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보건학석사 학위논문

**Associations between
Noncommunicable Diseases (NCDs),
Mental Health and Multimorbidity
Using Korea Health Panel Data (KHP)**

한국의료패널을 이용한 비전염성질환 (NCDs)과
정신건강문제 및 다중이환 (Multimorbidity)의
연관성 연구

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Abstract

OBJECTIVE: To explore the association between multimorbidity of NCDs and mental health problems.

METHODS: Based on the 2019 Korea Health Panel Data (KHP), a total of 14,741 participants were included in the study. Among them, 4,465 individuals were aged 65 years or older. Excluding those diagnosed with depression or bipolar disorder, the final sample size for analysis was 4,135. The exposure variables were noncommunicable diseases (NCDs), which were determined as positive or negative based on physician-diagnosed presence or absence of each disease at the time of the survey. The NCDs include hypertension, diabetes mellitus, malignant neoplasm, cardiovascular disease, and chronic respiratory disease. The outcome variables focused on mental health problems, including stress, depression, anxiety, suicidal ideation, and medication use for mental health issues. Sociodemographic variables such as gender, age, marital status, and education level, along with health behavior variables including smoking, alcohol consumption, physical activity, and BMI were considered as confounding variables. All were categorized into binary variables to assess the statistical significance of the association between exposure and outcome variables. This study is an analytical epidemiology research conducted in the form of a cross-sectional study. Logistic regression analysis using R software (ver. 4.2.2) was performed to examine the relationship between NCDs and mental health problems. Odds ratio (OR) with 95% confidence intervals (CI) were calculated to determine the strength of the association.

RESULTS: The analysis indicated that a greater proportion of individuals with NCDs reported experiencing stress. Moreover, as the number of NCDs in multimorbidity increased, there was a notable increase in the prevalence of medication use for mental health issues. However, no significant correlation was found between multimorbidity and stress, depression, anxiety or suicidal ideation. When adjusting for confounding variables, the logistic regression analysis revealed that the prevalence of mental health problems was higher in women, individuals who were widowed, divorced, or single, those with education levels below junior high, smokers, drinkers, individuals who did not engage in regular physical activity, and individuals with multimorbidity of NCDs. The association between medication use for mental health issues and the presence of mental health problems was found to be significant. Additionally, the duration of noncommunicable diseases (NCDs) revealed that younger individuals diagnosed with hypertension had a higher correlation with stress and anxiety.

CONCLUSIONS: The study revealed a significant correlation between the use of medications for mental health problems and the presence of multiple NCDs. Moreover, individuals with longer durations of NCDs exhibited higher levels of stress and anxiety. Importantly, prolonged use of medications for NCDs and disease-specific treatments can give rise to both disease-drug interactions and drug-drug interactions. These interactions may result in reduced adherence to medication regimens and the occurrence of side effects. This finding highlights the necessity for a comprehensive treatment approach that addresses both NCDs and mental health problems in the elderly population aged 65 and above. Implementing an integrated treatment system

would not only help minimize polypharmacy but also optimize the effectiveness of disease management, leading to improved overall well-being and high quality of life for the elderly.

Keyword: Noncommunicable diseases, Multimorbidity, Mental health, Medication, Drug-Drug interaction (DDI)

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Chapter 1. Introduction

1.1 Background

South Korea's life expectancy exceeded the OECD average in 2001. Life expectancy continues to increase while the total fertility rate is decreasing, which is expected to result in a decrease in the overall population size and an increase in the proportion of elderly population. According to the 2020 Population Projection Statistics report provided by the Korean Statistical Office, the median life expectancy by gender was 80.5 years for men and 86.5 years for women, and is expected to increase to 89.5 years for men and 92.8 years for women by 2070. The increase in life expectancy affects the size and structure of the future population. Along with the increase in life expectancy, medical progress is one of the factors accelerating the aging of South Korea's population.¹

The proportion of the elderly population aged 65 and over in 2020, 2030, and 2070 is expected to increase from 81,520,000 people (15.7%) to 130,560,000 people (25.5%), and 174,730,000 people (46.4%), respectively. The proportion of the elderly population is expected to increase, while in contrast, the working-age population, defined as those aged 15-64, is expected to decrease from 373,800,000 people (72.1%) in 2020 to 173,700,000 people (46.1%) in 2070.¹ These social demographic features lead to a geometric increase in the elderly dependency ratio of the working-age population.^① The increasing elderly population and decreasing working-age population can impose an economic burden on healthcare systems. To alleviate the economic burdens, it is important to focus on disease prevention, early

^① The elderly dependency ratio is the ratio of the population aged 65 and over to every 100 people in the working-age population (aged 15-64). (Elderly dependency ratio = (Population aged 65 and over ÷ Working-age population aged 15-64) × 100)

treatment, and improving the efficiency of healthcare services.

Entering into an aging society due to increasing life expectancy and the proportion of elderly population have a significant impact on diseases. Noncommunicable diseases (NCDs) are not caused by viruses or bacteria, but instead are a result of complex interactions between genetic, physiological, environmental, and behavioral factors which persist for a long time.^② The most common NCDs are hypertension, diabetes, cancer, heart diseases, and respiratory diseases.²

NCDs cause 41,000,000 deaths annually (WHO, 2022), accounting for 74% of all deaths worldwide.³ When looking at the distribution of NCDs, the majority of deaths are attributed to cardiovascular diseases, accounting for 17,900,000 fatalities annually. Cancer follows behind with 9,300,000 deaths, followed by chronic respiratory diseases at 4,100,000 and diabetes at 200,000 including diabetic nephropathy deaths.² Chronic diseases were responsible for 79.6% of all deaths in South Korea (KOSTAT, 2021), with cardiovascular diseases (54,176 deaths, 17.0%), diabetes (8,961 deaths, 2.8%), chronic respiratory diseases (14,005 deaths, 4.4%) and malignant neoplasms (82,688 deaths, 26.0%).

WHO stated that tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol as risk factors for NCDs and recommends addressing certain risk factors to prevent NCDs.³ However, National Health Statistics 2020 by KDCA (Korea Disease Control and Prevention Agency) indicates that the management of these risk factors for NCDs is generally stagnant or inadequate.⁴ Inadequate management of risk factors for NCDs leads to development of multiple chronic conditions, also known as multimorbidity.⁵ Multimorbidity is defined as an individual having multiple diseases at the same time, which is different from comorbidity.^{6,7} The majority of population aged 60 and over have multimorbidity.⁸ The effective management of multimorbidity holds significant importance from a therapeutic standpoint. The treatment regimen to patients with multimorbidity for

^② Noncommunicable diseases (NCDs) are also known as chronic diseases.

each NCDs leads to polypharmacy.^③ Polypharmacy makes low adherence of medication. This results in negative outcomes for patients, including disease progression, increased costs for unplanned hospitalization, and adverse drug reactions.⁹ Thus, comprehensive care is crucial for elderly patients with multimorbidity.

In addition to NCDs, considering mental health problems in the elderly is a vital concern that needs to be addressed in aging societies. It is important to address both physical functional impairments and mental health problems when considering diseases that may occur in the elderly population. A report by WHO indicates that mental and neurological disorders affect over 20% of the elderly population aged 60 and above. Dementia and depression are commonly observed disorders among the elderly population, with a prevalence rate of approximately 5% and 7% respectively worldwide.¹⁰

According to Bäckman et al. (2005), depression can lead to physical and cognitive functional impairments in the daily lives of the elderly population. Mental health problems such as depression in the elderly population are frequently overlooked and not properly treated when patients have other health conditions. Numerous studies have shown that depression in the elderly can affect the management of NCDs.¹¹ Boing et al. (2012), the prevalence of depression in the study population was 16.2%. Individuals with one chronic disease had a 1.58-fold higher prevalence of depression compared to those without any diseases. Moreover, those with two or more chronic diseases had a 125% higher prevalence of depression than those without any. According to this study, there is a correlation between the increasing number of chronic diseases and the prevalence of depression.¹² Farooq et al. (2019) conducted a study to examine the frequency of depressive and anxiety symptoms in individuals with NCDs and identified the factors associated with the presence of these symptoms. 27.4% of the 2,867

^③ Polypharmacy is defined as five or more medications.¹³

participants reported experiencing symptoms of anxiety and depression. Multivariate logistic regression analysis revealed that the presence of multimorbidity, female, lower education level, having more children, and visiting a faith healer were significant factors associated with anxiety and depressive symptoms. It is crucial to consider the intersectionality of various factors when examining the development of mental health problems in individuals with NCDs.¹⁴ Thus, taking medication for treatment should be taken into consideration as it plays a significant role in relieving symptoms of NCDs and addressing mental health problems.

