GeroScience (2023) 45:1791–1801
https://doi.org/10.1007/s11357-023-00729-1

ORIGINAL ARTICLE

Understanding changes in mental health symptoms from young-old to old-old adults by sex using multiple-group latent transition analysis

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Received: 7 December 2022 / Accepted: 4 January 2023 / Published online: 10 January 2023

Abstract Older adults are classified into three homogeneous groups: young-old (age 65–74), old-old (age 75–84), and oldest-old (age 85 and over). Mental health symptoms are likely to change over time, especially when older adults transition from one age group to another. Yet, little is known on changes in mental health symptoms as they transition to another age group, and if these changes differ by sex. This is a secondary data analysis using the longitudinal data from the National Social Life, Health, and Aging Project. A total of 1183 young-old adults at wave 1 was included. Mental health symptoms were depression, anxiety, loneliness, perceived stress, and happiness. Multiple-group latent transition analysis was conducted to model the transition probabilities of latent classes and to compare these differences between sex. Descriptive and inferential statistics were conducted to obtain demographic characteristics and to test for differences. Three latent classes were identified based on severity: class 1—mild, class 2—moderate, and class 3—severe. Regardless of sex, young-old adults remained in the same class from waves 1 to 2. However, they moved to a less severe group when transitioning into the old-old from waves 2 to 3. Statistically significant differences were found in their demographic characteristics among the latent classes. Older adults, when transitioning from young-old to old-old, are likely to transition to latent classes with less severe mental health symptoms in both sex. Clinicians need to provide a comprehensive assessment to all older adults, regardless of the severity of their mental health symptoms, to promote well-being.

Keywords Aging · Mental health · Older adults · Transition

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Introduction

The number of older adults is rapidly increasing, and it is expected that more than a quarter of Americans will be aged 65 years and over by 2030 [1, 2]. Global population aging has led to unprecedented challenges such as increased disease burden, expenditure on long-term care and healthcare services, and lack of support resources [3]. Aging has been closely associated with mental health symptoms as older adults undergo significant physiological changes and are

exposed to psychosocial stressors [4]. Yet, symptoms are often dismissed as a part of the normal process of aging and often keep symptoms to themselves [5]. Some of these symptoms include anxiety, depression, loneliness, stress, and a sense of happiness or unhappiness about life [6–8]. As a result, many mental health symptoms are underdiagnosed or undertreated in older adults, which can adversely affect their functional ability and health outcomes [9].

Older adults are a heterogeneous group of individuals 65 years and over, and classified into three groups: young-old adults (age 65—74 years), old-old adults (age 75—84 years), and oldest-old adults (age 85 years and over) [10]. Previous studies often examined this heterogeneous group as a whole to understand the prevalence, risk factors, and protective factors of mental health symptoms and their association with health outcomes [11, 12]. However, Jo et al. (2009) found statistically significant differences in the sociodemographic factors (e.g., marital status, income, and religion) of these three groups, such as the existence of spouse, income, and religion, that predicted life satisfaction [13]. Similarly, Cohen-Mansfield et al. (2013) found that there was increased widowhood, institutionalization, comorbidities, and changes in social support from young-old adults to oldest-old adults, all of which adversely affected the overall health, function, and well-being over time [14]. Thus, it is important to consider older adults as a heterogeneous group, and to understand the potential differences in their mental health symptoms across the different groups of older adults.

Mental health symptoms are likely to change over time, especially among older adults who experience multiple biopsychosocial changes in life [15, 16]. These biopsychosocial changes include health concerns, changes in social and family ties, the experience of deaths of family and friends, and a sense of loss and questions about the meaning of life [11, 15]. However, to date, cross-sectional studies have examined older adults' symptoms at one point in time [17, 18]. While these studies provide critical insights into symptom experience, the study findings from cross-sectional data may provide an inaccurate view of symptom experience in this population. For example, a longitudinal study has reported that older adults experience more mental health symptoms over time as they encounter social challenges, such as bereavement and residential relocation [19]. In addition, sex differences were denoted in the longitudinal symptom experience of older adults, with female sex increasing the likelihood of experiencing a higher burden of anxiety and depressive symptoms [16, 20, 21]. It is critical to take a longitudinal approach to understand how older adults experience changes in symptoms over time and if these changes differ by sex.

