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Changes in Depressive Symptoms and Cognitive Impairment in Older Long-Stay Nursing Home Residents in the USA: A Latent Transition Analysis

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Abstract

Objectives—To longitudinally examine the latent statuses of depressive symptoms and their association with cognitive impairment in older U.S. nursing home (NH) residents.

Method—Using Minimum Data Set 3.0, newly-admitted, long-stay, older NH residents with depression in 2014 were identified ($n = 88,532$). Depressive symptoms (Patient Health Questionnaire-9) and cognitive impairment (Brief Interview of Mental Status) were measured at admission and 90 days. Latent transition analysis was used to examine the prevalence of and the transition between latent statuses of depressive symptoms from admission to 90 days, and the association of cognitive impairment with the statuses at admission.

Results—Four latent statuses of depressive symptoms were identified: ‘Multiple Symptoms’ (prevalence at admission: 17.3%; 90 days: 13.6%), ‘Depressed mood’ (20.0%; 19.5%), ‘Fatigue’ (27.4%; 25.7%), and ‘Minimal Symptoms’ (35.3%; 41.2%). Most residents remained in the same status from admission to 90 days. Compared to residents who were cognitively intact, those with moderate impairment were more likely to be in ‘Multiple Symptoms’ and ‘Fatigue’ statuses; those

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with severe impairment had lower odds of belonging to ‘Multiple Symptoms’, ‘Depressed Mood’, and ‘Fatigue’ statuses.

Conclusion—By addressing the longitudinal changes in the heterogeneous depressive symptoms and the role of cognitive impairment, findings have implications for depression management in older NH residents.

Keywords

Late life depression; Cognitive impairment; Nursing Home; Latent transition analysis

Introduction

Nursing homes in the U.S. provide care to over 1.2 million older adults over the age of 65 years (Centers for Medicare & Medicaid Services, 2015). Depression affects nearly half of this population, making it the most prevalent mental health disorder (Harris-Kojetin et al., 2016). The diagnosis and treatment of depression in older adults could be complicated by its heterogeneous symptom profile (Fried, 2017). In our previous study of older adults with depression at nursing home admission using latent class analysis (LCA), we found four distinct latent subgroups of depressive symptoms, characterized by one subgroup experiencing multiple depressive symptoms, one predominantly depressed mood, one primarily fatigue, and one with minimal presence of any depressive symptoms (Yuan et al., 2020). It is unknown if and how this heterogeneous presentation of depression changes during older adults’ nursing home stay.

Cognitive impairment is one of the most common comorbidities of depression in older adults (Butters et al., 2004; Fiske et al., 2009). In nursing home residents with depression, 47% experience mild to severe cognitive impairment at admission (Ulbricht et al., 2017). The presence of cognitive impairment may further complicate the management of depression in older nursing home residents. Findings on the efficacy of pharmacotherapy for depression with comorbid cognitive deficits have been inconsistent and vary vastly across different types of antidepressants (Koenig et al., 2014; Manning et al., 2015; Morimoto & Alexopoulos, 2013). Cognitive impairment may persist after antidepressant treatment in older adults who achieve depression remission (Bhalla et al., 2009). Therefore, consideration of how cognitive impairment is associated with the longitudinal course of depressive symptoms during nursing home stay could be helpful in tailoring care for older nursing home residents with depression.

Latent transition analysis (LTA), the longitudinal extension of LCA, can be informative in capturing the potential changes in depressive symptoms in nursing home residents with depression over their prolonged stay. LTA can identify the subgroups of depressive symptoms over time, referred to as “statuses”, and transitions between statuses over time. In a nationally representative cohort of older adults over 60 years in China, three statuses of depressive symptoms primarily distinguished by the severity of depressive symptoms and lack of positive feelings were identified through LTA (Ni et al., 2017). In another cohort of older adults over 60 years with major depressive disorder in the Netherlands, two statuses of depressive symptoms that differed mainly by appetite and weight were identified with

LTA (Veltman et al., 2020). To date, no studies have explicitly examined the latent statuses of depressive symptoms and to what extent cognitive impairment would be associated the statuses in older nursing home residents.

In a national cohort of older nursing home residents, we used LTA to examine the latent statuses of depressive symptoms and the impact of cognitive impairment. This longitudinal analysis focused on the early period of nursing home stay from admission to 90 days, a critical timeframe of older adults' adjustment to the changes in living environment, clinical care and social support (Banaszak-Holl et al., 2011; Lee et al., 2002). The objectives were to (1) examine the prevalence of and transition between latent statuses of depressive symptoms from admission to 90 days and (2) estimate the association of cognitive impairment with the latent statuses at admission.

Materials and Methods

The University Institutional Review Board approved this study.