Commonly prescribed medications for depression are Selective Serotonin Reuptake Inhibitors (SSRIs), Serotonin-Norepinephrine Reuptake Inhibitors (SNRIs), and Norepinephrine-Dopamine Reuptake Inhibitors (NDRIs).¹⁵ Common side effects to antidepressants include dizziness and headaches. However, hyponatremia may occur rarely in the elderly. Sodium is a vital electrolyte in the human body but when its concentration becomes too low, it can lead to significant side effects such as vomiting, muscle weakness, and, in severe cases, coma.¹⁶ According to Zhang et al. (2009), elderly patients with depression are more likely to experience medication side effects. The study also demonstrated that preventing and managing depression can help reduce the incidence of these side effects.¹⁷ Therefore, it is crucial to consider when prescribing medications to the elderly population with mental health problems.¹⁷

Recently, a case of hyperglycemia after taking quetiapine for symptom relief in bipolar disorder was reported to the Korean Pharmaceutical Association (KPA). Second-generation atypical antipsychotic drugs such as quetiapine may cause weight gain and increase the risk of hyperglycemia.¹⁸ Quetiapine is one of the antipsychotic drugs that should be considered when prescribing it to patients with a risk of high blood sugar, obesity, or diabetes.¹⁹ Similarly, beta blockers are commonly used as anxiolytics to treat symptoms such as palpitations and tremors.

However, they are contraindicated in patients with asthma because they can worsen the symptoms.²⁰

Existing research and clinical outcomes indicate that caution is needed when prescribing medication for NCDs and mental health problems in the elderly population. Drug-drug interaction (DDI) refers to the phenomenon where the effects of one drug are altered when it is taken in combination with another drug.²¹ The most common drug interactions occur among medications that target the cardiovascular system, corticosteroids, antibiotics, antidepressants, antipsychotics, immunosuppressants, and opioids.²² Antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs) like sertraline and fluvoxamine, have the potential to increase the risk of bleeding when used in combination with antiplatelet medications or anticoagulants such as warfarin.²³⁻²⁶ SSRIs can inhibit the reuptake of serotonin in platelets, which can impair platelet function and aggregation. This effect, combined with the antiplatelet or anticoagulant, can lead to an increased risk of bleeding. Bipolar disorder medications such as valproic acid and lithium can interact with ACE inhibitors or angiotensin receptor blockers (ARBs), which are commonly used to treat hypertension and certain cardiac conditions. The combination use of these medications can reduce renal blood flow and impair the excretion of lithium. As a result, lithium levels in the body can increase, potentially leading to lithium toxicity.²³⁻²⁶ Haloperidol, which is a first-generation antipsychotic medication, has the potential to prolong the QT interval on an electrocardiogram (ECG), which can lead to a specific type of life-threatening arrhythmia called Torsades de Pointes (TdP). This risk is increased when haloperidol is used with other medications that also have QT-prolonging effects or in patients with underlying cardiac conditions.²³⁻²⁶

Conclusively, it is crucial to take a multidisciplinary approach to treating diseases, especially in elderly patients with NCDs. This approach should consider potential drug-drug interactions (DDIs) that may occur due to polypharmacy.

1.2 Objectives

The main purpose of this study is to explore the association between multimorbidity of NCDs and mental health problems. Previous studies have mainly focused on specific mental health problem, which is depression, associated with NCDs. Moreover research has been conducted extensively on younger populations in low- and middle-income countries.^④ This study focused on the elderly aged 65 or above, considering NCDs with mental health problems such as not only depression but also anxiety, stress, suicidal ideation, and medication use for mental health issues. The purpose of this study can be summarized into three main objectives as follows:

Firstly, to explore the association between NCDs and mental health problems, focusing on depression, stress, anxiety, suicidal ideation, and medication use related to mental health issues.

Secondly, to examine the association between the number of NCDs and mental health problems while controlling for confounders such as gender, age, marital status, education level, smoking, alcohol consumption, physical activity, and BMI.

Finally, to investigate the association between the duration of NCDs and mental health factors.

This study stands out for its unique approach in analyzing the results based on the duration of NCDs, which adds a comprehensive dimension to the investigation. In contrast to most studies that either combine all age groups or focus on specific age ranges, this research takes a meticulous approach by segmenting the data according to the duration of prevalence through age at diagnosis. As a result, this study

^④ According to the WHO, NCDs disproportionately affect people in low- and middle-income countries, where more than three quarters of global NCD deaths (31,400,000) occur.

distinguishes itself by conducting a thorough analysis of the relationship between physical diseases considering the duration of NCDs and mental health factors.

Underlying mental health problems have been associated with an increased risk of NCDs.²⁷ In many previous studies highlight the importance of targeted prevention and treatment of mental health and NCDs integratively in order to reduce the burden of multimorbidity.²⁸ The aim of this study is to establish a foundation for an integrated healthcare approach for managing NCDs and mental health problems in elderly populations, resulting in improved well-being and quality of life through effective healthcare management. Also the utilization of this distinct methodology and the emergence of significant analytical outcomes make this research particularly noteworthy, offering valuable insights to researchers in relevant fields.

Chapter 2. Methods

2.1 Data Sources and Study Populations

The annual data from the Korea Health Panel Data (KHP) for the year 2019 (Version 2.0.1) was obtained by submitting a data usage agreement to KHP and receiving it via email after approval. KHP survey is a government approved statistic, conducted by the Korea Institute for Health and Social Affairs (KIHASA) and the National Health Insurance Service (NHIS) since 2008, and is designated as official statistics (Approval No. 920012). The sample households for the second wave of the KHP were selected by extracting sample survey units (clusters) in the first stage, and then extracting sample households within the sample survey units using stratified cluster sampling method in the second stage. The total number of survey units was about 700, and the average sample size by 17 regions was about 500 households per region with the maximum allowable error at a 95% confidence level.

The second wave of the KHP was conducted in 2019 and included a total of 14,741 participants. Of these, 4,465 individuals were aged 65 years or older which included in this study. Age of household members used in this study was calculated by subtracting the birth year from the survey year (2019) and then grouped into six categories based on five-year intervals starting from 65 years old and up to 90 years old. The composition of each age group is presented below.

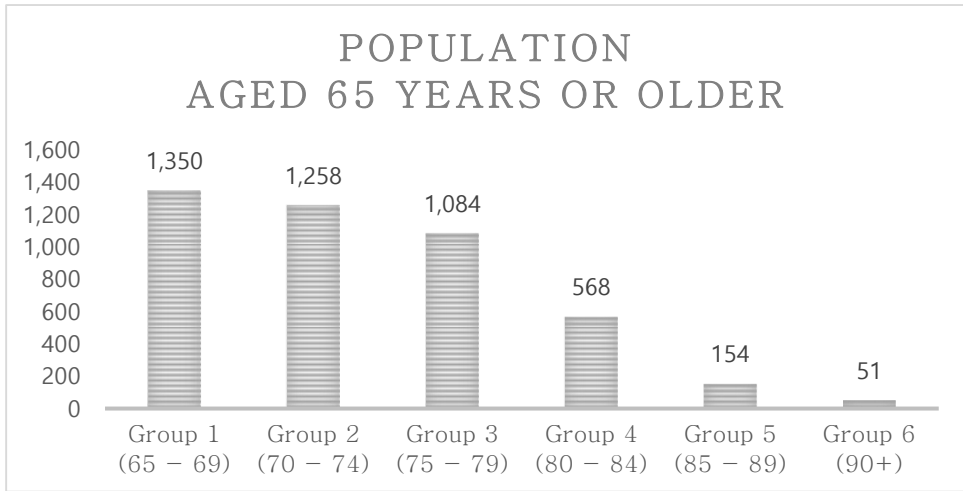


Figure 1. Population of elderly aged 65 years or older

Based on Figure 1, the population of people in group 1 was the highest with 1,350 individuals, while it decreased by almost half in group 4 after reaching 1,084 in group 3. The population of those aged 90 years and older was 51.

Excluding patients who responded "Yes" to the NCDs questionnaire on depression or bipolar disorder, which could confound the association between exposure and outcome variables, the population of elderly aged 65 years or older was 4,135. Populations with specific conditions were grouped into six categories by five-year interval starting from 65 years old up to 90 years old. The composition of the population in each group is as follows.