To date, symptom research in older adults often used latent class analysis (LCA), which is a person-centered approach to identify homogeneous subpopulations within the heterogeneous population based on their mental health symptoms [22, 23]. However, LCA is conducted with cross-sectional data and does not capture how mental health symptoms are likely to change over time. Thus, latent transition analysis (LTA) has been recently used to provide better analytical insights into symptom trajectories over time. LTA is also a person-centered approach using longitudinal data in symptom research [24]. It is a type of mixture model and an extension of the LCA framework to handle changes in latent classes of individuals over time [24, 25]. LTA estimates the transition probability of transitioning from one class to another class and provides identical latent class memberships over time by constraining item-response probabilities [25]. For example, three symptom classes were identified for cancer patients undergoing chemotherapy using LTA, and the class membership changed over the course of symptom management [25]. When comparing between sex, the use of multiple-group LTA with the grouping variable as sex can help estimate the group-specific probability of belonging to a latent class at each time point as well as the group-specific transition probability over time [26].

The purpose of this current study is (1) to identify latent classes of mental health symptoms among young-old adults based on LCA, (2) to examine the transitions of latent classes of mental health symptoms from young-old to old-old adults over time based on LTA, and (3) to examine the differences in the transition patterns and probabilities between male and female sex based on multiple-group LTA.

Methods

Design and data collection

This is a secondary data analysis using the longitudinal data of wave 1 (2005–2006), wave 2 (2010–2011),

and wave 3 (2015–2016) from the National Social Life, Health, and Aging Project (NSHAP).

Description of the data set

The NSHAP is a population-based study to understand the well-being of community-dwelling older adults in the USA. It focused on understanding the interactions among physical health, emotional health, health behaviors, social connectedness, cognitive function, sensory function, and illness. Wave 1 was conducted in 2005–2006 with a nationally representative sample of 3005 participants aged between 57 and 85 years at the time of recruitment. Wave 2 was conducted in 2010–2011 where the surviving participants from wave 1 were re-interviewed, and their spouses/co-resident partners were invited for interview. Wave 3 was conducted in 2015–2016 where all surviving participants were re-interviewed, and a new cohort born during the Baby Boom (1948–1965) was introduced together with their spouses/co-resident partners [27, 28].

Participants

We included young-old adults aged between 65 and 74 years at wave 1 to examine their transitions of mental health symptoms as they become old-old adults aged between 75 years and 84 years at wave 3. A total of 1183 participants met the inclusion criteria for the current study.

Measures

Mental health symptoms

Depression was assessed using the 11-item Center for Epidemiological Studies Depression (CESD-11) scale, which has good internal reliability (Cronbach's alpha=0.80) with the original 20-item CESD scale. Participants were asked to rate the frequency of their feelings in the past week from 0 "rarely or none of the time" to 3 "most of the time." Positively worded questions were reverse-coded when creating the total score. The total score ranged from 0 to 33, and a higher score represents higher severity of depressive symptoms [29, 30].

Anxiety was measured using the 7-item Hospital Anxiety and Depression Scale (HADS), which has been used with good reliability and validity in other population-based studies. Participants were asked to rate the frequency of their feelings in the past week from 0 "rarely or none of the time" to 3 "most of the time." Positively worded questions were reverse-coded when creating the total score. The total score ranged from 0 to 21, and a higher score represents higher severity of anxiety symptoms [29, 30].

Stress was measured using the modified 4-item Perceived Stress Scale (PSS) from the 14-item Cohen's PSS. The modified version of PSS was validated, and the 4-items with the highest correlation to the 14-item scale were selected [30]. Participants were asked to rate the frequency of their feelings of stress from 0 "none of the time" to 3 "most of the time." Positively worded questions were reverse-coded when creating the total score. The total score ranged from 0 to 12, and a higher score represents a higher degree of stress [30, 31].

