Research Square

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Multidimensional Health Profiles and Cognitive Outcomes Among Adults with Stroke: A Longitudinal Study Using CHARLS

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Research Article

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Abstract

Background

Stroke survivors often experience co-occurring functional, psychological, sleep, and sensory problems, but whether multidimensional health profiles are associated with cognitive performance and longitudinal cognitive change remains unclear. We aimed to identify multidimensional health profiles among adults with stroke and examine their associations with longitudinal cognitive outcomes.

Methods

We included 289 participants with self-reported physician-diagnosed stroke from the 2011 baseline of the China Health and Retirement Longitudinal Study (CHARLS), of whom 250 contributed data to the longitudinal cognitive analyses. Latent class analysis was used to identify multidimensional health profiles based on activities of daily living disability, instrumental activities of daily living disability, depressive symptoms, abnormal sleep duration, visual impairment, and hearing impairment. Global cognition, immediate recall, and delayed recall were assessed in 2011, 2013, 2015, and 2020. Linear mixed-effects models were used to examine differences in cognitive level and annual cognitive change across profiles, with adjustment for sociodemographic characteristics, health behaviors, and chronic conditions.

Results

Two profiles were identified: a low-burden profile (38.1%) and a high-burden profile (61.9%). The high-burden profile was characterized mainly by higher probabilities of activities of daily living and instrumental activities of daily living disability, together with depressive symptoms and abnormal sleep duration. After covariate adjustment, the high-burden profile was associated with lower global cognition ($\beta = -1.19$, 95% CI − 1.88 to − 0.50; $P < 0.001$) and immediate recall ($\beta = -0.54$, 95% CI − 0.87 to − 0.21; $P = 0.001$), whereas the difference in delayed recall was not statistically significant. Profile-by-time interactions were not significant for any cognitive outcome. In sensitivity analyses additionally adjusting for baseline cognitive performance, the high-burden profile remained associated with subsequent immediate and delayed recall, whereas the association with global cognition was attenuated.

Conclusions

Multidimensional health profiles were associated with cognitive performance among adults with stroke. The high-burden profile was associated with poorer cognition but not with a significantly different rate of longitudinal cognitive change.

Background

Poststroke cognitive impairment is a common and clinically important long-term consequence of stroke and is closely associated with functional limitations and reduced quality of life [1]. Cognitive outcomes after stroke vary considerably across individuals. Previous studies have identified age, educational attainment, stroke severity, and diabetes as factors associated with the risk of poststroke dementia [2]. However, these demographic and disease-related factors capture only selected aspects of poststroke health status, whereas the cognitive relevance of co-occurring functional, psychological, sleep, and sensory problems remains less well understood.

Beyond cognitive problems, stroke survivors often experience functional limitations, depressive symptoms, sleep disturbances, and other health problems, which tend to co-occur rather than appear in isolation [3]. Much of the existing literature has examined these problems separately in relation to cognitive outcomes [4–7]. Although this approach is useful, it does not fully describe how different impairments coexist within the same individual or the overall burden represented by these patterns. Emerging evidence suggests that stroke survivors are a heterogeneous population. Distinct latent subgroups defined by multimorbidity have been identified and shown to differ in clinical outcomes [8], and poststroke symptoms such as depression, anxiety, fatigue, and sleep disturbance may cluster into distinct symptom-burden profiles [9]. These findings support a person-centered approach to identifying patterns of co-occurring health problems among stroke survivors. Such profiles may provide a more integrated representation of poststroke health status than analyses of individual conditions alone. Composite measures reflecting broader health status have also been associated with poststroke cognitive outcomes. Physical frailty and brain frailty were associated with cognitive impairment 18 months after ischemic stroke or transient ischemic attack [10], and baseline frailty was also associated with cognitive impairment at 3 months after stroke, although the association was attenuated after adjustment for baseline cognitive performance [11]. Nevertheless, it remains unclear whether these associations mainly reflect differences in cognitive performance, or whether they also relate to cognitive change over time.

