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The Effect of Vitamin D and Calcium on Cognitive Function and Depression in the Elderly Living in a City

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Purpose: This study aims to examine the influence of vitamin D and calcium on depression and cognitive function of the elderly living alone in a city. **Methods:** The participants were registered in eight senior centers in S city and they had lived alone. Data were collected between November 28, 2014 and March 7, 2015. A total of 155 people participated in data collection to measure the serum vitamin D, the serum calcium, depression, and cognitive function. The data were analyzed with t-test, ANOVA, Pearson's correlation and multiple regression analysis. **Results:** There were significant differences in depression according to gender and perceptions of health status. Depression correlated significantly with the serum calcium and perceptions of health status, and a stepwise regression analysis showed that the perceptions of health status were significant. There were significant differences in cognitive function according to education level and age. Cognitive function correlated significantly with the serum vitamin D and a stepwise regression analysis showed that education level and age were significant. **Conclusion:** Consequently, elderly people with poor perceptions of their health status need a depressive intervention program and those with a higher age and lower level of education need a cognitive function intervention program.

Key Words: Vitamin D, Calcium, Aged, Depression, Cognitive function

INTRODUCTION

1. The Need for Research

According to 2014 the Korean Elderly Survey, elderly people living in urban areas increased by 20.2% from 56.4% to 76.6% compared to 20 years ago, and those living alone increased from 13.6% to 23.0%[1]. The living arrangement pattern is rapidly changing from existing households of elderly people living with their children to households of older adults living alone, and policies for the elderly living alone are required.

90.4% of the elderly living alone have a chronic illness, economic poverty and social isolation put them at a high risk of dying a 'lonely death' after suffering from diseases alone without receiving help even if an emergency occurs [1]. Especially, depression is a serious problem in the elderly living alone. Since there is no one to take care of them nor even a person to talk to, the elderly living alone have a higher level of depression than those living with the family [2], and the results of 2014 the Korean Elderly Survey showed that the depression level of the elderly living alone was the highest with 43.7% for the elderly living alone, 34.9% for those living with children, and 26.2% for elderly couple households. The prevalence of suicidal ideation was higher in the elderly living alone (15.3%) than in those living with their children (11.7%) or those living with their spouse (8.1%)[1].

The incidence rate of the decline of cognitive function is rapidly increasing with the increase of elderly population. According to the results of 2014 the Korean Elderly Survey, cognitive decline in older adults occurred in 31.5% of all elderly people, and the number of people with dementia is estimated to be 1.14 million in 2030[1]. In partic-

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ular, the elderly living alone were reported to have significantly lower cognitive functions in cognitive abilities such as mathematical ability, communication, ability to deal with a task, and memory than those living with family members [3].

Vitamin D is an essential hormone that forms and maintains the skeleton by facilitating the absorption of calcium and phosphorus. Since it has recently been reported that the vitamin D receptor is distributed in the brain and 25 (OH)-vitamim D activation and the use of vitamin D in cells occur in brain organs, studies on the effects of vitamin D on mental health have been conducted [4]. In addition, vitamin D also affects the synthesis of neurotransmitters such as acetylcholine esterase, serotonin, nerve growth factor, and thyroid hormone, and it has been suggested that vitamin D may thereby affect cognitive function and depression [5].

However, the results of studies on the relationship between vitamin D and depression are not consistent. A study using the data of the National Health and Nutrition Examination Survey (NHANES) conducted from 2005 to 2006 found no relationship between the vitamin D level and depression [6]. However, a study of 3,369 people aged 40~79 in Europe conducted in 2009 and a prospective cohort study in the United States conducted in 2010 reported that the lower the level of vitamin D was, the higher the level of depression was [7,8]. In Korea, the relationship between vitamin D and depression was analyzed by the data of the Korean National Health and Nutrition Examination Survey (KNHANES) conducted from 2008 to 2010, and no association was found [9]. Depression in older adults is a serious social problem, and elderly people living alone have a higher level of depression compared to those living with family members. Especially, 69.5% of elderly people in Korea have vitamin D deficiency, so it is considered necessary to investigate the serum vitamin D level in older adults living alone and the effect of the serum vitamin D level on depression.