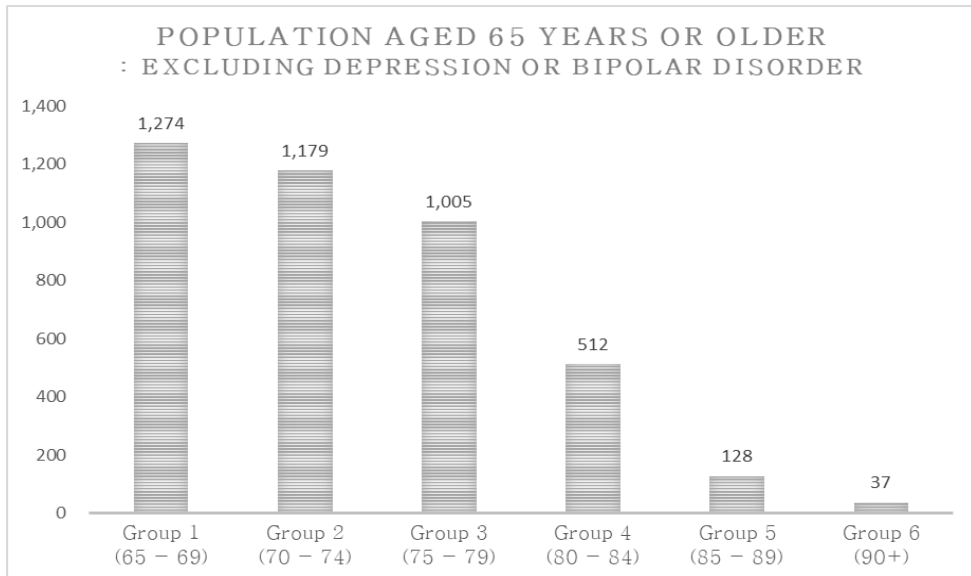


Figure 2. Population of elderly aged 65 years or older
: Excluding patients diagnosed with depression or bipolar disorder

Based on Figure 2, excluding individuals diagnosed with depression or bipolar disorder, the number of population slightly decreased in each age group. The highest number of population was in group 1 with 1,274, and there was a sharp decline in population from group 3 to group 4. The smallest number of population was 37 in group 6.

2.2 Measurement

2.2.1 Study Design

Exposure Variables: Noncommunicable Diseases (NCDs)

NCDs were defined as positive or negative based on the presence or absence of each disease according to the diagnosis of a physician at the time of the survey.

NCDs, which have high prevalence rates in South Korea, include hypertension, diabetes mellitus, malignant neoplasm, cardiovascular disease, and chronic respiratory disease. Malignant neoplasm was defined as positive if the participant had been diagnosed with any of the following: stomach cancer, colon cancer, lung cancer, breast cancer, cervical cancer, thyroid cancer, or other types of cancer. Similarly, cardiovascular disease was defined as positive if the participant had been diagnosed with any of the following: angina pectoris, myocardial infarction, cerebral hemorrhage, or cerebral infarction. Chronic respiratory disease was defined as positive if the participant had been diagnosed with any of the following: asthma, emphysema, chronic obstructive pulmonary disease, or bronchiectasis.

Outcome Variables: Mental Health Problems

Mental health problems include stress, depression, anxiety, suicidal ideation, and medication use for mental health issues. The stress variable was measured on a four-point scale, consisting of "Very much", "Much", "Somewhat", and "Almost not". Depression, anxiety, and suicidal ideation variables were defined as positive or negative based on the presence or absence of symptoms. Medication use for mental health issues variable has three response options: "Positive", "Negative", and "No mental health problems".

Confounding variables

Confounding variables are factors that can distort the association between exposure and outcome variables. In this study, sociodemographic and health behavior variables were identified as confounding variables. Sociodemographic variables included gender, age, marital status, and education level, while health behavior variables included smoking, alcohol consumption, physical activity, and BMI. The response options for each variable were as follows:

- Marital status: Married and living together, married but not living together, widowed, divorced, never married, refused to answer.

- Education level: No education received, elementary school, middle school, high school, university/college, graduate school.
- Smoking (lifetime): Less than 100 cigarettes, 100 cigarettes or more, never smoked.
- Alcohol (frequency in the past year): Has never drink alcohol, hasn't had a drink in the past year, less than once a month, once a month, 2-4 times a month, 2-3 times a week, 4 or more times a week, almost every day.
- Physical activity (regular exercise in the past year): Regularly exercise, do not regularly exercise.
- BMI_Weight Status: Under 18.5_Underweight, 18.5 - 24.9_Healthy Weight, 25.0 - 29.9_Overweight, 30.0 or above_Obesity.

2.2.2 Subgroup Analysis

Variables conducted categorization to evaluate the statistical significance of the association between exposure and outcome variables. NCDs were classified into positive and negative based on the prevalence of NCDs. The age of diagnosis for NCDs was categorized as follows: 19 years and below, 20-29 years, 30-49 years, 50-64 years (coded as 0), and 65 years and above (coded as 1). In the mental health problems variable, the following categories were used.

- Stress: "Very much", "Much" as positive while "Somewhat", "Almost not" as negative.
- Depression, anxiety, and suicidal ideation: positive or negative.
- Medication use for mental health issues: "Positive" as positive while "Negative", "No mental health issues" as negative.

Sociodemographic and health behavior variables were also adjusted. To conduct logistic regression analysis, most of the confounding variables were transformed into binary categorical variables. Among the sociodemographic variables, age was

categorized into five-year intervals starting at 65 years old and up to 80 years old. Marital status was classified as “Married and living together” if the respondent had a spouse, and “No spouse” otherwise. Education level was divided as middle school or higher and less than middle school, with middle school serving as the cutoff point. For health behavior variables such as smoking and alcohol consumption respondents were categorized as 'never' or 'ever' depending on whether they had engaged in the behavior at least once. Physical activity was categorized into "Do not regularly exercise" and "Regularly exercise". Lastly, BMI was divided into two groups: below 25 and 25 or higher, with 25 as the cutoff point.

2.3 Statistical Analysis

R software (ver. 4.2.2) and Microsoft Excel 2016 were used to analyze the study population. Descriptive statistics were used to summarize basic characteristics of participants. The number of participants and percentages (%) were indicated for exposure and outcome variables. To examine the relationship between NCDs and mental health problems, logistic regression analysis was conducted. The magnitude of the association between NCDs and mental health problems was assessed through odds ratio (OR) with 95% confidence intervals (CI). Variables having p-value \leq 0.05 in the analysis were considered as statistically significant.

2.4 Ethics Statement

Seoul National University Research Ethics Team obtained IRB exemption approval for this study based on Article 13, Section 1, Clause 3 of the Enforcement Rules of the Bioethics and Safety Act and the utilization of pre-existing data from the KHP of the KIHASA. (Approval number: IRB No. E2303/004-011)

Chapter 3. Results

A total of 4,135 participants provided responses regarding NCDs, but data from only 4,048 participants were used in the analysis of the health behavior variables questionnaire. Among the total of 4,135 participants, 2,303 were diagnosed with hypertension. The number of participants diagnosed with diabetes mellitus was 994, with malignant neoplasm being 310, cardiovascular disease being 666, and chronic respiratory disease being 152. The population diagnosed with hypertension was the largest, followed by diabetes mellitus, cardiovascular disease, malignant neoplasm, and chronic respiratory disease. Table 1 shows the sociodemographic and health behavior characteristics of NCDs.

The study examined the demographic characteristics of NCDs and mental health problems in the elderly population aged 65 and over. A cross table analysis was conducted to identify correlations between NCDs and mental health problems. Logistic regression analysis was employed to determine the association between NCDs and mental health problems, with adjusted values presented for gender and age. The odds ratios (OR) were also presented, adjusted for the number of NCDs, gender, age, marital status, education level, smoking, alcohol consumption, physical activity, and BMI. Statistically significant values at a 95% confidence intervals are denoted in bold in the table.