Loneliness was measured using the 3-item shortened UCLA-loneliness scale with good internal validity (Cronbach's alpha=0.81). Participants were asked to rate the frequency of their feelings of stress from 0 "hardly ever" to 2 "often." The total score ranged from 0 to 6, and a higher score represents greater loneliness [30].

Happiness was measured using a single item on self-rated general happiness: "If you were to consider your life in general these days, how happy or unhappy would you say you are on the whole?" This question was selected due to its similarity to an item from the General Social Survey, which has established concurrent validity in other studies. The total score ranged from 0 "unhappy usually" to 4 "extremely happy" [30].

Sociodemographic, lifestyle, and clinical characteristics

Using the study-designed questionnaire, the sociodemographic, lifestyle, and clinical characteristics were obtained from self-reports. These characteristics included age, sex, marital status, race/ethnicity, level of education, current employment status, annual household income, and presence/absence of comorbidities such as hypertension, diabetes, stroke, arthritis, thyroid, and dementia, current smoking, current alcohol consumption, level of physical activity, rested sleep, and social support.

Herein, social support was measured using the six items following previous research that asks how often the participants could rely on and open up to their spouses/partners, family members, or friends from 0 "hardly ever or never" to 3 "often." The total score ranged from 0 to 18, and a higher score indicates more social support [32, 33].

Ethical considerations

The NSHAP study database, codebook, and survey questionnaires are available for public access from the Inter-university Consortium for Political and Social Research (ICPSR) website. Only the de-identified information was archived and analyzed for the current study. The current study received Columbia university institutional review board declaration of exemption [IRB-AAAU4294].

Data analysis

We performed the LCA and LTA using Mplus, Version 4.1. LCA was initially conducted to identify the optimal number of latent classes based on the combinations of mental health symptoms. Then, multiple-group LTA was conducted to model the transition probabilities of latent classes over time and to compare these differences between male and female older adults [34]. In addition, demographic characteristics of each class at baseline were obtained, and the differences in demographic characteristics among the identified classes were tested.

First, LCA was conducted to determine the number of latent classes of older adults with distinct mental health symptom profiles. The model was tested from a 1-class model to 5-class model to select the best-fitting model. Statistical fit indices such as Akaike information criterion (AIC), Bayesian information criterion (BIC), sample size–adjusted BIC (SSABIC), Vuong-Lo-Mendell-Rubin adjusted likelihood ration test (VLMR-LRT), Lo-Mendell-Rubin likelihood ratio test (LMR-LRT), and entropy were calculated for 2–5 class models. The AIC, BIC, and SSABIC measure the goodness-of-fit of each model, with a lower value representing a better model. The VLMR-LRT and LMR-LRT tests where the current model (k) is a better model than the former model (k-1) and produces corresponding p-value. If the p-value is significant, it indicates that the current model (k) is significantly better than the former model (k-1). Entropy ranges from 0 to 1, which is a fit index for classification accuracy. While a higher entropy value indicates a more accurate classification, there is no set cutoff value because it depends on the number of classes. The final model was selected based on the combination of statistical fit indices, clinical meaning, and interpretability of each class based on the authors' clinical judgment [35, 36].

Second, LTA was conducted to examine the transition probabilities of latent classes from wave 1, wave 2, to wave 3. As the current study is interested in examining sex differences, sex (male vs. female) was used as the grouping variable. Herein, measurement invariance was assumed that there is no difference in the way latent classes were constructed across the three waves [22]. The assumption of measurement invariance allows the transitions to be based on the changes in latent classes, instead of their compositions. LTA produces item-response probabilities, latent status probabilities, and transition probabilities. The item-response probabilities indicate the likelihood of participants in each latent class to provide different responses to each continuous variable (e.g., mental health symptom) [23]. The latent status probabilities represent the proportion of participants expected to belong to the latent class at each time point [22]. The transition probabilities show patterns of change among the latent classes and describe how one latent class at a time point is likely to transition to another latent class at another time point [37]. In the matrix, the row corresponds to latent status membership at time t and column corresponds to latent status membership at another timepoint at t+1 [38].

