Latent profile analysis of walking, sitting, grip strength, and perceived body shape and their association with mental health in older Korean adults with hypertension
A national observational study

Saengryeol Park, PhD[a], Diana Castaneda-Gameros, PhD[b], In-Hwan Oh, MD, PhD[a],*

Abstract
Evidence suggests that mental health is associated with multiple factors such as physical activity, sedentary behavior, and physical function in older adults. The present study used latent profile analysis to identify classes of older adults based on their health profile among a representative sample of Korean older adults with hypertension. Differences in mental health between these classes were also examined.

Seven hundred and sixty seven participants (mean age = 70.23, SD = 6.08; men 45.6%) were included in the analysis.

There were 3 latent classes (class 1: a physically inactive lifestyle with low physical function and body perception; class 2: a physically moderate lifestyle with moderate physical function and low body perception; class 3: a physically active lifestyle with high physical function and body perception). According to class comparisons, older adults in class 3 had significantly lower anxiety/depression levels than classes 1 and 2. Older adults in class 3 had significantly lower stress levels than class 1.

It is possible that among older adults, having a positive attitude of one's body shape may also be important for improving anxiety/depression along with having a physically active lifestyle and maintaining physical function.

Abbreviations: AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, BLRT = bootstrapped likelihood ratio test, BMI = body mass index, DBP = diastolic blood pressure, EQ-5D = EuroQol five-dimensional, EQ-5D-5L = EuroQol five-dimensional descriptive system, GPAQ = global physical activity questionnaire, HADS = hospital anxiety and depression scale, IPAQ = International Physical Activity Questionnaire, KNHANES VI = Sixth Korea National Health and Nutrition Examination Survey, MLR = Robust maximum likelihood, PA = physical activity, SBP = systolic blood pressure, SSA = sample-size adjusted.

Keywords: grip strength, hypertension, mental health, older adults, perceived body shape, physical activity

1. Introduction

Hypertension is a primary risk factor for heart disease and stroke, which are leading causes of worldwide mortality. Hypertension is a cardiovascular risk factor in three-quarters of older adults (≥75 years old) in the United States[1–3] and in 64.7% of Korean older adults (≥65 years old).[4] Among older adults, hypertension is associated with high rates of hospitalization,[5] health care cost,[6] and lower quality of life.[7] However, the negative association between psychological factors and hypertension is less known, particularly in Korean older adults.

Previous research has indicated that having a physically active lifestyle and managing psychological triggers (i.e., stress) is imperative for those with hypertension.[8,9] Engaging in regular physical activity (PA) plays a positive role in managing depression, anxiety,[10] and stress[11] in older adults. In contrast, spending more time in sedentary behavior is a negative predictor of mental health.[12] A recent study showed that older adults who were grouped depending on their levels of PA, sedentary behavior, and physical function had different mental health outcomes.[13] However, it is unknown whether those associations about mental health exist when other health-related variables are added such as perceived body shape.

Perceived body dissatisfaction can be an important factor associated with mental health. For instance, body dissatisfaction rates among the general population, have increased from 23% to 56% in women and from 15% to 43% in men in over 2 decades.[14,15] Among older women, the association between body dissatisfaction and self-esteem is weaker than younger women.[16] Notably, previous studies exploring perceived body shape or body dissatisfaction have focused largely on women and

younger generations.[17] Furthermore, older adults have different standards for their body and are likely to focus on physical function rather than body appearance.[18] It has been reported that participating in exercise positively affects body shape[19] and mental health (i.e., anxiety).[20] However, body dissatisfaction has been found to be negatively associated with depression and self-esteem.[21] Older sedentary adults (65–75 years) may not be satisfied with their body shape[18]; however, a desire to be thin has not showed to affect their exercise motivation, physical health, and physical fitness.[22] The concept of body image is multifaceted[23] and this study sought to explore if perceived body satisfaction plays a role among other health-related factors on mental health in particular in older adults with hypertension.

Latent profile analysis is a useful analytical model to converge a range of components simultaneously. The underlying theory of latent profile analysis is to identify unobserved groups of individual interrelationships depending on given profile variables.[24] This modeling is helpful in deriving detailed characteristics of older adults whose health profile could largely vary.[13] To date, no previous studies have attempted to explore the associations between PA (e.g., walking time), sedentary behavior (e.g., sitting time), and perceived body shape and mental health

(depression/anxiety and stress) among hypertensive Korean older adults using latent profile analysis.