The results of research on the relationship between vitamin D and cognitive function are not consistent either. The research using the NHANES data from 1988 to 1994 reported that there was no association between the vitamin D level and cognitive function, and a study of elderly people in some areas of the United States reported that the lower the level of vitamin D, the lower cognitive function [10,11]. In Korea, a five year follow-up study of the subjects with severe vitamin D deficiency reported that the level of vitamin D was highly correlated with dementia and Alzheimer's disease [12]. Since the elderly living alone have no care-giver, the detection of cognitive decline in them is delayed, and it inevitably leads to further deterioration of the quality of life of the elderly living alone. The effect of vitamin D on cognitive function has been investigated, but no study has been conducted with older adults living alone in Korea [3,12].

Calcium is the most abundant minerals in the human body, and although its effect on depression has not been clarified yet, ionized calcium is thought to be involved in the synthesis and secretion of neurotransmitters and affects the mental state. Previous studies showed inconsistent results, and while foreign studies reported that there was no association between the severity of clinical symptoms and the serum calcium level in depression patients, a domestic study reported that the calcium intake improved depression and anxiety in housewives in Korea [13,14]. However, a study by the KNHANES conducted in 2010 reported that there was no association between calcium intake and the prevalence of depression [15]. The study results about the relationship between calcium and cognitive function are also inconsistent. High calcium levels have been reported to result in accumulation of calcium in brain cells and nerve cells, causing cell necrosis and adversely affecting cognitive function, whereas a large cohort study of 2,000 Chinese showed that the higher the calcium level, the better cognitive function [16,17]. In Korea, a study of 38 Alzheimer's patients aged 65 years or older reported that calcium had a negative effect on cognitive function [18]. Recently, there has been an increasing number of elderly people taking calcium supplements along with vitamin D with vague expectations, although the effects of them on depression and cognitive function have not been elucidated. However, calcium has been reported to have both positive and negative effects on cognitive function. Thus, if you do not know their calcium level, recommended calcium supplements may have harmful effects. Therefore, this study intended to investigate the serum calcium level in the elderly living alone and to investigate the effect on depression and cognitive function.

The purpose of this study was to investigate the serum vitamin D level, the serum calcium level, depression and cognitive function in the elderly living alone in urban areas and to investigate the related factors affecting depression and cognitive function. Although the number of the elderly living alone in urban areas has been rapidly increasing compared to 20 years ago, the policies for them are focused on physical exercise and health screenings, which are major social concerns, and thus they are concentrated on physical health to increase the physical activity participation rate and the participation rate in the health screening program. The prolongation of life expectancy and the

increase in the elderly living alone require active intervention in mental health and require changes in the policy paradigm to reflect the increasing depression and cognitive decline. Therefore, this study aimed to provide the basic data of health promotion programs for older adults living alone in urban areas by investigating the correlations between the blood level of vitamin D, the blood level of calcium, depression, and cognitive function in the elderly living alone in urban areas.

METHODS

1. Research Design

This study is a descriptive correlation study conducted to measure the blood level of vitamin D, the blood level of calcium, demographic characteristics, depression, cognitive function and investigate correlations between variables in the elderly living in S city.

2. Subjects

The subjects were older adults aged 65 or more living along in 8 dongs (neighborhoods) in S city, Gyeonggi Province who were registered at the visiting health care center and regularly used the local senior center. The subjects were recruited after explaining the purpose and procedures of the study in 8 senior centers located in S city, Gyeonggi Province, where data collection would be conducted. For the subjects aged 70 years or older, who are categorized as vulnerable subjects by the Institutional Review Board (henceforth, IRB) of Catholic university, written informed consent forms signed by the president of the senior center as their representative were obtained. For illiterate subjects, if they voluntarily agreed to participate in the presence of the president of the senior center who accompanied them as their representative, informed consent forms signed by the representative was obtained. After the subjects were checked for discomfort or abnormal symptoms on the day of the tests, the tests were performed. After the tests, they took a rest for more than 5 minutes, and their discomfort and abnormal symptoms were reconfirmed. The number of subjects required was 107 people as a result of multiple regression analysis using the G-Power 3.1.7 program, with the significance level of .05, statistical power of .95, and medium effect size of .15. In this study, 9 out of 164 subjects were excluded because some tests were not performed, and a total of 155 subjects participated in the study.

3. Instruments

1) The blood level of vitamin D

In order to measure the blood level of vitamin D, 3 mL of blood was collected from the brachial vein and stored in the refrigerator. Then, it was sent to a laboratory for clinical testing and analyzed by conducting CLIA (chemiluminescence immunoassay) using a UniCel® DxI 800 Access Immunoassay System (Beckman Coulter, United States of America).