Third, descriptive statistics were obtained for demographic information about the participants. Then, the chi-square test for categorical variables and analysis of variance (ANOVA) for continuous variables were conducted to test for significant differences among the identified latent classes at baseline.

Results

Latent class and transition model selection

A total of 5-class models were built from a 1-class model to a 5-class model. The 3-class, 4-class, and 5-class models indicated a good fit based on AIC,

BIC, and SSABIC. While entropy was the highest in the 5-class model, entropy depends on the number of classes, indicating that the model with the highest entropy may not be the best-fitting model [35, 36]. When further examining the VLMR and LMR-LRT, the 4-class and 5-class model were not significantly better than the 3-class model ($p>0.05$). We also considered the clinical meaning and interpretability of the 3-class, 4-class, and 5-class models. Among all the class models, the 3-class model had distinct differences among the classes in terms of the severity of mental health symptoms. When considering statistical fit indices, clinical meaning and interpretability of each class, the 3-class model was selected as the final model (AIC=47865.578, BIC=48180.278, SSABIC=47983.344, VLMR=0.1496, LMR-LRT=0.1531, entropy=0.749). Table 1 details the model fit indices.

Multiple-group LTA

Table 2 details the multiple-group LTA parameters by sex. The item-response probabilities, which are constrained to be equal across the three time points, establish the basis for latent class interpretation and labeling [39]. The 3-class model consisted of class 1—mild, class 2—moderate, and class 3—severe based on their severity of symptoms. Class 1—mild had the lowest severity of mental health symptoms of depression, anxiety, loneliness, and perceived stress and the highest degree of happiness. In contrast, class 3—severe had the highest severity of depression, anxiety, loneliness, and perceived stress and the lowest degree of happiness.

The latent status probabilities reflect the proportion of older adults who are expected to belong to each class at each time point [40]. A high proportion of both male and female older adults were more likely to belong to class 1—mild, followed by class 2—moderate, and class 3—severe at all three waves. In male older adults, the latent status probability for class 1—mild decreases at wave 2 but increases again at wave 3. In contrast, the latent status probability for class 2—moderate and class 3—severe increases at wave 2 but decreases at wave 3. In female older adults, the latent status probability for class 1-mild continues to increase at each wave. However, the latent status probability for class 2—moderate and class 3—severe increases at wave 2 and decreases at wave 3.

The transition probabilities indicate the probability of older adults in a latent class transitioning to another class at a different time point [40]. While both male and female older adults tend to remain in the same class from wave 1 to wave 2, some proportion of older adults in class 2—moderate moves to class 1—mild and class 3—severe to class 2—moderate (transition

Table 1 Model fit statistics from LCA

No. of classes	Number of each class	AIC	BIC	SSABIC	VLMR	LMR-LRT	Entropy
1	C1= 1183	49,911.513	50,063.787	49,968.497	N/A	N/A	1.000
2	C1=864 C2=319	48,237.094	48,470.581	48,324.469	0.0000	0.0000	0.824
3	C1= 382 C2= 138 C3= 663	47,865.578	48,180.278	47,983.344	0.1496	0.1531	0.749
4	C1=241 C2=91 C3=668 C4=183	47,543.091	47,939.004	47,691.247	0.1715	0.1742	0.796
5	C1=38 C2=228 C3=193 C4=642 C5=82	47,274.309	47,751.435	47,452.857	0.1244	0.1263	0.822