Data

The Minimum Data Set (MDS) 3.0 was used. MDS 3.0 is the mandated assessment for all residents in U.S. Medicaid-/Medicare-certified nursing homes. The assessment is conducted at admission, quarterly, and annually during the nursing home stay to collect data on diagnosis, receipt of treatment, mood and behavioral symptoms, and physical and cognitive functional status (Centers for Medicare & Medicaid Services, 2016).

Sample

We identified residents who were aged 65 years or older, newly admitted to nursing homes between January 1 and December 31, 2014, and long-stay with a length of stay (LOS) of at least 100 days (Centers for Medicare & Medicaid Services, 2016). "Newly-admitted" was defined as having no nursing home visits during a 90-day look-back period prior to the current admission. Relevant MDS 3.0 assessments in 2013 and 2015 were used in determining the look-back period and LOS. Further, we refined the sample to consist of those with both MDS 3.0 assessments at admission and 90 days. Of these residents, those who had a diagnosis of depression at admission and were not comatose at both admission and 90 days were included. Finally, in MDS 3.0, depressive symptoms and cognitive function can be measured either via interview with the residents or evaluation by the staff when residents are unable to participate in the interviews. Of all newly-admitted, long-stay, older adults with a depression diagnosis, 83% were able to self-report PHQ-9 and BIMS at admission; 92% of these self-reporting residents were able to participate for both assessments again at 90 days. We excluded residents who had undergone the staff evaluation for depressive symptoms and cognitive function at either admission or 90 days, because they may differ substantially from those who were able to participate with respect to clinical and/or functional deficits. (Supplemental Figure 1)

Measures

Depressive symptoms—The 9-item Patient Health Questionnaire (PHQ-9; MDS 3.0 Section D) is a feasible and validated tool to measure depressive symptoms with high specificity in older adults in nursing homes (Bélanger et al., 2019; Saliba, DiFilippo, et al., 2012). Residents able to participate in the PHQ-9 interview were asked to report if they have experienced the following depressive symptoms (symptom presence; yes/no) and their frequency (symptom frequency; 0 for never or 1 day, 1 for 2 to 6 days, 2 for 7–11 days, and 3 for 12–14 days) during the two weeks before the given assessment: anhedonia, depressed mood, insomnia/hypersomnia, fatigue, decreased/increased appetite, worthlessness, impaired concentration, psychomotor retardation and suicidal ideation (Saliba, DiFilippo, et al., 2012). In examining the latent statuses of depressive symptoms, we focused on symptom presence to be able to also capture subsyndromal symptoms (Lyness et al., 2007). As such, each PHQ-9 item was included in the latent variable models as a binary indicator defined as the presence or absence of the symptom. Additionally, to describe the severity of depressive symptoms of the sample, total PHQ-9 score (range: 0–27) was calculated by summing the scores from all nine items and categorized into minimal (0–4), mild (5–9), moderate (10–14), and moderately severe/severe (15–27) (Kroenke et al., 2001).

Cognitive Impairment—The Brief Interview for Mental Status (BIMS; MDS 3.0 Section C) was conducted to assess cognitive impairment (Saliba, Buchanan, et al., 2012). BIMS has good criterion validity, as it has been shown to strongly correlate with the Modified Mini-Mental State Exam, an expansion of the Mini Mental State Exam with greater reliability validity (Saliba, Buchanan, et al., 2012). Residents who were able to participate in the BIMS were asked six questions on the repetition of words, temporal orientation and ability to recall. Cognitive impairment is measured by categorizing the total BIMS score (range: 0 to 15) into three levels, using thresholds previously demonstrated to have high sensitivity and specificity in assessing cognitive impairment: cognitively intact (13–15), moderately impaired (8–12), and severely impaired (0–7) (Saliba, Buchanan, et al., 2012). Cognitive impairment level at admission was included in the best-fitted LTA model as a covariate to assess its association with latent statuses of depressive symptoms.

Demographic and clinical characteristics—We included the following demographic and clinical characteristics at admission as covariates in the LTA model: age group, sex, race/ethnicity, receipt of any antidepressant within seven days prior to the assessment, any presence of pain, total number of comorbidities (0–2; >2), and limitations in activities of daily living (ADL). The active diagnoses in MDS 3.0 (Section I) reflect physician-documented diagnoses that have a direct impact on residents' current health status (Centers for Medicare & Medicaid Services, 2016). These diagnoses were used to ascertain residents' comorbidities, including arthritis, diabetes mellitus, hypertension, cancer, cerebrovascular accident/transient ischemic attack/stroke, heart failure, asthma/chronic obstructive pulmonary disease (COPD)/chronic lung disease, non-Alzheimer's dementia, Alzheimer's disease, Parkinson's disease, and anxiety disorder. The comorbid conditions were summed to a total number of comorbidities as a proxy for comorbidity burden. The MDS-ADL Self-Performance Hierarchy (total score: 0–6) was used to measure residents' dependency in performing ADLs in three levels: independence to limited

assistance required (0–2), extensive assistance required (3–4), and dependence to total dependence (5–6) (Morris et al., 1999). We also described residents' marital status, receipt of other psychotropic medications (antipsychotic, antianxiety, and hypnotic medications), psychotic symptoms (hallucinations; delusions), and behavioral symptoms (physical; verbal; other) at admission, but these variables were not included in the LTA model.

