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Ph.D. Dissertation of Nursing

Factors and at-risk group
associated with hypertension self-
management behavioral patterns
among people with physical
disabilities: A latent class analysis

잠재계층분석을 활용한 고혈압 지체장애인의
자가관리행위 유형과 관련요인 탐색

February 2023

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Submitting a Ph.D. Dissertation of Nursing
October 2022

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Abstract

People with disabilities are vulnerable to chronic diseases such as hypertension. In South Korea, over half of the population living with a physical disability suffers from hypertension. Understanding the typology of hypertension self-management behavioral patterns will assist with behavioral interventions for people with physical disabilities. Thus, this study aims to identify the typology of hypertension self-management behavioral patterns, the factors associated with the latent classes, and to recognize potential at-risk populations by comparing potential health outcomes among hypertensive adults with physical disabilities.

Data of 1,551 participants were extracted from the 2017 National Survey of Disabled Persons. Latent classes were analyzed using five dichotomous indicators of self-management behaviors: smoking, alcohol consumption, physical activity, diet, and weight control. LCA model comparisons were performed using the measure of model-fit indices including AIC, BIC, saBIC, entropy, and LMR. Determinants of self-management behavioral patterns, such as general characteristics, health-related factors, and social relationships, were identified using multinomial logistic regression. Further, health measures, such as health-related quality of life, subjective health, psychological health, patient satisfaction, and unmet medical needs, were compared.

The following three latent classes were identified: “high self-management” group (40.8%), “harmful habitual behavior” group (20.6%), and “inactive behavior” group (38.6%). Compared with the high self-management group, the predictors of belonging to the harmful habitual behavior group were being male, young, and single. Being female, employed, severely disabled, dependent with ADL, and unsatisfied with the number of friendships were predictors of the inactive behavior group. Those in the inactive behavior group had a poor health-related quality of life, poor subjective health, depression, and unmet medical needs.

This study provides evidence that there are mutually exclusive subgroups of patients with hypertension regarding self-management behavioral patterns, identifies an array of predictive factors in each latent class membership, and distinguishes a high-risk group by comparing the health measures among patients with hypertension with physical disabilities. Analyzing subgroups may assist in identifying and meeting the diverse needs of self-management behavior support in hypertensive patients with physical disabilities.

Keywords: chronic diseases; hypertension; health behavior; latent class analysis; lifestyles; physically disabled; self-management

Student Number: 2013-20421

This doctoral dissertation includes the contents of the published article listed as below.

Nam, H. J., & Yoon, J. Y. (2022). Factors and at-risk group associated with hypertension self-management patterns among people with physical disabilities: a latent class analysis. *BMC Public Health*, 22(1), 1–12.

This dissertation offers an expansion of the literature review and the theoretical framework according to the doctoral dissertation format of College of Nursing, Seoul National University.

In addition, the study uses the data collected by the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs and provided through the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs. It is clearly stated that neither the organizations have been involved in the process of the study, nor did they intervene with the study results.

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I. Introduction

1. Study Background

Hypertension is a major risk factor for cardiovascular disease and premature death. The World Health Organization (WHO) estimates that hypertension affects more than one billion individuals worldwide and accounts for 13.5% of total deaths per year (WHO, 2009). Serious concerns about hypertension in people with disabilities have been regularly reported in national studies. People with disabilities have been shown to be at 2.3-fold high risk of developing hypertension and five times higher mortality rates due to hypertension than the general population (Havercamp et al., 2004; Ministry of Health and Welfare, 2020a). Statistical reports have consistently identified people with disabilities as experiencing poorer health outcomes, resulting in a higher mortality rate than their peers in the general population. In particular, attention should be focused on those with physical disabilities as this population accounts for the largest proportion, which encounter approximately 50.5% of whole disabled population in South Korea and the number of people experiencing physical disability is steadily increasing owing to the rapid increases in aging population (Korea Disabled People's Development Institute, 2019). Moreover, considering the fact that the higher number of people with physical disabilities appear in older

population (Kim et al., 2017; Martin, Freedman, Schoeni, & Andreski, 2010), it can be anticipated that they tend to have a higher risk of hypertension and associated risk factors because age is the major risk factor for hypertension (Charlson et al., 2014). Evidence indicates that 56.4% of the population living with a physical disability was affected by hypertension, which was twice as high as the population without a disability in South Korea (Kim et al., 2017). Unfortunately, to date, most studies have focused mainly on hypertension in the general population, whereas the subpopulation that experiences physical disabilities has largely been neglected.

Engagement in self-management behavior is indispensable for the management of hypertension as failure to manage hypertension is a potential risk factor for cardiovascular diseases, such as arteriosclerosis, myocardial infarction, congestive heart failure, and stroke (Law, Morris, & Wald, 2009), which are strongly linked with early mortality (Kearney et al., 2004). Noting the high prevalence of hypertension complications, WHO strongly argued that one essential way to control hypertension is to involve patients in their own self-management surveillance (Chobanian et al., 2003; WHO, 2021). The 2018 Korean Society of Hypertension Guidelines provide self-management recommendations essential for the control of high blood pressure including abstaining from smoking, limiting alcohol consumption, eating a diet rich in fruits and vegetables, taking part in regular physical activity, and maintaining a healthy weight (Lee et al., 2019). Adherence to

such self-management behaviors significantly reduces blood pressure, resulting in more cost-effective use of healthcare resources (Penaloza-Ramos et al., 2016). The main causes of mortality in hypertensive patients are linked to unhealthy behaviors such as physical inactivity, tobacco smoking, poor diet, obesity, and excessive alcohol consumption (Ghanbari et al., 2018; Eckel et al., 2014). Overwhelming substantive evidence supports the significant role of self-management behavior on blood pressure control (Ford et al., 2011). Understanding hypertension self-management behaviors may provide important information for medical practitioners and health experts to control high blood pressure and also to allow policy makers to better support the hypertensive patients.

Despite the clear benefits of self-management behaviors, many hypertensive patients do not comply with the suggested recommendations, thereby failing to regulate their blood pressure. Self-management may be even more challenging for those with physical disabilities due to their complex needs, such as physical restrictions and co-morbid health conditions, thus highlighting the need for extra support and appropriate accommodations (Kim et al., 2020). Providing safe, appropriate, and accessible options for people with disabilities requires support across many sectors to help them engage more easily in essential healthy behaviors (Carroll et al., 2012). Thus, it is particularly important to understand the self-management behavior in people with physical disabilities because physical disability can further limit a person's ability to perform essential

hypertension management tasks. However, there is a lack of scientific evidence that supports addressing priority health needs and the identification of key determinants of health behaviors in people with physical disabilities.

A diverse array of characteristics and physical needs has been demonstrated among people with physical disabilities (Rimmer & Braddock, 2002). Thus, it is critical to take special consideration of the unique needs of individuals with physical disabilities in relation to self-management behaviors. Furthermore, self-management behaviors are unlikely to occur in an entirely uniform manner in a population, yet those modifiable self-management behaviors usually exist simultaneously or cluster within individuals (Ha, Choi, & Lee, 2017; Marbaniang, Lhungdim, & Chungkham, 2022). It is argued that lifestyle behaviors within individuals are not random, but more likely to cluster with other health-promoting behaviors; thereby the interventions that simultaneously support these self-managements are necessary from the health professional perspective (Poortinga, 2007; Schuit et al., 2002). Exploration of person-centered typologies could contribute to understanding the heterogeneity of self-management behaviors. Thus far, however, it remains unclear how the different aspects of hypertension management regimes appear in behavioral patterns among people with physical disabilities. To date, the majority of studies have focused only on hypertension management behavior as a single concept, and the level of practice was evaluated by a total score of unidimensional measure (Ghanbari et al., 2018). This traditional variable-level method has

limitations as it has led to reduced appreciation of the diversity of patient challenges and specific needs, which has then fostered misleading and overgeneralized conclusions with study findings representing the overall sample (Collins & Lanza, 2009). This methodological limitation of traditional variable-centred methods may be avoided by utilizing a latent class analysis (LCA) approach. LCA is a person-centred method, suitable for discrete and dichotomous variables; it also enables the identification of distinct configurations of heterogeneity within a given population sample (Collins & Lanza, 2009). Hence, LCA has been described as a more logical and informative approach for exploring health behaviors (Ghanbari et al., 2018; Collins & Lanza, 2009).

2. Purpose of Study

This study aimed to identify the patterns of hypertension self-management behaviors to improve understanding of self-management behaviors in people with physical disabilities using LCA on the basis of the clustering of five hypertensive management recommendations: abstaining from smoking, limiting alcohol consumption, adequate physical activity, balanced diet, and weight control. We also aimed to explore the factors associated with these behaviors and how these classes differ with respect to various health measures including health-related quality of life, subjective health, psychological health, patient satisfaction, and unmet medical needs to identify potential unobserved, at-risk groups among hypertensive adults with physical disabilities living in South Korea.

The specific research questions are:

1. What patterns do people with physical disabilities have in hypertension self-management behaviors?
2. What are the factors associated with the hypertension self-management behaviors in people with physical disabilities?
3. Among the identified latent classes, which group of people is the most at-risk when compared the health measures including health-related quality of life, subjective health, psychological health, patient satisfaction, and unmet medical needs?

3. Definition of terms

1) Physical disability

A disability is any condition of the physical or mental impairment that makes it difficult for the person with the condition to engage in certain activities, resulting in activity limitation, or difficulties interacting with their surroundings due to participation restrictions (CDC, 2020). Disability term includes impairments, activity limitations and participation restrictions (Krahn, 2011). This study follows the definition of physical disability according to Welfare Act for Persons with Disabilities Article 2 which defines a physical disability as physical limitations that result from a permanent functional disorder in a physical body part such as muscle, nervous system, or bone structure, whether the patients acquired the disability either congenitally or postnatally (Ministry of Health and Welfare, 2021a).

In this study, the definition of people with physical disability refers to those who self-indicated that they have a physical disability in the 2017 National Survey of Disabled Persons (Kim et al., 2017).

2) Self-management behavior

The term self-management refers to the activities performed by the individuals and such activities include managing symptoms, treating health conditions, aiming to produce changes in lifestyle and in coping with

chronic conditions (Barlow et al., 2002). Lin et al. (2008) defined self-management as “an active, flexible process in which patients develop strategies for achieving desired goals by regulating their own actions, collaborating with healthcare providers and significant other, and performing preventive and therapeutic health-related activities” (p. 371). Self-management also refers to the activities people undertake to create order, discipline, and control in their lives (Kralik, Koch, Price, & Howard, 2004)

In this study, hypertension self-management behaviors refer to health promoting behaviors including smoking cessation, limited alcohol consumption, physical activity, balanced diet, and weight control, according to the 2018 Korean Society of Hypertension Guidelines (Lee et al., 2019).

II. Literature Review

1. Hypertension in people with physical disabilities

In 1980, WHO announced the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) which provides a conceptual framework for information by enabling classification, and description, the dimensions of the phenomenon of disablement such as impairment, disability and handicap. Then, in 1997, ICIDH-2, which was developed from the existing concept of ICIDH, was basically adopted the concept of disability considering the contextual factors. Disabilities in ICIDH-2 encountered by individuals were divided into impairment, activities, and participation. This classification is distinctive that it defines a disability more comprehensively within the mutual relationship with their surroundings. In 2001, the International Classification of Functioning Disability and Health (ICF), which corresponds to the revised version of ICIDH, was published. Health domain and health related domain are included in order to present a system for expressing health or health related conditions and a unified standard classification. An individual's function and disability are recognized as a complex interrelationship between health conditions including disease, morbidities, injury, trauma, etc., and their background factors including personal and environmental aspects (WHO,

2007).

According to Welfare Act for Persons with Disabilities Article 2 in South Korea, the definition of disabled person refers to those who have been severely restricted in daily life or social life for a long time due to physical or mental impairment. The types of disability can be categorized into 15 types such as physical disability, brain lesion disability, visual disability, hearing disability, language disability, intellectual disability, developmental disability, psychiatric disability, kidney disability, heart disability, respiratory disability, liver disability, facial disability, stoma/ureteral disability, and epilepsy (Ministry of Health and Welfare, 2013). The degree of disability, determined by Korean disability registration system under the Welfare Law for Persons with Disabilities, was previously classified into 6 levels (from grade 1 to 6). However, from July 1, 2019, the government abolished the former disability classifications and divided it into ‘severe’ and ‘mild’ degree of disability. The established grades 1 to 3 are now recognized as person with severe disabilities, and grades 4 to 6 are recognized as person with mild disabilities (Kim et al., 2017).

Of the population with disabilities in South Korea, 79.3% suffered from chronic diseases lasting for more than 3 months. Hypertension was the most prevalent chronic disease as more than a half of the population with disabilities who have a chronic disease suffer from hypertension, followed by back and neck pain, osteoarthritis, and diabetes. Among the population with physical disabilities, 56.4% suffered from hypertension and it also was

the most prevalent chronic disease within this population (Kim et al., 2017). The prevalence of hypertension among the population with disabilities is higher than that of the nationwide adult population which accounted for 22.0% in 2017 (Korea Disease Control and Prevention Agency, 2021).

A growing body of literatures indicates that people with physical disabilities are more likely to have comorbidity with chronic diseases than their able-bodied counterparts (Stevens et al., 2014; Martin et al., 2010). The risk factors for hypertension include non-modifiable factors such as heredity, genetic factors, age, and comorbidities, and modifiable factors such as unhealthy diet, physical inactivity, consumption of tobacco and alcohol, and being overweight or obese (WHO, 2021). In addition to these well-known risk factors, physical dysfunction itself can be the significant risk factor for hypertension among population with physical disabilities. A previous study demonstrated that being physically disabled was a major determinant of hypertension after adjusting for demographic variables (Wu et al., 2021). The prevalence of hypertension appears to increase with the number of functional limitations: hypertension was present in 34% of women with 3 or more functional limitations, compared to 27% of women with 1 or 2 limitations, and 15% of women with no limitations in a national sample (Chevarley et al., 2006). Moreover, when compared to the other types of disabilities, people with physical disabilities have higher rates of hypertension (Wu et al., 2021; Kim et al., 2017).

Physical disability may also contribute to other chronic diseases, for

instance, chronic lung disease, depression, and anxiety, or trigger the development of some health conditions at a younger age leading to additional health complications (Mattacharya, Choudhry, & Lakwawalla, 2006; Diab & Johnston, 2004; Khoury et al., 2013). Besides the impact of being physically inactive which is a main risk factor for hypertension itself, physically disabled people are also vulnerable against psychological stress induced by social isolation, stigma, or chronic pain and it can be another risk factor for developing hypertension (Kagan, Itzick, & Tal-Katz, 2018). Wu et al. (2021) suggested a possible reason for the higher risk for hypertension lies in the fact that people with physical disabilities are more severely affected by their physiological deficiencies and environmental factors when compared to subjects with any other single disability. Kang et al. (2016) further noted that physically disabled people may receive less benefits from the rehabilitation and healthcare services and this may also contribute to a higher risk for hypertension among people with physical disabilities. Specifically, a person with physical disability may have difficulty obtaining assistive devices, such as motorized wheelchairs and limb prostheses necessary to allow mobility to access services because of financial issues, insurance regulations, or other bureaucratic barriers (Wilby, 2019). For such reasons, it is well understood that the health issues in people with disabilities deserves attention though they are still at high risk of health inequality.