Therefore, the aims of the study are to classify subgroups of individuals according to their walking time, sitting time, grip strength, and perceived body shape, and to examine the associations between observed groups and anxiety/depression and stress.

2. Materials and methods

2.1. Participants

This study used data from the Sixth Korea National Health and Nutrition Examination Survey (KNHANES VI-2) 2015, conducted by The Korea Centers for Disease Control and Prevention. Cross-sectional data were collected from 7380 participants from 192 sampling districts. The data set consisted of demographics, physical function, and mental health data as well as time spent sitting and walking. For the purpose of this study, participants who were over 60 years (age range=60–80 years; n=767) and previously diagnosed with high blood pressure were selected. Participants with any missing item were excluded from the analysis (see Fig. 1). Ethical approval was obtained by the Ethics
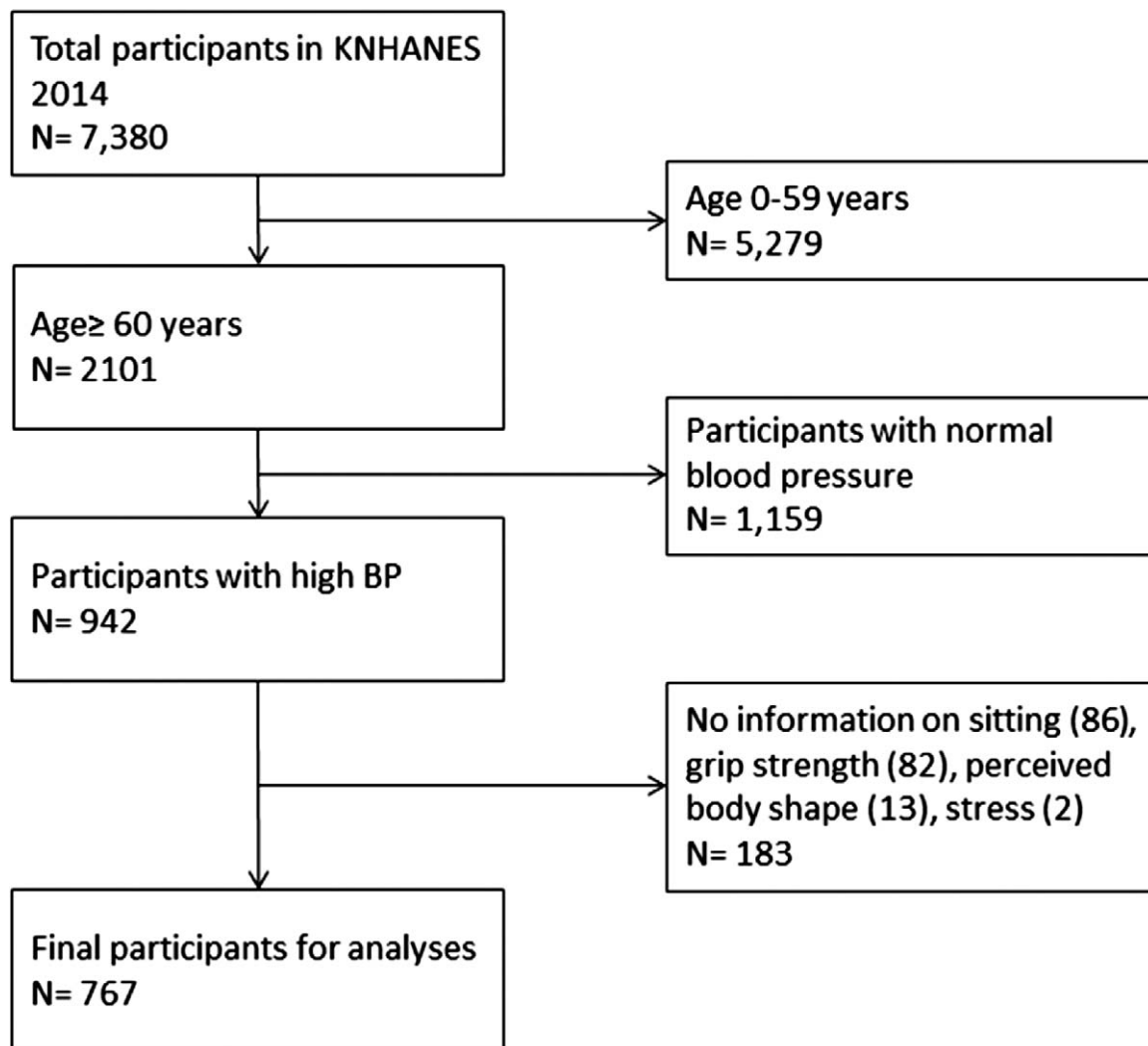
Figure 1. Participants included in the study. BP=blood pressure, KNHANES=Korea National Health and Nutrition Examination Survey.