Analysis

We described the demographic and clinical characteristics for the entire sample and by cognitive impairment level at admission. We also described the presence of each depressive symptom and the severity of depressive symptoms at both admission and at 90 days. Because trivial differences could be statistically significant given the large sample size, differences of 5% or more were deemed noteworthy.

We followed the framework proposed by Ryoo and colleagues (Ryoo et al., 2018) to build, evaluate, and identify the best-fitting LTA model with covariates:

Step 1: Prior to longitudinal analysis in LTA, LCA would be used to explore and compare latent subgroups of depressive symptoms cross-sectionally at admission and at 90 days. LCA models with 2 to 6 subgroups were fit separately for each time point using the PHQ-9 items as indicators. The first goal of this step was to generate a subset of candidate models with the numbers of subgroups that would best characterize the data at each time point, based on a comprehensive consideration of entropy, fit statistics [Akaike Information Criterion (AIC)/Bayesian Information Criterion (BIC)/sample-size adjusted BIC (aBIC)], model parsimony, and clinical relevance. Higher entropy values suggest greater differentiation between subgroups. Lower fit statistics indicate better model fit. Increasing the number of subgroups may improve the fit statistics but may also result in overlapping subgroups with similar patterns of item-response probabilities, reducing model parsimony. Models with one or more subgroups with prevalence less than 5% were not considered, as small subgroups may represent a subgroup unlikely to be clinically relevant. The second goal was to compare if the interpretations of the subgroups in these potential models change over time, using the item-response probabilities of the depressive symptom indicators.

Step 2: If the candidate LCA models of depressive symptoms at admission and at 90 days are comparable in terms of the number and the interpretation of latent subgroups, LTA models would be fitted to formally examine if the latent statuses of depressive symptoms are similar between admission and 90 days. This is to test the measurement invariance assumption, explicitly, if the item-response probabilities of depressive symptom indicators are consistent over time. Two sets of LTA models were fit, one constraining the item-response probabilities to be identical at admission and 90 days (nested model) and the other allowing them to be freely estimated (full model). Log-likelihood ratio tests (LRT) were used to assess if the nested model fit the data as well as the full model with the same number of statuses. The patterns of item-response probabilities at each time were also compared, since the test statistics for LRT would likely be statistically significant given the large sample size (Collins & Lanza, 2013).

Step 3: Based on a comprehensive consideration of fit statistics, parsimony and clinical relevance, we selected the best-fitting LTA model and assigned descriptive labels to the latent statuses of depressive symptoms based on the item-response probabilities, described the prevalence of the latent statuses, and estimated the transitions between latent statuses from admission to 90 days with transition probabilities.

Step 4: To examine the association between cognitive impairment and latent statuses, we used multinomial logistic regression with latent statuses from the best-fitted LTA model as the dependent variable and cognitive impairment as the primary independent variable, controlling for the aforementioned demographic and clinical covariates. We presented the adjusted odds ratios (aOR) and the 95% confidence intervals (95%CI), representing the odds of membership in a given latent status compared to odds of membership in the reference latent status given cognitive impairment level at admission, adjusted for demographic and clinical covariates.

Analyses were conducted in SAS 9.4 (SAS Institute, Cary NC) and Mplus 8.4 (Muthén & Muthén, 2017).

Results

Sample characteristics

The final sample included 88,532 newly-admitted, long-stay, older residents with a depression diagnosis at nursing home admission. About 94% continued to have a depression diagnosis after 90 days.

As shown in Table 1, 39% of the residents were aged 85 years and over, with half of those having severe cognitive impairment. Nearly 70% were women and 12% were racial/ethnic minorities, both consistent across cognitive impairment levels. Over half of the residents were widowed, with a greater proportion among those with severe cognitive impairment.

Nearly two thirds of all residents had more than two comorbid conditions. The prevalence of diabetes, heart failure, and asthma/COPD/chronic lung disease were lower in those with severe cognitive impairment while the prevalence of non-Alzheimer's dementia and Alzheimer's disease were much higher. The prevalence of other comorbid conditions was similar across cognitive impairment levels. More than 80% of residents required extensive assistance or were dependent to totally dependent in performing ADLs, which did not vary by cognitive impairment level. Any presence of pain was reported in around 60% of residents who were cognitively intact, almost twice as much as for those with severe cognitive impairment. Close to 90% of residents received antidepressants, similar across cognitive impairment levels. Antipsychotics were received by one in every five residents overall, and one in every three residents with severe cognitive impairment. The presence of delusions and behavioral symptoms appeared higher in residents with severe cognitive impairment, although the presence of psychotic and behavioral symptoms was uncommon.

