in depression. In line with previous research that investigated the relationship between daily life changes and depression in the elderly, which found no relationship between smoking and depression [23]. This study partly agrees with our findings that the initial value of smoking did not significantly influence the initial value of depression. In previous studies, smoking was associated with a higher prevalence of depressive symptoms compared to non-

smokers, and individuals who quit smoking exhibited relatively fewer depressive symptoms or diagnoses than those who continued smoking [24]. Other research also demonstrated a decrease in depressive feelings following smoking cessation [25]. Moreover, a study focusing on elderly individuals in London, UK, indicated that male smokers were at a higher risk of depression onset and worsening compared to non-smokers [26], partially aligning with the findings of our study. However, in the domain of depressive improvement among male smokers, statistically non-significant contrasting results were observed. These results may reflect intercountry differences between our study conducted in South Korea and previous research conducted in the United Kingdom.

Furthermore, the data emphasizes the finding that smoking significantly influences the rate of change in depression, particularly indicating that a higher initial value of smoking is associated with a more rapid increase in depression over time. This indicates the necessity to incorporate considerations of smoking habits for individuals experiencing depression in real programs or business contents. Specifically, when implementing a program for elderly men experiencing depression, it is necessary to consider their smoking habits and incorporate this consideration into the program content.

Finally, the rate of change in smoking significantly influenced the rate of change in depression. As the rate of decrease in smoking became more gradual over time, there was a more rapid increase in depression. Conversely, a more rapid decrease in smoking over time was associated with a more gradual increase in depression. Thus, although the initial value of smoking did not significantly influence the initial value of depression, it did significantly influence the rate of change in depression, thus indicating that long-term care for smoking should be undertaken concurrently with depression care.

Based on our data, we must consider specific practical and policy recommendations. Firstly, even if the amount of smoking is not high, it gradually decreases over time; therefore, a system needs to be established that can consistently monitor and support the subject. Secondly, elderly men with high initial depression values should be classified as a high-risk group requiring concentrated care and more proactive strategies; furthermore, appropriate responses should be implemented. To achieve this, senior welfare centers, home elderly support centers, integrated care centers, and other elderly welfare institutions, must work in collaboration with mental health welfare centers in each area. In addition, in contrast to programs operating in a short-term and temporary manner, targeting depressed elderly individuals requires more comprehensive and systematic individual case management due to the necessity for long-term and continuous care. A previous case study of a customized health management program targeting elderly people in rural areas revealed a reduction in mental health problems such as depression alongside physical health promotion *via* individual customized physical activity programs or activities such as telephone and visit consultations [27]. Therefore, it is necessary to plan and activate customized programs centered on the recipients *via* collaboration and cooperation between related institutions. For example, the elderly can accumulate experiences of communication and interaction by participating in the process of recording daily steps and exercise duration

with institutional personnel *via* wearable devices. In addition, the opportunity to spend time with peers in similar situations can gradually increase in group programs, and positive changes in participants can be expected *via* consistent counseling and monitoring. Of course, to enable individual case management, group programs, and counseling and monitoring for depressed elderly individuals, it is necessary for the related infrastructure and professional body is necessary. In particular, the role of regional mental health welfare centers needs to be expanded and appropriate professionals need to be secured [28].

Thirdly, as smoking is a significant variable affecting changes in depression, it must be considered when planning depression-related programs. When promoting programs for improving depression, specific measures should be developed to support the reduction or cessation of smoking separately from the basic program for participants who smoke; this will require coordination with local health centers and mental health welfare centers. Previous studies showed that individuals who smoked exhibited more depressive symptoms than non-smokers, and those who quit smoking showed fewer depression symptoms or medical diagnoses than those who continued smoking [24]. Furthermore, a reduction in depression was observed after subjects quit smoking [25]; hence, the development and distribution of programs considering the relationship between smoking and depression should be undertaken as a matter of urgency.

Therefore, in practical settings, during the recruitment and selection phase of depression-related programs, not only depression but also smoking-related screenings should be conducted during initial consultations to comprehensively consider the degree of depression, smoking status, the amount of smoking, and the duration of smoking to enhance the effectiveness of the program. Lastly, while smoking does not affect the initial stage of depression, it does influence changes in depression over the medium and long term. Therefore, it is necessary to create budgets, strengthen the use of systematic devices to expand infrastructure, and secure professionals who can promote and enhance the mental health of the elderly for long-term and continuous care regarding smoking.

This study has limitations in that the results cannot be generalized to elderly males in other countries since we only analyzed elderly males in South Korea. In addition, due to the limitations of the analytical method used in this study, we were unable to address the confounders and risk factors related to depression. Moreover, in this study, the amount of smoking was set as the independent variable, but due to limitations imposed by the secondary data, various smoking characteristics were not considered, such as the type of smoking and the duration of smoking. We hope that future research will address these limitations and continue in subsequent studies. However, our findings are significant in that we verified the changing relationship between smoking and depression *via* a longitudinal study targeting elderly males to understand the relationship between smoking and depression.

5. Conclusions

This research study highlights the intricate dynamics between smoking habits and depression in elderly South Korean men

over a span of 14 years. A marked decline in daily smoking habits was observed from 2006 to 2020, contrasting with fluctuating depression scores during the same period. While general correlations between smoking and depression remain inconclusive, a linear growth model revealed more nuanced insights. Specifically, higher initial smoking rates were correlated with steeper increases in depression over time. Conversely, as the initial rates of smoking were lower, the increase in depression manifested more gradually. Furthermore, as smoking habits diminished over time, there was a sharper rise in depression. Given these findings, it is evident that while the overall decline in smoking is a positive health trend, it might be accompanied by an unintended increase in depression among elderly men. This underlines the necessity for integrated approaches in public health interventions that address both the challenges of smoking cessation and mental well-being in a simultaneous manner.

The development and implementation of comprehensive programs that integrate smoking cessation support are imperative. Although our findings are specific to the South Korean context and cannot be generalized globally, our findings provide a significant step in recognizing the intertwined relationship between smoking and depression, thereby highlighting the urgency to amplify infrastructure and expertise for long-term and effective care.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

KJ and HS—designed and conducted the research study. KJ—collected and analyzed the data. KJ, SK and HJC—interpreted the data. KJ, SK, JHK and HJC—drafted the manuscript. KJ and HJC—revised the manuscript’s content. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Semyung University in Korea (SMU-EX-2023-09-001). Informed consent was obtained from all participants.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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