Committee Board at Sungkyunkwan University (approval number: 2018-03-012-001).

2.2. Procedures

Demographics (e.g., annual income) and the presence of chronic conditions including hypertension were reported through a health interview. Self-reports for mental health, walking, and sitting time and objective measures for anthropometrics were taken by trained staff. Additional procedures can be found elsewhere.[25]

3. Measures

3.1. Blood pressure

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using a sphygmomanometer (Baumanometer Wall Unit 33 [0850], WA Baum, NY) according to the standardized protocol by registered nurses.[26] The cutoff scores of high blood pressure were SBP ≥140mmHg and DBP ≥90mmHg.

3.2. Walking

Walking time was measured using a Korean version of the International Physical Activity Questionnaire (IPAQ-short form; Kim et al,[27]). Two items were used to assess weekly frequency in walking ("during the last 7 days, on how many days did you walk for at least 10 minutes at a time?") and time spent at each occasion ("how much time did you usually spend walking on one of those days?"). The time spent in walking was calculated in min/d.

3.3. Sitting

Sitting time was assessed through the Korean version of Global Physical Activity Questionnaire (GPAQ; Jeon,[28]). One item was used to report sitting or reclining time ("how much time do you usually spend sitting or reclining on a typical day?"). Sitting was presented in min/d for the analyses.

3.4. Grip strength

Grip strength was measured using digital grip strength dynamometer (T.K.K 5401, Japan). The mean of 3 results was used, high scores represent high grip strength (kg).

3.5. Perceived body shape

Perceived body shape was measured using 1 item ("how do you feel about your body shape") on a 5 Likert scale (1 = very lean, 2 = a bit lean, 3 = normal, 4 = a bit obese, 5 = very obese). Higher scores indicate worse perceived body shape. The result of this item was used in a previous study.[29]

3.6. Anxiety/Depression

The Korean version of EuroQol 5-dimensional (EQ-5D) descriptive system (EQ-5D-5L) was used.[30] The scale measured mobility, self-care, usual activities, pain/discomfort, and anxiety/depression using one item each. For the purpose of this study, one item relating to anxiety/depression was used under the heading "please tick the one box that best describe health today" on a 5-Likert scale (1 = "I am not anxious or depressed," 2 = "I am slightly anxious or depressed," 3 = "I am moderately anxious or depressed," 4 = "I am severely anxious or depressed," 5 = "I am extremely anxious or depressed"). High scores indicated high anxiety/depress levels.

3.7. Stress

Stress was assessed using one item.[25] Participants were asked 1 item "what is your general stress level" on a 4 Likert-scale (1 = very high, 2 = high, 3 = low, 4 = very little). The score scale was reversed so that a higher score represented high levels of stress.[31]

3.8. Demographic and anthropometric data

Age, sex, and annual income were reported. Annual income was quartilized (Q1 = low, Q2 = middle/low, Q3 = middle/high, Q4 = high). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared and rounded to 1 decimal place.

3.9. Statistical analysis

Descriptive statistics were calculated for all participant characteristics using SPSS version 22 (IBM Corp, Armonk, NY, 2012). Latent profile analysis was conducted using Mplus (Version 7.3; Muthén & Muthén, Los Angeles, CA). We used the robust maximum likelihood (MLR) estimator to handle non-normal data. All profile variables were standardized (z-scores) before converging latent classes. We began with one-class model to examine class membership of individuals using probability being assigned to a specific class. To determine model fit, we used Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), the sample-size adjusted BIC (SSA-BIC), Bootstrapped likelihood ratio test (BLRT), entropy and percent of participants per class. Lower AIC, BIC, and SSA-BIC values and high entropy represent better model of fit. As the last step, the BCH method[32] was performed to compare the classes on dependent variables. Statistical significance was set at $P < .05$.

4. Results

4.1. Descriptive statistics

Table 1 shows the sample characteristics. Participants were on average 70.2 years old (SD 6.1; women 54.4%) and their average BMI was 24.3 kg/m². More than half of the participants reported their annual income as middle/low (68.7%). All participants reported taking medication to control high blood pressure.