Depressive symptom indicators and severity

As shown in Table 2, the prevalence of each individual depressive symptom was consistent between admission and 90 days with only slight decreases over time. Depressed mood and fatigue were the two most common symptoms. At both times, the proportions of residents with severe cognitive impairment who reported depressed mood, insomnia/hypersomnia, and fatigue were lower than those with intact cognition or moderate impairment.

The distribution of depressive symptom severity was similar over time, with slight improvement after 90 days, and consistent across cognitive impairment levels. The severity of depressive symptoms was minimal in nearly three quarters of all residents.

Latent statuses of depressive symptoms and association with cognitive impairment

Step 1 - Cross-sectional analysis with LCA (Supplemental Table 1): At nursing home admission, the 3- and 4-subgroup LCA were selected as the candidate models. While the entropy favored models with fewer subgroups, the fit statistics suggested the opposite. The prevalence of two subgroups in the 6-subgroup model was too low to be clinically relevant. Two of the subgroups in the 5-subgroup model overlapped. The 2-subgroup LCA did not appear to adequately capture the heterogeneity of depressive symptoms compared to the 3- and 4-subgroup models. Models with 3 and 4 subgroups were also preferable at 90 days, with similar subgroup interpretations.

Step 2 - Test measurement invariance across time (Supplemental Table 2): Since the number and interpretation of the latent subgroups appeared consistent at admission and at 90 days, we formally tested measurement invariance in the item-response probabilities of depressive symptom indicators across time by comparing the full and nested LTA models with 3 and 4 statuses, respectively. The resulting significant LRT p-value suggested the assumption of measurement invariance was violated and that a full model would more adequately fit the data. However, despite the significant test statistics, which may result from the large sample size, patterns of item-response probabilities were consistent between the full and nested models, indicating identical latent statuses at admission and 90 days. We thus concluded that measurement invariance held across time.

Step 3 - Identify the best-fitting LTA model: We compared the 3-status and 4-status LTA models with measurement invariance in the item-response probabilities across time and concluded that the 4-status LTA fit the data best. The entropy and fit statistics both favored the 4-status LTA model. (Supplemental Table 2) Additionally, the 4-status LTA provided a more nuanced description of the distinct statuses of depressive symptoms than the 3-status model.

As shown in Table 3, based on the patterns of item-response probabilities, we assigned qualitative labels to describe the latent statuses: “*Multiple Symptoms*”, “*Depressed Mood*”, “*Fatigue*”, and “*Minimal Symptoms*”. Those in the “*Multiple Symptoms*” status, comprised of about 17% of residents at admission, had high probabilities of experiencing depressed mood, insomnia/hypersomnia, fatigue, and impaired concentration. Those in the “*Depressed Mood*” status, 20% of residents at admission, predominantly reported depressed mood

whereas 27% of residents belonging to the “*Fatigue*” status primarily reported fatigue. The “*Minimal Symptoms*” status, to which 35% of residents likely belonged, was defined by low probabilities of endorsing any depressive symptom indicator. Most residents had a high probability of remaining in the same status over times. The probabilities of residents starting in the “*Multiple Symptoms*”, “*Depressed Mood*”, and “*Fatigue*” statuses transitioning into the “*Minimal Symptoms*” status at 90 days were 0.07, 0.22, and 0.17, respectively.

Step 4 – Association between cognitive impairment and latent statuses of depressive symptoms: Cognitive impairment was added to the LTA model through a multinomial logistic regression model to examine the association between cognitive impairment and the latent statuses of depressive symptoms at admission using the “*Minimal Symptoms*” as the reference status, adjusting for characteristics listed in Table 4. Compared to those who were cognitively intact, residents with moderate cognitive impairment were 28% (aOR: 1.28, 95%CI: 1.20–1.35) and 19% (aOR: 1.19, 95%CI: 1.12–1.26) more likely to be in the “*Multiple Symptoms*” and “*Fatigue*” statuses than in the “*Minimal Symptoms*” status. Those with severe cognitive impairment were significantly less likely to be in the “*Multiple Symptoms*” (aOR: 0.79, 95%CI: 0.74–0.85), “*Depressed Mood*” (aOR: 0.73, 95%CI: 0.67–0.79), and the “*Fatigue*” (aOR: 0.92, 95%CI: 0.85–0.99) statuses.

For the demographic and clinical characteristics adjusted in the model, younger residents, compared to those age 85 years or older, had higher odds of being in the “*Multiple Symptoms*” status (aOR_{65–74}: 1.20, 95%CI: 1.12–1.27; aOR_{75–84}: 1.07, 95%CI: 1.01–1.13) and lower odds of being in the “*Fatigue*” status (aOR_{65–74}: 0.76, 95%CI: 0.71–0.81; aOR_{75–84}: 0.90, 95%CI: 0.86–0.95). Women had significantly higher odds of being in all three statuses (“*Multiple Symptoms*” aOR: 1.13, 95%CI: 1.08–1.20; “*Depressed Mood*” aOR: 1.17, 95%CI: 1.10–1.23; “*Fatigue*” aOR: 1.07; 95%CI: 1.02–1.13). Racial/ethnic minority residents were 28–49% less likely than non-Hispanic white residents to be in any of these three statuses (“*Multiple Symptoms*” aOR: 0.51, 95%CI: 0.47–0.55; “*Depressed Mood*” aOR: 0.72, 95%CI: 0.66–0.78; “*Fatigue*” aOR: 0.55, 95%CI: 0.51–0.59).