Table 2 Multi-group latent transition analysis parameters

Item-response probabilities				
	C1: mild		C2: mod	C3: high
Depression	9.031 (0.096)		11.531 (0.241)	14.320 (0.633)
Anxiety	4.892 (0.075)		6.424 (0.170)	7.922 (0.432)
Loneliness	0.231 (0.013)		2.512 (0.046)	4.566 (0.107)
Perceived stress	10.139 (0.032)		10.277 (0.079)	10.524 (0.158)
Happiness	2.840 (0.023)		2.227 (0.042)	1.615 (0.100)
Latent status probabilities				
Sex			**C1**	**C2**	**C3**
Male	Wave 1		0.758	0.196	0.046
	Wave 2		0.661	0.250	0.089
	Wave 3		0.840	0.114	0.046
Female	Wave 1		0.662	0.269	0.069
	Wave 2		0.609	0.277	0.114
	Wave 3		0.702	0.236	0.062
Transition probabilities				
Sex	(Rows: wave 1, columns: wave 2)		C1	C2	C3
Male	Class 1		0.786	0.181	0.033
	Class 2		0.328	0.497	0.174
	Class 3		0.011	0.338	0.652
Female	Class 1		0.779	0.183	0.038
	Class 2		0.363	0.537	0.100
	Class 3		0.152	0.361	0.487
Sex	(Rows: wave 2, columns: wave 3)		C1	C2	C3
Male	Class 1		0.927	0.057	0.016
	Class 2		0.572	0.374	0.054
	Class 3		0.547	0.051	0.402
Female	Class 1		0.858	0.115	0.026
	Class 2		0.495	0.416	0.088
	Class 3		0.000	0.691	0.309

probability ≈ 0.30). When transitioning from wave 2 to wave 3, the majority of older male adults in class 1—mild remain in the same class, while more than half of transition from class 2—moderate to class 1—mild, and from class 3—severe to class 1—mild. Similarly, female older adults in class 1—mild remain in the same class while those in class 2—moderate transition to class 1—mild, and class 3—severe to class 2—moderate.

Baseline participant characteristics

When comparing the three classes, class 3—severe had the highest mean age of 70.34 (SD 3.58) years, and class 2—moderate had the lowest mean age of 69.71 (SD 3.01) years. There was a higher proportion of male older adults in class 1—mild (52.39%) than female older adults, and a higher proportion of female older adults in class 2—moderate (58.17%) and class 3—severe (62.30%) than male older adults, p=0.0020. While more than half of older adults were married across all classes, class 2—moderate had less than half widowed/separated/divorced (42.21%). In addition, class 3—severe had the highest proportion of older adults who were never married (8.20%), p=<0.0001. In terms of race/ethnicity, class 1 had the highest proportion of White (76.61%) and the lowest proportion of African American (17.08%), and Asian, Pacific Islander, American Indian (6.32%). Contrastingly, class 2—moderate had the lowest proportion of White (68.08%) and the highest proportion of African Americans (25.48%), p=0.0408. For the level of

education, class 1—mild had more than half of older adults who received some college education (30.97%) or college graduates of above (22.24%). In comparison, class 3 had more than half who received less than a high school education (42.62%) and high school graduate (29.51%), p=0.0011. Thus, class 3—severe had the highest proportion of older adults receiving \$0—\$24,999 (64.29%) and class 1—mild receiving \$50,000—\$99,999 (27.42%) and \$100,000 or higher (10.18%), p=<0.0001.

Regarding clinical characteristics, there was a statistically significant difference in the presence of diabetes, stroke, and dementia among the classes. Class 2—moderate had the highest proportion of older adults with diabetes (34.22%), p=<0.0001; class 3—severe had the highest proportion with stroke (16.39%), p=0.0201 and dementia (4.92%), p=0.0010. In terms of lifestyle characteristics, class 3—severe had a quarter of current smokers (26.23%) which was notably high among the classes, p=0.0308. However, there were more alcohol drinkers in class 1—mild (57.04%) and class 2—moderate (51.71%), p=0.0414. The majority of older adults in class 1—mild were very physically active (68.30%), while more than a quarter of older adults in class 3—severe were not active at all (18.03%) or mildly active (19.67%), p=<0.0001. Last, the level of social support was the highest in class 1—mild and the lowest in class 3—severe, which was statistically significant, p=0.0007. Table 3 details the participant characteristics at baseline.

Discussion

To the best of our knowledge, this is the first study to use multiple-group LTA to examine the transition probabilities in mental health symptoms among the latent classes by sex, especially from the young-old stage to the old-old stages of life. Our current study identified three latent classes of older adults based on their mental health symptoms of depression, anxiety, loneliness, perceived stress, and happiness: class 1—mild, class 2—moderate, and class 3—severe. Regardless of sex, older adults remained in the same class from wave 1 to wave 2. However, these older adults moved to a less severe group when transitioning into the old-old stage of life from wave 2 to wave 3.