2) The blood level of calcium

For the measurement of the blood level of calcium, 3 mL of blood was collected from the brachial vein and stored in a refrigerator, and it was sent to a clinical laboratory and analyzed by Colorimetric assay using Modular D-D-P (Roche, Germany).

3) Depression

Depression was measured using the Geriatric Depression Scale Short Form-Korean Version (henceforth, GDSSF-K), which was developed by Kee [19] in 1996 by modifying the Geriatric depression scale short form (GDSSF) developed by, Yesavage and Sheikh [20] in 1986 to make it suitable for assessing Korean older adults [19,20]. After the consent of the developer for the use of the instrument was acquired, the test was performed by the research assistant who was trained in the methods and precautions to ensure accurate and consistent measurements. The score ranged from 0 to 15, the higher the score, the higher the level of depression, and the score of 5 points or more indicates depression. The reliability of the instrument was Cronbach's α =.88 in Kee [19] and .86 in this study.

4) Cognitive Function

The cognitive function was assessed by the Mini-Mental State Examination-Korean version (MMSE-K), which was developed for Korean older adults by Kwon and Park [21] by revising and standardizing the Mini-Mental State Examination developed by Folstein et al. in 1975 [22]. The MMSE-K is a measurement tool used to assess depression in older adults in the local community and it was conducted by a research assistant who was trained in methods and precautions for accurate and consistent measurements. The scale consisted of 12 items in a total of 6 domains, the scores ranged from 0 to 30, and higher scores indicate higher cognitive function. A score of 23 or less indicates suspected dementia, and a score of 19 or less indicates dementia. The reliability of the tool was Cronbach's α =.86 at the time of development and was .81 in this study.

4. Data Collection

Data collection was conducted from November 28, 2014 to March 7, 2015. Before this study was conducted, it was approved by the Institutional Review Board (IRB) of Catholic University (approval number: MC14OISE0101), and before data collection, verbal approval was received from the director of the visiting health care center after the explanation of the purpose and procedure of the study was provided. The subjects were a total of 164 elderly people living alone who voluntarily agreed to participate in the research after they were provided with the explanation of the purpose and procedure of the research in 8 local senior centers. The data were collected from 155 subjects excluding 9 people who refused some measurements of the tests performed.

5. Statistical Analysis

The collected data were analyzed using IBM PASW Statistics (SPSS/WIN) 20.0, and the significance level for all statistical tests was $p < .05$. The demographic characteristics of the subjects were analyzed by descriptive statistics, such as frequency, percentage, mean, and standard deviation. Differences in the blood level of vitamin D, the blood level of calcium, depression, and cognitive function were analyzed by the t-test and ANOVA. In addition, the Scheffé test was conducted for post-hoc analysis of differences between groups. Pearson's correlation was used to determine the correlation between measurement variables, and multiple regression analysis was used to determine the correlation between variables.

RESULTS

The demographic characteristics of the subjects are shown in Table 1. Of the subjects, 78.7% were female and 90.3% were 70 years old or older. The mean age of females was 76.5 years, which was lower than 78.4 years for males, but there was no statistically significant difference. The outdoor activity time was 79.87 minutes on average, and less than 60 minutes was most common (43.2%). The blood level of vitamin D was 18.88 ng/mL and the blood level of calcium was 9.25 mg/dL. The mean score for the level of depression was 5.59 points, the scores of 45.2% of the subjects were below 5 points, and the scores of 54.8% were 5 points or more, which indicates depression. The mean score for cognitive function was 23.88 points (Table 1).

Among the demographic characteristics of the subjects, gender and perceived current health status were significantly related to the level of depression. The level of depression was 5.93 points in females and 4.30 points in males, respectively, so the level of depression was significantly higher in females than in males (t=-2.12, p=.036). For the perceived current health status, there was a significant difference between the group who perceived themselves to be unhealthy and the group who perceived their health status to be normal (t=9.72, p=.001)(Table 2).

There were differences in cognitive function according to age and education, among the demographic character-

Table 1. Characteristics, Vitamin D, Calcium, Depression, Cognitive Function of the Study Population (*N*=155)