As shown in Table 2, participants spent 37.5 min/d in walking and 466.1 min/d in sitting time. Walking time was negatively correlated with sitting time and with anxiety/depression but positively correlated with grip strength. Sitting time was positively correlated with anxiety/depression. Grip strength was negatively correlated with anxiety/depression and stress.

4.2. Profile classification

Table 3 shows fit statistics of classification. AIC, BIC, and SSA-BIC decreased from one-class to three-class model. Higher entropy was shown in the three-class model in comparison to the two-class model. BLRT P-values indicated that the three-class model was better than the two-class model. In the two-class model, the percent of participants per class was 68% and 32%.

Table 1

Sample characteristics (n = 767).

Variables

	Mean (SD)	Range
Age, y	70.23 (6.08)	60–80
BMI, kg/m^2	24.87 (1.06)	14–39
Blood pressure, mm Hg		
Systolic blood pressure	131.33 (16.98)	87–202
Diastolic blood pressure	73.91 (9.97)	39–121

	n (%)	
Gender		
Male	350 (45.63)	
Female	417 (54.37)	
Annual income (home)		
Low (1)	300 (39.11)	
Middle/low (2)	227 (29.60)	
Middle/high (3)	143 (18.64)	
High (4)	94 (12.26)	
Missing	3 (0.39)	
Education		
Elementary school	411 (53.59)	
Middle school	126 (16.43)	
High school	150 (19.56)	
≥University	77 (10.04)	
Missing	3 (0.39)	
Medication for blood pressure control	767	100%

BMI = body mass index; SD = standard deviation.

In the three-class model, the percent of each class was 59% (class 1), 38% (class 2), and 3% (class 3), respectively. Although percent of class was small, we decided to use the three-class model based on fit statistics. The decision to use this three-class model was based not only on goodness-of-fit indexes but also on the theory of the research field including previous findings and aim of this research.[24] The four-class model was not converged. The first class (class 1) was labeled as "a physically inactive lifestyle with low physical function and low body perception"; class 2 as "a physically moderate lifestyle with moderate physical function and low body perception," and class 3 as "a physically active lifestyle with high physical function and high body perception."

Table 4 shows unstandardized latent profile characteristics of the three-class model. Participants tend to spend more time in walking but less time sitting in class 3 in comparison to class 1. Grip strength was higher in participants belonging to class 3 in comparison to class 1. In terms of perceived body shape, participants in class 2 had the highest score and participants in class 3 had the lowest score (see Fig. 2), which indicates positive perceived body shape. Although participants in class 2 showed slightly higher score in body shape than those from class 1, the difference was small (Cohen $d = 0.02$).

4.3. Class comparisons on anxiety/depression and stress

Table 5 shows the results of class comparisons on anxiety/depression and stress. The levels of anxiety/depression were lower in class 3 in comparison to classes 1 and 2. There were significant differences between class 1 and 3, and class 2 and 3. With regard to stress, the average stress level was lower in class 2 than classes 1 and 3. Stress levels were only significantly different between class 1 and class 2.

5. Discussion

This study identified groups of older adults sharing similar attributes for time spent on walking, sitting, grip strength, and perceived body shape among a representative sample of Korean hypertensive older adults. After identifying 3 latent profile

Table 2

Descriptive statistics and bivariate correlation analyses.

	M	SD	2.	3.	4.	5.	6.
1. Walking	37.49	56.43	−0.13**	0.09*	−0.03	−0.08*	−0.06
2. Sitting	466.09	212.74		−0.19**	−0.02	0.11**	0.00
3. Grip strength	25.93	8.43			0.01	−0.18***	−0.08*
4. Body shape	3.28	0.98				0.03	0.06
5. Anxiety/Depression	1.16	0.40					0.23**
6. Stress	1.93	0.75					

2. Sitting, 3. Grip strength, 4. Body shape, 5. Anxiety/Depression, 6. Stress; M = mean, SD = standard deviation.

* $P < .05$.
** $P < .01$.
*** $P < .001$.

Table 3

Fit statistics of latent profile analysis.

Fit statistics	1 Class	2 Classes	3 Classes	4 Classes
AIC	8711.26	7995.25	7748.96	–
BIC	8748.39	8074.15	7869.63	–
SSA-BIC	8722.98	8020.17	7787.06	–
Entropy	1	0.65	0.73	0.44
BLRT P-value		0.00	0.00	–
Percent of participants per class (%)		519 (68%)	454 (59%)	–
		247 (32%)	292 (38%)	
			20 (3%)	

AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, BLRT = Bootstrapped likelihood ratio test, SSA-BIC = the sample-size adjusted BIC.