2. Hypertension self-management behaviors in people with physical disabilities

Healthy lifestyle changes, as a non-pharmacological treatment for hypertension, can help managing high blood pressure and preventing complications, such as cerebrovascular diseases, cardiovascular diseases, kidney diseases, and retinal hemorrhage, in combination with an appropriate pharmacological treatment (Sawicka et al., 2011). The 7th report of the JNC reports that the goals of hypertension management are to prevent complications and reduce morbidity and mortality which can be achieved with lifestyle modifications including monitoring blood pressure, weight control, low-sodium diet, and physical activity as well as pharmacological treatment. The Korean Society of Hypertension (Lee et al., 2019) also announced hypertension management guidelines which include smoking cessation, low sodium diet, limited drinking alcohol, weight control, physical activity, healthy diet, stress management, and anti-hypertensive medications. It is essential for complementary reasons in hypertension management; to lower blood pressure to normal range, to reduce the need for antihypertensive medications, to minimize associated risk factors, to prevent associated cardiovascular diseases. Vast of researches have been conducted on lifestyle measures in hypertension management and they have agreed on the calls for importance of such lifestyle modification such as avoiding use of tobacco, limiting alcohol consumption, eating healthy diet,

being physically active, and keeping a healthy weight (Lee et al., 2019; Sawicka et al., 2011).

Supporting such self-management behaviors in people with physical disabilities must become a greater priority in the health delivery system, since people with physical disabilities may encounter additional risks, which are not usually faced by the general population, due to their functional limitations and complications (Reichard et al., 2015). People with physical disabilities require adequate support to involve in hypertension self-management behavior; and for this to occur, it is essential to understand the characteristics of self-management behavior in people with physical disabilities and raise the level of awareness on risk factors and barriers related to such behaviors (Rimmer, 1999). However, little attention has been directed toward lifestyle modification for people with physical disabilities (Rimmer & Draddock, 2002). Since there is a lack of researches on the hypertension-specific studies among people with physical disabilities, the following sub-sections would focus on the characteristics of self-management behaviors demonstrated in people with physical disabilities essential for hypertension management as well as on the importance of five self-management behaviors including cigarette smoking, drinking alcohol, physical activity, diet, and obesity in terms of hypertension control.

1) Smoking

Smoking is a risk factor for hypertension as well as for the associated

complications such as cardiovascular diseases. Cigarette smoking causes an acute rise in blood pressure and heart rate. Nicotine contained in cigarettes acts as an adrenergic agonist, mediating local and systemic catecholamine release and release of vasopressin (Cryer et al., 1976; Primatesta et al., 2001). An epidemiological and clinical study demonstrated significant differences in 24-h blood pressure monitoring between smokers and non-smokers (Verdecchia et al., 1995). Few studies showed no significant association between hypertension control and smoking status (Chang et al., 2013; Wang et al., 2017), whereas a study discovered that both male and female smokers had significantly higher blood pressure values than non-smokers (Al-Safi, 2005). Minami et al. (1999) also found that during non-smoking period, the blood pressure was significantly lower than in the smoking period. Although incongruent results about the direct effect of smoking on blood pressure elevation were noted, the Korean Society of Hypertension strongly emphasizes the need of smoking cessation to reduce the risk of cardiovascular diseases (Lee et al., 2019).

People with physical disabilities have greater risk factors for smoking, such as greater levels of depression and stress, and low income (Chevarley et al., 2006; Borrelli, Busch, & Dunsiger, 2014). In a study using data from the National College Health Assessment, cigarette smoking prevalence in college students with physical disabilities was significantly higher than in those without disabilities (Jarrett & Pignataro, 2013). Based on the National Health Interview Survey, men with physical disabilities had greater smoking

prevalence than women with physical disabilities. On the other hand, Emerson's study (2018) particularly concerned the markedly higher comparative rates of smoking among young women with physical disabilities using an annual household panel study in the United Kingdom (Emerson, 2018). Additionally, smokers with physical disabilities were less likely to attempt quitting than smokers without disabilities (Borrelli, Busch, & Dunsiger, 2014) yet, a study conducted in Korea identified that people with physical disabilities were more likely to attempt smoking cessation, compared to those with mental health disorders and asserted that disability type should be considered to provide effective smoking cessation (Kang et al., 2021).

According to a report, people with disabilities may face unique barriers preventing them from quitting smoking such as financial issues, which can be a barrier to afford Nicotine Replacement Therapy (Cancer Council NSW, 2022). Smokers with physical disabilities often encounter numerous barriers to treatment engagement and attendance, such as lack of transportation, architectural access issues, pain, fatigue, energy fluctuations, and procedures of daily care (Becker & Stuifbergen, 2004; Hughes et al., 2003). More attention on smoking cessation should be made in order to reduce the chronic diseases and health disparities experienced by the population with physical disabilities.

2) Alcohol intake

Excessive drinking raises blood pressure and increases resistance to antihypertensive drugs (Acin et al., 2020). Reduction of alcohol intake over a period of 1 to 4 weeks results in lowering blood pressure (WHO Expert Committee on Hypertension Control & WHO, 1996). Moderating alcohol intake and reducing excess weight have cumulative effects in reducing overall cardiovascular risk (WHO Expert Committee on Hypertension Control & WHO, 1996). In Yong et al.'s study (2006), a logistic regression analysis result suggested that the probability of having an elevated blood pressure was higher for the persons who periodically drank alcohol. A meta-analysis of 15 intervention trials showed systolic blood pressure and diastolic blood pressure lowered by 3.3mmHg and 2.0 mmHg with a reduction in alcohol intake, respectively (Xin et al., 2001). Another meta-analysis further discovered that blood pressure fell 5.5/4.0 mmHg when participants consuming ≥ 6 drinks per day reduced their alcohol intake by 50% (Roerecke et al., 2017). It is recommended that alcohol consumption should be reduced to less than 20–30g per day for men and 10–20g per day for women (Lee et al., 2019).

Alcohol abuse has been reported as the seventh leading contributing cause of death among individuals with physical disabilities (Block et al., 2011). The rate of problematic alcohol use rates among people with physical disabilities are as high or higher than among people with other disabilities (Block, Bock, & Becker, 2001; Yu et al., 2008). Reif et al. (2022) indicated

that higher rates of alcohol and substance use among people with physical disabilities accounting for depression or anxiety, physical health, and chronic pain, with pain being a significant mediator. Alcohol is often used as a method of coping or self-medication in this population (Block, Bock, & Becker, 2001). The stress and pain that people with physical disabilities experience on a regular basis may be hard to handle, leading them to a dependency on alcohol or another substance (Reif et al., 2022). Other contributing risk factors for alcohol abuse in people with physical disabilities are as follows: limited education, lower socioeconomic status, poor self-esteem, social isolation and loneliness, and unemployment (Block, Bock, & Becker, 2001).

Some of most frequently reported barriers to limiting alcohol consumption that affect both disabled and non-disabled individuals include family or work obligation and financial hardships (Block et al., 2011). People with physical disabilities, however, face even more barriers and hardships which include accessibility to treatment, additional financial hardships as the cost of managing the disability may already be overwhelming, lack of resources or programs that cater to those with disabilities, physical barriers at the rehabilitation center for alcohol, and social isolation, which helps to conceal and hide the substance use disorders. (Kunst, 2019). In addition, concerning alcohol and drug abuse prevention and treatment, professionals often are not trained to meet the needs of people with physical disabilities (Block, Bock, & Becker, 2001). For

example, rehabilitation professionals may inadvertently support addictive behavior by recommending drinking alcohol at non-abusive levels to increase relaxation, improve appetite, and enhance social interaction (Block, Bock, & Becker, 2001). People with physical disabilities may confront more and different barriers to preventing alcohol abuse, thus require extra support from professionals as well as families or care givers.

3) Physical activity

Physical activity is another key component of non-pharmacological lifestyle therapy for hypertension control. Physical activity has a positive impact on lowering blood pressure, improving cardiorespiratory function, weight loss and dyslipidemia, as well as reducing stress (Lee et al., 2019). Previous studies demonstrated beneficial effects of physical activity on hypertension with reduction in blood pressure with as much as 5–6 mmHg reductions in those with hypertension (Carlson et al., 2014; Diaz & Shimbo, 2013; Hedge & Solomon, 2015). A proposed mechanism for blood pressure reduction induced by physical activity is thought to be due to attenuation in peripheral vascular resistance (Hamer, 2006), and others proposed that the reduction in blood pressure with physical activity include favorable changes in body systems such as oxidative stress, inflammation, endothelial function, arterial compliance, body mass, and renin angiotensin system activity (Diaz & Shimbo, 2013). Aerobic exercise such as walking, running, biking, or swimming is recommended 5 to 7 times a week for at least 30 minutes at a

time for hypertension management (Lee et al., 2019).

The vast majority of people with physical disabilities are not obtaining the recommended amount of physical activity needed to confer health benefits and prevent secondary conditions associated with a sedentary lifestyle (Rimmer, 1999). It is usually encouraged to walk with the goal of 30 minutes a day; however, this recommendation may be appropriate only for the general population and be difficult or impossible to achieve in people who have difficulty with mobility (Rimmer & Draddock, 2002). A modification of this recommendation in a fitness guideline for such groups should be made to some form of upper body exercise such as using an arm ergometer, wheeling or rolling around an indoor track for wheelchair uses, or swimming; and for persons wanting to exercise at home, performing various types of chair-exercise videos (Rimmer & Draddock, 2002).

Literatures underscore the barriers for people with physical disabilities to engaging physical activity at an individual, social, environmental level (Jaarsma et al., 2014). For example, at an individual level, the barriers may include lack of accessible information about physical activity (Wadey & Day, 2018), how much activity should one do or how safe is physical activity, fear of falling, and pain during activity (de Hollander & Proper, 2018). The barriers at social level include negative attitudes about disability from others, or lack of staff or trained professionals and their preparation to work with people with disabilities. An investigation found that the majority of subjects with mobility limitations felt that fitness centers did not have the

type of equipment or professional staff needed to assist them in improving their fitness level (Nikolajsen et al., 2021). Also the environmental barriers are accessibility, barriers in outdoor areas, inadequate transportation, and unsuitable equipment (Martin, 2013; Nikolajsen et al., 2021) which are the major reasons why people with physical disabilities find it difficult to engage the recommended level of physical activity. Parks, fitness centers, health clubs, spas, gyms, playgrounds, pools, trails, and sports fields are considered inaccessible environments for people with physical disabilities (Wadey & Day, 2018). The report recommended that public health agencies begin to evaluate which environmental factors (e.g., architectural or knowledge barriers, social attitudes, policies and procedures) enhance or impede participation (Rimmer & Draddock, 2002).

4) Diet

A balanced diet is one of the essential measures to control hypertension. Dietary habits, involving balanced and diverse diets, can prevent overweight and potential long-term consequences such as hypertension and diabetes (Dalton, 2003). Lee et al. (2010) showed that a balanced diet was associated with the control of hypertension in men. The American Heart Association recommends the Dietary Approach to Stop Hypertension (DASH) for the non-pharmacological management of hypertension, which involves a dietary pattern that promotes a higher intake of protective nutrients and a lower intake of refined carbohydrates and saturated fat (Appel et al., 2006). The

DASH diet has been found to be significantly effective in reducing blood pressure, total cholesterol, and the risk of cardiovascular diseases in hypertensive patients (Siervo et al., 2015). Likewise, in terms of dietary approach to control high blood pressure, it is also paramount important to adhere to reducing dietary sodium. The American Society of Hypertension (2009) and Dietary Guidelines for Americans (Dietary Guidelines Advisory Committee, 2010) recommend reducing sodium intake to a goal of <1500mg per day for individuals with hypertension. A meta-synthesis of 37 randomized controlled trials demonstrated the significant positive relationship between dietary sodium and blood pressure (Aburto et al., 2013). Furthermore, DASH-sodium trials demonstrated the effect of low sodium diet as compared to a typical American diet, with progressively lower blood pressure results (Bray et al., 2004). The evidences on the positive relationship between low-sodium diet and controlled blood pressure are strong and consistent. The Korean Society of Hypertension recommends to have a diet high-fiber and low-fat diet and a balanced diet adequately containing protein, fat, carbohydrates, and nutrients such as fiber, minerals, and vitamins (Lee et al., 2019).

People with disabilities are significantly less likely than able-bodied counterparts to meet the recommended dietary intake goals for key macronutrients and micronutrients linked to cardiometabolic disease risk, such as saturated fat, dietary fiber, and potassium (An et al., 2015). Although having a disability does not necessarily require a significant

alteration from recommended dietary guidelines (e.g., low fat, low cholesterol, high fiber intake), certain modifications to the nutritional component of a health promotion curriculum may need to be tailored according to the types of disabilities (Rimmer & Draddock, 2002). For example, people with physical disabilities are at risk of increased or decreased weight gain related to medication use and limited physical activity (Cooper et al., 1999).

People with physical disabilities often report a lack of healthy food choices due to chronic pain, limited physical strength, fatigue, or difficulty chewing or swallowing, which contribute to unhealthy dietary habits (Wetherill et al., 2021). Furthermore, as food access depends on an individual's resources such as money, transportation, physical capability, social network, and time, the disability may increase the risk of food insecurity and inaccessibility (Webber, Sobal, & Dollahite, 2013). Various indexes of functional ability, such as the IADL which is often deprived in people with physical disabilities, are related to inability to perform shopping, cooking, and eating to maintain healthy diet, resulting in food insecurity. (Schwartz, Buliung, & Wilson, 2019). In a systematic review, Wetherill et al. (2021) noted that it is more challengeable for people with physical disabilities to have unprocessed foods which generally require more preparation time, skill, and physical strength compared to having processed, convenience food items and it may lead to high-sodium and low-quality diet. Thus, nutrition education and other food programs need to consider

functional limitations and adapt nutrition guidance to include nutritional foods that are not only affordable, but also easy and safe to prepare (Wetherill et al., 2021).

5) Obesity

Weight reduction is recommended for the patients whose body mass index (BMI) is more than 25kg/m^2 . Weight reduction enhances the effectiveness of antihypertensive medications and helps in lowering blood pressure (Harsha & Bray, 2008). The Framingham Study supported the relationship between overweight and hypertension that the participants in the highest BMI quintile exhibited 16mmHg higher systolic and 9mmHg higher diastolic blood pressures than those in the lowest quintile (Higgins et al., 1998). The results indicated that systolic blood pressure translated into an increase of 4mmHg for each 4.5kg of increased weight. The increased metabolic demand of overweight individuals is known to raise the cardiac output, and when vascular resistance increases, a high cardiac output related to obesity may act as an important factor contributing to the development of hypertension (Ashraf & Baweja, 2013). In Sabaka et al.'s study (2017), during the 1-year follow-up, a decrease in BMI by at least 1kg/m^2 was negatively associated with uncontrolled hypertension. Also Ali & Sasidharan (2022) demonstrated that the mean reduction in systolic blood pressure was 16.8mmHg when 9.4kg weight loss was achieved. The Korean Society of Hypertension recommends controlling BMI up to 25kg/m^2 (Lee

et al., 2019).

Difficulty with weight management is one of the most frequently reported secondary conditions among people with physical disabilities (Washburn et al., 2020). Obesity in this population induces a higher risk of chronic conditions such as cardiovascular disease, hypertension, and diabetes than obese people without disabilities (Wu et al., 2021). A high incidence of metabolic syndrome with increased abdominal obesity, blood pressure, blood sugar, and serum cholesterol has been noted in wheelchair users (Ellapen et al., 2017). The different prevalence of obesity is found in gender as the mean of BMI was significantly higher in females than males among hypertensive people with physical disabilities (Keramat et al., 2021). Moreover, a low economic status is a widely accepted risk factor for overweight or obesity, and more significantly effects on people with physical disabilities than those without disabilities (Harris, Hendershot, & Stapleton, 2005). People with physical disabilities thereby are more vulnerable to the same risk factors related to obesity than able-bodied counterparts (Reichard et al., 2015). Furthermore, one study on 125 community-dwelling wheelchair users found that more than 70% of them were overweight or obese (Froehlich-Grobe et al., 2012). Greater physical disability severity is related to greater obesity and its disparities may be even greater when those with more severe mobility impairment are involved (Betts & Froehlich-Grobe, 2017).