Characteristics	Categories	n (%) or M±SD
Age (year)	≤69	15 (9.7)
	70~79	90 (58.1)
	≥80	50 (32.2)
		76.9±5.90
Gender	Male	33 (21.3)
	Female	122 (78.7)
Education	Illiteracy	61 (39.4)
	Elementary school	61 (39.4)
	Middle school	21 (13.5)
	High school	11 (7.1)
	≥College	1 (0.6)
Religion	Christianity	25 (16.1)
	Catholic	37 (23.9)
	Buddhism	41 (26.5)
	No religion	52 (33.5)
Alcohol use	Yes	38 (24.5)
	No	117 (75.5)
Smoking	Yes	10 (6.5)
	No	145 (93.5)
Perceptions of health status	Not very healthy	3 (1.9)
	Not healthy	80 (51.6)
	Moderate	55 (35.5)
	Healthy	17 (11.0)
Outdoor activity time (min/day)	<60	67 (43.2)
	60~<180	64 (41.3)
	180~<300	20 (12.9)
	≥300	4 (2.6)
		79.87±74.55
Vitamin D		18.88±9.24
Calcium		9.25±0.38
GDSSF-K†		5.59±3.97
MMSE-K‡		23.88±3.60

† GDSSF-K: Geriatric depression scale short form-Korean version (0~4: normal, 5~9: mild depression, 10~15: severe depression);
‡ MMSE-K: Mini-mental state examination- Korean version (High score: Good cognitive function).

istics of the subjects. There were significant differences in the cognitive function among the age group of 70~79 years, the age group of 80 years or over and the age group of 69 years or less (t=5.58, p=.005), and there were significant differences in cognitive function among the groups of those without formal schooling, elementary school graduates, middle school graduates, and high school graduates (t=11.54, p=.001)(Table 2).

Table 3 shows the correlation between the blood level of vitamin D, the blood level of calcium, the degree of depression, cognitive function, outdoor activity time, and perceived current health status. The level of depression was significantly correlated with the level of calcium in the blood and perceived current health status, and cognitive function showed a significant correlation with the blood level of vitamin D. The higher the blood level of calcium, the higher the level of depression (r=.17, p=.039), and the lower the perceived health status, the higher the level of depression (r=-.38, p<.001). The higher the blood level of vitamin D, the higher the cognitive function (r=.17, p=.032)(Table 3).

In order to identify the factors affecting depression, multiple regression analysis was performed by using gender, perceived current health status, and the blood calcium level as independent variables. By entering variables by a stepwise method, it was found that perceived current health status had a significant effect (β=-.37, p<.001), and the regression model was statistically significant (F=17.54, p<.001)(Table 4).

In order to identify the factors affecting cognitive function, multiple regression analysis was performed with age, education, and the blood level of vitamin D as independent variables. As a result of conducting multiple regression analysis by entering variables by a stepwise method, it was found that education (β=.43, p<.001) and age (β=-.21, p=.016) had a significant effect, and the regression model was statistically significant (F=21.05, p<.001). The total coefficient of determination of two variables for cognitive func-

Table 2. Depression, Cognitive Function by General Characteristics (*N*=155)

Characteristics	Categories	Depression			Cognitive function		
		n (%) or M±SD	t or F	*p*	n (%) or M±SD	t or F	*p*
Age (year) †	≤69[a]	6.73±3.91	1.06	.349	26.40±2.69	5.58	.005
	70~79[b]	5.68±4.14			23.97±3.38		b, c<a
	≥80[c]	5.08±3.63			22.98±3.89		
Gender †	Male	4.30±3.87	-2.12	.036	25.18±3.25	2.37	.019
	Female	5.93±3.94			23.53±3.62		
Education †	Illiteracy[a]	6.05±4.10	1.50	.204	21.92±3.61	11.54	.001
	Elementary school[b]	5.82±3.73			24.59±2.30		a<b
	Middle school[c]	4.90±4.31			25.57±2.30		a, b<c
	High school[d]	3.36±3.41			27.27±1.62		a, b, c<d
	≥College[e]	2.00±0.00			28.00±0.00		
Religion	Christianity	5.56±4.20	0.06	.980	23.88±3.91	0.27	.847
	Catholic	5.81±4.13			24.24±3.52		
	Buddhism	5.59±3.93			23.98±3.31		
	No religion	5.44±3.87			23.56±3.80		
Alcohol use	Yes	5.56±3.99	-0.13	.900	23.83±3.61	-0.33	.740
	No	5.66±3.95			24.05±3.59		
Smoking	Yes	5.48±3.94	-1.25	.214	23.97±3.47	1.08	.284
	No	7.10±4.25			22.70±5.19		
Perceptions of health status †	Not very healthy[a]	9.33±1.53	9.72	.001	23.00±1.00	1.09	.354
	Not healthy[b]	6.95±3.90		c>b	23.50±3.27		
	Moderate[c]	3.96±3.38			24.58±3.48		
	Healthy[d]	3.76±3.63			23.59±3.60		
Outdoor activity time (min/day)	<60	4.97±3.69	2.11	.102	23.93±3.78	0.65	.585
	60~<180	5.73±4.02			24.11±3.24		
	180~<300	7.40±4.49			23.45±3.72		
	≥300	4.50±3.11			21.75±5.85		

† Scheffé test.

tion was 28%, and the coefficient of determination of education and age was 24% and 4%, respectively (Table 5).