	Hypertension		Diabetes mellitus		Malignant neoplasm		Cardiovascular disease		Chronic respiratory disease	
	Positive (n)	Negative (n)	Positive (n)	Negative (n)	Positive (n)	Negative (n)	Positive (n)	Negative (n)	Positive (n)	Negative (n)
Sex										
Male	982	42,64	455	45,77	1,424	45,34	344	51,65	1,535	44,25
Female	1,321	57,36	935	51,04	54,23	1,717	54,66	322	48,35	1,934
Age										
65 - 69	624	27,10	650	35,48	302	30,38	972	30,95	143	21,47
70 - 74	649	28,18	530	28,93	264	26,56	915	29,13	89	28,71
75 - 79	602	26,14	403	22,00	278	27,97	727	23,15	75	24,19
80 - 84	315	13,68	197	10,75	113	11,37	399	12,70	50	16,13
85 - 89	87	3,78	41	2,24	31	3,12	97	3,09	6	1,94
90 +	26	1,13	11	0,60	6	0,60	31	0,99	4	1,29
Marital status										
Married and living together	1,523	66,13	1,354	73,91	657	66,10	2,220	70,68	223	71,94
Married, not living together	23	1,00	15	0,82	5	0,50	33	1,05	1	0,32
Widowed	651	28,27	377	20,58	270	27,16	758	24,13	72	23,23
Divorced	91	3,95	67	3,66	48	4,83	110	3,50	9	2,90
Never married	14	0,61	19	1,04	13	1,31	20	0,64	5	1,61
Refused to answer	1	0,04	0	0,00	1	0,10	0	0,00	0	0,00
Education level										
No education received	283	12,29	169	9,22	114	11,47	338	10,76	35	11,29
Elementary school	922	40,03	683	37,28	378	38,03	1,227	39,06	123	39,68
Middle school	467	20,26	386	21,07	203	20,63	648	20,63	66	21,29
High school	462	20,06	419	22,87	208	20,93	673	21,43	65	20,97
University/College	145	6,30	151	8,24	78	7,85	218	6,94	18	5,81
Graduate school	24	1,04	24	1,31	11	1,11	37	1,18	3	0,97
Smoking										
Less than 100 cigarettes	32	1,39	23	1,26	17	1,71	38	1,21	4	1,29
100 cigarettes or more	735	31,91	659	35,97	363	36,52	1,031	32,82	122	39,35
Never smoked	1,493	64,83	1,106	60,37	593	59,66	2,006	63,87	164	52,90
Alcohol										
Has never drunk alcohol	1,065	46,24	799	43,61	443	44,57	1,421	45,24	115	37,10
Hasn't had a drink in the past year	327	14,20	266	14,52	174	17,51	419	13,34	87	28,06
Less than once a month	202	8,77	171	9,33	84	8,45	289	9,20	25	8,06
Once a month	112	4,86	95	5,19	47	4,73	160	5,09	18	5,81
2-4 times a month	228	9,90	158	8,62	92	9,26	294	9,36	17	5,48
2-3 times a week	164	7,12	134	7,31	72	7,24	226	7,20	13	4,19
4 or more times a week	47	2,04	44	2,40	16	1,61	75	2,39	1	0,32
Almost every day	115	4,99	121	6,60	45	4,53	191	6,08	14	4,52
Physical activity										
Regularly exercise	1,280	55,58	1,047	57,15	559	56,24	1,768	56,29	159	51,29
Do not regularly exercise	980	42,55	741	40,45	414	41,65	1,307	41,61	131	42,26
BMI Weight Status										
Under 18.5 Underweight	57	2,48	121	6,60	29	2,92	149	4,74	14	4,52
18.5 - 24.9 Healthy Weight	1,439	62,48	1,279	69,81	611	61,47	2,107	67,08	191	61,61
25.0 - 29.9 Overweight	680	29,53	372	20,31	299	30,08	753	23,97	77	24,84
30.0 or above Obesity	84	3,65	16	0,87	34	3,42	66	2,10	8	2,58

Table 1. Sociodemographic and Health Behavior Characteristics of NCDs (N = 4,135)

Among the elderly population, hypertension (n = 2,303) accounted for the highest proportion of the NCDs, followed by diabetes mellitus (n=994), cardiovascular disease (n=666), malignant neoplasm (n=310), and chronic respiratory disease (n=152). The proportion of males diagnosed with hypertension was 42.64%, while that of females was 57.36%. Diabetes mellitus (45.77% for males and 54.23% for females), cardiovascular disease (51.65% for males and 48.35% for females), malignant neoplasm (53.55% for males and 46.45% for females), and chronic respiratory disease (53.95% for males and 46.05% for females) were results of NCDs in the elderly population. Hypertension was most prevalent in age group 1 (27.10%) and age group 2 (28.18%), while diabetes mellitus was most prevalent in age group 1 (30.38%), malignant neoplasm in age group 2 (28.71%), cardiovascular disease in age group 3 (27.63%), and chronic respiratory disease in age group 3 (28.95%). The highest prevalence of NCDs was observed among the elderly population in age group 1 and 2.

The prevalence of NCDs in health behavior variables, excluding individuals who have never smoked, was as follows: hypertension (31.91%), diabetes mellitus (36.52%), malignant neoplasm (39.35%), cardiovascular disease (42.19%), and chronic respiratory disease (49.34%). These conditions were most prevalent among those who had smoked 100 cigarettes or more in their lifetime. When considering recent alcohol consumption frequency, excluding individuals who have never drunk alcohol or haven't had a drink in the past year, a higher proportion of the study population reported drinking alcohol 2-4 times a month in cases of hypertension (9.90%), diabetes mellitus (9.26%), and cardiovascular disease (7.96%). The prevalence of NCDs was similar among the study population who reported regularly exercising and those who did not engage in sports or regular exercise. When considering BMI variable, it showed a higher prevalence of NCDs among individuals with a healthy weight (BMI 18.5 - 24.9).

Among the study population aged 65 years and older who responded "Yes" to stress (Very much=64.60%, Much=61.92%), depression (70.59%), anxiety (67.45%), suicidal ideation (63.17%), and medication use for mental health issues (64.40%), female had a relatively higher proportion than male. In age group 1 showed a higher proportion of stress (Very much=33.63%, Much=32.72%) and depression (29.41%), suicidal ideation (30.48%) while in age group 2 showed a higher proportion of anxiety (28.77%) and medication use for mental health issues (28.80%). In the marital status, the population categorized as "Married and living together" responded negatively to questions regarding depression (70.74%), anxiety (70.31%), suicidal ideation (70.83%), and medication use for mental health issues (62.27%).

The prevalence of mental health problems in health behavior variables, excluding individuals who have never smoked, was as follows: stress (Very much=30.09%, Much=28.91%), depression (25.26%), anxiety (25.47%), suicidal ideation (30.16%), and medication use for mental health issues (31.41%) were most prevalent among those who had smoked 100 cigarettes or more in their lifetime. The study population who do not regularly exercise in the past year had a higher proportion of stress (Much=55.29%), depression (55.02%) and anxiety (52.83%). When considering BMI variable, it showed a higher prevalence of mental health problems among individuals with a healthy weight (BMI 18.5 - 24.9). Inconsistent results were observed among individuals aged 65 years and older who responded "Yes" to each mental health problem variables.

In the cross table analysis, a higher proportion of patients with NCDs reported experiencing stress. The study population with hypertension reported a higher proportion of stress (54.32%) but a lower proportion of depression (3.98%), anxiety (2.99%), suicidal ideation (4.42%), and medication use for mental health issues (3.09%). For patients with diabetes mellitus, the proportions of stress (23.32%), depression (1.90%), anxiety (1.46%), suicidal ideation (2.30%), and medication use for mental health issues (1.43%) were reported. Patients with malignant neoplasms reported stress (6.92%), depression (0.74%), anxiety (0.54%), suicidal ideation (0.74%), and medication use for mental health issues (0.49%). Patients with cardiovascular disease reported stress (15.24%), depression (1.43%), anxiety (1.11%), suicidal ideation (1.26%), and medication use for mental health issues (0.79%). Patients with chronic respiratory disease reported stress (3.56%), depression (0.35%), anxiety (0.27%), suicidal ideation (0.42%), and medication use for mental health issues (0.47%). The number of NCDs in multimorbidity increased, there was an increasing trend in depression, anxiety, suicidal ideation, and medication use for mental health issues. However, there was no proportional relationship observed between multimorbidity and stress.

Beside the fact that study population reported a higher proportion of stress in prevalence of NCDs, some notable findings were observed in other mental health problems. In depression variable, relatively higher rates were observed in individuals with hypertension (3.98%). For suicidal ideation, relatively higher rates were found in individuals with hypertension (4.42%) and diabetes mellitus (2.30%). Lastly, in the context of medication use for mental health issues, chronic respiratory disease (0.47%) exhibited a relatively higher prevalence.

The following tables present the results of logistic regression analyses examining the associations between NCDs and each mental health problems. Unadjusted logistic regression results are provided, as well as the results from logistic regression analyses adjusted for confounding variables such as gender and age.

Statistically significant values at the 95% confidence intervals are indicated in bold.