People with physical disabilities encounter barriers to weight control,

such as limited availability of accessible exercise facilities, pain and muscle, poor understanding about the capacity and skills needed to manage healthy-weight, and limited social support weakness (Rimmer et al., 2005; Weil et al., 2002). In addition, biologic characteristics of the disability or effects of prescribed medication may predispose them to weight gain (Must et al., 1999). Also BMI negatively correlated with level of independence. Use of a wheelchair as the sole means of mobility has a significant effect on musculoskeletal and cardiovascular function. Use of upper extremity muscles rather than larger lower extremity muscles uses less energy, making it more difficult for wheelchair users to maintain a healthy BMI (Ellapen et al., 2017). The urgent need of improvement in modifiable risk factors including inactivity and obesity has been demonstrated with people with disabilities (Marks & Sisirak, 2017).

3. Factors associated with hypertension self-management behaviors

Factors that affect self-management behaviors are complex so that a comprehensive understanding of multiple factors in self-management behaviors has important implications for the design of self-management interventions and the well-being of hypertensive individuals (Ding et al., 2018). Patients do not always adhere to self-management behaviors, which can lead to suboptimal therapeutic outcomes, increased medical expenditure, and increased mortality rates (Acharya et al., 2022). Therefore, harmful consequences due to non-adherence problem highlight the need to identify the patients that are most likely to exhibit non-adherence and to propose appropriate support (Xie et al., 2020).

Majority of researches on hypertension management identified the associated demographic factors with self-management behaviors, such as gender, age, marital status, employment, monthly income, place of residence, education level, and religion. (Acharya et al., 2022; Gelaw, Yenit, & Nigatu, 2021; Chang et al., 2013; Heo & Kim, 2018; Zhang et al., 2020; Zareban et al., 2022). A study using a nationally representative sample demonstrated that gender, age, marital status, and employment status were the effecting factors for hypertension management (Chang et al., 2013). Also being male, and having low income were found to be associated with less hypertension self-management (Heo & Kim, 2018; Zhang et al., 2020), whereas

hypertensive patients who were married, more educated were more likely to engage in self-management behaviors (Zareban et al., 2022). Ding (2018) asserted that it is universally acknowledged that better adherence to self-management behaviors can be found among patients with higher education and higher income yet, in regard to age, sex, marital status, and employment status, the relationships with self-management behaviors remain heterogeneous.

Regarding health-related factors, comorbidities and functional health can also influence hypertension self-management behaviors (AlHadlaq et al., 2019; Nicoletti-Rojas, 2022). Fix et al. (2014) analyzed the reasons how the comorbidities can play a role as a barrier to self-management. The researchers emphasized that comorbidities may lead to a breakdown in hypertension self-management behaviors as patients assign hypertension a lower priority or struggle managing multiple medications. Moreover, functional health also can influence the ability of hypertension self-management behavior. Being independent with activities of daily living (ADL) was associated with better hypertension self-management behavior in middle-aged and older hypertensive patients (Liu et al., 2020) as the level of ADLs represents the baseline abilities to maintain their lives and perform self-care and health-promoting behaviors. ADL and instrumental ADL (IADL) are widely used to predict the prognosis and evaluate the self-management ability of hypertensive patients (Han et al., 2022). In the similar vein, a reduced physical function can be a barrier for self-

management activities, especially for those with disabilities. Among working-age women with disabilities, those with severe limitations evidenced highest risk for adverse health behaviors and chronic conditions (Jones & Bell, 2004). In a cohort of Medicare beneficiaries study, those with physical disabilities reported more self-care limitations and poorer perceived health (Hauenstein et al., 2022). Another study using a longitudinal trajectory also found that the worsening of functional disability was consistently associated with self-management behaviors (Salinas-Rodriguez et al., 2022). However, studies specifically focusing on hypertension self-management activities associated with disability characteristics such as severity of disability or disabled areas are limited, and most of previous studies were focusing on the disability as a risk factor for hypertension. Having mental disability such as developmental, intellectual, or psychiatric disability also can influence the ability to perform self-management (Siantz & Aranda, 2014). For example, people with mental disabilities may require extra support to follow doctor's order and adhere to healthy lifestyle those who are living in community independently (Friedman, Rizzolo, & Spassiani, 2019). Furthermore, the factors related to hypertension such as hypertension duration, knowledge (Gebremichael et al., 2019; Tibebu, Mengistu, & Negesa, 2017; Ademe, Aga, & Gela, 2019), family history of hypertension (Salim et al., 2019), perception of the disease severity (Larki, Tahmasebi, & Reisi, 2018), availability of blood pressure device at home (Pahria, Nugroho, & Yani, 2022) also can influence self-management

behavior and its outcome. For example, patients with longer hypertension duration showed better lifestyle modification practice due to the continued counseling and health education on self-management behaviors (Gebremichael et al., 2019). Higher level of knowledge about hypertension and awareness of disease severity are also promoting factors for self-management as having better knowledge and awareness of current status of hypertension would promote patients to give more emphasis on appropriate hypertension management (Tibebu, Mengistu, & Negesa, 2017; Larki, Tahmasebi, & Reisi, 2018).

In terms of social-related factors, hypertension self-management behaviors were found to be associated with social support and social activities. Family members' supports are known to be a facilitator that influences hypertension self-management behaviors (Flynn et al., 2013; Zhang et al., 2020). Adequate and available social support enables patients with hypertension to cope with disease effectively (Pan et al., 2021). A systematic review further suggested that family members can support hypertensive patient in the ways including encouraging them positively, monitoring health, sharing information, and helping in healthcare behaviors (Shahin et al., 2021). Social network size also influences hypertension self-management behaviors. Higher network sizes were associated with lower odds of uncontrolled hypertension as it may be the provision of information support related to advice, emotional support related to decision, and practical support related to sickness (Thuy et al., 2021). A 1% increase of

network members was related to an increase of hypertension self-management adherence score (Thuy et al., 2021). Moreover, existence of a place to exercise can influence participating in self-management behaviors since a safe, easily accessible, and aesthetically pleasing physical environment positively affects those involved in physical activity (Nazeri et al., 2022; Barentt et al., 2017). Other factors such as self-efficacy (Ma, 2018), effectiveness of communication with physicians (Widiawatie, Handayani, & Sobirin, 2021), beliefs on treatment (Niriayo et al., 2019), are associated with self-management behaviors.

Increased understanding on influencing factors on self-management behaviors may offer insights into developing tailored recommendations for lifestyle modifications based on individual behavioral determinants, thereby a call for identifying related factors for self-management behaviors are continuously emphasized in the research area on hypertension. Nonetheless, there is still a lack of attention on elucidating self-management behaviors focusing specifically on hypertension management in people with physical disabilities. Hence, it is necessary to explore the factors related to promoting self-management behaviors in this underserved population.

4. Health measures in hypertension self-management behaviors

The positive effects of hypertension self-management behaviors on the treatment and management of high blood pressure have been demonstrated in many studies (Dickinson et al., 2006), whereas poor adherence to self-management behaviors may explain in part the health disparities in the population with hypertension (Warren-Findlow, Seymour, & Brunner Huber, 2012). Failure to manage hypertension leads to uncontrolled blood pressure and to increase potential risk factors for complications, such as congestive heart failure, renal failure, and cardiovascular disease, which result in premature death among people with hypertension (Briasoulis et al., 2014). Effective hypertension management has a positive impact on a better quality of life that reducing health expenditure (Gelaw, Yenit, & Nigatu, 2021) and hospital admissions (McManus et al., 2018). Hypertension self-management is related to various positive health measures, yet in this section, specific health measures, such as health-related quality of life, subjective health, psychological health, patient satisfaction, and unmet medical needs are going to be discussed via review of literatures.

1) Health-related quality of life

Health-related quality of life (HRQoL) provides a multidimensional perspective encompassing a patient's emotional, physical, and social

functioning (Baladon et al., 2016). HRQoL is related to an individual's perception of the position in life in the context of culture and value systems and is influenced in a complex way by the person's physical health, psychological state, level of independence, and social relationships (Halaweh et al., 2015). It is an assessment of how the individual's well-being may be affected over time by a disease, disability, or disorder (Wang et al., 2017). An assessment of HRQoL is critical in enhancing self-management behaviors of patient with hypertension (Hussein et al., 2021). HRQoL of hypertensive patients is not only affected by the disease itself but also by subjective factors such as self-management and psychological factors (Xu et al., 2014). Studies have indicated that people with hypertension had a poorer quality of life than people without the condition (Li et al., 2005; Xu et al., 2016) and uncontrolled hypertension due to an inadequate adherence to self-management was related to the decreased perception of HRQoL (Baghi & Banhban Karimi, 2018; Parra, Romero, & Cala, 2021). Vast of studies found that hypertensive patients with existent co-morbidities tend to have lower HRQoL, and identified the number of co-morbid illnesses as an independent determinant of HRQoL (Soni et al., 2010). It may imply that hypertensive patients with poorer health status are likely to have lower HRQoL. Having a proven link between the disease and HRQoL established, the health management outcomes should be focused on improving HRQoL which is an alternative relevant therapeutic objective in hypertensive individuals (Li et al., 2005).

Zheng et al., (2014) emphasized the importance of quality of life as a proxy measure of health status by stating that quality of life status opens a window of opportunity to identify ineffective treatment among people with disabilities. HRQoL was found to be a strong indicator of both physical and mental status in people with physical disabilities and demonstrated unmet needs and intervention outcomes (Rajati et al., 2018; Sunde et al., 2021). Because of the complexity of health challenges in population with physical disabilities, exploring HRQoL is pivotal for assessing their health (Andrew-Essien & Ojule, 2020).

2) Subjective health

Subjective health status is another subjective measure which can play an important role in the health assessment of a patient's overall health status, since lower perceived health status has been associated with an increase in morbidity and mortality (Verschuuren et al., 2013). Subjective health is defined as the appraisal of one's functioning, mood, and satisfaction with life complements the concept of overall health (Diener et al., 1999). Patients with hypertension have shown to have a lower perceived health status than those without hypertension (Al-Mandhari et al., 2011). Although hypertensive patients who received more intense, goal directed antihypertensive therapy were not associated with an increased subjective health (Burla et al., 2014), health-promoting lifestyle represented an importance factor affecting perceived health among elderly people with

hypertension (Li et al., 2018).

A cross-sectional study examining the factors associated with perceived health in older persons identified the number of functional limitations and chronic illness were the strongest explanatory variables for poor perceived health (Ebly, Hogan, & Fung, 1996). Given the pervasive effects of disability on major areas of everyday life, it is important to consider the subjective appraisal of one's welling (Tough, Siegrist, & Fekete, 2017). Dunn, Love, & Ravesloot (2000) asserted that an increased subjective health, independence, and better health outcomes in those physically disabled individuals who were involved in ongoing healthcare and rehabilitation.

3) Psychological health

Poor psychological health is associated with the onset of hypertension (Ojike et al., 2016). Hypertensive individuals represent a vulnerable population concerning psychological health (Liang et al., 2016). Also it has been suggested that psychological health is predictive of adverse cardiovascular outcomes for those with hypertension. For example, Simonsick et al.'s study (1995) found that depressive symptoms were a risk factor for stroke among older adults with hypertension and Wassertheil-Smoller et al. (1996) supported this assertion by indicating that increased depressive symptoms over time are associated with increased risk for stroke and myocardial infarction in patients with hypertension. Hypertension commonly co-exists with depression as it affects approximately one-third of

patients with hypertension (Xue et al., 2017). Co-existence of the two conditions complicates treatment; for instance, depression may affect medication adherence in patients with hypertension. Conversely, uncontrolled hypertension aggravates symptoms of depression (Voinov, Richie, & Bailey, 2013).

Some of the factors that increase psychological burden in people with chronic diseases are functional deterioration at a physical level as a result of fear of and feeling of loss of health due to the chronic illness and guilt for having uncontrolled illness with an unhealthy lifestyle (Gask, Macdonald, & Bower, 2011). Likewise, those who have depressive symptoms are commonly exposed to suicidal ideation and suicidal attempts (Nanauyakkara et al., 2013). Suicidal ideation is a significant risk factor for suicidal attempt and suicide, which is a momentous part and inevitable stage of suicidal behavior (Ge et al., 2019). Many studies have demonstrated that the suicidal ideation was associated with chronic physical conditions including hypertension (Ge et al., 2019; Lehmann et al., 2019). In Lehmann et al (2019)'s clinical trial pointed out that hypertension was a clinical vulnerability of suicidal ideation. Hypertensive patients found to manifest symptoms of depression and stress, which were strongly related to suicidal ideation (Kretchy, Owusu-Daaku, & Danquah, 2014). By noticing that the number of hospital admission and comorbidities in hypertensive patients were the influencing factors for suicidal ideation (Ge et al., 2019), deterioration of health status induced by uncontrolled illness with an

unhealthy lifestyle tend to aggravate the depressive symptoms. Moreover, alcohol use and inadequate physical activity had indirect effect on suicidal ideation mediated by psychological distress (Ge et al., 2019). Placido et al. (2009) demonstrated that the incidence of suicide was positively correlated with those with ischemic heart disease and stroke which are the well-known complications of uncontrolled hypertension. A significant association between high blood pressure and suicide attempts was found in several literatures. The cohort studies using a nation-wide population analyzed that cardiovascular diseases which are the main complications of hypertension were associated with an increased risk of suicidal attempt and suicidal mortality after controlling for the confounders (Hu & Lin, 2019; Jee et al., 2011). Goodwin et al. (2003) reported increased odds of suicide attempt among those with hypertension; however, after adjusting for regular physical activity, this relationship was no longer statistically significant. By remarking the results, hypertension self-management behaviors may act as a role to decrease the incidence of suicidal behavior in hypertensive patients.

Furthermore, reduced mental health is one of the major burdens of disease in population with physical disabilities and physical disability is found to be related to depressive symptoms (Noh et al., 2016). Substantial evidence shows that people living with physical disabilities are at least three times more likely to experience depression compared to the general population (Chevarley et al., 2006; Hughes et al., 2001). People with physical disability experience multiple risk factors for depressive symptoms,

including stereotypic social and personal attitude, stressors related environmental barriers, and lack of access to appropriate health care which lead to a negative impact on physical and psychological health (Shen et al., 2017).

4) Patient satisfaction

Patient satisfaction which is an important and commonly used indicator for measuring the quality in health care is critical to enhance healthy lifestyle and improve clinical outcomes for the growing number of hypertensive patients (Prakash, 2010); and it is even more important in individuals with physical disability, considering health disparities shown in this population. Patient experience with quality of health care is related with patient safety and clinical effectiveness for a wide range of disease areas (Doyle, Lennox, & Bell, 2013). Better patient experience with the healthcare is associated with better adherence to prevention and treatment recommendations, and better clinical outcomes (Doyle, Lennox, & Bell, 2013). Patient satisfaction therefore can be a proxy and an effective indicator to measure of adherence to the treatment regimen instructed by doctors (Prakash, 2010). Patients with chronic disease indicated that inadequate self-management is directly related to mistrust of the medical system and low satisfaction with healthcare services (Vest et al., 2013). An intervention study by Sun et al. (2017) supported that self-management intervention improved patient's level of engagement and empowerment in

their care and decision-making, thereby improved experience of quality of care. Another study on individuals with chronic pain identified better relationship with healthcare providers as a positive outcome of health management, which may directly affect to satisfaction with healthcare services (Mann et al., 2017). Based on the Self- and Family Management Framework, Grey et al. (2006) described that self-management influence how environmental resources such as the health care system and community supports are accessed and utilized, as well as the satisfaction with healthcare providers. The distal outcomes of improved self-management at an environmental level are improved patient-provider relationship (Grey, Knafl, & McCorkle, 2006; Grey et al., 2015). A well-controlled blood pressure is a consequence of self-management skills as well as effective health care delivery (Banerjee, Mukherjee, & Basu, 2016). A qualitative study on hypertensive patients in Ethiopia mentioned that “experience in the quality of health care” related to the hypertension self-management practice. Access to health services, patient-centered care, behavior of health care providers, and time and patient flow management were essential aspects in maintenance of self-management behavior (Hussein et al., 2021).