DISCUSSION

The purpose of this study was to investigate the blood level of vitamin D, the blood level of calcium, depression and cognitive function in the elderly living alone in urban areas and to identify related factors affecting depression and cognitive function in order to provide basic data for development of health promotion programs.

In this study, 78.7% of the subjects were women, while 58.3% of the participants of 2014 the Korean Elderly Survey were females. This difference is thought to be due to the fact that the present study was conducted only with the elderly living alone and the average life expectancy of females is higher than that of males.

In the present study, the blood level of vitamin D was 18.88 ng/mL, which is lower than 20.0 ng/mL, the criterion for vitamin D deficiency in Koreans, and was higher than 15.11 ng/mL reported in Kim and Kim [23], a study of female older adults. It was also lower than the levels reported by Jung [24], which analyzed the results of the KNHANES from 2010 to 2011 and found that the blood level of vitamin D was 20.20 ng/mL in older adults aged 60 to 69, 20.51 ng/mL in those aged 70 to 79, and 20.13 ng/mL in those aged 80 or more [24]. The findings of Kim and Kim [23] differed from the results of this study, which may be explained by the fact that Kim and Kim [23] was conducted only with female elderly people while the subjects of this study included both male and female elderly people as the subjects, taking into account the study results that vitamin D deficiency is more severe in females than in males [23,24]. In addition, it is thought that the subjects of this study had a longer sun exposure time than those of Kim and Kim [23], and it had an effect on the blood level of vitamin D [23]. The blood level of vitamin D in this study was lower than that of Jung [24]. It is believed to be due to the fact that while the subjects of this study were composed of only the elderly living alone, the subjects of Jung [24] included the elderly living with family members. Therefore, it is suggested that the blood level of vitamin should be investigated in both the elderly living with family members and those living alone in the future

Table 3. Correlations between Depression, Cognitive Function, Vitamin D, Calcium, Perceived Health and Outdoor Activity Time (*N*=155)

Variables	MMSE-K	Vitamin D	Calcium	Perception of health status	Outdoor activity time
	r (*p*)	r (*p*)	r (*p*)	r (*p*)	r (*p*)
GDSSF-K	-.09 (.294)	-.05 (.557)	.17 (.039)	-.38 (< .001)	.12 (.162)
MMSE-K		.17 (.032)	.02 (.852)	.08 (.357)	-.09 (.261)
Vitamin D			-.09 (.296)	.13 (.103)	.10 (.233)
Calcium				-.01 (.921)	.00 (.970)
Perceptions of health status					-.01 (.876)

Table 4. Factors influencing Depression (*N*=155)

Factors	B	SE	β	t	*p*
Perceptions of health status	-2.21	0.53	-.37	-4.19	< .001
R^2=.14, Adj. R^2=.13, F=17.54, p < .001					

Table 5. Factors influencing Cognitive Function (*N*=155)

Factors	B	SE	β	t	*p*
Education	1.56	0.31	.43	5.05	< .001
Age	-0.13	0.05	-.21	-2.46	.016
R^2=.28, Adj. R^2=.27, F=21.05, p < .001					

research [24].

A comparative review of the research results in other countries showed that although the criterion of vitamin D deficiency in the US is 25.0 ng/mL and it is higher than that of Korea, it was reported that while 45% of older adults aged 60 to 79 and 51.5% of those aged 80 years or older have vitamin D deficiency in the US, 69.5% of older adults have vitamin D deficiency in Korea, and this shows that vitamin D deficiency of the elderly in Korea is more severe [25]. Therefore, it is necessary to educate and encourage elderly people to increase the intake of foods which are good sources of vitamin D and increase sun exposure time.