Variables	Label	Stress			
		Unadjusted odds ratio		Adjusted odds ratio	
		OR	95% CI	OR	95% CI
Hypertension		0.91	[0.78, 1.06]	0.89	[0.77, 1.04]
Sex	Male				
	Female			1.47 ***	[1.26, 1.73]
Age	65 - 69				
	70 - 74			0.94	[0.77, 1.14]
	75 - 79			1.04	[0.85, 1.27]
	80 +			0.76 *	[0.59, 0.97]
Diabetes mellitus		1.04	[0.87, 1.24]	1.03	[0.86, 1.24]
Sex	Male				
	Female			1.46 ***	[1.25, 1.71]
Age	65 - 69				
	70 - 74			0.93	[0.77, 1.14]
	75 - 79			1.02	[0.83, 1.25]
	80 +			0.75 *	[0.58, 0.96]
Cardiovascular disease		1.11	[0.90, 1.36]	1.18	[0.95, 1.45]
Sex	Male				
	Female			1.47 ***	[1.26, 1.72]
Age	65 - 69				
	70 - 74			0.93	[0.76, 1.13]
	75 - 79			1.01	[0.83, 1.24]
	80 +			0.73 *	[0.57, 0.94]
Chronic respiratory disease		0.85	[0.55, 1.28]	0.89	[0.57, 1.35]
Sex	Male				
	Female			1.46 ***	[1.25, 1.71]
Age	65 - 69				
	70 - 74			0.93	[0.77, 1.14]
	75 - 79			1.03	[0.84, 1.26]
	80 +			0.75 *	[0.58, 0.96]
Malignant neoplasm		1.25	[0.93, 1.64]	1.29	[0.97, 1.71]
Sex	Male				
	Female			1.47 ***	[1.26, 1.72]
Age	65 - 69				
	70 - 74			0.93	[0.76, 1.13]
	75 - 79			1.03	[0.84, 1.26]
	80 +			0.75 *	[0.58, 0.95]

Table 4. Logistic Regression Analysis between Stress and NCDs

In the logistic regression analysis, unadjusted results did not show statistical significance between NCDs and stress. Age variable was grouped into 5-year intervals starting from 65 years old, and those aged 80 years and above were combined into a single group for adjustment.

Adjusted results revealed that for each NCDs, females with hypertension (OR = 1.47), diabetes mellitus (OR=1.46), cardiovascular disease (OR=1.47), chronic respiratory disease (OR=1.46) or malignant neoplasm (OR=1.47) were more likely to experience stress than males ($p<0.001$). Among the study population aged 80 or above with NCDs who reported experiencing stress showed statistical significance with hypertension (OR = 0.76), diabetes mellitus (OR=0.75), cardiovascular disease (OR=0.73), chronic respiratory disease (OR=0.75) or malignant neoplasm (OR=0.75). Overall, stress is associated with NCDs, especially in females and in individuals aged 80 or above.

Variables	Label	Depression			
		Unadjusted odds ratio		Adjusted odds ratio	
		OR	95% CI	OR	95% CI
Hypertension		1.00	[0.78, 1.27]	0.94	[0.73, 1.20]
Sex	Male				
	Female			2.09 ***	[1.61, 2.72]
Age	65 - 69				
	70 - 74			1.03	[0.75, 1.41]
	75 - 79			1.28	[0.93, 1.77]
	80 +			1.08	[0.73, 1.57]
Diabetes mellitus		1.16	[0.88, 1.52]	1.16	[0.88, 1.51]
Sex	Male				
	Female			2.09 ***	[1.61, 2.71]
Age	65 - 69				
	70 - 74			1.03	[0.74, 1.41]
	75 - 79			1.27	[0.92, 1.74]
	80 +			1.07	[0.73, 1.56]
Cardiovascular disease		1.37 *	[1.00, 1.83]	1.47 *	[1.04, 1.92]
Sex	Male				
	Female			2.11 ***	[1.63, 2.75]
Age	65 - 69				
	70 - 74			1.01	[0.73, 1.39]
	75 - 79			1.24	[0.70, 1.70]
	80 +			1.01	[0.69, 1.48]
Chronic respiratory disease		1.35	[0.73, 2.28]	1.41	[0.77, 2.41]
Sex	Male				
	Female			2.09 ***	[1.61, 2.72]
Age	65 - 69				
	70 - 74			1.02	[0.74, 1.40]
	75 - 79			1.27	[0.92, 1.74]
	80 +			1.06	[0.72, 1.54]
Malignant neoplasm		1.56 *	[1.03, 2.29]	1.65 *	[1.11, 2.48]
Sex	Male				
	Female			2.11 ***	[1.63, 2.75]
Age	65 - 69				
	70 - 74			1.02	[0.74, 1.40]
	75 - 79			1.27	[0.93, 1.75]
	80 +			1.07	[0.73, 1.55]

Table 5. Logistic Regression Analysis between Depression and NCDs

In the logistic regression analysis between NCDs and depression revealed that patients with cardiovascular disease were 1.37 times more likely to experience depression than those without ($p < 0.05$). Also patients with malignant neoplasm were 1.56 times more likely to experience depression than those without ($p < 0.05$).

After adjusting for gender and age, the results showed that female with hypertension (OR=2.09), diabetes mellitus (OR=2.09), cardiovascular disease (OR=2.11), chronic respiratory disease (OR=2.09) or malignant neoplasm (OR=2.11) were more likely to experience depression than male, while age did not show statistically significant. However, patients with cardiovascular disease were 1.47 times more likely to experience depression than those without ($p < 0.05$). Similarly patients with malignant neoplasm were 1.65 times more likely to experience depression than those without ($p < 0.05$).

		Anxiety			
Variables	Label	Unadjusted odds ratio		Adjusted odds ratio	
		OR	95% CI	OR	95% CI
Hypertension		1.05	[0.80, 1.40]	0.99	[0.75, 1.31]
Sex	Male				
	Female			1.77 ***	[1.32, 2.38]
Age	65 - 69				
	70 - 74			1.21	[0.83, 1.76]
	75 - 79			1.38	[0.94, 2.01]
	80 +			1.38	[0.89, 2.11]
Diabetes mellitus		1.23	[0.90, 1.67]	1.23	[0.90, 1.67]
Sex	Male				
	Female			1.77 ***	[1.32, 2.38]
Age	65 - 69				
	70 - 74			1.21	[0.83, 1.76]
	75 - 79			1.36	[0.93, 1.99]
	80 +			1.38	[0.89, 2.11]
Cardiovascular disease		1.46 *	[1.03, 2.04]	1.47 *	[1.03, 2.07]
Sex	Male				
	Female			1.79 ***	[1.34, 2.41]
Age	65 - 69				
	70 - 74			1.19	[0.82, 1.73]
	75 - 79			1.33	[0.91, 1.95]
	80 +			1.30	[0.84, 1.99]
Chronic respiratory disease		1.44	[0.73, 2.60]	1.47	[0.74, 2.65]
Sex	Male				
	Female			1.78 ***	[1.32, 2.39]
Age	65 - 69				
	70 - 74			1.20	[0.83, 1.75]
	75 - 79			1.36	[0.93, 1.99]
	80 +			1.36	[0.88, 2.08]
Malignant neoplasm		1.54	[0.95, 2.39]	1.61 *	[0.99, 2.50]
Sex	Male				
	Female			1.79 ***	[1.33, 2.41]
Age	65 - 69				
	70 - 74			1.20	[0.83, 1.75]
	75 - 79			1.37	[0.94, 2.01]
	80 +			1.37	[0.89, 2.10]

Table 6. Logistic Regression Analysis between Anxiety and NCDs

In the logistic regression analysis between NCDs and anxiety showed that patients with cardiovascular disease were 1.46 times more likely to experience anxiety than those without ($p < 0.05$).

After adjusting for gender and age, the results revealed that female with hypertension (OR=1.77), diabetes mellitus (OR=1.77), cardiovascular disease (OR=1.79), chronic respiratory disease (OR=1.78) or malignant neoplasm (OR=1.79) were more likely to report experiencing anxiety than male, while age did not show statistically significant. However, patients with cardiovascular disease were 1.47 times more likely to experience anxiety than those without ($p < 0.05$). Similarly patients with malignant neoplasm were 1.61 times more likely to experience anxiety than those without ($p < 0.05$). Depression and anxiety exhibited similar patterns in relation to NCDs (cardiovascular disease and malignant neoplasm), but the prevalence of depression was significantly higher in females, with rates exceeding twice that of males.