Accordingly, using longitudinal data from the China Health and Retirement Longitudinal Study (CHARLS), we applied latent class analysis to identify multidimensional health profiles among participants with stroke. We then examined whether these profiles were associated with differences in global cognition, immediate recall, and delayed recall, as well as with their longitudinal rates of change. By distinguishing differences in cognitive level from differences in subsequent cognitive change, we sought to clarify how baseline multidimensional health status relates to longitudinal cognitive outcomes after stroke.

Methods

Setting and Sample

CHARLS is an ongoing, nationally representative longitudinal study of middle-aged and older adults in China [12]. We identified 413 participants who reported a physician diagnosis of stroke at the 2011 baseline survey. After excluding 124 participants with missing data on latent class indicators or covariates, 289 participants were included in the latent class analysis. A further 39 participants with no available global cognition measurements across all study waves were excluded, leaving 250 participants for the longitudinal cognitive analyses. Cognitive outcomes were assessed in 2011, 2013, 2015, and 2020. Because the content and administration of some cognitive tests changed substantially in 2018, cognitive data from that wave were excluded to reduce potential measurement-related inconsistencies in longitudinal comparisons [13]. Participants with intermittent missing cognitive data during follow-up were retained if they had at least one available global cognition measurement in any study wave. The study flow is shown in Fig. 1, and baseline characteristics of included and excluded participants are presented in the supplementary material (Supplementary Table S1).

Latent Class Indicators

All indicators used in the latent class analysis were derived from the 2011 baseline survey of CHARLS. Six indicators were included: activities of daily living (ADL) disability, instrumental activities of daily living (IADL) disability, depressive symptoms, abnormal sleep duration, visual impairment, and hearing impairment. The six indicators were selected to represent functional, psychological, sleep, and sensory domains that are commonly affected after stroke and were consistently assessed at the CHARLS baseline. All indicators were coded as binary variables. ADL disability was assessed using six activities: dressing, bathing, eating, getting in or out of bed, toileting, and continence. Participants who reported difficulty with, required assistance with, or were unable to perform any of these activities were classified as having ADL disability. IADL disability was assessed using five activities: doing household chores, preparing meals, shopping for groceries, managing money, and taking medications, using the same classification criteria. Depressive symptoms were assessed using the 10-item Center for Epidemiologic Studies Depression Scale (CES-D-10). Items were scored according to symptom frequency, with positively worded items reverse-scored, and were summed to obtain a total score. Participants with a CES-D-10 score ≥ 10 were classified as having depressive symptoms [14]. Abnormal sleep duration was assessed based on self-reported actual nighttime sleep duration during the past month. Participants reporting < 6 or > 8 hours of sleep per night were classified as having abnormal sleep duration [15]. Visual impairment was determined from self-reported blindness and ratings of distance and near vision. Participants were classified as having visual impairment if they reported blindness or rated either their distance or near vision as fair or poor. Hearing impairment was based on self-rated hearing, with participants reporting fair or poor hearing classified as having hearing impairment.

Cognitive Assessment

Cognitive function was assessed at each study wave using the CHARLS cognitive module. Three cognitive outcomes were examined: global cognition, immediate recall, and delayed recall. Immediate and delayed recall were assessed using a 10-word recall task. After the interviewer read aloud a list of 10 words, participants were asked to recall as many words as possible immediately and again after completing several intervening survey items. Scores for immediate and delayed recall were based on the number of correctly recalled words. For the 2020 wave, the score from the first immediate-recall trial was used [13]. Both scores ranged from 0 to 10, with higher scores indicating better memory performance. Global cognition was measured using a composite cognitive score comprising episodic memory, orientation and calculation, and visuospatial ability. Episodic memory was calculated as the mean of the immediate- and delayed-recall scores. Orientation was assessed by correctly identifying the year, month, date, day of the week, and season, and calculation was assessed using the serial 7 subtraction task. Visuospatial ability was assessed using a figure-copying task. The global cognition score ranged from 0 to 21, with higher scores indicating better cognitive performance [16].