Table 4

Unstandardized profile characteristics of three-class model.

|	Class 1 (n = 454, 59%)		Class 2 (n = 292, 38%)		Class 3 (n = 20, 3%)		Cohen *d* effect size		
	M	SD	M	SD	M	SD	d_{2-1}	d_{3-1}	d_{3-2}
Walking	9.15	28.85	58.00	81.22	225.52	177.93	0.80	1.70	1.21
Sitting	490.22	283.54	446.60	222.91	320.45	150.38	−0.17	−0.75	−0.66
Grip strength	24.57	12.32	27.41	10.1	29.08	10.38	0.25	0.40	0.16
Perceived body shape	3.28	1.19	3.30	1.06	3.0	1.06	0.02	−0.25	−0.29

Class 1: a physically inactive lifestyle with low physical function and body perception; Class 2; a physically moderate lifestyle with moderate physical function and body perception; Class 3: a physically active lifestyle with high physical function and body perception. M = mean, SD = standard deviation.

groups, we found that there were significant differences between groups on anxiety/depression and stress. This study highlights the importance of investigating mental health in older adults, particularly those with chronic conditions such as hypertension, through a person-centered approach.

5.1. Classes of participants based on walking time, sitting time, grip strength, and perceived body shape

Individuals shared similar profiles in walking time, sitting time, grip strength, and perceived body shape. This indicates that lifestyle factors (i.e., walking, sitting) and grip strength are inter-correlated with perceived body shape. Although, a previous study successfully converged PA, sitting time, and grip strength,[13] this is the first study showing latent classes of those profiles including perceived body shape in older Korean adults with hypertension and its association with mental health. Individuals in class 3 had higher perceived body shape than their counterparts. It is well known that older adults rarely increase their levels of PA.[33] Thus, an option to increase both PA and perceived body shape could be shifting individual's attention to health benefits of engaging in regular PA (i.e., heart rate, positive mood) rather than weight loss.[34]
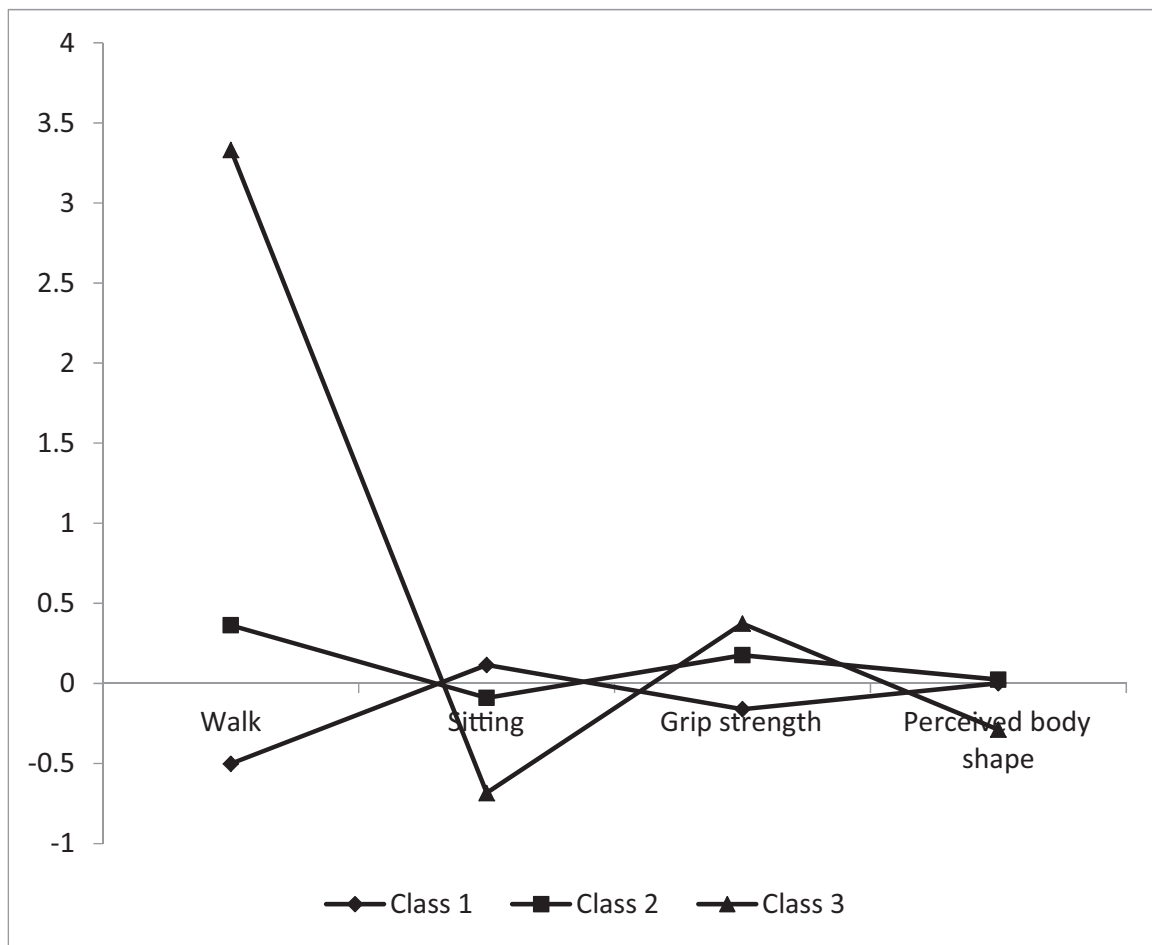
Figure 2. Three-class model of walking, sitting, grip strength, and perceived body shape. Class 1: a physically inactive lifestyle with low physical function and body perception (n = 454, 59%). Class 2: a physically moderate lifestyle with moderate physical function and body perception (n = 292, 38%). Class 3: a physically active lifestyle with high physical function and body perception (n = 20, 3%).