		Suicide			
Variables	Label	Unadjusted odds ratio		Adjusted odds ratio	
		OR	95% CI	OR	95% CI
Hypertension		1.04	[0.83, 1.32]	1.00	[0.79, 1.27]
Sex	Male				
	Female			1.46 **	[1.15, 1.85]
Age	65 - 69				
	70 - 74			0.87	[0.63, 1.18]
	75 - 79			1.13	[0.83, 1.54]
	80 +			1.28	[0.90, 1.79]
Diabetes mellitus		1.36 *	[1.05, 1.74]	1.36 *	[1.05, 1.75]
Sex	Male				
	Female			1.46 **	[1.15, 1.85]
Age	65 - 69				
	70 - 74			0.87	[0.64, 1.19]
	75 - 79			1.11	[0.82, 1.52]
	80 +			1.28	[0.91, 1.80]
Cardiovascular disease		1.03	[0.74, 1.39]	1.02	[0.74, 1.39]
Sex	Male				
	Female			1.46 **	[1.15, 1.85]
Age	65 - 69				
	70 - 74			0.87	[0.63, 1.18]
	75 - 79			1.13	[0.83, 1.54]
	80 +			1.28	[0.90, 1.79]
Chronic respiratory disease		1.53	[0.88, 2.50]	1.53	[0.88, 2.51]
Sex	Male				
	Female			1.47 **	[1.16, 1.86]
Age	65 - 69				
	70 - 74			0.87	[0.63, 1.18]
	75 - 79			1.12	[0.82, 1.52]
	80 +			1.26	[0.89, 1.77]
Malignant neoplasm		1.41	[0.93, 2.06]	1.45	[0.96, 2.12]
Sex	Male				
	Female			1.47 **	[1.16, 1.87]
Age	65 - 69				
	70 - 74			0.87	[0.63, 1.18]
	75 - 79			1.13	[0.83, 1.54]
	80 +			1.28	[0.90, 1.78]

Table 7. Logistic Regression Analysis between Suicidal Ideation and NCDs

In the logistic regression analysis between NCDs and suicidal ideation revealed that patients with diabetes mellitus were 1.36 times more likely to commit suicidal ideation than those without ($p < 0.05$).

After adjusting for gender and age, the results showed that female with hypertension (OR=1.46), diabetes mellitus (OR=1.46), cardiovascular disease (OR=1.46), chronic respiratory disease (OR=1.47) or malignant neoplasm (OR=1.47) were more likely to report suicidal ideation than male, while age did not show statistically significant results. However, unlike depression and anxiety, patients with diabetes mellitus were 1.36 times more likely to report suicidal ideation than those without ($p < 0.05$). Suicidal ideation showed a statistically significant association with diabetes mellitus.

Variables	Label	Medication			
		Unadjusted odds ratio		Adjusted odds ratio	
		OR	95% CI	OR	95% CI
Hypertension		1.53 **	[0.65, 1.81]	1.45 *	[1.07, 1.98]
Sex	Male				
	Female			1.49 *	[1.10, 2.02]
Age	65 - 69				
	70 - 74			1.19	[0.80, 1.76]
	75 - 79			1.26	[0.84, 1.89]
	80 +			1.41	[0.90, 2.20]
Diabetes mellitus		1.40 *	[1.01, 1.92]	1.41 *	[1.02, 1.93]
Sex	Male				
	Female			1.53 **	[1.13, 2.07]
Age	65 - 69				
	70 - 74			1.22	[0.82, 1.81]
	75 - 79			1.29	[0.86, 1.94]
	80 +			1.51	[0.96, 2.33]
Cardiovascular disease		1.07	[0.71, 1.56]	1.05	[0.70, 1.54]
Sex	Male				
	Female			1.53 **	[1.13, 2.07]
Age	65 - 69				
	70 - 74			1.21	[0.82, 1.80]
	75 - 79			1.31	[0.87, 1.96]
	80 +			1.49	[0.95, 2.31]
Chronic respiratory disease		3.12 ***	[1.83, 5.04]	3.14 ***	[1.84, 5.13]
Sex	Male				
	Female			1.57 **	[1.15, 2.12]
Age	65 - 69				
	70 - 74			1.21	[0.82, 1.79]
	75 - 79			1.28	[0.85, 1.91]
	80 +			1.42	[0.91, 2.21]
Malignant neoplasm		1.55	[0.93, 2.45]	1.60	[0.96, 2.53]
Sex	Male				
	Female			1.55 **	[1.14, 2.10]
Age	65 - 69				
	70 - 74			1.21	[0.82, 1.80]
	75 - 79			1.31	[0.88, 1.97]
	80 +			1.49	[0.96, 2.31]

Table 8. Logistic Regression Analysis between Medication and NCDs

In the logistic regression analysis between NCDs and medication use for mental health issues showed statistically significant results for hypertension, diabetes mellitus and chronic respiratory disease. The results indicated that patients with hypertension had 1.53 times ($p<0.01$) higher medication use for mental health issues. Patients with diabetes mellitus had 1.40 times ($p<0.05$) higher medication use for mental health issues and patients with chronic respiratory disease showed 3.12 times ($p<0.001$) higher medication use for mental health issues.

After adjusting for gender and age, the results showed that female with hypertension (OR=1.49), diabetes mellitus (OR=1.53), cardiovascular disease (OR=1.53), chronic respiratory disease (OR=1.57) or malignant neoplasm (OR=1.55) had a higher proportion of medication use for mental health issues, while age did not show statistically significant results. However, patients with hypertension were 1.45 times more likely to report medication use for mental health issues than those without ($p<0.05$). Similarly patients with diabetes mellitus were 1.41 times ($p<0.05$) and patients with chronic respiratory disease were 3.14 times ($p<0.001$) more likely to report medication use for mental health issues than those without. Among the mental health problems, medication use for mental health issues showed the most statistically significant association with NCDs.

Variables	Label	Stress		Depression		Anxiety		Suicide		Medication	
		Adjusted odds ratio	95% CI	Adjusted odds ratio	95% CI	Adjusted odds ratio	95% CI	Adjusted odds ratio	95% CI	Adjusted odds ratio	95% CI
		OR		OR		OR		OR		OR	
Number of NCDs	No morbidity										
	One morbidity	0.86	[0.71, 1.04]	1.07	[0.79, 1.46]	0.77	[0.54, 1.11]	1.00	[0.75, 1.35]	1.26	[0.85, 1.91]
	Two or more morbidity	1.01	[0.82, 1.23]	1.28	[0.96, 1.82]	1.28	[0.92, 1.86]	1.28	[0.94, 1.73]	1.98 ***	[1.37, 3.05]
Sex	Male										
	Female	1.52 **	[1.15, 2.01]	2.34 ***	[1.43, 3.82]	1.64	[0.98, 2.77]	1.60 *	[1.04, 2.47]	2.00 *	[1.13, 3.56]
Age	65 - 69										
	70 - 74	0.93	[0.76, 1.13]	0.96	[0.71, 1.34]	1.18	[0.82, 1.74]	0.85	[0.62, 1.16]	1.15	[0.79, 1.74]
	75 - 79	1	[0.82, 1.24]	1.06	[0.78, 1.51]	1.24	[0.86, 1.87]	0.99	[0.74, 1.39]	1.16	[0.78, 1.79]
	80 +	0.69 **	[0.53, 0.90]	0.77	[0.53, 1.18]	1.15	[0.75, 1.85]	1.04	[0.75, 1.53]	1.27	[0.83, 2.08]
Marital status	Widow/divorced/single			1.42 *	[1.09, 1.87]	1.25	[0.91, 1.71]	1.54 ***	[1.19, 2.00]	1.22	[0.88, 1.70]
	Currently married	1.19	[0.99, 1.43]								
Education level	Below junior high	1.35 **	[1.12, 1.63]	1.23	[0.91, 1.67]	1.02	[0.73, 1.44]	1.34 *	[1.00, 1.80]	1.01	[0.71, 1.44]
	Junior high or higher										
Smoking	Never										
	Ever	1.04	[0.79, 1.36]	1.64 *	[1.02, 2.64]	1.04	[0.62, 1.73]	1.24	[0.82, 1.89]	1.55	[0.89, 2.69]
Alcohol	Never			1.18	[0.89, 1.56]	1.01	[0.73, 1.40]			1.01	[0.72, 1.42]
	Ever	1.1	[0.91, 1.31]					1.38 *	[1.06, 1.81]		
Physical activity	Do not regularly exercise	1.78 ***	[1.52, 2.09]	1.63 ***	[1.27, 2.08]	1.48 **	[1.11, 1.96]	1.26	[1.00, 1.59]		
	Regularly exercise									1.1	[0.82, 1.49]
BMI	Under 18.5 (Underweight),										
	18.5 - 24.9 (Healthy Weight)	1.09	[0.91, 1.29]	1.40 *	[1.05, 1.86]	1.09	[0.79, 1.49]	1.02	[0.79, 1.32]		
	25.0 - 29.9 (Overweight), Over 30.0 (Obesity)									1.05	[0.76, 1.44]