Covariates

Baseline covariates included sociodemographic characteristics, health behaviors, and physician-diagnosed chronic conditions. Sociodemographic characteristics included age, sex, marital status, and educational attainment. Marital status was categorized as married/partnered or separated/divorced/widowed/never married. Educational attainment was categorized as no formal education/illiterate, primary school or below, middle school, and high school or above. Health behaviors included smoking and alcohol consumption, both of which were entered as binary variables. Smoking history was defined based on any history of chewing tobacco, a pipe, hand-rolled cigarettes, or cigarettes/cigars. Alcohol consumption was defined as drinking more than once per month either during the past year or previously. Chronic conditions included hypertension, dyslipidemia, diabetes/hyperglycemia, and heart disease. Each condition was based on self-reported physician diagnosis and was included in the analyses as a binary variable.

Statistical Analysis

Statistical analyses were conducted using R version 4.4.2. Latent class analysis (LCA) was performed using six binary indicators to identify baseline multidimensional health profiles among participants with stroke: ADL disability, IADL disability, depressive symptoms, abnormal sleep duration, visual impairment, and hearing impairment. Models with one to five classes were compared using the log-likelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC), entropy, and smallest-class proportion. Class enumeration was guided primarily by BIC, together with model parsimony, class size, and clinical interpretability [17]. Each participant was assigned to the latent profile with the highest posterior probability of membership. Classification quality of the final model was evaluated using the average posterior probability (AvePP) and odds of correct classification (OCC), with AvePP ≥ 0.80 indicating acceptable classification quality [18].

Linear mixed-effects models were used to examine the associations between baseline multidimensional health profiles and longitudinal cognitive outcomes. Global cognition, immediate recall, and delayed recall were modeled separately. Time was represented as the actual number of years since the 2011 baseline assessment. Each model included latent profile, time, and a profile-by-time interaction term as fixed effects, together with a participant-specific random intercept to account for within-participant correlation across repeated cognitive assessments. The main effect of latent profile represented the adjusted difference in baseline cognitive level between profiles, whereas the profile-by-time interaction represented the between-profile difference in the annual rate of cognitive change. All models were adjusted for baseline age, sex, marital status, educational attainment, smoking, alcohol consumption, hypertension, dyslipidemia, diabetes/hyperglycemia, and heart disease, with the low-burden profile used as the reference group.

To assess the robustness of the main findings, we conducted several sensitivity analyses. First, the longitudinal models were restricted to the 2011, 2013, and 2015 waves to assess whether the findings were robust to the exclusion of later waves in which cognitive test administration had changed. Second, in models restricted to cognitive outcomes measured at follow-up waves, we further adjusted for the corresponding 2011 baseline cognitive performance to examine whether the associations between latent profile and subsequent cognitive performance persisted after accounting for baseline cognition. Third, the six latent class indicators were summed to derive a cumulative impairment count ranging from 0 to 6, which was entered into the linear mixed-effects models as a continuous variable; the analysis was then repeated using a 0 to 5 count after excluding visual impairment. Fourth, all six latent class indicators were entered simultaneously into the models to assess their independent associations with cognitive outcomes. Finally, we compared random-intercept models with models including both random intercepts and random slopes for time to evaluate the robustness of the main findings to the specification of the random-effects structure.

Results

Identification of multidimensional health profiles

Among the 289 participants with complete data on the latent class indicators and covariates, models with one to five latent classes were fitted and compared (Supplementary Table S2). The two-class model had the lowest BIC among the candidate models (BIC = 2169.98), with an entropy of 0.680. Considering BIC, model parsimony, class size, and clinical interpretability, the two-class solution was selected as the final model. Classification quality was acceptable, with AvePP values of 0.884 and 0.932 and OCC values of 12.40 and 8.42 for the low- and high-burden profiles, respectively.

The LCA identified two multidimensional health profiles, with their conditional probabilities shown in Figure 2. The high-burden profile comprised 61.9% of the sample, whereas the low-burden profile comprised 38.1%. The two profiles were distinguished most clearly by ADL and IADL disability, with additional differences in depressive symptoms and abnormal sleep duration. Specifically, the conditional

probabilities of ADL disability were 76.0% and 6.4% in the high- and low-burden profiles, respectively, and those of IADL disability were 88.3% and 3.6%. In contrast, visual impairment was common in both profiles (87.2% vs. 80.9%), with relatively little between-profile separation.