Table 5

Class comparisons on anxiety/depression and stress.

	Anxiety/Depression		Stress	
	M	**SD**	**M**	**SD**
Class 1	1.18	0.49	2.02	0.94
Class 2	1.15	0.43	1.82	0.75
Class 3	0.99	0.01	1.91	0.82
Class comparison	**Chi square**	**P**	**Chi square**	**P**
Overall test	122.14	.000	8.66	.01
1 vs. 2	0.90	.34	8.54	.00
1 vs. 3	71.04	.00	0.35	.56
2 vs. 3	34.34	.00	0.21	.65
Cohen *d* effect size				
d_{2-1}	−0.07			−.24
d_{3-1}	−0.55			−.12
d_{3-2}	−0.53			.12

Class 1: a physically inactive lifestyle with low physical function and body perception; Class 2: a physically moderate lifestyle with moderate physical function and body perception; Class 3: a physically active lifestyle with high physical function and body perception. M = mean, SD = standard deviation.

5.2. Differences of anxiety/depression between participants' classes

The results indicate that individuals in class 3 have lower levels of anxiety/depression compared with individuals in classes 1 and 2 (Cohen *d* = −0.55 to −0.53). Our findings are in line with the previous study that found that individuals with high profiles were associated with better mental health than individuals with low profiles in terms of their lifestyle, physical function, and perceived health.[13] However, the current study extends our knowledge by examining perceived body shape as another measure of mental health in older Korean adults with hypertension. It has been reported that older adults with hypertension tend to perceive their body image differently, although they have similar BMI.[35] Therefore, it is possible that having a positive attitude of one's body shape may also be important for managing anxiety/depression along with having a physically active lifestyle and maintaining physical function, particularly in cultures where slimmer body shapes are highly valued.[36]

5.3. Stress differences between participants' classes

Having a physically active lifestyle, high grip strength, and perceived body shape is likely to be associated with better mental health. However, this association was only found in classes 1 and 2. Not having any significant differences between class 3 and the other classes is somewhat unexpected because engaging in PA is associated with lower levels of stress.[37] A possible explanation is that moderate amounts of walking, sitting, and grip strength could be helpful to manage stress. In general, it would be daunting to define the moderate amounts of walking, sitting, and grip strength that may be able to help older adult managing stress. Using latent profile analysis enables to particularly detect individuals with the moderate amount of walking, sitting, and grip strength (class 2) which might positively affect stress compared with individuals with low levels of walking, sitting, and grip strength (class 1).