Residents who received antidepressants within seven days before admission assessment had lower odds of being in the “*Multiple Symptoms*” status (aOR: 0.87; 95%CI: 0.81–0.93), but not the other two statuses. Residents who experienced any presence of pain were much more likely to belong to all three statuses (“*Multiple Symptoms*” aOR: 2.28, 95%CI: 2.17–2.40; “*Depressed Mood*” aOR: 1.56, 95%CI: 1.47–1.65; “*Fatigue*” aOR: 1.66, 95%CI: 1.58–1.75). Residents with more than two comorbidities were 14% and 12% more likely to belong to the “*Multiple Symptoms*” (aOR: 1.14, 95%CI: 1.09–1.20) and “*Fatigue*” (aOR: 1.12; 95%CI: 1.07–1.18) than to the “*Minimal Symptoms*” statuses, respectively. Those with higher levels of dependency in ADLs were more likely to belong to all three statuses, with higher odds associated with greater dependency level: “*Multiple Symptoms*” (aOR_{Extensive assistance required}: 1.50, 95%CI: 1.41–1.60; aOR_{Dependence to total dependence}: 1.73, 95%CI: 1.59–1.87), “*Depressed Mood*” (aOR_{Extensive assistance required}: 1.08, 95%CI: 1.01–1.16; aOR_{Dependence to total dependence}: 1.11, 95%CI: 1.02–1.21), and “*Fatigue*” (aOR_{Extensive assistance required}: 1.38, 95%CI: 1.30–1.47; aOR_{Dependence to total dependence}: 1.43, 95%CI: 1.33–1.55) than the “*Minimal Symptoms*” status.

Discussion

In older adults with depression diagnoses who are newly-admitted for long-term stays in U.S. nursing homes, our findings suggest four distinct latent statuses of depressive symptoms from admission to 90 days of stay: “*Multiple Symptoms*”, “*Depressed mood*”, “*Fatigue*”, and “*Minimal Symptoms*”. Most residents likely remained in the same latent status during the first 90 days of nursing home stay. Compared to those who were cognitively intact, residents who were moderately impaired had significantly higher odds of belonging to the “*Multiple Symptoms*” and “*Fatigue*” statuses than the “*Minimal Symptoms*” status at admission, while those with severe cognitive impairment were less likely to belong to “*Multiple Symptoms*”, “*Depressed Mood*” as well as the “*Fatigue*” statuses. Aside from these main results, several demographic and clinical characteristics also appeared to be associated with the odds of latent status membership at admission. In particular, characteristics generally indicating poor overall health status, including presence of pain, higher number of comorbidities, and greater dependency in ADLs, were associated with higher odds of being in the “*Multiple Symptoms*”, “*Depressed mood*” and “*Fatigue*” statuses.

To the best of our knowledge, this is the first study to longitudinally examine the latent statuses of depressive symptoms and the association with cognitive impairment in older nursing home residents. Building on our previous cross-sectional research on latent subgroups of depressive symptoms at nursing home admission (Yuan et al., 2020), an important contribution of the current study is that the majority of residents likely remain in the same latent status after 90 days. This finding in older nursing home residents adds to the literature suggesting high stability of latent statuses of depressive symptoms in community-dwelling older adults (Ni et al., 2017; Veltman et al., 2020). However, although most residents in our sample received antidepressants within seven days of admission, probabilities of transitioning to the “*Minimal Symptoms*” status by 90 days were relatively low. Nursing home residents with depression may receive antidepressants with limited evidence for their effectiveness (Boyce et al., 2012) or at sub-therapeutic dosage (Brown et al., 2002), but the question as to why improvement in depressive symptoms was limited in this national cohort of older nursing home residents still remains.

Systematic reviews and meta-analyses of randomized clinical trials of antidepressants for depression treatment in older adults suggest inconsistent evidence on the efficacy of these pharmacotherapies (Kok et al., 2012; Nelson et al., 2008; Tedeschini et al., 2011; Tham et al., 2016). The inconsistency may stem from the heterogeneous symptom profiles of depression, since response to a particular treatment may vary from older adults experiencing one distinctive pattern of symptoms to another (Fried, 2017). Furthermore, deficits in cognitive domains such as executive functioning are associated with poorer antidepressant treatment outcomes (Etkin et al., 2015; Manning et al., 2015; Pimontel et al., 2016). For older adults with both depression and cognitive impairment, a substantial proportion continue to experience cognitive impairment after antidepressant treatment (Devanand et al., 2003; Koenig et al., 2014). Therefore, cognitive impairment should be carefully considered and incorporated into depression treatment plans for older adults.