Quality of care and support is an important factor associated with quality of life among people with physical disabilities (Zhen et al., 2014). Satisfaction with healthcare services in people with disabilities is mainly influence by healthcare provider attitudes toward them and it may lead to inequities in healthcare delivery to people with disabilities (Satchidanand et

al., 2012). Because caring for patients with physical disabilities can be challenging for healthcare providers as it requires more burden, time, and higher complexity to provide comprehensive care, negative healthcare provider attitude and misperceptions about disability is often experienced and have negative impact on quality care to patients with disabilities (Satchidanand et al., 2012).

4) Unmet medical needs

Unmet medical needs are another crucial indicator that is widely related to health outcomes, financial risk protection, improvement in efficiency, and responsiveness to individuals' reasonable health expectations (Ramos et al., 2019). Unmet medical needs could occur due to three characteristic reasons, such as availability, accessibility, and acceptability (Chen & Hou, 2002). Availability is a barrier related to the lack of medical facilities or long waiting time, whereas accessibility is determined by economic status and transportation. Acceptability is the factor addressing the lack of information about healthcare services or awareness of the need for medical services (Chen & Hou, 2002). Those who have physical disabilities more often report the barriers for the medical needs due to accessibility of medical care such as an economic issues and available transportation (Hwang et al., 2011). As mentioned earlier, the Self- and Family Management Framework pronounces access and utilization of healthcare services as a key distal outcome of self-management (Grey et al., 2015). Wagner et al. (2001)

advocated that self-management helps to create active, involved patients, which leads to better outcomes, such as access and utilization of healthcare services. In a mixed-method study by White (2018), stroke survivors who regularly monitored their blood pressure at home tend to have improved healthcare access, which was supported by ease of using health information technology. Patients with chronic illness demonstrated being too busy or had other personal responsibilities and reluctance to accept health condition and treatment as the reasons for reduced self-care, eventually resulting in unmet healthcare needs (Mahendran, Speechley, & Widjaja, 2017). It is beneficial for chronic disease prevention and control policy makers to determine priorities by accurately identifying and measuring the unmet needs of patients with chronic diseases and to better target chronic disease prevention and control policies (Ke et al., 2021). Hence, identifying unmet needs in hypertensive patients especially those with physical disabilities may assist recognize the objective needs proposed by patients with prevention, medical treatment, rehabilitation, and health care according to gaps between their actual health conditions and their subjective ideal health status (Ke et al., 2021).

Evidence indicates that people with disabilities have greater health needs than people without disabilities and that these unmet needs may more critically impact on health (Clemente et al., 2022). Studies in US have suggested that increasing disability is risk factor for less satisfaction with healthcare and more unmet healthcare needs (Burns et al., 1990). It has been

reported that population with disability often lacks opportunities to engage in preventive healthcare activities and does not have adequate access to primary healthcare, hospital care, and long-term care services, which increases the risks of developing secondary conditions (Lishner et al., 1996; DeJong, 1997)

Based on previous studies, it may be acknowledged that various aspects of individual's health can be benefited from hypertension self-management. Although it is vital to consider the levels of blood pressure or complications of hypertension as an outcome of hypertension self-management, the health measures, such as quality of life, subjective health, psychological health, patient satisfaction, and unmet medical needs can be essential proxy measure of health status in people with physical disabilities.

III. Theoretical framework

The theoretical framework used in this study was the Theory of Self-care Management for Vulnerable Populations, a middle-range theory that primarily focuses on the role of the individual in self-care management and the factors that influence ability to manage one's chronic illness (Dorsey & Murdaugh, 2003; Figure 1). This theory suggests that self-care management depends on a combination of intra-personal factors and vulnerability factors. It is theorized that self-care management is influenced by modifiable vulnerability factors (i.e., economic situation and education), non-modifiable vulnerability factors (i.e., age, chronic condition, gender, and race/ethnicity), and intra-personal factors (i.e., assertiveness, coping behavior, knowledge, self-efficacy, and social support). Contextual factors (i.e., community values and community resources) are hypothesized to indirectly influence self-care management through vulnerability factors. Self-care management is theorized to affect both health status, such as physical, social, and mental well-being, and quality of life (Dorsey & Murdaugh, 2003). Dorsey and Murdaugh (2003) defined vulnerable populations as a social group who experience health disparities as a result of a lack of resources and increased exposure to risk.

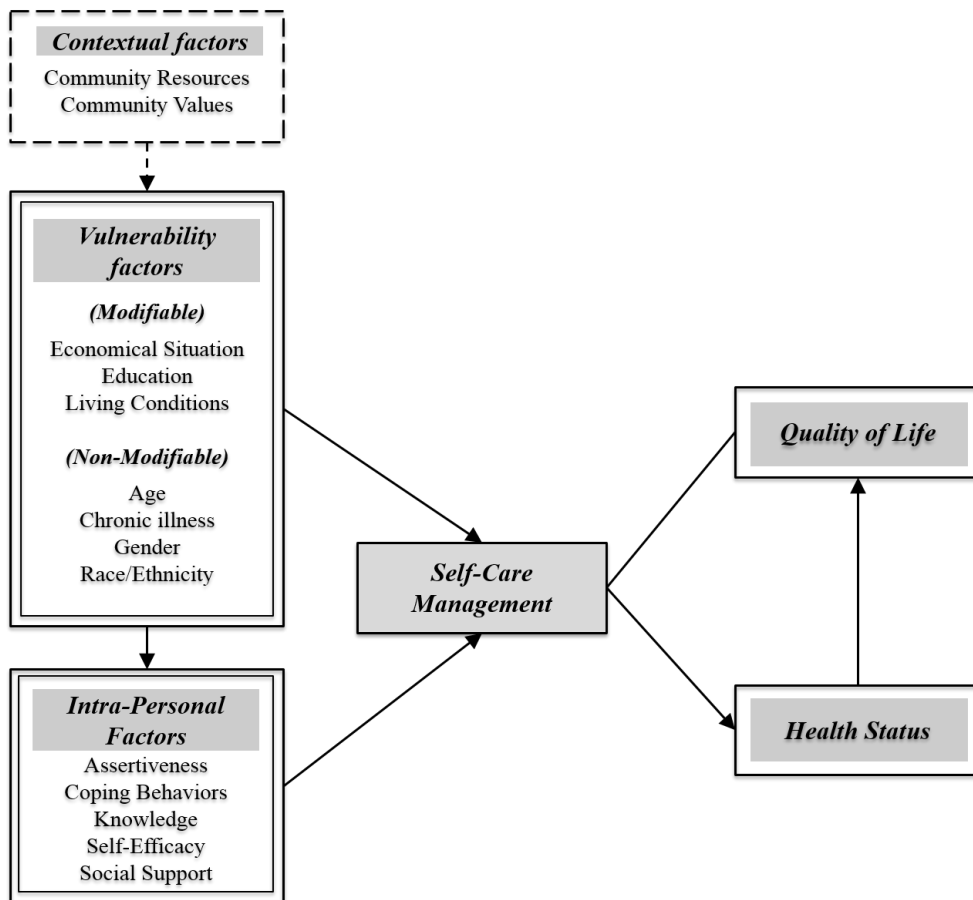


Figure 1. The Theory of Self-Care Management for Vulnerable Population Model

(Source: illustrated based on Dorsey & Murdaugh, 2013)

Hypertensive patients with physical disabilities are vulnerable group with complex healthcare needs because they possess at least two prolonged health issues, hypertension and impaired physical function. Since the management of complex health issues may lead to important self-management challenge, the self-management theories which mainly focus on the context of a specific chronic disease may be insufficient for a comprehensive appraisal (Gobeil-Lavoie et al., 2019). Instead, the Theory of Self-care Management for Vulnerable Populations offers a theoretical perspective that can lead to greater understanding of chronically ill vulnerable populations so that it supports to identify significant factors which predict health status and quality of life in persons with chronic illnesses (Dorsey & Murdaugh, 2003).

Based on an adaption of Dorsey and Murdaugh's (2003) theory, the research framework of this study was developed as shown in Figure 2. Self-care management includes the five key hypertension self-management behaviors, such as no smoking, limited alcohol drinking, regular physical activity, balanced diet, and weight control (Lee et al., 2019).

Modifiable vulnerability factors include education, marital status, employment status, and household income. Evidence supports education, marital status, employment, and household incomes are associated with hypertension self-management behaviors (Acharya et al., 2022; Gelaw, Yenit, & Nigatu, 2021; Chang et al., 2013; Heo & Kim, 2018; Zhang et al., 2020; Zareban et al., 2022). Non-modifiable vulnerability factors are age,

gender, disability, ADL, IADL, and number of comorbidities, considered as affecting factors for hypertension self-management behaviors in this study (AlHadlaq et al., 2019; Nicoletti-Rojas, 2022; Fix et al., 2014; Liu et al., 2020). The Theory of Self-Care Management for Vulnerable Populations proposes that intra-personal resources have a mediating effect between the relationship between vulnerability and self-care management, as well as a direct impact on self-care management. In this study, social support was considered as the intra-personal factor which directly influences the hypertension self-management behaviors. Social support was addressed using friendship network (Thuy et al., 2021) and satisfaction with family relationships (Flynn et al., 2013; Zhang et al., 2020; Shahin et al., 2021).

The outcome of self-management behaviors was addressed through quality of life and health status as presented in the theory. Quality of life was described using health-related quality of life in this study which may be influenced by hypertension self-management behaviors (Pan et al., 2021; Shahin et al., 2021; Thuy et al., 2021). Health status was addressed through subjective health, patient satisfaction, and unmet medical needs which are widely used health measures that represent an individual's health status as a proxy indicator (Verschuuren et al., 2013; Doyle, Lennox, & Bell, 2013; Hussein et al., 2021; Ke et al., 2021). Also psychological health including suicidal ideation, suicide attempts, and depression were included as a health outcome of self-management behaviors (Simonsick et al., 1995; Wassertheil-Smoller et al., 1996; Wang et al., 2022). The Theory of Self-

Care Management for Vulnerable Populations acknowledges the influences of contextual factors, however, no attempts were made to alter or directly test the contextual factors in the dissertation.

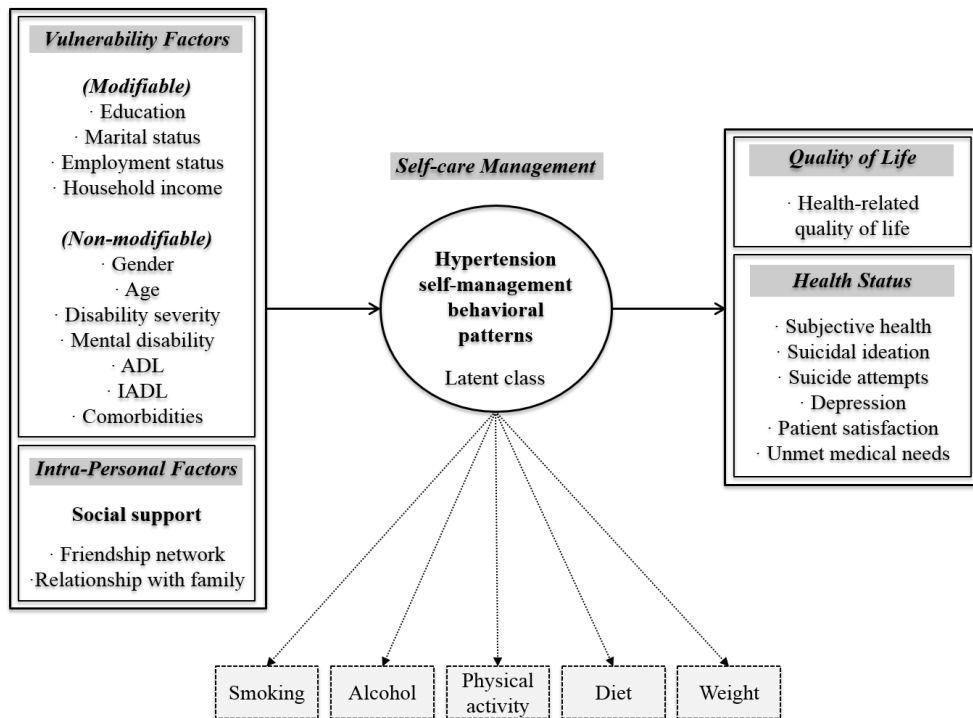


Figure 2. Research framework of this study

IV. Methods

1. Study design

This study was conducted to describe the hypertension self-management behavioral patterns in people with physical disabilities in South Korea and to investigate the associated factors and health measures according to hypertension self-management behavior typology. The study design is a cross-sectional descriptive study using a nationwide population-based data from the 2017 National Survey of Disabled Persons collected by the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs.

2. Study data

This cross-sectional study analyzed data from the 2017 National Survey of Disabled Persons, a nationally representative survey of community-dwelling people with disabilities in South Korea (Kim et al., 2017). This survey is conducted by the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs every three years, in order to provide nationally representative data and descriptive statistics of people with disabilities. It utilizes a two-stage, stratified random cluster sampling method drawn from the 2015 Population and Housing Census of Korea.

3. Study subjects

The inclusion criteria for this study were those patients who self-indicated that they have a physical disability and were diagnosed with hypertension. Physical disability refers to physical limitations that result from a permanent functional disorder in a physical body part such as muscle, nervous system, or bone structure, whether the patients acquired the disability either congenitally or postnatally (Ministry of Health and Welfare, 2021a). Consequently, 1,551 eligible participants were extracted from the dataset of 6,549 patient samples (Figure 3).

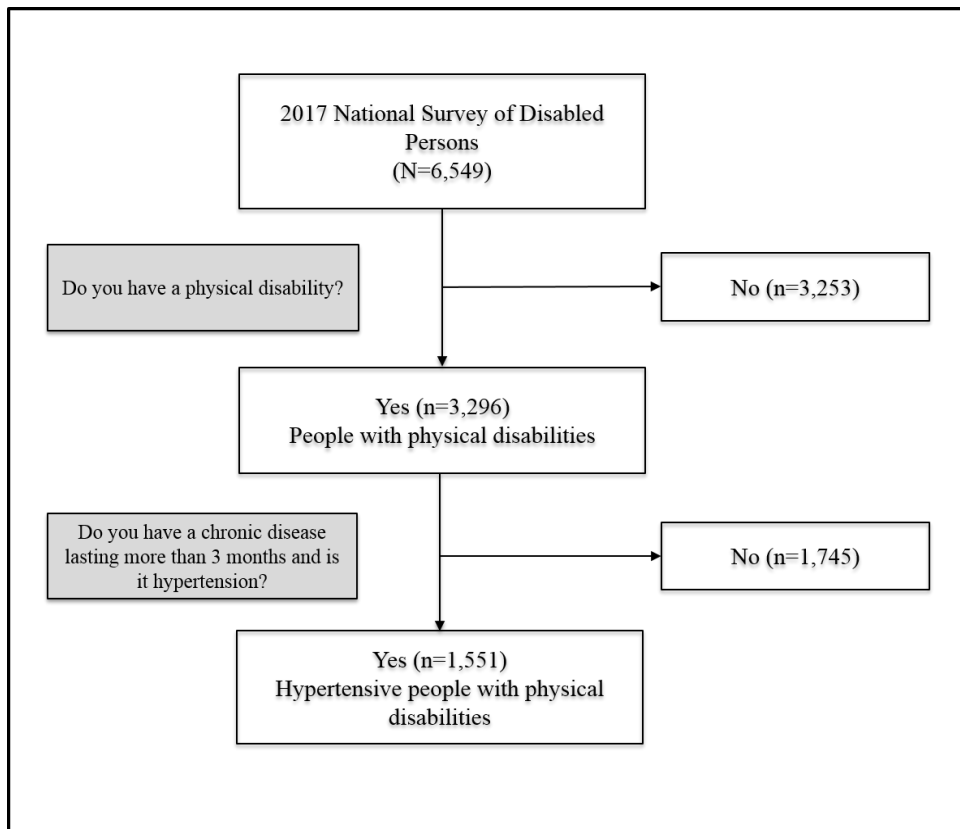


Figure 3. Flow chart of extracting study subjects

4. Study variables

1) Latent class indicators

Five hypertension self-management behavior indicators were selected: cigarette smoking, alcohol consumption, physical activity, diet, and weight control. Dichotomous indicators, “yes” versus “no,” for each self-management behavior were created based on existing recommendations of 2018 Korean Society of Hypertension Guidelines (Lee et al., 2019) as described below.