Older adults, when transitioning from young-old to old-old, are likely to transition to latent classes with less severe mental health symptoms. For male older adults, both class 2—moderate and class 3—severe transitioned to class 1—mild. For female older adults, class 3—severe transitioned to class 2—moderate, while class 2—moderate transitioned to class 1—mild. This aligns with the findings of a meta-analysis that there was an intrinsic reduction to susceptibility to anxiety and depression with aging, after adjusting for covariates [41]. Similarly, a longitudinal study reported that the severity of depression decreased while life satisfaction increased over time among older adults [42]. Among the young-old adults, objective conditions of life (e.g., sex, marital status, employment status, education) significantly affect their well-being [42]. For example, young-old adults, who experience major life transitions, often retire from their long-held jobs [43]. Retirement involves sudden changes in social roles and networks as well as financial situation (e.g., income, health insurance), all of which may impact the risk of depression [43]. In contrast, based on the gerotranscendence theory, old-old adults are likely to follow the developmental adaptation process toward wisdom and maturation [44]. As a result, the objective conditions of life do not significantly affect old-old adults compared with young-old adults, making them less susceptible to depression and anxiety [44]. As the subjective conditions of life (e.g., social support) have a higher impact on older adults' well-being, more efforts should focus on providing resources for social engagement and religious or spiritual involvement [45].

Furthermore, using symptom measurement tools validated in the general adult population may not be appropriate for older adults. For example, older adults were less accurate in labeling their symptoms as anxiety or depression using DSM-IV when compared with younger adults [46]. Even among the educated and cognitively intact group of older adults with a mean age of 80 years, the Center for Epidemiological Studies Depression scale performed poorly in detecting major and minor depression using the standard cutoffs [47]. This may be due to the similarity between mental health symptoms and the effects of aging, where some measures of depression include items that may arise from a physical cause and thus generate measurement error [48]. While the severity of mental health symptoms is reported to be less

Table 3 Participant characteristics at wave I

	Class 1: mild	Class 2: moderate	Class 3: severe	*p*-value
Cluster size, n	859	263	61	
Age, mean (SD)	69.71 (3.01)	69.49 (3.10)	70.34 (3.58)	0.1403
Sex				0.0020**
Male	450 (52.39)	110 (41.83)	23 (37.70)	
Female	409 (47.61)	153 (58.17)	38 (62.30)	
Marital status				<0.0001***
Married/living with a partner	584 (67.99)	139 (52.85)	39 (63.93)	
Widowed/separated/divorced	146 (17.08)	111 (42.21)	17 (27.87)	
Never married	21 (2.44)	13 (4.94)	5 (8.20)	
Race/ethnicity				0.0408*
White	655 (76.61)	179 (68.06)	43 (70.49)	
African American	146 (17.08)	67 (25.48)	13 (21.31)	
Asian, Pacific Islander, American Indian	54 (6.32)	17 (6.46)	5 (8.20)	
Education				0.0011**
Less than high school	181 (21.07)	70 (26.62)	26 (42.62)	
High school graduate	221 (25.73)	66 (25.10)	18 (29.51)	
Some college	266 (30.97)	81 (30.80)	9 (14.75)	
College graduate or above	191 (22.24)	46 (17.49)	8 (13.11)	
Currently working (yes)	224 (26.11)	64 (24.33)	15 (24.59)	0.8317
Annual household income				
$0–24,999	201 (33.00)	82 (44.57)	27 (64.29)	<0.0001***
$25,000–49,999	179 (29.39)	61 (33.15)	13 (30.95)	
$50,000–$99,999	167 (27.42)	31 (16.85)	2 (4.76)	
$100,000 or higher	62 (10.18)	10 (5.43)	0 (0)	
Hypertension (yes)	506 (58.91)	164 (62.36)	42 (68.85)	0.2212
Diabetes (yes)	182 (21.29)	90 (34.22)	17 (27.87)	<0.0001***
Stroke (yes)	61 (7.10)	26 (9.89)	10 (16.39)	0.0201*
Arthritis (yes)	442 (51.42)	153 (58.17)	31 (50.82)	0.1524
Thyroid (yes)	132 (15.37)	47 (17.87)	13 (21.31)	0.3413
Dementia (yes)	4 (0.47)	3 (1.14)	3 (4.92)	0.0010**
Smoking (yes)	122 (14.22)	45 (17.11)	16 (26.23)	0.0308*
Alcohol (yes)	490 (57.04)	136 (51.71)	26 (42.62)	0.0414*
Physical activity				<0.0001***
None	60 (6.99)	41 (15.59)	11 (18.03)	
Mildly active	82 (9.56)	41 (15.59)	12 (19.67)	
Moderately active	130 (15.15)	48 (18.25)	11 (18.03)	
Very active	586 (68.30)	133 (50.57)	27 (44.26)	
Rested sleep (yes)	774 (90.21)	222 (84.41)	46 (75.41)	0.0003**
Social support	14.82 (2.21)	14.05 (2.28)	13.76 (3.11)	0.0007**