These prior studies may not be entirely applicable to older nursing home residents who usually have more complex care needs, leading to an evidence gap on how to manage the most prevalent mental health disorder and frequently co-occurring cognitive impairment in this vulnerable population. Alternative non-pharmacological treatment options might be promising. Psychotherapeutic and psychosocial interventions have been demonstrated to be effective in treating depression in older adults (Cuijpers et al., 2006; Jayasekara et al., 2015; Pinquart et al., 2007). For older community-dwelling adults with depression and comorbid cognitive impairment, various psychosocial interventions, including problem solving therapy, interpersonal psychotherapy and problem adaptation therapy, have indicated positive effect in reducing depression (Kiosses et al., 2015; Wilkins et al., 2010). Nonetheless, whether the success from these nonpharmacological treatments would translate to older adults in nursing homes warrant more research (Simning & Simons, 2017).

Our results extend previous research on the subgroups of older residents with distinct patterns of depressive symptoms by indicating that such latent subgroups of residents remain over the first three months of nursing home stay and that cognitive impairment is associated with the odds of latent status membership. Matching pharmacological and non-pharmacological interventions to specific symptom profiles and cognitive impairment level may be helpful for maximizing the effectiveness of the treatment and improving treatment response. We did not have information on the duration or the types of antidepressants or psychotherapies received by residents to further investigate the impact of the specific treatment. Future research should consider addressing this gap to guide the development of long-term treatment plans tailored to older residents' specific care needs in addressing both depression and cognitive impairment.

It is worth noting that although all residents in this study had active depression diagnoses, the majority had a minimal level of depressive symptom severity. The presence of cognitive impairment may influence the evaluation of the depressive symptoms. Older adults with cognitive impairment have worse performance in recall (McDougall, 1998) and/or experience anosognosia so that they may be unaware of their symptoms (Mondragón et al., 2019), which may lead to underestimation of the depressive symptoms during the assessment time period. In this study, those with severe cognitive impairment appeared to have the lowest endorsement of all items except for impaired concentration. Future efforts are warranted to develop instruments to comprehensively capture the depressive symptoms in the presence of cognitive impairment in older adults. This finding could also suggest that the PHQ-9 severity score alone does not completely capture the extent of the depressive symptoms experienced by older nursing home residents and could mask the heterogeneity of depressive symptoms in older adults (Fried, 2017). In the current study, the proportion of residents with minimally severe depressive symptoms increased slightly after 90 days, indicating potential but rather modest improvement. Older residents who may have experienced improvement in a subset of symptoms while worsening in another may end up having similar severity scores over time, when the changes in the symptoms had important clinical implications. Hence, focusing on the presence of one or more clusters of depressive symptoms provides salient aspects in the monitoring of longitudinal changes in specific symptoms and the evaluation of factors associated with these changes.

Findings should be interpreted in light of a few limitations. First, 9%–14% of residents without depression at nursing home admission are diagnosed with depression after 90 days (Hoover et al., 2010; Phillips et al., 2011; Yuan et al., 2019). Residents with incident onset of depression were not included, since their depression may be partially attributed to post-admission factors such as social isolation (Drageset et al., 2015) and represent a population different from those admitted with depression. We used PHQ-9 as it was the instrument available in MDS 3.0. Although this screener has been validated in the nursing home population, there are concerns about its sensitivity in general (Bélanger et al., 2019) and specificity in the presence of cognitive impairment (Boyle et al., 2011). More research should be conducted using other validated instruments, such as the Geriatric Depression Scale (Jongenelis et al., 2005), to thoroughly examine the latent statuses of depressive symptoms in older nursing home residents with depression. Likewise, MDS 3.0 only captures broad information about cognitive impairment. Closer assessment of specific cognition domains, e.g., executive function deficits, may provide additional information in improving depression management for older adults (Alexopoulos, 2019). Further, older residents unable to participate in the interviews to self-report depressive symptoms or cognitive impairment at either time were excluded. It is possible that some of these residents declined the interviews due to more severe depressive symptoms and/or cognitive impairment. Although staff evaluations for depressive symptoms and cognitive impairment are available in MDS 3.0, both use instruments different from the resident interviews, and therefore not directly comparable, limiting our ability to assess the impact of the potential selection bias introduced by this exclusion criteria. Further analysis is warranted to examine the latent statuses of depressive symptoms in these residents, as they may represent a population with more complex care needs. We were not able to obtain the association between cognitive impairment, demographic and clinical characteristics and the transition of depressive symptom statuses from admission to 90 days due to issues in the LTA estimation process. These characteristics may also change over residents' nursing home stay. How these changes are associated with latent statuses of depressive symptoms may have additional implications for the long-term management of depressive symptoms and should be evaluated in future studies.