(1) Cigarette smoking

The 2018 Hypertension Guidelines emphasize that smoking cessation is strongly recommended as smoking is a major risk factor for hypertension (Lee et al., 2019). The answers to a single question asking “Do you smoke?” were recoded as a binary variable. Thus, the responses “never smoked” and “former smokers” were classified as “yes,” and “daily smoker” and “occasional smoker” were recoded as “no” in regards to whether or not the participant adhered to the 2018 Hypertension Guidelines.

(2) Alcohol consumption

Excessive alcohol intake can elevate blood pressure and resistance to antihypertensive drugs. Thus, it is recommended that hypertensive patients drink less than two glasses of alcohol per day (Lee et al., 2019). The

participants who did not drink alcohol within the last year and those who reported “1–2 glasses” were recoded as “yes” and those who drank “3–4 glasses” or more were classified as “no” in regards to whether or not the participant adhered to the 2018 Hypertension Guidelines.

(3) Physical activity

Physical activity can contribute to the control of high blood pressure and deter complications. The 2018 Hypertension Guidelines recommend regular physical activity for >30 min a day at least three times per week for hypertension management (Lee et al., 2019). Those who reported that they engaged in physical activity for 30 or more minutes at a time, more than three times a week were classified as “yes”; others were classified as “no.”

(4) Balanced diet

Eating a low-fat diet rich in whole grains, vegetables, and fruits and contains adequate nutrients can help control high blood pressure (Lee et al., 2019). Participants were asked, “During the last week, have you consumed a nutritionally-balanced diet?” Those who answered “yes” to the question were considered as adherent to dietary recommendations.

(5) Weight control

Body weight control is suggested to avoid obesity, which is a risk factor for uncontrolled high blood pressure. It is recommended that Body Mass

Index (BMI) be maintained at 25kg/m^2 (Lee et al., 2019) as the lowest mortality rate was found around 25kg/m^2 compared to those with underweight and overweight (Jee et al., 2006). BMI values were calculated by dividing the participant's weight in kilograms by the square of their height in meters. This variable was categorized as "yes" for a BMI of $\leq 25\text{kg/m}^2$, as adhering to the 2018 Hypertension Guidelines and "no" if $>25\text{kg/m}^2$. Missing values were found because some participants were unable to measure the weight or height ($n=98$) and it was handled statistically.

2) General characteristics

General characteristics of the participants included demographics, health-related variables, and social relationships. Demographic characteristics such as age, gender, education level, marital status, employment status, monthly household income, and National Health Insurance status as well as health-related variables such as mental health disabilities, severity of disability, ability to perform ADL or IADL, and the number of comorbidities were recorded. Household income was calculated based on equalized income (i.e., total household income divided by the square root of the number of household members). It was classified as higher or lower based on the median income for regression or categorized into quartile for frequency. In terms of current marital status, "single" included never married, widowed, divorced, and separated. Mental disability

refers to those who have developmental disability, intellectual disability, or psychiatric disability, as well as physical disability. Disability severity was assessed by asking about the degree of disability as registered in the Disability Registration System; missing data ($n=23$) was discovered because some participants had not been officially registered. ADL and IADL, used in the 2017 National Survey of the Disabled Persons, have been modified to take account of the disability by the research institute (Kim et al., 2017). ADL was consisted of 12 items on the degree of assistance required with dressing, bathing, oral care, swallowing, eating, changing position while lying down, transferring to sit down, maintaining a sitting position, walking, transfer, bowel management, and bladder management. IADL contained 8 items that inquired about ability to use telephone, shop, prepare meals, clean, do laundry, manage medications, manage finances, and use public transportation system independently. The response options regarding ADL and IADL included “no assistance required”, “some assistance required”, “substantial assistance required”, and “full assistance required” and they were categorized into “dependent” if the participant required assistance with one or more activities (Ng et al., 2009; Jung et al., 2009). Comorbidity was measured by the number of chronic diseases that the participants have been suffered from for 3 months or more. Quality of social relationships was assessed using satisfaction with friendship network and family relationship. It was surveyed via a 4-point scale from “very satisfied” to “very dissatisfied”, which was used to answer to the questions “are you satisfied

with the number of friends you have?” and “are you satisfied with your family relationship”. The responses were dichotomized into “satisfied” and “dissatisfied”. The Missing values in the satisfaction with relationship with family were noted as some of the participants had no family ($n=4$).

3) Health measures

The EuroQOL-5 Dimension (EQ-5D) was used to assess the HRQoL. The EQ-5D consists of 5 dimension of health including mobility, self-care, usual activities, pain/discomfort, and anxiety or depression with three possible answers for each item (1=no problem, 2=moderate problem, 3=severe problem). Value sets developed by Lee et al. (2009) were applied to the data to convert the states derived from the EQ-5D into an index score. The index scores range from -0.171 indicating the worst health state to 1.000 indicating full health.

Subjective health was assessed using a single question “How do you feel about your health in general?” in a 5-point scale from “very bad” to “very good” and a higher score indicated better subjective health.

Psychological health was measured using suicidal ideation, suicide attempts, and depression. Suicidal ideation and suicide attempts were assessed using questions “Have you ever felt suicidal within the last year?” and “Have you ever attempted suicide within the last year?”, respectively. Depression was assessed by asking “Have you ever felt sad or desperate enough such that it interfered with your daily life for more than two weeks

in a row within the last year?” and requesting a dichotomous response “yes” or “no”.

Patient satisfaction, an indicator for quality of care, consisted of a single item that questioned the degree of satisfaction with the healthcare services that the participants used recently. The response options in a 5-point scale include from “dissatisfied at all” to “very satisfied”.

Unmet medical needs, an indicator for healthcare utilization, were assessed by asking whether the participants experienced being unable to use the hospital or healthcare services when they needed to during the last year using a dichotomous option “yes” or “no”.

5. Statistical analysis

LCA is optimal for identifying unobserved at-risk populations represented in a heterogeneous sample like people with disability. It allows for subgroups with similar characteristics which are known as latent variables that increase the chance of having the outcome to be identified (Asparouhov & Muthén, 2014). Categorical latent variables correspond to the person-centered components in that the categories describe groups of individuals who are homogeneous within a given category and are heterogeneous across categories (Asparouhov & Muthén, 2014). Because hypertension self-care regimes exist on a dichotomy such as non-smoking or smoking, this can be an essential methodology to employ with adherence behaviors (Ghanbari et al., 2018). LCA may have a benefit to identify subtypes of non-adherence, while avoiding limitations that other traditional methodologies employed.

Data analysis was conducted using IBM SPSS Statistic 21.0 (IBM Corp., Armonk, NY, USA) and Mplus 8.0 (Muthén and Muthén, Los Angeles, CA, USA). LCA was conducted using five indicators: cigarette smoking, alcohol consumption, physical activity, balanced diet, and weight control; all variables were considered binary categories. The analytical strategy in LCA involves identifying the statistically optimal number of classes that explain hypertension self-management behavioral patterns across the five indicators. The optimal number of classes was determined by progressively increasing

the number of classes and comparing the model selection statistics of each subsequent model (Asparouhov & Muthén, 2014). Missing data were handled using full information maximum likelihood.

Model comparisons were performed using the measures of model-fit indices, including Akaike's Information Criteria (AIC), Bayesian Information Criterion (BIC), the adjusted BIC (saBIC), entropy, and the Lo-Mendell-Rubin Likelihood Ratio test (LMR). Smaller values of AIC, BIC, and saBIC suggest a better, more parsimonious model and inform the decision on the best model to be retained (Ghanbari et al., 2018). A significant p -value on the LMR ($p < .05$) indicates a model with good fit (Asparouhov & Muthén, 2014). Entropy calculations close to 1.0 indicate a better classification (Asparouhov & Muthén, 2014). In addition to the model fit, we reviewed the substantive meaning of latent class models.

Descriptive statistics, such as frequencies, percentages, means, and standard deviations, were used to describe the general characteristics of the total sample. Once the appropriate number of latent classes was determined, the characteristics of each group and health measures were compared using a chi-squared test and analysis of variance with Duncan's test for significance. The demographics and health-related variables were compared among emergent latent classes using multinomial latent class logistic regression. Missing values were estimated using multiple imputations by chained equations which allow different types of variables to be handled within the same dataset (White, Royston, & Wood, 2011).

6. Ethical considerations

This study was a secondary analysis of cross-sectional survey data. The 2017 National Survey of Disabled Persons has stringent protocols that ensure confidentiality and participants' autonomy. Written informed consent was obtained from all subjects or their legal guardians. To ensure compliance with de-identified data handling procedures, our study was approved by the Institutional Review Board of the University (IRB No. E2011/002-013).

V. Results

1. Baseline characteristics of participants

The sample of 1,551 hypertensive patients with physical disabilities is described in Table 1.

Regarding the demographics of our study samples, nearly a half of participants were male (46.6%) and the mean age of the participants were 69.88, ranged between 33 and 97. More than half of the participants were over 70 years old whereas only 3.5% were 49 years old or younger. The participants who received no education were 19.4% and more than half of them were married. Those who were currently employed were only 36.0% and the mean monthly household income was 131.41 in 10,000 Korean Won. Of the participants, 12.0% received medical aids for their health insurance.

Considering the health status, most of them had a mild degree of disability (81.2%). Six people with physical disabilities concurrently had a mental disability (0.4%). Those who were dependent with ADL and IADL were 40.9% and 47.9%, respectively.

In terms of social relationship factors, most of the participants were satisfied with the number of friends (75.1%) and relationship with their family (82.2%).

In regard to self-management behaviors, those who smoke every day or occasionally were about 14.8% and adhere to non-smoking were 82.2%.

The participants who do not drink alcohol or drink alcohol only 1 or 2 glasses at time, thereby adhere to limited alcohol consumption were 77.8%. Approximately 33.5% reported that they engage in physical activity almost every day whereas 39.8% do not engage in physical activity at all. Of the participants who engage in physical activity for 30 or more minutes at a time and more than three times a week were 46.7%. There were only 34.0% who had a balanced diet considering nutrition. Considering the weight based on BMI classification for Korean adults (Kim et al., 2021), those who were underweight were only 2.8% and normal weight were 31.2%. On the other hand, the participants whose BMI was categorized into obesity or severe obesity were about 40.0 %. Those who adhere to weight control as BMI is 25.0kg/m^2 or less were 56.2%.

Table 1. Baseline characteristics of participants

(N=1551)

Variables	Category	n (%) or M±SD
<i>Socio-demographics</i>		
Gender	Male	722 (46.6)
	Female	829 (53.4)
Age (years)		69.88±10.28 (range 33~97)
	≤49	56 (3.5)
	50–59	208 (13.4)
	60–69	432 (27.9)
	70–79	588 (37.9)
	≥80	269 (17.3)
Education	No education	301 (19.4)
	Elementary school	609 (39.3)
	Middle school	260 (16.8)
	High school	283 (18.2)
	≥University	98 (6.3)
Current marital status	Married	889 (57.3)
	Single	662 (42.7)
Employment status	Employed	559 (36.0)
	Unemployed	992 (64.0)
Monthly household income (10,000 KRW) ^{b, c}		131.41±98.90 (range 8.94~1166.25)
	Low	401 (25.9)
	Mid-low	376 (24.2)
	Mid	384 (24.8)
	High	390 (25.1)
National Health Insurance	Employer-sponsored insured	900 (58.0)
	Self-employed insured	465 (30.0)
	Medical Aids	186 (12.0)

Table 1. Cont.

Variables	Category	<i>n</i> (%) or M±SD	
<i>Health status</i>			
Disability severity ^d	Mild	1259	(81.2)
	Severe	269	(17.3)
Mental disability ^a	Yes	6	(0.4)
	No	1545	(99.6)
ADL	Dependent	635	(40.9)
	Independent	916	(59.1)
IADL	Dependent	743	(47.9)
	Independent	808	(52.1)
Number of chronic diseases		2.39±1.64 (range 0~10)	
<i>Social relationship</i>			
Relationship with friends	Satisfied	1165	(75.1)
	Dissatisfied	386	(24.9)
Relationship with family ^d	Satisfied	1271	(82.2)
	Dissatisfied	276	(17.8)
<i>Self-management behaviors</i>			
Smoking cigarette	Everyday	196	(12.6)
	Occasionally	33	(2.2)
	Ex-smoker	348	(22.4)
	Never	974	(62.8)
Adherence to non-smoking ^e	Yes	1322	(85.2)
	No	229	(14.8)
Amount of alcohol consumption at a time	Not at all	1000	(64.5)
	1–2 glasses	206	(13.3)
	3–4 glasses	119	(7.7)
	5–6 glasses	56	(3.6)
	7–9 glasses	116	(7.5)
	Over 10 glasses	54	(3.5)
Adherence to limited alcohol consumption ^f	Yes	1206	(77.8)
	No	345	(22.2)

Table 1. Cont.

Variables	Category	<i>n</i> (%) or M±SD
Frequency of physical activity	Almost everyday	520 (33.5)
	≥3 times a week	234 (15.1)
	2 times a week	122 (7.9)
	1 time a week	34 (2.2)
	1–2 times a month	20 (1.3)
	<1 times a month	4 (0.3)
	Not at all	617 (39.8)
Adherence to physical activity ^g	Yes	724 (46.7)
	No	827 (53.3)
Balanced diet	Yes	528 (34.0)
	Rarely	796 (51.4)
	No	227 (14.6)
Adherence to balanced diet ^h	Yes	528 (34.0)
	No	1023 (66.0)
Weight based on BMI ^{d, i}	Underweight	41 (2.8)
	Normal	454 (31.2)
	Overweight	376 (25.9)
	Obesity	487 (33.5)
	Severe obesity	95 (6.5)
Adherence to weight control ^j	Yes	871 (56.2)
	No	582 (37.5)

Note. ^aIncluding developmental, intellectual, or psychiatric disability; ^bEquivalized household income; ^cLow ≤65, Mid-low >65–102.53, Mid >102.53–164.54, High >165.54; ^dMissing values excluded; ^eThose who are ex-smokers or never smoked; ^fThose who drink alcohol 1–2 glasses at a time; ^gThose who engage in physical activity for 30 or more minutes at a time, more than three times a week; ^hThose who consume a nutritionally-balanced diet; ⁱUnderweight <18.5 kg/m², Normal 18.5–22.9 kg/m², Overweight 23.0–24.9 kg/m², Obesity 25.0–29.9 kg/m², Severe obesity ≥30.0 kg/m²; ^jThose whose BMI 25.0 kg/m² or less; BMI=body mass index; KRW=Korean Won; M=Mean; SD=Standard deviation.