This study has a few limitations. Due to the cross-sectional nature of the study, causality cannot be inferred. Nevertheless, this study used national secondary data comprising 767 older individuals with hypertension. Although there are a range of mental and physical health measures in relation to body shape such as self-esteem[22] and physical fitness,[23] the current study is limited to a few measures which limits the generalizability of these results. In addition, there is a lack of consistency in previous studies relating to body shape among older adults.[22,23,18] Given this, further research should explore the study results with additional physical and perception measures in relation to mental health. Another limitation is that only one item was used to measure anxiety/depression. These type of measures are commonly used in nationally representative samples and this item has been previously validated in the Korean population.[25,30] Nonetheless, further studies would benefit from using formal anxiety and depression scales such as the Hospital Anxiety and Depression Scale (HADS).[38] The proportion of class 3 was only 3%, which is small compared with other classes. However, given the characteristics of older adults in general (e.g., sedentary), it is likely that only a few individuals show very physically active lifestyles as well as high physical function and body perception. Including this group of highly active and functional older adults remain relevant to increase our understanding of the association of a physically active lifestyle, physical function, and body shape on mental health in older adults with hypertension. However, based on the robustness of latent profile analysis and the large sample size, the results of this study further extend our understanding of the mental health of older Korean adults with hypertension. Furthermore, the current study used self-reported PA data. It is well known that self-reported PA measures overestimate time spent in PA in comparison to objective measures of PA (e.g., pedometers, accelerometers).[39] Therefore, a study using objectively-measured PA is needed to confirm our findings. Despite its limitations, the study adds more knowledge to the field of older adults' physical characteristics and body shape perceptions and their associations with mental health in a clinical population using latent profile analysis.

6. Conclusion

Hypertensive older adults with a physically active lifestyle tend to have higher levels of physical function and body perception than those being less physically active. In addition, highly active individuals with high levels of physical function and body perception have lower levels of anxiety/depression and stress compared with those who are less active, less physically

functional, and have lower levels of body perception. Therefore, further studies should explore the influence of, and how to increase, perceived body shape in older adults with hypertension, particularly in those countries were slimmer figures are preferred.

Author contributions

Conceptualization: In-Hwan Oh, Saengryeol Park.
Supervision: In-Hwan Oh.
Writing – original draft: Saengryeol Park.
Writing – review & editing: Diana Castaneda-Gameros.