In conclusion, in older adults with depression newly-admitted to U.S. nursing homes, we identified four distinct latent statuses of depressive symptoms and found that the majority of older residents were likely to remain in the same status from admission to 90 days of stay. Cognitive impairment was shown to be associated with latent statuses at admission. This study provides new information concerning the longitudinal changes in the heterogeneous depressive symptoms and the role of cognitive impairment, which have important implications for tailoring and evaluating the long-term management of depression and cognitive impairment in older nursing home residents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Demographic and clinical characteristics by level of cognitive impairment among newly admitted long-stay nursing home residents with depression diagnosis in 2014

	All n=88,532	Cognitive status at admission		
		<u>Cognitively intact</u> n=34,595	<u>Moderate impairment</u> n=26,875	<u>Severe impairment</u> n=27,062
		(percentage)		
Age, years				
65 – <75	24.9	35.3	22.1	14.3
75 – <85	36.0	35.9	36.2	35.9
≥ 85	39.1	28.8	41.7	49.8
Women	69.6	69.4	67.7	71.9
Racial/ethnic minority ¹	11.9	10.3	12.0	14.0
Marital status				
Never married	9.2	11.2	8.9	7.0
Married	24.5	23.7	24.5	25.6
Widowed	51.7	47.1	52.6	56.8
Divorced/separated	14.5	18.0	14.0	10.6
Comorbidities				
Arthritis	31.5	33.4	31.2	29.3
Diabetes mellitus	34.0	39.3	33.5	27.6
Hypertension	79.8	80.6	80.5	78.1
Cancer	6.7	7.8	6.6	5.4
Cerebrovascular accident/Transient ischemic attack/ Stroke	15.1	15.2	15.7	14.3
Heart failure	20.8	24.2	21.1	16.2
Asthma/Chronic obstructive pulmonary disease/Chronic lung disease	24.5	30.0	24.1	17.8
Non-Alzheimer's dementia	40.1	21.8	43.0	60.6
Alzheimer's disease	11.6	3.9	10.6	22.5
Parkinson's disease	7.1	7.3	7.6	6.3
Anxiety disorder	35.4	36.7	34.6	34.5
Number of comorbidities > 2	64.5	62.7	64.9	66.5
Activities of daily living dependency status				
Independence to limited assistance required	18.7	19.4	19.0	17.4
Extensive assistance required	62.0	61.3	62.1	63.0
Dependence to total dependence	19.3	19.3	19.0	19.7
Any presence of pain	47.1	59.9	46.4	31.0
Psychotropic medications				
Antipsychotic	22.2	16.8	21.4	29.9
Antianxiety	25.5	26.8	24.7	24.7
Antidepressant	88.7	88.7	88.5	88.9
Hypnotic	6.3	8.5	5.8	4.1

	All	Cognitive status at admission		
		<u>Cognitively intact</u>	<u>Moderate impairment</u>	<u>Severe impairment</u>
	n=88,532	n=34,595	n=26,875	n=27,062
	(percentage)			
Psychotic and behavioral symptoms				
Hallucination	1.6	1.0	1.7	2.2
Delusion	4.3	2.0	4.3	7.2
Physical behavioral symptoms	3.3	0.9	2.5	7.1
Verbal behavioral symptoms	5.9	3.2	5.6	9.7
Other behavioral symptoms	5.0	2.1	4.8	8.9

Notes:

¹ Includes all residents who were not non-Hispanic White.

Table 2.

Indicators and severity of depressive symptoms by cognitive impairment at admission among newly admitted long-stay nursing home residents with depression diagnosis in 2014

	All	Cognitive impairment at admission		
		<u>Intact</u>	<u>Moderate</u>	<u>Severe</u>
	n=88,532	n=34,595	n=26,875	n=27,062
	(percentage)			
<u>At admission</u>				
Depressive symptoms				
Anhedonia	14.4	14.6	15.7	13.1
Depressed mood	39.1	41.4	41.3	33.8
Insomnia/hypersomnia	25.2	30.0	26.1	18.3
Fatigue	43.8	46.1	46.6	38.2
Decreased/increased appetite	18.1	19.7	19.1	15.1
Worthlessness	13.0	13.6	13.9	11.2
Impaired concentration	18.6	14.6	20.3	22.0
Psychomotor retardation/agitation	11.1	10.8	12.1	10.7
Suicide ideation	2.8	3.1	3.2	2.1
Severity of depressive symptoms¹				
Minimal	74.3	72.3	72.4	78.7
Mild	17.9	18.9	19.2	15.3
Moderate	5.7	6.3	6.2	4.5
Moderately severe/severe	2.2	2.6	2.3	1.5
<u>At 90 days</u>				
Depressive symptoms				
Anhedonia	13.1	13.4	14.0	11.7
Depressed mood	35.0	38.3	36.3	29.6
Insomnia/hypersomnia	21.5	25.4	22.4	15.5
Fatigue	39.0	41.1	40.9	34.4
Decreased/increased appetite	15.1	16.3	15.8	13.0
Worthlessness	10.9	11.4	11.7	9.4
Impaired concentration	16.5	12.8	17.8	19.9
Psychomotor retardation/agitation	8.8	8.7	9.3	8.7
Suicide ideation	1.9	2.0	2.1	1.5
Severity of depressive symptoms¹				
Minimal	78.2	76.7	76.8	81.6
Mild	15.5	16.4	16.4	13.4
Moderate	4.9	5.3	5.3	3.9
Moderately severe/severe	1.5	1.6	1.5	1.2