2. Latent class model of hypertension self-management behaviors

Of the 6,549 people with disabilities who participated in the 2017 National Survey of Disabled Persons, 1,551 people were included in the study. To determine the latent classes for hypertension self-management behavior, two-, three-, four-, and five-latent class models were tested as shown in Table 2. Two and three-latent classes were better fitting models in terms of accurately reflecting the data, since their LMR was found to be significant ($p < .05$). Although a two-latent class model exhibited the lowest BIC value, a three-latent class model was selected based on the values of AIC, saBIC, entropy, and the p -value of the LMR as the overall values indicated that it was the parsimonious, best-fitting model and could estimate a predicted probability of membership to each latent class. The entropy of the three-latent class model was 0.74, which was beyond the criteria for good class separation, and 0.60, which exceeded the criteria for a good class separation (Asparouhov & Muthén, 2014).

Table 2. Comparison of latent class analysis models with different latent classes based on model selection statistics

Category ^a	2-latent class	3-latent class	4-latent class	5-latent class
AIC	8873.32	8859.62	8854.69	8859.10
BIC	8932.13	8950.51	8977.66	9015.05
saBIC	8897.19	8896.50	8904.59	8922.92
Entropy	0.58	0.74	0.48	0.83
LMR	176.26*	25.13*	16.55	7.48

Note. * $p < .05$; ^aAIC, BIC, and saBIC with lower values indicates better model fit and parsimony, a significant p -value in LMR indicates that a model (with k classes) has better model fit compared to a corresponding model with one less class (with $k-1$ classes), entropy with values closer to 1 (the maximum value) indicate better classification utility; AIC=Akaike's information criterion; BIC=Bayesian Information Criterion; saBIC=the adjusted BIC; LMR=Lo-Mendell-Rubin likelihood ratio test.

The latent class membership and response probabilities for the five self-care behaviors are detailed by each of the latent classes in Table 3 and Figure 4. Figure 5 also illustrates the magnitude of the discrepancy between the three latent classes by visualizing the response probabilities for each indicator. The latent classes 1, 2, and 3 were labelled as the “high self-management” group, the “harmful habitual behavior” group, and the “inactive behavior” group, respectively, based on the probabilities of hypertension self-management behaviors from each latent class.

The high self-management group (Class 1; 40.8%; $n=633$) consisted of hypertensive adults with physical disabilities who had relatively high probabilities of all five self-management behavior indicators (non-smoking, 94.9%; limited alcohol consumption, 88.5%; balanced diet, 36.5%; and weight control, 63.8%). Noticeably, all of the participants in this group were adherent to regular physical activity (100.0%).

The harmful habitual behavior group (Class 2; 20.6%; $n=319$) exhibited the lowest probabilities of being a non-smoker (50.4%) and of limiting alcohol consumption (33.1%). They had moderate probabilities of practicing regular physical activity (38.1%), having a balanced diet (44.6%), and weight within the normal range (60.3%).

The inactive behavior group (Class 3; 38.6%; $n=599$) had the highest probabilities of non-smoking status (98.5%) and limited alcohol drinking (96.4%). Conversely, they had the lowest probabilities of having a balanced diet (2.4%) and proper weight control (55.7%), and no one from this group

engaged in regular physical activity (0.0%).

Table 3. Estimated classes and response probabilities from a three class model of hypertension self-management behavior in patients with physical disabilities

Variables	Category	Total	High self- management group	Harmful habitual behavior group	Inactive behavior group
Probability of latent class membership		100% (N=1551)	40.8% (Class 1; n=633)	20.6% (Class 2; n=319)	38.6% (Class 3; n=599)
No cigarette smoking	Yes	0.852	0.949	0.504	0.985
	No	0.148	0.051	0.496	0.015
Limited alcohol consumption	Yes	0.778	0.885	0.331	0.964
	No	0.222	0.115	0.669	0.036
Physical activity	Yes	0.467	1.000	0.381	0.000
	No	0.533	0.000	0.619	1.000
Balanced diet	Yes	0.340	0.365	0.446	0.248
	No	0.660	0.635	0.554	0.752
Weight control ^a	Yes	0.562	0.638	0.603	0.557
	No	0.375	0.362	0.397	0.443

Note. ^aMissing values included using full information maximum likelihood.

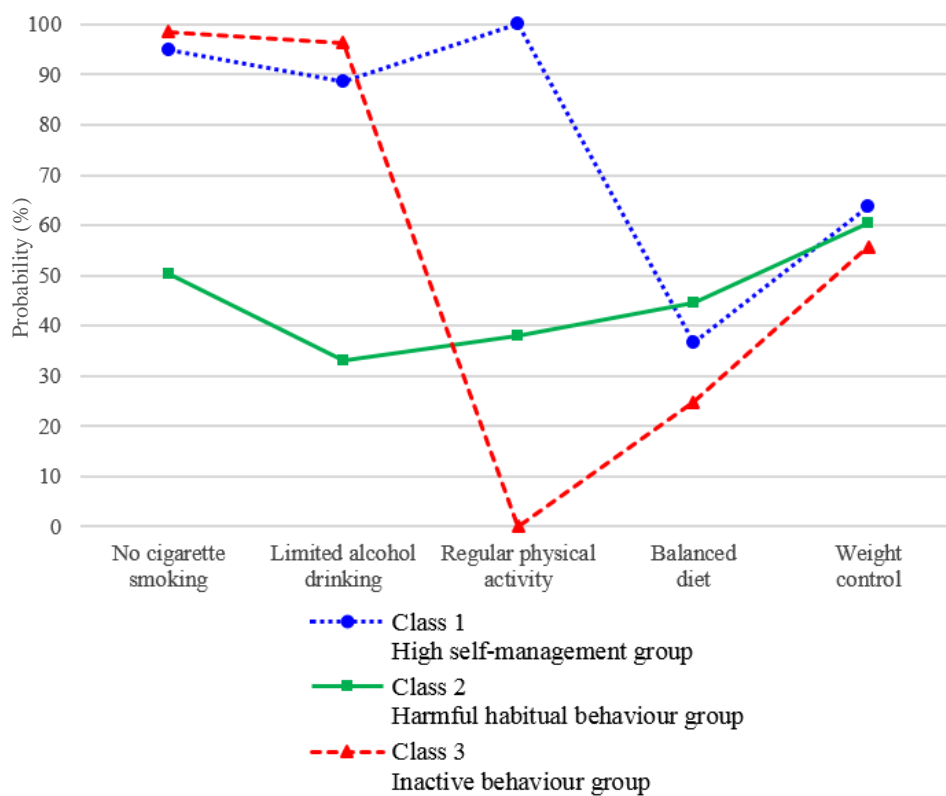


Figure 4. Profiles of the latent classes in the 3-group model with five indicator variables

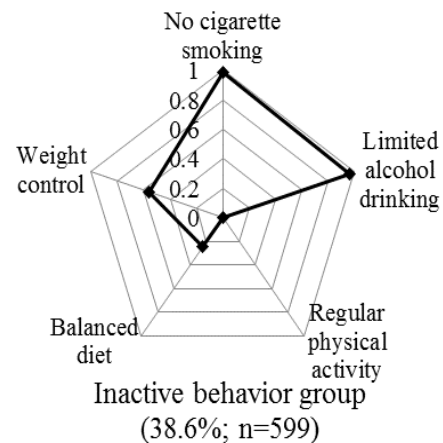
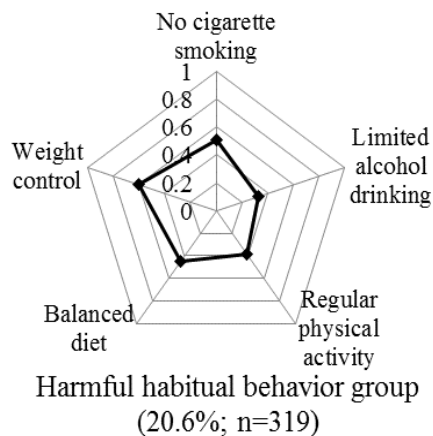
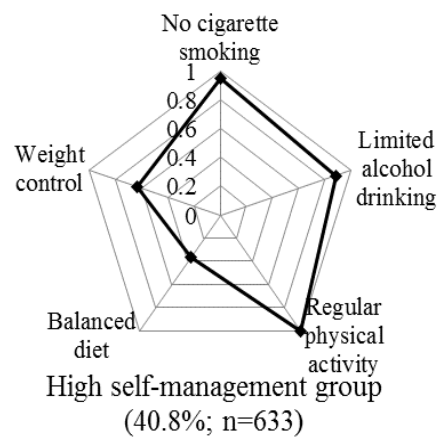


Figure 5. Probabilities of five hypertensive self-management behavior indicators estimated in three latent classes

3. Participants' characteristics according to latent classes

Table 4 displays the comparisons of the characteristics between the three latent classes. Results showed that gender ($p<.001$); age ($p<.001$); education ($p<.001$); marital status ($p=.002$); employment status ($p<.001$); monthly household income ($p<.001$); area of physical disability such as upper limbs ($p<.001$), lower limbs ($p=.001$), or spine ($p=.001$); disability severity ($p<.001$); ADL ($p<.001$) and/or IADL ($p<.001$) dependent status; the number of comorbidities ($p<.001$); and satisfaction with friendships ($p<.001$) were significantly different among the three classes.

Harmful habitual behavior group were consisted mostly with male (89.7%) while majority of inactive behavior group were female (72.3%). Inactive behavior group appeared to be the oldest (72.25 ± 9.32), and harmful habitual behavior group was the youngest (61.96 ± 10.80). People in their 60s were most frequently shown in harmful habitual behavior group (33.5%), whereas high self-management group and inactive behavior group showed the highest percentages of people in their 70s (41.4% and 44.2%, respectively). High school was the most frequently reported education level in harmful habitual behavior group (33.9%), whereas elementary school was the most frequent in high self-management group (42.2%) and in inactive behavior group (43.2%). More than half of the participants in all classes were married (high self-management group, 58.5%; harmful habitual

behavior group, 64.3%; inactive behavior group, 52.4%). Nearly half of harmful habitual behavior group (58.0%) was employed, but in contrast, the greater percentages of unemployed were presented in high self-management group (70.5%) and inactive behavior group (68.8%). The monthly household income was the highest in harmful habitual behavior group (15.07 ± 5.45) while high self-management group (12.74 ± 5.36) and inactive behavior group (12.45 ± 5.3) showed no difference. Majority of the participants in the three groups had mild degree of disability though high self-management group had the highest percentage in mild disability degree (87.0%). The highest percentage of independent level of ADL (71.8%) and IADL (67.1%) were noted in harmful habitual behavior group while the highest percentage of dependent level of ADL (52.9%) and IADL (59.6%) were found in inactive behavior group. Harmful habitual behavior group had the lowest average number of chronic diseases (1.83 ± 0.09). Regarding the social relationships, harmful habitual behavior group had the highest percentages in satisfied with the relationship with friends, whereas inactive behavior group had the lowest percentages in dissatisfaction. Concurrent of mental disability and the satisfaction with the relationship with family were not significantly different across the three classes.

Table 4. Comparisons of characteristics between the latent classes in hypertensive patients with physical disabilities

Variables	Category	High self-management group (Class 1; <i>n</i> =633)	Harmful habitual behavior group (Class 2; <i>n</i> =319)	Inactive behavior group (Class 3; <i>n</i> =599)	<i>x</i> ² or <i>F</i> ^a	<i>p</i>	Post- hoc ^b
		<i>n</i> (%) or Mean±SD					
Gender	Male	270 (42.7)	286 (89.7)	166 (27.7)	327.51	<.001	
	Female	363 (57.3)	33 (10.3)	433 (72.3)			
Age (years)		71.17±8.77	61.95±10.80	72.75±9.32	146.35	<.001	2<1<3 ^c
	≤49	8 (1.3)	37 (11.6)	9 (1.5)	252.68	<.001	
	50–59	61 (9.6)	97 (30.4)	50 (8.3)			
	60–69	189 (29.9)	107 (33.5)	135 (22.7)			
	70–79	262 (41.4)	61 (19.1)	265 (44.2)			
	≥80	113 (17.9)	17 (5.3)	139 (23.2)			
	Education	No education	119 (18.8)	20 (6.2)	162 (27.0)	163.81	<.001
Elementary school		267 (42.2)	83 (26.0)	259 (43.2)			
Middle school		107 (16.9)	64 (20.1)	89 (14.9)			
High school		105 (16.6)	108 (33.9)	70 (11.7)			
≥University		35 (5.5)	44 (13.8)	19 (3.2)			

Table 4. Cont.

Variables	Category	High self-management group (Class 1; <i>n</i> =633)	Harmful habitual behavior group (Class 2; <i>n</i> =319)	Inactive behavior group (Class 3; <i>n</i> =599)	<i>x</i> ² or <i>F</i> ^a	<i>p</i>	Post- hoc ^b
		<i>n</i> (%) or Mean±SD					
Current marital status	Married	370 (58.5)	205 (64.3)	314 (52.4)	12.45	.002	
	Single	263 (41.5)	114 (35.7)	285 (47.6)			
Employment status	Employed	187 (29.5)	185 (58.0)	187 (31.2)	84.33	<.001	
	Unemployed	446 (70.5)	134 (42.0)	412 (68.8)			
Monthly household income ^d	Low	335 (52.9)	103 (32.3)	339 (56.6)	52.60	<.001	
	High	298 (47.1)	216 (67.7)	260 (43.4)			
Disability severity ^e	Mild	551 (87.0)	251 (78.6)	477 (79.6)	16.10	<.001	
	Severe	82 (13.0)	68 (21.4)	122 (20.4)			
Mental disability ^f	Yes	3 (0.5)	1 (0.3)	2 (0.3)	0.21	.899	
	No	630 (99.5)	318 (99.7)	567 (99.7)			
ADL	Dependent	228 (36.0)	90 (28.2)	317 (52.9)	63.27	<.001	
	Independent	405 (64.0)	229 (71.8)	282 (47.1)			

Table 4. Cont.

Variables	Category	High self-management group (Class 1; <i>n</i> =633)	Harmful habitual behavior group (Class 2; <i>n</i> =319)	Inactive behavior group (Class 3; <i>n</i> =599)	χ^2 or F^a	p	Post- hoc ^b
<i>n</i> (%) or Mean±SD							
IADL	Dependent	281 (44.4)	105 (32.9)	357 (59.6)	64.68	<.001	
	Independent	352 (55.6)	214 (67.1)	242 (40.4)			
Number of chronic diseases		2.45±1.56	1.83±0.09	2.62±1.72	25.99	<.001	2<1,3 ^c
Relationship with friends	Satisfied	496 (78.4)	261 (81.8)	408 (68.1)	26.94	<.001	
	Dissatisfied	137 (21.6)	58 (18.2)	191 (31.9)			
Relationship with family ^e	Satisfied	529 (83.6)	258 (80.9)	488 (81.5)	1.42	.492	
	Dissatisfied	104 (16.4)	61 (19.1)	111 (18.5)			

Note. ^aComparisons among the three latent classes; ^bDuncan's test; ^c1=high self-management group, 2=harmful habitual behavior group; 3=inactive behavior group; ^dEquivalized household income; ^eMissing values included using multiple imputation; ^fIncluding developmental, intellectual, or psychiatric disability; ADL = Activities of Daily Living; IADL = Instrumental Activities of Daily Living; SD = Standard Deviation.