*$p<0.05$; **$p<0.01$; ***$p<0.0001$

severe in old-old adults, mental health symptoms may present differently in this population [49]. Thus, it is important to understand and assess the less specific mental health symptoms such as insomnia, fatigue, anorexia, and cognitive impairment among the old-old adults regardless of sex.

While the pattern of transition was similar in both sex, we found statistically significant differences in

the sociodemographic characteristics among the latent classes. When comparing class 3—severe to class 1—mild, there was a higher proportion of female sex, African Americans, Asian Pacific Islander, American Indian, education equivalent or less than high school, lower annual household income, presence of diabetes, stroke, dementia, current smokers, worse quality of sleep, and lower social support. This highlights how social determinants interact at different levels, adversely affecting the mental health of older adults across both sex [50]. In addition, our study findings support previous research where female sex of African American race have been associated with a higher prevalence and severity of depression and loneliness across the lifespan [51, 52]. However, the severity of mental health symptoms is not directly associated with the risk of suicide [53]. Suicide attempt has been one of the major public health issues worldwide, with the suicide rate being the highest in male older adults of White race [53]. Thus, it is important for clinicians to provide a comprehensive assessment to all older adults, regardless of the severity of their mental health symptoms, to prevent the worsening of symptoms and future suicide attempts. In addition, older adults with high education tend to hold a more positive attitude leading to a better psychological adjustment to aging, and the ability to better seek mental health services [54, 55]. This highlights the importance of education in identifying mental health symptoms and seeking care. As a result, educational practitioners need to acknowledge educational interventions as public health interventions to reduce the risk of mental health symptoms among older adults [54, 55].

There are several limitations to consider. First, our sample consists of only three race/ethnic groups, which may limit the generalizability of our study findings. As cultural diversity exists in mental health, future research should be conducted with a more diverse sample of race/ethnic groups, which could yield different numbers and transition patterns of latent classes over time. Second, the current study examined the transition from young-old to old-old stage of life. Because older adults are a heterogeneous group, it is important to understand how the latent classes transition from old-old to old-oldest stage, which can further contribute to current knowledge. Third, the influence of covariates has not been considered. Future study should consider the use of latent transition analysis with covariates to understand how the influence of covariates on their transition patterns.

Conclusion

The current study aimed to examine the transitions of latent classes of mental health symptoms from young-old to old-old adults over time, and to understand the differences in transition patterns and probabilities based on sex using multiple-group LTA. A total of three latent classes of mild, moderate, and severe mental health symptoms were identified. Statistically significant differences were found in sociodemographic, lifestyle, and clinical characteristics among the latent classes such as sex, marital status, race/ethnicity, level of education, annual household income, presence of comorbidities, current smoking, current alcohol consumption, level of physical activity, rested sleep, and social support. When entering the old-old stage of life, both male and female older adults transitioned to less severe groups over time.

Declarations

Conflict of interest The authors declare no competing interests.

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