Notes:

¹Severity of depressive symptoms was based on total PHQ-9 score (range: 0–27): minimal (0–4), mild (5–9), moderate (10–14), moderately severe/severe (15–27).

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Table 3.

Latent status prevalence, item-response probability and transition probability between statuses for 4-status latent transition analysis model at admission and 90-day stay in newly admitted long-stay nursing home residents with depression diagnosis in 2014

	Latent status			
	Multiple Symptoms	Depressed Mood	Fatigue	Minimal symptoms
Item-response probabilities ¹				
Anhedonia	0.47	0.15	0.11	0.01
Depressed mood	<u>0.88</u>	<u>0.85</u>	0.18	0.05
Insomnia/hypersomnia	<u>0.60</u>	0.24	0.31	0.02
Fatigue	<u>0.89</u>	0.46	<u>0.64</u>	0.04
Decreased/increased appetite	0.46	0.15	0.23	0.02
Worthlessness	0.46	0.18	0.04	0.01
Impaired concentration	<u>0.53</u>	0.14	0.22	0.02
Psychomotor retardation/agitation	0.34	0.07	0.10	0.01
Suicide ideation	0.11	0.03	0.00	0.00
Latent status prevalence				
At admission	17.3%	20.0%	27.4%	35.3%
At 90 days	13.6%	19.5%	25.7%	41.2%
Transition probabilities ²				
Multiple symptoms	0.66	0.09	0.19	0.07
Depressed mood	0.00	0.78	0.00	0.22
Fatigue	0.05	0.00	0.78	0.17
Minimal symptoms	0.02	0.07	0.03	0.89

Notes:

¹Because measurement invariance in item-response probabilities was assumed across time, the item-response probabilities listed in here applied to both the latent statuses at admission and at 90 days. Given the consistency in the number of statuses and the patterns of the item-response probabilities of depressive symptom indicators at admission and 90 days, full measurement invariance of item-response probabilities was imposed across time. Item-response probabilities > 0.5 were bolded and underlined to help with the interpretation that residents belonging to this status would have higher probability of experiencing the respective depressive symptom.

²Probabilities of transitioning to a given status at 90 days (column) conditional a given status at admission (row).

Table 4.

Associations between cognitive impairment and latent status of depressive symptoms at admission, adjusting for demographic and clinical covariates

Covariates ¹	Latent status at admission (ref: Minimal Symptoms)					
	Multiple Symptoms		Depressed Mood		Fatigue	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
Cognitive impairment (ref: Intact cognition)						
Moderate	1.28	(1.20–1.35)	1.04	(0.98–1.11)	1.19	(1.12–1.26)
Severe	0.79	(0.74–0.85)	0.73	(0.67–0.79)	0.92	(0.85–0.99)
Age group, years (ref: 85 or above)						
65 – 74	1.20	(1.12–1.27)	1.03	(0.96–1.10)	0.76	(0.71–0.81)
75 – 84	1.07	(1.01–1.13)	1.02	(0.96–1.08)	0.90	(0.86–0.95)
Women	1.13	(1.08–1.20)	1.17	(1.10–1.23)	1.07	(1.02–1.13)
Racial/ethnic minorities	0.51	(0.47–0.55)	0.72	(0.66–0.78)	0.55	(0.51–0.59)
Receipt of antidepressant	0.87	(0.81–0.93)	0.96	(0.88–1.03)	0.97	(0.90–1.04)
Any presence of pain	2.28	(2.17–2.40)	1.56	(1.47–1.65)	1.66	(1.58–1.75)
Number of comorbidities>2	1.14	(1.09–1.20)	1.04	(0.99–1.10)	1.12	(1.07–1.18)
ADL impairment (ref: Independence to limited assistance)						
Extensive assistance required	1.50	(1.41–1.60)	1.08	(1.01–1.16)	1.38	(1.30–1.47)
Dependence to total dependence	1.73	(1.59–1.87)	1.11	(1.02–1.21)	1.43	(1.33–1.55)

Notes:

¹ Multinomial logistic regression was used to examine the association between latent statuses at admission (reference status: “Minimal Symptoms”) and cognitive impairment, adjusting for the covariates listed in Table 4.