4. Factors associated with latent class membership

Table 5 presents the results of multinomial latent class logistic regression, with the high self-management group as the reference group. Among hypertensive patients with physical disabilities, male (odds ratio [OR] 8.63, 95% confidence interval [CI] 5.53–13.46), younger (OR 0.94, CI 0.92–0.95), or currently single patients, including never married, widowed, divorced, and separated (OR 1.55, CI 1.06–2.26), were more likely to belong to the harmful habitual behavior group. In contrast, those who were male (OR 0.46, CI 0.34–0.61) or were unemployed (OR 0.49, CI 0.36–0.65) were less likely to belong to the inactive behavior group compared with the high self-management group. The inactive behavior group also had severe disabilities (OR 1.91, CI 1.36–2.70), dependent status on the ADL (OR 1.50, CI 1.09–2.07), and dissatisfaction with their relationships with friends (OR 1.61, CI 1.21–2.15).

Table 5. Odd ratios of the association of the harmful habitual behavior group (class 2) and the inactive behavior group (class 3) relative to the high self-management group (class 1) based on multinomial latent class logistic regression models

Variables	Category	Harmful habitual behavior group			Inactive behavior group		
		OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Gender	Male (ref. Female)	8.63	5.53–13.46	<.001	0.46	0.34–0.61	<.001
Age		0.94	0.92–0.95	<.001	1.01	0.99–1.03	.133
Education	≤Elementary school (ref. >Elementary school)	1.09	0.77–1.56	.618	1.08	0.82–1.44	.555
Current marital status	Single (ref. Married)	1.55	1.06–2.26	.023	0.97	0.75–1.25	.807
Employment status	Unemployed (ref. Employed)	0.72	0.49–1.06	.094	0.49	0.36–0.65	<.001
Monthly household income	Low (ref. High)	0.77	0.53–1.11	.162	0.99	0.77–1.28	.963

Table 5. Cont.

Variables	Category	Harmful habitual behavior group			Inactive behavior group		
		OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Disability severity ^a	Severe (ref. Mild)	1.16	0.75–1.79	.512	1.91	1.36–2.70	<.001
Mental disability ^b	Yes (ref. No)	0.14	0.01–1.45	.099	0.63	0.10–4.08	.628
ADL	Dependent (ref. Independent)	1.30	0.83–2.02	.247	1.50	1.09–2.07	.013
IADL	Dependent (ref. Independent)	1.04	0.68–1.60	.861	1.30	0.94–1.79	.115
Number of chronic diseases		0.98	0.87–1.09	.651	0.79	0.92–1.07	.990
Relationship with friends	Dissatisfied (ref. Satisfied)	0.82	0.54–1.23	.331	1.61	1.21–2.15	.001
Relationship with family ^a	Dissatisfied (ref. Satisfied)	1.16	0.74–1.82	.527	1.04	0.75–1.44	.838

Note. ^aMissing values included using multiple imputation; ^bIncluding developmental, intellectual, or psychiatric disability; CI = Confidence Interval; OR = Odds Ratio; ref. = reference; ADL = Activities of Daily Living; IADL = Instrumental Activities of Daily Living.

5. Comparisons of health measures between latent class memberships

The latent classes were compared in terms of quality of life and health status as shown in Table 6. The mean HRQoL score in the inactive behavior group was 0.72 ± 0.23 , which was significantly lower than in the other two groups ($p < .001$). Subjective health was lowest in the inactive behavior group (2.09 ± 0.75) and highest in the harmful habitual behavior group (2.57 ± 0.80 ; $p < .001$). There was a significant difference in self-report of depression among the groups ($p = .006$), although suicidal ideation and suicide attempts did not show any differences. The inactive behavior group had a higher prevalence of depression (21.9%) than the other two groups. The results indicated that the harmful habitual behavior group had the lowest score of satisfaction with healthcare services (3.54 ± 0.67 ; $p < .001$), while the other two groups did were comparable. Lastly, there was a significant difference in unmet medical needs among the three groups ($p = .001$). The rate of unmet medical needs was higher in the inactive behavior group (23.7%) than in the other two groups.

Table 6. Differences in health measures by latent classes

Characteristics	Class ^a	<i>n</i> (%) or Mean±SD	χ^2 or <i>F</i>	<i>p</i>	Post-hoc ^b
Health-related Quality of Life (range -0.171~1)	1	0.81±1.50	44.95	<.001	1,2>3
	2	0.82±1.71			
	3	0.72±0.23			
Subjective health (range 1~5)	1	2.40±0.76	46.59	<.001	2>1>3
	2	2.57±0.80			
	3	2.09±0.75			
Suicidal ideation	1	84 (13.3)	0.80	.671	
	2	40 (12.5)			
	3	87 (14.5)			
Suicide attempts	1	10 (1.6)	3.40	.183	
	2	4 (1.3)			
	3	3 (0.5)			
Depression	1	98 (15.5)	10.33	.006	
	2	49 (15.4)			
	3	131 (21.9)			
Satisfied with healthcare services (range 1~5)	1	3.77±0.68	13.19	<.001	1,3>2
	2	3.54±0.67			
	3	3.73±0.64			
Unmet medical needs	1	98 (15.5)	14.34	.001	
	2	55 (17.2)			
	3	142 (23.7)			

Note. ^a1=high self-management group, 2=harmful habitual behavior group, 3=inactive behavior group; ^bDuncan's test; SD = Standard Deviation.

VI. Discussion

1. Hypertension self-management behavioral patterns

The present study has identified three mutually exclusive subgroups of hypertension self-management behaviors: a high self-management group, a harmful habitual behavior group, and an inactive behavior group, based on five self-management behaviors: smoking, alcohol intake, physical activity, diet, and weight control. Only 40.8% of our respondents showed adherence to the 2018 Hypertension Guidelines in their self-management of hypertension. Therefore, our results extend the existing literature observations that a large proportion of patients with hypertension do not perform self-management behaviors well (Ghanbari et al., 2018; Kim et al., 2020; Trivedi et al., 2010). On the other hand, contrary to prior studies of people without disabilities using LCA (Ghanbari et al., 2018; Kim et al., 2020) a clear distinction in the self-management behaviors between the three groups was evident in our study. In particular, the classes exhibited stark differences with respect to physical activity (high self-management group; 100.0% vs. inactive behavior group; 0%), although the overall probability of physical activity was not particularly different compared to previous studies (Ghanbari et al., 2018; Kim et al., 2020). Since inadequate physical activity is a well-known challenge for people with physical

disabilities (Rimmer, 2015), it is important to define the characteristics and health measures among the groups.

Given the distinctive feature regarding physical activity found in our sample, it is important to account that the degree of participation in physical activity among people with physical disabilities is affected by a multifactorial set of barriers and facilitators that are unique to this population (Cho, Shin, & Kong, 2021). When people with physical disabilities attempt to become physically active, they often face barriers to becoming, and staying, physically active (Martin Ginis et al., 2016). Unavailable or unaffordable transportation to accessible facilities and recreation centers, and a lack of accessible equipment and training programs can be other barriers to physical activity (Krahn, Walker, & Correa-De-Araujo, 2015; Rimmer et al., 2014). Communities should provide the necessary supports such as transportation, accessible information and facilities, and tailored exercise program (Rimmer, 2015). The provision of healthcare professional's instructions and options on physical activity that match their specific physical abilities is also essential because people with severe physical disabilities may face challenges in engaging in the types and amount of physical activities that are appropriate for them (Krahn, Walker, & Correa-De-Araujo, 2015). Because it can pose substantial challenges to overcome the issues, people with severe physical disabilities often possess the multiple barriers (Rimmer, 2015). Accordingly, policy and infrastructure changes to promote the inclusion of people with diverse forms and degrees

of physical disabilities in physical activity initiatives are a high priority, and there should be ongoing monitoring of approaches that support physical activity for sustainable health improvements in this underserved population. It is of utmost importance to recognize and appreciate the specific factors and characteristics of those who involve in insufficient physical activities; therefore, this study is an important first step that would provide information using a large-scale data to enhance understanding about hypertensive patients with physical disabilities.

Another behavioral feature that attracts attention was the low adherence to a balanced diet. Overall, 66.0% of the whole samples in this study as well as more than half of the participants in all of the three groups failed to have nutritionally balanced diet. Impaired physical function may be the main barrier to dietary intake preparation for people with physical disabilities thereby, supplying of healthy, low-cost, ready-to-eat foods might be particularly beneficial for promoting equity for this population (Huang et al., 2012). In addition to an individual's physical limitation, environmental limitations may be more difficult to overcome. For example, grocery stores, which are designed for able-bodied counterparts, provide physical and environmental obstacles to shop for people who require a wheelchair or a walker (Schwartz, Buliung, & Wilson, 2021). Poor dietary intake is an important modifiable risk factor for chronic diseases leading to mortality, which benefit from a nutritionally balanced diet rich in minimally processed, whole foods (Wetherill et al., 2021). Although studies are limited on dietary

intake in people with physical disabilities, one study indicated that meeting dietary guidelines is associated with a 40% reduced risks of all-cause of death in this population (Loprinzi et al., 2018). Public health attention is required in terms of diet and food accessibility for people with physical disabilities to prevent avoidable risk factors for health disparities.

Individuals living with physical disabilities entail a diverse, heterogeneous population as shown in the different behavioral patterns across the three groups in this study yet, relatively less pronounced variations in weight control probability were shown among the groups. The response probabilities of weight management in the three groups were between from 55.7 to 63.8%, which were similar with those without disabilities (61.3%; Ministry of Health and Welfare, 2021b). Nonetheless, obesity in people with physical disabilities may be doubly disturbing as it may also limit a person's ability to participate in social events and community activities (Liou, Pi-Sunyer, & Laferrere, 2005). Excess weight and additional health problems may further restrict their function, activity, and independence (Froehlich-Grobe & Lollar, 2011). Obesity in individuals with physical disabilities, especially involving impaired low extremities, leads to additional risk of secondary conditions including pressure sores, physical inactivity, depression, and fatigue, and further all of which can interfere with their ability to care for themselves and eventually diminish their quality of life (Reichard et al., 2015; Liou, Pi-Sunyer, & Laferrere, 2005). The combination of obesity and disability may therefore result in a

mutually reinforcing, vicious cycle (Plow et al., 2014). In common, individuals living with physical disabilities face challenges in controlling their weight, which is different from the difficulties experienced by people without disabilities, such as a lack of time and motivation. They often experience difficulties related to the dietary issues, such as a lack of healthy food choices and changes in appetite due to medications or pain, and to the lack of accessible environments and resources to increase physical activity (Liou, Pi-Sunyer, & LaFerrere, 2005). Additional studies on elucidating determinants of weight control in this population may reveal opportunity to advance health equity for people with physical disabilities.

2. Associated factors with hypertension self-management behavioral patterns

Use of tobacco and alcohol, which are strongly correlated, are known to be common health-risk behaviors that negatively impact control of high blood pressure. Within the present analysis, the harmful habitual behavior group exhibited the lowest percentages of people avoiding smoking or excessive alcohol intake; young, single males were most likely to belong to this group. This result was in agreement with a previous study that reported frequent substance use, such as cigarettes and alcohol, is often amplified among those who are young, male, and single (Cui et al., 2018). Young men display a greater tendency toward substance use when coping with their problems (Kim et al., 2020) and prioritize other goals before taking care of their health (Salim et al., 2019). Conversely, female sex predicted membership in the inactive behavior group, whose members satisfactorily complied with avoiding harmful habitual behaviors, such as tobacco and alcohol use. Such findings built on previous literature reporting that women are likely to have a lower prevalence of tobacco and alcohol use (Kim et al., 2020; Yang et al., 2008), likely because of social and cultural factors that might discourage women from smoking and alcohol intake (Cui et al., 2018). Accordingly, targeted policy and individual level interventions that simultaneously address tobacco use and excessive alcohol drinking could

arguably be most effective when targeting addressing unhealthy behaviors in young, single males.

Regarding employment status, Rimmer (2015) argued that unemployment or underemployment is related to reduced physical activity in people with disabilities. By contrast, our results indicated that being employed was associated with those in the inactive behavior group who were physically inactive. The reasons for the inconsistency in results are uncertain, but can likely be attributed to the type of jobs that members of the disabled population tend to hold. Compared to people with other types of disabilities, those who have physical disability are more likely to have a sedentary job that requires no physical exertion. As a prior study proposed that sedentary jobs can contribute to inadequate physical activity; the participants categorized in this group are highly likely to have sedentary jobs due to their physical limitations (AlHadlaq et al., 2019). Still, further research is warranted to explore the underlying mechanisms between health behaviors and employment among people with physical disabilities.

Dissatisfaction with friendships was another variable associated with belonging to the inactive behavior group. Studies have provided evidence that social relationships influence health behaviors. Umberson and Karas (2010) highlight that social relationships can instill a sense of responsibility and concern for others that then lead individuals to engage in positive self-care behaviors. Similarly, social isolation is associated with less favorable lifestyle choices (Holt-Lunstad et al., 2015). Notably, people who have poor

functional status tend to experience a lower quality of social relationships, resulting in social isolation (Guo et al., 2020). Coordinated programs thereby should identify socially isolated adults with physical disabilities and mobilize local resources to offer instrumental and social support to these individuals.

Many researchers have raised concerns about the high prevalence of low-quality diet in people with disabilities (Schwartz et al., 2019). This corresponds to our findings that the vast majority of the participants across the whole sample reported having an unhealthy diet, which is of high prevalence compared to the similar studies of people without disabilities (Trivedi et al., 2010; Kim et al., 2017). The low probability of achieving adequate nutrient intake was more apparent in the participants belonging to the inactive behavior group which was associated with severe disability and ADL dependency. Among people with physical disabilities, those who are more dependent in terms of ADL may have additional functional limitations other than physical disability, such as trouble seeing or hearing, resulting in an increased risk of having a diet that may interfere with disease management protocols (Heflin et al., 2019). Thus, it is of paramount importance to identify the at-risk individuals who have poor functional abilities and urgent need for policy interventions aiming to improve diet quality among people with disabilities.

Achieving the recommended level of physical activity can be challenging for people with severe physical disabilities, particularly among

those who have difficulty walking due to pain or imbalance, or those who are unable to walk due to paralysis (Rimmer, 2015). A distinctive feature noted from the behavioral patterns in the inactive behavior group was that none of the members engaged in regular physical activity. It can be expected the participants belonging to this group may experience substantial challenges to overcoming insufficient physical activity as they were likely to have a severe degree of physical disability (Rimmer, 2015). Since functional level is strongly associated with physical activity, co-occurring health conditions and level of independence should be considered as important determinants of physical activity in those with physical disabilities (Van der Ploeg et al., 2004). Thus, policy and infrastructure changes to promote the inclusion of people with diverse forms and degrees of physical disabilities in physical activity initiatives are a high priority to promote physical activity and to reduce health disparity within the population with disability.

3. Health measures according to hypertension self-management behavioral patterns

Our study further attempted to identify and differentiate previously unidentified, at-risk groups within the population of individuals with physical disabilities by comparing the health measures between the subgroups. The inactive behavior group displayed the poorest HRQoL and subjective health and had the highest prevalence of depression and unmet medical needs. This phenomenon implies that the inactive behavior group represents the most-at-risk population among the three groups.

Accumulated evidence has demonstrated that these health measures are largely determined by various health-promoting behaviors. In particular, physical activity is emphasized as a critical behavior that significantly impacts both immediate and long-term health (Rêgo et al., 2019). Extant studies indicate that engaging in physical activity is associated with a better HRQoL and subjective health in hypertensive patients and is also effective for the treatment of depression (Robertson et al., 2012; Zhang et al., 2016; Suh & Lee, 2011; Sarris et al., 2014). Additionally, previous studies on people with physical disabilities indicated that physical activity levels were strong predictor of HRQoL and claimed the need of interventions aiming to improve physical activity which would improve HRQoL in the group of physical disabilities (Rajati et al., 2018; Sunde et al., 2021).