Table 9. Predictors of Mental Health Outcomes by Logistic Regression Analysis

Examining the predictors of mental health outcomes, significant results were observed for stress (OR = 1.52, $p < 0.01$), depression (OR = 2.34, $p < 0.001$), suicidal ideation (OR = 1.60, $p < 0.05$), and medication use for mental health issues (OR = 2.00, $p < 0.05$) among females. Regarding age, only the stress variable showed a statistically significant result. Individuals aged 80 and above had a lower likelihood of experiencing stress (OR = 0.69, $p < 0.01$). Therefore, it can be inferred that age has a limited influence on outcome variables⁵. Marital status showed statistically significant results for depression and suicidal ideation variables. In the case of depression, individuals who were widowed, divorced or single tend to had a higher likelihood (OR = 1.42, $p < 0.01$). Similarly, for the suicidal ideation variable, individuals who were widowed, divorced or single had a higher likelihood (OR = 1.54, $p < 0.001$). Education level exhibited statistically significant associations with stress and suicidal ideation variables. For stress, individuals with below junior high school had a higher likelihood (OR = 1.35, $p < 0.01$). The same pattern was

⁵ Mental health problems: stress, depression, anxiety, suicidal ideation, medication use for mental health issues

observed for the suicidal ideation variable, with individuals below junior high school had a higher likelihood (OR = 1.34, $p < 0.05$). In terms of smoking, statistically significant results were found for only depression variable. The depression was higher among smokers (OR = 1.64, $p < 0.05$). Alcohol consumption showed statistically significant results for suicidal ideation variable. Individuals who reported consuming alcohol had a higher likelihood of experiencing suicidal ideation (OR = 1.38, $p < 0.05$). Physical activity exhibited statistically significant associations with stress, depression, anxiety and suicidal ideation variables. Study population who did not engaged in regular exercise had a higher likelihood of reporting stress (OR = 1.78, $p < 0.001$), depression (OR = 1.63, $p < 0.001$), anxiety (OR = 1.48, $p < 0.01$), and suicidal ideation (OR = 1.26, $p < 0.1$). Regarding BMI, a statistically significant result was observed only for the depression variable. Underweight or healthy weight individuals with a BMI of 25.0 or lower had a higher likelihood of experiencing depression (OR = 1.40, $p < 0.05$). Lastly, when examining multimorbidity among study population with NCDs, a statistically significant association was found for the medication use for mental health issues variable. Study population who reported having two or more NCDs had a higher likelihood of (OR = 1.98, $p < 0.001$) taking medication for mental health issues.

Variables	Medication		Medication	
	Unadjusted odds ratio		Adjusted odds ratio	
	OR	95% CI	OR	95% CI
Stress	2.33 ***	[1.72, 3.17]	2.29 ***	[1.68, 3.11]
Depression	5.37 ***	[3.79, 7.60]	5.12 ***	[3.60, 7.27]
Anxiety	6.34 ***	[4.37, 9.21]	6.03 ***	[4.14, 8.78]
Suicide	3.57 ***	[2.48, 5.16]	3.45 ***	[2.38, 4.98]

Table 10. Effects of Medication Use on Mental Health Problems

Considering the observed association between medication use for mental health issues and NCDs and multimorbidity, the results were presented by setting medication use for mental health issues as a covariate. The impact of medication use on stress, depression, anxiety, and suicidal ideation was evaluated. The results indicated a statistically significant influence of medication use on all four mental health problems. Anxiety showed the greatest impact (OR=6.03), followed by depression (OR=5.12), suicidal ideation (OR=3.45), and stress (OR=2.29).

The results presented in Table 9, indicating a correlation between medication use for mental health issues and the number of NCDs, may have been influenced by factors that decreased the number of participants reporting stress, depression, anxiety, and suicidal ideation in relation to medication use. Consequently, statistically significant associations between mental health problems (such as stress, depression, anxiety, and suicidal ideation) and the prevalence of NCDs were not observed.

		Stress		Depression		Anxiety		Suicide		Medication	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension	Under 65	1.29 *	[1.04, 1.60]	1.39	[0.98, 1.95]	1.72 **	[1.14, 2.59]	1.08	[0.79, 1.48]	1.53 *	[1.03, 2.26]
	Over 65										
Diabetes mellitus	Under 65	1.17	[0.85, 1.61]	1.12	[0.69, 1.80]	1.23	[0.71, 2.12]			1.1	[0.64, 1.90]
	Over 65							1.14	[0.74, 1.76]		
Cardiovascular disease	Under 65			1.22	[0.71, 2.09]			1.16	[0.66, 2.06]	1.06	[0.52, 2.16]
	Over 65	1.07	[0.73, 1.56]			1.05	[0.57, 1.93]				
Chronic respiratory disease	Under 65	1.35	[0.58, 3.16]					1.97	[0.68, 5.72]		
	Over 65			1.07	[0.34, 3.34]	1.4	[0.38, 5.16]			1.01	[0.39, 2.66]
Malignant neoplasm	Under 65										
	Over 65	1.01	[0.58, 1.77]	1.06	[0.49, 2.33]	2.19	[0.78, 6.12]	2.16	[0.89, 5.21]	1.46	[0.54, 3.92]

Table 11. Logistic Regression Analysis between Duration of NCDs and Mental Health Problems

Considering individual predispositions, the duration of the disease was into account to assess the levels of stress, depression, anxiety, suicidal ideation and medication use for mental health issues. Hypertension (n=1,205) and diabetes mellitus (n=493) were predominantly diagnosed in the 50-64 age group, while cardiovascular disease (n=405), chronic respiratory disease (n=80), and malignant neoplasm (n=215) had higher diagnosis rates among those aged 65 and above.

The table provides the associations between mental health problems and duration of NCDs. Among the study subjects diagnosed with hypertension at the age of 65 and below, there is a statistically significant association between hypertension and stress (OR = 1.29, 95% CI [1.04, 1.60]), anxiety (OR = 1.72, 95% CI [1.14, 2.59]) and medication use for mental health issues (OR = 1.53, 95% CI [1.03, 2.26]). The associations with depression and suicidal ideation are not statistically significant. Aged over 65, the associations between hypertension and mental health factors are not reported. There were no statistically significant associations found between medical conditions such as diabetes mellitus, cardiovascular disease, chronic respiratory disease, or malignant neoplasm, and mental health factors.

In summary, the study found a significant link between hypertension and stress, anxiety in the younger population, indicating a potential influence of hypertension

on mental health symptoms. However, no significant associations were observed between mental health factors and other medical conditions such as diabetes mellitus, cardiovascular disease, chronic respiratory disease, or malignant neoplasm.

Chapter 4. Discussion

The annual data from the Korea Health Panel Data (KHP) for the year 2019 (Version 2.0.1) include a total of 14,741 participants. Among the population, 4,465 individuals aged 65 years or older were included in this study. The study was conducted with a sample size of 4,135 participants after excluding individuals diagnosed with depression or bipolar disorder. Out of the total 4,135 participants, 4,048 were included in the analysis of the health behavior variables questionnaire. A total population of 4,135, 2,303 were diagnosed with hypertension, 994 with diabetes mellitus, 310 with malignant neoplasm, 666 with cardiovascular disease, and 152 with chronic respiratory disease. When examining mental health problems, 822 individuals reported feeling stressed, 289 individuals reported experiencing depression, 212 individuals reported feeling anxious, 315 individuals reported having suicidal thoughts, and 191 individuals reported having a history of medication use for mental health issues.

The cross table analysis revealed a relationship between NCDs and mental health problems. A higher proportion of patients with NCDs reported experiencing stress. Additionally, as the number of NCDs in multimorbidity increased, there was a corresponding upward trend in the prevalence of depression, anxiety, suicidal ideation, and medication use for mental health issues. However, no proportional relationship was observed between multimorbidity and stress. A more detailed examination of the cross table analysis, patients with hypertension reported a higher frequency of stress, while patients with malignant neoplasms reported a higher frequency of depression and suicidal ideation. Moreover, patients with chronic respiratory disease more frequently reported suicidal ideation and medication use for mental health issues.

Logistic regression analysis adjusting for confounding variables showed that

women were more likely to demonstrate a positive relationship between NCDs and mental health problems. Overall, the prevalence of mental health problems was higher among women, individuals who were widowed, divorced, or single, those with education levels below junior high, smokers, drinkers, individuals who did not engage in regular physical activity, and individuals with multimorbidity of NCDs.

The impact of medication uses on stress, depression, anxiety, and suicidal ideation influence on all four mental health problems. Among them, anxiety demonstrated the highest impact with an OR of 6.03, followed by depression with an OR of 5.12, suicidal ideation with an OR of 3.45, and stress with an OR of 2.29. The results presented in Table 9, which indicated a correlation between the use of medication for mental health issues and the number of NCDs, could have been affected by factors that diminished the number of participants responding positively to the questionnaire regarding stress, depression, anxiety, and suicidal ideation in relation to medication use. However, the presence of mental health problems despite medication use signifies the inadequate provision of appropriate mental health treatment for the elderly population.