References

 [1] Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics—2016 update. Circulation 2016;133:e38–60.
 [2] Ferrucci L, Guralnik JM, Pahor M, et al. Hospital diagnoses, medicare charges, and nursing home admissions in the year when older persons become severely disabled. JAMA 1997;277:728–34.
 [3] den Ouden ME, Schuurmans MJ, Mueller-Schotte S, et al. Do subclinical vascular abnormalities precede impaired physical ability and ADL disability? Exp Gerontol 2014;58:1–7.
 [4] Korea Centers for Disease Control and Prevention. Korea Health Statistics 2012: Korea National Health and Nutritional Examination Survey (KNHANES V-3). Cheongju; 2013.
 [5] Liu L, An Y, Chen M, et al. Trends in the prevalence of hospitalization attributable to hypertensive diseases among United States adults aged 35 and older from 1980 to 2007. Am J Cardiol 2013;112:694–9.
 [6] Chi M, Lee C, Wu S. Multiple morbidity combinations impact on medical expenditures among older adults. Arch Gerontol Geriatr 2011;52:e210–4.
 [7] Trevisol DJ, Moreira LB, Kerkhoff A, et al. Health-related quality of life and hypertension: a systematic review and meta-analysis of observational studies. J Hypertens 2011;29:179–88.
 [8] Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. Compr Physiol 2012;2:1143–211.
 [9] World Health Organisation. Health topics: Hypertension; 2018. Available at: http://www.who.int/features/qa/82/en/. Accessed February 7, 2018.
[10] Ströhle A. Physical activity, exercise, depression and anxiety disorders. J Neural Transm 2009;116:777–84.
[11] Hamer M. Psychosocial stress and cardiovascular disease risk. Psychosom Med 2012;74:896–903.
[12] Rebar AL, Vandelanotte C, van Uffelen J, et al. Associations of overall sitting time and sitting time in different contexts with depression, anxiety, and stress symptoms. Men Health Phy Act 2014;7:105–10.
[13] Park S, Thøgersen-Ntoumani C, Ntoumanis N, et al. Profiles of physical function, physical activity, and sedentary behavior and their associations with mental health in residents of assisted living facilities. Appl Psychol Heal Well Being 2017;9:60–80.
[14] Berscheid E, Walster E, Bohrnstedt G. The happy American body: a survey report. Psychol Today 1973;7:119–31.
[15] Garner DM. The 1997 body image survey results. Psychol Today 1997;30:30–44. 75–80, 84.
[16] Webster J, Tiggemann M. The relationship between women's body satisfaction and self-image across the life span: the role of cognitive control. J Genet Psychol 2003;164:241–52.
[17] Tiggemann M. Body image across the adult life span: stability and change. Body Image 2004;1:29–41.
[18] Reboussin BA, Rejeski WJ, Martin KA, et al. Correlates of satisfaction with body function and body appearance in middle- and older aged adults: the activity counseling trial (ACT). Psychol Health 2000;15:239–54.
[19] McAuley E, Blissmer B, Katula J, et al. Physical activity, self-esteem, and self-efficacy relationships in older adults: a randomized controlled trial. Ann Behav Med 2000;22:131–9.
[20] McAuley E, Marquez DX, Jerome GJ, et al. Physical activity and physique anxiety in older adults: fitness, and efficacy influences. Aging Ment Health 2002;6:222–30.
[21] Cafri G, Thompson JK, Ricciardelli L, et al. Pursuit of the muscular ideal: physical and psychological consequences and putative risk factors. Clin Psychol Rev 2005;25:215–39.
[22] Schuler PB, Broxon-Hutcherson A, Philipp SF, et al. Body-shape perceptions in older adults and motivations for exercise. Percept Mot Skills 2004;98:1251–60.
[23] Cash TF, Pruzinsky T. Body Images: Development, Deviance, and Change. New York: Guilford Press; 1990.
[24] Marsh HW, Lüdtke O, Trautwein U, et al. Classical latent profile analysis of academic self-concept dimensions: synergy of person- and variable-centered approaches to theoretical models of self-concept. Struct Equ Model A Multidiscip J 2009;16:191–225.
[25] Kweon S, Kim Y, Jang M-j, et al. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). Int J Epidemiol 2014;43:69–77.
[26] Kirkendall WM, Burton AC, Epstein FH, et al. Recommendations for human blood pressure determination by sphygmomanometers. Circulation 1967;36:980–8.
[27] Kim S-H, Kim T-H, Hwang H-J. The relationship of physical activity (PA) and walking with sarcopenia in Korean males aged 60 years and older using the Fourth Korean National Health and Nutrition Examination Survey (KNHANES IV-2, 3), 2008-2009. Arch Gerontol Geriatr 2013;56:472–7.
[28] Jeon JY. Development of the Korean Version of Global Physical Activity Questionnaire and Assessment of Reliability and Validity. 2013 Academic Research on Task, Final Report. Cheongju: Korea Center for Disease Control and Prevention; 2013.
[29] Bang I, Jeong Y, Park Y, et al. Secondhand smoking is associated with poor mental health in Korean adolescents. Tohoku J Exp Med 2017;242:317–26.
[30] Kim M-H, Cho Y-S, Uhm W-S, et al. Cross-cultural adaptation and validation of the Korean version of the EQ-5D in patients with rheumatic diseases. Qual Life Res 2005;14:1401–6.
[31] Lee DS, Kim YJ, Han HR. Sex differences in the association between socio-economic status and type 2 diabetes: data from the 2005 Korean National Health and Nutritional Examination Survey (KNHANES). Public Health 2013;127:554–60.
[32] Bakk Z, Vermunt JK. Robustness of stepwise latent class modeling with continuous distal outcomes. Struct Equ Model A Multidiscip J 2016;23:20–31.
[33] Sparling P, Howard B, Dunstan D, et al. Recommendations for physical activity in older adults. BMJ 2015;350:h100.
[34] King NA, Hopkins M, Caudwell P, et al. Beneficial effects of exercise: shifting the focus from body weight to other markers of health. Br J Sports Med 2009;43:924–7.
[35] Heinberg LJ, Haythornthwaite JA, Rosofsky W, et al. Body image and weight loss maintenance in elderly African American hypertensives. Am J Health Behav 2000;24:163–73.
[36] Robineau D, de Saint Pol T. Body Fatness Standards: An International Comparison (No.504). Paris, France; 2013. Available at: https://www.ined.fr/en/publications/editions/population-and-societies/body-fatness-standards-international-comparison/.
[37] Bherer L, Erickson KI, Liu-Ambrose T. A review of the effects of physical activity and exercise on cognitive and brain functions in older adults. J Aging Res 2013;2013:657508.
[38] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.
[39] Troiano RP, Berrigan D, Dodd KW, et al. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 2008;40:181–8.