In the present study, the blood calcium level was 9.25 mg/dL, which was higher than the results for the elderly women in Kim and Kim [23], in which the blood calcium level was 9.06 mg/dL in the experimental group and 9.11 mg/dL in the control group, but the result of this study was similar to the results of Son and Chun [26], which was conducted with the healthy elderly people using the senior welfare center and reported that the blood calcium level was 8.98 mg/dL in males and 9.35 mg/dL in females, respectively [26]. In the case of foreign studies, a study conducted in India to investigate the relationship between the blood calcium level and depression reported that blood calcium levels in the normal group and the group of outpatients were 10.08 mg/dL and 9.76 mg/dL, respectively [27]. Although these results were slightly different from those of Kim and Kim [23], they showed that the blood calcium levels in domestic studies was much lower than those reported in foreign studies [23,27]. Therefore, it is necessary to encourage the intake of foods which are major food sources of calcium.

In the present study, the mean score of the depression level was 5.59 points, which exceeds 5 points indicating the normal level and indicates mild depression. The results of this study are lower than those of Seo and So [28], a study of elderly residents in a town, and are similar to those of Kim and Park [29], research of elderly people aged 65 and over in urban areas [28,29]. The subjects of Seo and So [28] were composed of 58.4% of high-risk frail older people and 49.4% of older people requiring the care by the visiting health care center, and their health status was worse than that of the subjects of this study, which is thought to be the reason why the level of depression was lower in this study [28]. The scores for cognitive function were 25.18 points in males and 23.53 points in females, with an average of 23.88 points, indicating a steady state without cognitive impairment. These results are similar to those of Seo and So [28], which was a study of the elderly living alone [28].

There was a statistically significant difference in the level of depression according to gender and perceived current health status among the demographic characteristics of the subjects. Specifically, females were found to be more depressed than males, and the worse perceived current health status, the higher the level of depression. These results showed that an intervention program for depression is needed for females in the poor heath condition. The results of this study were consistent with the results of Seo and So [28], Kim and Park [29], and Won and Kim [30]. However, Won and Kim [30] and Seo and So [28] reported that significant differences according to the educational level were also observed. This difference in the study results may be attributed to the differences in the categories for classifying the educational levels and in the educational levels of the subjects between the studies [28,30]. For differences in the cognitive functions depending on the demographic characteristics of the subjects, there was a statistically significant difference according to age and the educational level; the higher the age and the lower the level of education, the lower the cognitive function. The results of this study were consistent with those of Seo and So [28] and Won and Kim [30], and it was found that the higher the age is and the lower the educational level is, the greater the need for a cognitive intervention program is [28,30].

This study was conducted to investigate whether vitamin D and calcium affect depression and cognitive function of the elderly living alone. The correlation analysis of the study results showed that there was a significant correlation between the blood level of vitamin D and cognitive function and between the blood level of calcium and depression, but such significant correlations were not found in the stepwise regression analysis. As a result of the stepwise regression analysis, when depression was used as the dependent variable, only the perceived current health status was significantly correlated with it, and when cognitive function was the dependent variable, only the education level and age were significantly correlated with it. This study has limitations with respect to generalizing the results because research was limited to a local area and especially because the levels of vitamin D and calcium may be temporarily affected by dietary habits and dietary intake at the time of investigation. Thus, we believe there were limitations in investigating the effects of vitamin D and calcium on depression and cognitive function, and we suggest that repeated research should be conducted by expanding the subjects, a prospective cohort study should be conducted instead of a cross-sectional study, and an ex-

perimental study should be carried out to investigate the changes in depression and cognitive function after supplementation of vitamin D and calcium. In addition, since it was confirmed that the elderly living alone in urban areas were deficient in vitamin D and calcium, it is suggested that education about increasing the intake of foods known as good food sources of vitamin D and calcium and activities to increase sun exposure should be included in the education for older people living alone in urban areas conducted by nurses and health care workers in local communities.

CONCLUSION

In this study, it was confirmed that the worse the perceived health status, the higher the level of depression, and the higher the age and the lower the education level, the lower the cognitive function. However, the effects of vitamin D and calcium on depression and cognitive function were not confirmed in this study. Based on the results of the study, the following suggestions are presented. First, since this study was conducted in a limited local area with a limited number of elderly people living alone who visited senior centers in a single city, it is suggested that a prospective cohort study should be conducted in the future to expand the area and the target population. Second, we suggest an experimental study to confirm changes in depression and cognitive function of elderly living alone after supplementing vitamin D and calcium. Third, it is suggested that older people living alone in urban areas should be educated to increase the intake of foods known as good food sources of vitamin D and calcium and also increase activities that can increase the sun exposure time. Fourth, it is proposed that when health promotion programs of the local community are implemented, the depression intervention program should be performed for elderly people who live alone and perceive their health status to be poor and the cognitive intervention program should be conducted for elderly people living alone at very high ages with a low educational level.

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