Taking the individual disposition into consideration, which accounts for the duration of the disease, this study found a significant correlation between younger-aged patients (65 years or below) diagnosed with hypertension and stress or anxiety. This finding suggests a potential influence of hypertension on the manifestation of mental health symptoms. However, no significant associations were found between mental health factors and other medical conditions such as diabetes mellitus, cardiovascular disease, chronic respiratory disease, or malignant neoplasm.

The strengths of this study lie in its focus on the association between NCDs and mental health problems, encompassing depression, stress, anxiety, suicidal ideation, and medication use for mental health issues. It has been well established in previous studies that patients with NCDs are more likely to experience stress, depression, anxiety, and suicidal ideation.^{29,30} However, a notable finding in this

study is the positive relationship between medication use for mental health issues and the presence of two or more NCDs. An important advantage of this study is its specific focus on the geriatric population, specifically individuals aged 65 and above in South Korea. Furthermore, the study considers the presence of multimorbidity in NCDs and controls for confounding variables to analyze the relationship based on the number of NCDs individuals have. This study stands out due to its unique approach in analyzing the results based on the duration of NCDs, providing a comprehensive examination. Unlike most studies that either aggregate all age groups or focus on specific age ranges, this research has thoroughly segmented the findings according to age, exploring conditions such as hypertension, diabetes mellitus, and malignant neoplasm. The employment of such a distinctive methodology and the emergence of analytical outcomes make this research particularly noteworthy. However, the study has certain limitations. Firstly, the utilization of data based on responses from household members limits the ability to establish causality and may not fully represent the entire population of South Korea. Secondly, there is a positive association between medication use for mental health issues and mental health problems such as stress, depression, anxiety, and suicidal ideation but unable to establish the temporal sequence of these relationships. Additionally, the study is unable to consider the influence of family history, which is an important contributing factor to NCDs, on the association between NCDs and mental health problems.³¹

Based on the findings that indicate a link between medication use for mental health issues and the presence of multimorbidity of NCDs, future research aims to explore the relationship between psychiatric medication use and mental health within the context of NCDs. To evaluate the specific impact associated with certain medications, a prospective cohort study will be employed. If mental health problem, such as stress, persists for a prolonged period or appropriate treatment methods are not utilized, it may lead to depression and anxiety. In severe cases, these

conditions can escalate to thoughts of suicide or self-harm. Such issues can significantly impact various aspects of daily life, including social relationships and job satisfaction. Therefore, the future research will consider the severity of mental health problems and utilize ordinal logistic regression to analyze their relationship with NCDs. Furthermore, future research will also examine the association between NCDs and mental health problems by considering factors of family history in relation to NCDs.

Chapter 5. Conclusion

NCDs contribute to a significant portion (79.6%) of the overall mortality rate in South Korea, thereby adding to the burden on the healthcare system.³² Moreover, the elderly population aged 65 and above may experience mental health problems as a result of economic constraints and the decline in interpersonal relationships.³³ Multimorbidity, which refers to the presence of multiple coexisting NCDs, is commonly observed among individuals in this age group.^{34,35} This study revealed that individuals with chronic respiratory disease, diabetes mellitus, or cardiovascular disease also experience mental illness, leading to higher morbidity rates. Prolonged use of medication for NCDs or concurrent psychiatric substance abuse can lead to immune system suppression and worsened organ function, thereby increasing the risk of nosocomial infections among this population.³⁶ Disease-focused treatments in such cases can not only result in disease-drug interactions but also drug-drug interactions due to polypharmacy, which leads to decreased medication adherence and the occurrence of side effects.³⁷ According to the study by Paulo et al. (2012), there was a 6% incidence of DDI-related ADRs among elderly outpatients.^{38,39} The occurrence of DDI-related ADRs was associated with age, comorbidity, and the consumption of five or more drugs. The study emphasizes the need for preventive measures due to the high incidence of DDI-related ADRs among elderly outpatients.^{38,39} Therefore, a comprehensive treatment system for both NCDs and mental health problems is essential for the elderly aged 65 and above. Additionally, an integrated treatment system can reduce polypharmacy resulting from disease-specific treatments and improve medication adherence. Improving medication adherence maximizes the effectiveness of disease treatment, ultimately enhancing overall health status and improving the quality of life. Such advancements can alleviate the burden on the healthcare system and reduce socioeconomic costs in South Korea.

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한국의료패널을 이용한 비전염성질환 (NCDs)과 정신건강문제 및 다중이환 (Multimorbidity)의 연관성 연구

황서정

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목적: 본 연구의 목적은 비전염성질환 (NCDs)의 다중이환 (multimorbidity)과 정신건강문제 사이의 연관성을 연구하는 것에 있다.

방법: 본 연구는 2019년 한국의료패널 데이터 (KHP)를 기반으로 총 14,741명의 참가자가 데이터에 포함되었다. 이 중 65세 이상인 노인인구 총 4,465명을 연구의 대상 인구로 설정하였다. 우울증이나 양극성 장애로 진단된 대상은 제외하여 연구 진행을 위한 최종 인구 크기는 4,135명이다. 본 연구의 노출변수는 비전염성질환 (NCDs)으로 의사의 진단을 받은 만성 질환을 대상으로 하였다. 비전염성질환 (NCDs)에는 고혈압, 당뇨병, 악성 신생물, 심혈관 질환, 만성 호흡기 질환이 포함되어 있다. 결과변수는 스트레스, 우울감, 불안감, 자살 생각, 정신건강문제로 인한 약물복용에 초점을 두어 정신건강문제로 설정하였다. 성별, 연령, 결혼 여부 및 교육 수준과 같은 인구사회학적변수와 흡연, 음주, 신체 활동 및 체질량 지수 (BMI)와 같은 건강생활변수는 혼란변수로 고려되었다. 모든 변수는 이분법적 변수로 범주화하여 변수 간의 통계적 유의성을 평가하는 데 사용되었다. 본 연

구는 분석역학연구로 그 중 단면조사연구로 진행되었다. R 소프트웨어 (버전 4.2.2)를 사용하여 기술분석과 더불어 로지스틱 회귀분석이 수행되었다. 오즈비 (OR)와 95% 신뢰구간 (CI)을 나타내어 관련성의 강도를 파악하였다.

결과: 비전염성질환 (NCDs)를 가진 노인인구 중 스트레스를 경험하였다고 답변한 비율이 높게 나타났다. 비전염성질환 (NCDs)의 다중이환 (multimorbidity)이 증가함에 따라 정신건강문제로 인한 약물복용 문항에 경험한 적이 있다고 답변한 비율이 현저히 증가하는 것으로 나타났다. 이와 다르게 스트레스, 우울감, 불안감 및 자살 생각과 다중이환 (multimorbidity)간에는 유의한 상관관계가 없었다. 혼란변수를 포함하여 진행한 로지스틱 회귀분석결과 여성, 사별, 이혼 또는 미혼인 개인, 중학교 이하의 교육 수준을 가진 개인, 흡연자, 음주자, 정기적인 신체 활동을 하지 않는 개인, 그리고 비전염성질환 (NCDs)의 다중이환 (multimorbidity)을 가진 연구대상에게 정신건강문제로 인한 약물 복용의 답변 비율이 높았다. 정신건강문제로 인한 약물복용을 한 사람들에게 정신건강문제와의 연관성이 높게 나타났다. 또한 비전염성질환 (NCDs)의 유병기간을 중심으로 한 연구결과, 고혈압으로 진단받은 사람들 중 나이가 어릴수록 스트레스 및 불안감과 연관성이 나타났다.

결론: 비전염성질환 (NCDs)의 다중이환(multimorbidity)을 가진 노인일수록 정신건강문제로 인한 약물복용과의 연관성이 나타났다. 또한 유병기간이 길수록 스트레스 및 불안감과 연관성이 나타났다. 비전염성질환 (NCDs)의 장기간 약물 복용 및 각 질환 중심의 치료는 질환-약물 상호작용뿐만 아니라 약물-약물 상호작용을 유발하여 치료약의 복약순응도 감소와 더불어 약물의 부작용을 야기할 수 있다. 이는 65세 이상의 노인 인구를 대상

으로 비전염성질환 (NCDs)과 정신건강문제 모두를 통합적으로 고려하는 종합적인 치료 방식의 필요성을 의미한다. 본 연구는 비전염성질환 (NCDs)과 정신건강질환의 통합적 의료시스템 접근방법의 기초자료로 활용되어 다약제 사용을 최소화하여 사회경제적 비용 부담 감소와 더불어 적절하고 효율적인 노인인구의 건강관리를 통한 65세 이상의 노인인구의 건강상태 및 생활만족도 증가에 도움이 될 것이다.

주요어: 비전염성질환, 다중이환, 정신건강, 약물복용, 약물-약물 상호작용
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