Considering the fact that none of the participants in the inactive behavior group performed physical activity, it is worth presuming that the self-management behavior pattern in this group may have led them to be at greater risk of hypertension. In other words, they exhibited a tendency to only practice certain self-management behaviors that do not require any physical capability to carry out. These findings imply that functional limitations may have acted as barriers to health-promoting activities that require physical capability, as the degree of disability and ADL dependence are closely interrelated and may have had a negative impact on their health measures. Therefore, it should be emphasized addressing the problem of inactivity and promote opportunities for physical activity among people with physical disabilities. Any physical activity guidelines for people with physical disabilities must take the unique barriers and their characteristics into consideration (Martin Ginis & Hicks, 2007). For example, since the inactive behavior group showed relatively poor perceived health status and psychological health, a theory-based physical activity guideline should be developed considering their physical ability as well as targeting their beliefs and perceptions of their health. Moreover, Stuifbergen and Becker (1994) asserted that the impact of inactivity related to the physical changes of ageing may be even more significant for a group of individuals already experiencing physical disabilities. Accordingly, efforts to promote physical activity across all age groups with physical disability as a preventive measure could help prevent a large burden of secondary illness.

Unmet medical needs are considered to be key determinants of health status in vulnerable populations living with disabilities and can potentially threaten the viability of community living (McColl et al., 2010). Our results indicate that the rate of unmet medical needs in the inactive behavior group was 23.7%, which is roughly twice as high as the 11.6% found in a previous study on Korean adults without disabilities (Yoon et al., 2019). It appears from the literature that those with the greatest need are also the least likely to have those needs met by the healthcare system (McColl et al., 2010). Those who experience unmet medical needs are likely to practice unhealthy behaviors and experience deteriorating health conditions; this conclusion is supported by previous studies that demonstrated correlations between unmet medical needs and various proxy indicators, such as health status and death (Kim et al., 2019). People with physical disabilities are likely to experience unmet medical needs due to inaccessibility to healthcare caused by a lack of transportations and economic burdens (Hwang et al., 2011; Sakellariou & Rotarou, 2017) and the existence of barriers in their access to healthcare may further compromise their health leading to a vicious cycle: poorer access to healthcare can lead to even poorer health (Sakellariou & Rotarou, 2017). Therefore, further investigation needs to discover the factors associated with unmet needs in hypertension management context, especially targeting those who are at high-risk, such as the inactive behavior group, to eliminate barriers to access to healthcare.

4. Implications and future research

What we can conclude, as indicated in the behavioral patterns in the inactive behavior group, is that avoiding certain harmful habitual behaviors, such as cigarette smoking and alcohol intake, alone may be insufficient to address the issues of increasing poor health risks. AlHadlq et al. (2019) highlights that the cycle of good practice of self-management behaviors is interrelated and each behavior will not work well without the other; thus, ideally these positive health behaviors should occur simultaneously. Policy makers and healthcare professionals should take into account that various components of health-promoting behaviors should be practiced in harmony. Moreover, healthcare intervention in the inactive behavior group should be prioritized and, more importantly, it should focus on providing appropriate assistance to enhance participants' engagement in health-promoting behaviors, especially those which require physical capability such as physical activity.

Our study made an important contribution to the limited adherence literature in hypertensive patients with physical disabilities. It proposed unique way of characterizing hypertensive patients with physical disabilities that may be both methodologically sound and clinically relevant. It also highlighted the complexity inherent in obtaining adequate hypertension self-management behavior based on the Theory of Self-Care Management for

Vulnerable Populations (Dorsey & Murdaugh, 2003). Further studies using LCA are essential to include more extensive hypertension control indicators and to investigate causal effect of different hypertension control patterns on complications. Furthermore, even though this was a theoretical based study, our study was unable to elucidate the effect of modifiable and non-modifiable vulnerable factors on self-management behaviors or to include various intra-personal factors and contextual factors influencing self-management behaviors suggested by the theory. It is strongly suggested that future studies explore the key mechanisms of critical factors influencing self-management behaviors based on the theory.

5. Limitations

Our study has several limitations, the most severe being insufficient information to assess specific dietary patterns and obesity due to data constraints caused by using the secondary data. First, we were only able to use a single-item measure of patient-reported balanced diet adherence. Although the optimal means of assessing diet is unclear, our use of a single-item diet measure remains a limitation in that it could not capture specific dietary patterns regarding food groups and serving sizes. Future studies should use questionnaires which measure extensive diet patterns such as a food frequency questionnaire to evaluate dietary approaches to stop hypertension diet scores. In addition to this, we were unable to detect a dietary behavior related to low-sodium diet, essential in hypertension management as there was no such variable available in the data. Similarly, using BMI to indicate obesity was another limitation in this study. Although BMI has been used globally as a simple indicator of obesity, it is not an optimal measure of obesity in people with physical disabilities. Height and weight may not be accurate, and standard cut-offs underestimate obesity in people with physical disabilities. Thus, it is recommended that alternative anthropometric measures, such as waist circumference, which is a simple, more sensitive alternative to BMI in population with disabilities, be used instead (Ravensbergen et al., 2014).

Due to limited information availability, we were unable to consider predicting factors associated with hypertension management adherence such as residential area, religion, time since diagnosis of hypertension, or knowledge, as well as other important outcome or self-management behavior measures including blood pressure control and medication adherence. The present study could not determine causal relationships due to the cross-sectional study design.

Another limitation was the potential bias caused by the self-report measurement. Although the National Survey of Disabled Persons ensures the representativeness of the population with disabilities, potential threats to measurement validity cannot be adjusted. Self-reported items such dietary assessment, are at risk of misinterpretation.

Our study sample included the participants who were not officially registered as a physically disabled person, though they identified themselves as having a physical disability. The reasons that they were not registered were that some of them were under the process of registration ($n=4$) and others did not register because of a financial burden ($n=2$), difficulty with registering ($n=9$), unwanted to be disclosed that they are disabled ($n=2$), unnecessary ($n=4$), and some other reasons ($n=2$; Kim et al., 2017). Unregistered disabled people does not necessarily mean that they do not have disabilities (Lee, 2021; Lee et al., 2004; Shin & Lee, 2013); however, there is still a limitation that it cannot be assured whether the person actually has a physical disability or not.

VII. Conclusions

This study demonstrated the typology of hypertension self-management behavioral patterns including abstaining from tobacco use, limiting alcohol consumption, engaging in regular physical activity, eating a balanced diet, and maintaining weight control, which are essential health behaviors for the management of hypertension, as evidenced using large-scale data. The present study considers the subgrouping of hypertensive adults with physical disabilities sample into three classes: a high self-management group, a harmful habitual behavior group, and an inactive behavior group.

Our study also identifies factors associated with hypertension self-management behaviors such as age, gender, marital status, employment, degree of physical and functional disability, and satisfaction with social relationships; it also provides important insights into how health-promotion strategies for hypertensive patients with physical disabilities might be targeted differently in each group. As such, a special consideration should be given by health professionals considering the self-management behaviors that appeared to be deficit in each group, such as avoiding habitual health-risk activities (i.e., harmful habitual behavior group) or practicing regular physical activity (i.e., inactive behavior group).

More importantly, the at-risk population, such as the inactive behavior group identified in our study, should be prioritized in receiving assistance

with hypertension self-management behaviors that require physical capability. These observations and their implications contribute to a better understanding of this heterogeneous, underserved population and provide evidence for healthcare teams to design strategies for supporting self-management behaviors and to develop a health-promoting service model for the population with physical disabilities.

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Appendix

Appendix 1.

IRB approval letter

심의 면제 확인서

수신

연구책임자	이름: 윤주영	소속: 간호대학 간호학과	직위: 교수
지원기관	해당없음		

과제정보

승인번호	IRB No. E2011/002-013		
연구과제명	잠재계층분석을 활용한 고혈압 지체장애인의 건강관리행위 유형과 관련 요인 탐색		
연구종류	공개된 정보 이용 연구		
면제일자	2020-11-05		
심의결과	면제승인		
검토의견	면제 검토의견	본 연구는 연구참여자에 대한 기존의 자료인 한국보건사회연구원의 '2017년 장애인 실태조사' 자료를 이용하는 연구로서 「생명윤리 및 안전에 관한 법률 시행규칙」 제13조 제1항 제3호에 근거하여 심의를 면제합니다.	

상기 연구과제에 대하여 본 위원회에서는 심의면제대상임을 확인합니다.

2020년 11월 05일

서울대학교 생명윤리위원회 위원장



본 위원회가 승인한 연구를 수행하는 연구자들은 다음의 사항을 준수해야 합니다.

1. 모든 연구자들은 아래의 사항을 준수하여야 합니다.
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4. 연구윤리를 위하여 관련부처가 필요시 조사 및 감독 차원에서 현장점검을 실시할 수 있습니다.
5. 연구와 관련된 기록은 연구가 종료된 시점을 기준으로 최소 3년간 보관하여야 합니다.

국문초록

잠재계층분석을 활용한 고혈압 지체장애인의 자가관리행위 유형과 관련요인 탐색

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현대사회가 고령화사회로 진입하면서 만성질환으로 인한 건강 문제가 심화되고 있으며 고혈압은 전체 인구 사망의 13.5%를 차지할 만큼 심각한 만성질환이다. 특히 장애인은 고혈압과 같은 만성질환의 유병률과 사망률이 높은 건강취약집단으로 알려져 있는데, 전체 15 종류의 장애유형 중 가장 많은 장애 비율을 차지하는 지체장애인의 고혈압 유병률은 56.4%로 절반 이상이 고혈압을 가지고 있는 것을 알 수 있다. 고혈압은 뇌졸중, 심근경색증과 같은 대부분의 심혈관계 질환의 주요 위험 인자이며 사망률을 증가시키는 주요 원인이라는 점에서 치명적인 질병이다. 더욱이 이는 한 번 발병하게 되면 평생을 두고 치료 및 관리가 필요한 만성질환으로 높은 의료비용을 야기하기 때문에 예방과 관리가 중요하다. 고혈압은 일시적인 치료나 간호로써 문제가 해결되는 것이 아니기 때문에 지속적인 혈압조절관리가 요구되고, 무엇보다 약물요법 외에 식이요법, 운동요법, 금연, 체중조절, 신체활동과 같은 생활양식을 통한 지속적인 자가 관리가 건강을 유지할 수 있는 최선의 방법이 된다. 이러한 생활습관 자가 관리의 중요성을 인지하여 그간 여러 연구들이 진행되어 왔지만 기존의 고혈압 관리를 위한 건강

관리행위 연구는 개별 변수를 중심으로 접근하여 여러가지 생활습관 변화의 상호관련성을 충분히 반영하지 못했다는 한계가 있다. 따라서 본 연구는 각 행위들의 경험가능성을 기반으로 각 사례들의 이질적 집단을 구분해내는 잠재계층분석(Latent Class analysis, LCA)을 사용하여 자가관리행위의 유형을 도출하고자 하였다. 이에 본 연구의 목적은 대표적인 건강취약집단인 지체장애인을 대상으로 고혈압 자가관리행위가 어떠한 유형으로 나타나는지를 LCA를 활용하여 확인하는 것이다. 또한 고혈압 자가관리행위 유형에 영향을 미치는 요인을 확인하고 각 유형집단에 따른 건강수준을 비교하고자 하였다.

본 연구는 2017년 장애인 실태조사 데이터를 활용하였고 분석을 위해 총 1,551명의 고혈압 지체장애인 데이터가 산출되었다. 잠재계층을 탐색하기 위하여 고혈압 자가관리의 대표적인 생활습관 지표인 금연, 절주, 신체활동, 건강한 식습관, 체중조절 등 다섯 개의 변수를 잠재변수로 설정하여 LCA 분석을 실시하였다. 잠재계층 추정을 위한 적합지표는 AIC, BIC, saBIC, entropy, LMR 을 이용하였다. 잠재계층분석을 통해 확인된 집단 유형의 영향요인을 살펴보기 위하여 인구사회학적 특성, 장애관련 특성, 건강관련 특성을 이용하여 다항 로지스틱 회귀분석을 실시하였다. 마지막으로, 각 집단 유형의 건강수준을 비교하기 위해 주관적 건강, 정신적 건강, 환자경험을 ANOVA 를 이용하여 비교하였다.

LCA 분석 결과, 세 개의 잠재계층 유형의 적합지수는 $AIC=8854.69$, $BIC=8977.66$, $saBIC=8904.59$, $Entropy=0.58$, $LMR=25.13(p < .05)$ 로 나타났으며, 다른 잠재계층 유형과 비교한 결과 가장 적합한 것으로 확인되었다. 세 개의 잠재계층 집단이 나타내는 특징에 따라 “high self-management” 그룹(40.8%), “harmful habitual behavior”그룹(20.6%), “inactive behavior”그룹(38.6%)으로 명명하였다. 세 그룹 중 가장 고혈압 자가관리행위를 잘 하는 것으로 보이는 high self-management 그룹은 다섯 개의 자가관리 행위를 모두 높은 수준으로 하는 것으로 나타났으며, 특히 이 그룹의 모든

구성원이 규칙적인 신체활동을 수행하는 것으로 확인되었다. 반면, harmful habitual behavior 그룹은 가장 낮은 수준의 금연과 절주를 하는 것으로 나타났으며, inactive behavior 그룹은 건강한 식습관과 체중조절을 할 확률이 가장 낮은 것과 더불어 규칙적인 신체활동에 참여하는 구성원은 아무도 없다는 특징이 확인되었다.

각 집단의 영향요인을 살펴보기 위해 high self-management 그룹을 참조그룹으로 설정하여 다항 로지스틱 회귀분석을 통해 비교한 결과, harmful habitual behavior 그룹의 영향요인은 남성 (OR=8.63, CI=5.53~13.46), 미혼 (OR=1.55, CI=1.06~2.26), 젊은 사람 (OR=0.94, CI=0.92~0.95)으로 나타났고 inactive behavior 그룹은 여성 (OR=0.46, CI=0.34~0.61), 경제활동을 하는 사람 (OR=0.49, CI=0.36~0.65), 중증 장애인 (OR=1.91, CI=1.36~2.70), 의존적 ADL (OR=1.50, CI=1.09~2.07), 친구 수에 대한 불만족 (OR=1.61, CI=1.21~2.15)이 영향요인으로 확인되었다. 건강수준을 비교하였을 때, inactive behavior 그룹이 가장 낮은 건강관련 삶의 질 (0.72 ± 0.23 , $p < .001$)과 주관적 건강 (2.09 ± 0.75 , $p < .001$), 높은 우울수준 (21.9%, $p = .006$), 미충족 의료경험 (23.7%, $p = .001$)을 보이는 것으로 나타났다.

본 연구는 대규모 고혈압 지체장애인 자료를 활용하여 자기관리행위의 상호배타적인 유형을 확인한 첫 연구이다. 또한 각 잠재 계층과 관련된 요인을 파악하고 건강수준을 비교하여 고위험 집단을 확인했다는 점에 의의가 있다. 건강행위는 단일 행동에만 영향을 받는 것이 아닌, 집단 유형의 특성과 욕구 등 차별적 요인에 따라 복합적으로 영향을 주기 때문에 유형화 연구를 통해 자기관리행위를 구분하고 특성을 파악함으로써 건강증진 개입 및 정책 수립에 주요한 정보를 제공했다고 할 수 있다. 특히 장애인이라는 집단 내부의 이질적 속성에 따른 자기관리행위 유형에 따른 중재개입의 근거 마련과 고위험 집단에 집중하여 집단의 특성에 따른 맞춤형 프로그램, 필요한 자원 및 서비스 연계 등에 보다 유용한 자료가 될 수 있을 것이다.

Keywords: 고혈압, 생활습관, 자기관리 행위, 잠재계층분석, 지체장애인
Student Number: 2013-20421