Figure 2. Conditional probabilities of latent class indicators according to multidimensional health profiles.

Notes: Conditional probabilities for the low-burden versus high-burden profiles were ADL disability, 6.4% vs 76.0%; IADL disability, 3.6% vs 88.3%; depressive symptoms, 40.0% vs 72.1%; abnormal sleep duration, 31.8% vs 58.7%; visual impairment, 80.9% vs 87.2%; and hearing impairment, 59.1% vs 71.5%. Percentages in parentheses in the legend indicate class proportions. ADL, activities of daily living; IADL, instrumental activities of daily living.

Baseline characteristics of the two profiles are presented in Table 1. Participants in the high-burden profile were slightly older on average than those in the low-burden profile, although the difference was not statistically significant. No significant between-profile differences were observed in sex, marital status, smoking history, alcohol consumption, or major chronic conditions. Educational attainment differed significantly between the two profiles, with a higher proportion of no formal education/illiterate participants in the high-burden profile. With respect to cognitive performance, participants in the high-burden profile had lower baseline scores for global cognition, immediate recall, and delayed recall. The distributions of the latent class indicators were generally consistent with the profiles shown in Figure 2.

Table 1. Baseline characteristics of participants according to multidimensional health profile.

Characteristics	Low-burden profile (n = 110)	High-burden profile (n = 179)	*P* value
Sociodemographic characteristics			
Age, years	62.34 (10.40)	64.59 (9.11)	0.055
Male sex	57 (51.8%)	88 (49.2%)	0.751
Married/partnered	98 (89.1%)	147 (82.1%)	0.152
Educational attainment			0.019
No formal education/illiterate	23 (20.9%)	61 (34.1%)	
Primary school	51 (46.4%)	73 (40.8%)	
Middle school	18 (16.4%)	32 (17.9%)	
High school or above	18 (16.4%)	13 (7.3%)	
Health behaviors and chronic conditions			
Smoking history	45 (40.9%)	79 (44.1%)	0.678
Alcohol consumption	38 (34.5%)	62 (34.6%)	1.000
Hypertension	61 (55.5%)	118 (65.9%)	0.098
Diabetes/hyperglycemia	23 (20.9%)	26 (14.5%)	0.214
Dyslipidemia	34 (30.9%)	54 (30.2%)	0.999
Heart disease	24 (21.8%)	47 (26.3%)	0.477
Baseline cognitive performance			
Baseline global cognition	11.79 (3.15), n = 94	10.00 (3.64), n = 121	<0.001
Baseline immediate recall	4.23 (1.63), n = 99	3.38 (1.65), n = 150	<0.001
Baseline delayed recall	3.15 (1.90), n = 98	2.45 (1.80), n = 150	0.004
Latent class indicators			
ADL disability	7 (6.4%)	136 (76.0%)	—
IADL disability	4 (3.6%)	158 (88.3%)	—
Depressive symptoms	44 (40.0%)	129 (72.1%)	—
Abnormal sleep duration	35 (31.8%)	105 (58.7%)	—
Visual impairment	89 (80.9%)	156 (87.2%)	—
Hearing impairment	65 (59.1%)	128 (71.5%)	—

Notes: Continuous variables are presented as mean (SD), and categorical variables as n (%), unless otherwise indicated. P values were calculated using Student's two-sample t test for continuous variables and Pearson's chi-square test for categorical variables. For cognitive measures, the effective sample size is reported because of missing values.

Latent Profiles and Longitudinal Cognitive Trajectories

After adjustment for covariates, participants in the high-burden profile had significantly lower baseline scores for global cognition and immediate recall than those in the low-burden profile, whereas the between-profile difference in delayed recall was not statistically significant, as shown in Table 2. None of the profile-by-time interaction terms were statistically significant for the three cognitive outcomes, indicating no evidence of significant between-profile differences in the long-term rates of cognitive change. These findings were also reflected in the adjusted predicted trajectories shown in Figure 3.

Table 2. Associations of multidimensional health profiles with longitudinal cognitive outcomes

Outcome	Effect	β	95% CI	P value
Global cognition	High-burden profile	-1.19	-1.88 to -0.50	<0.001
	Time per year	-0.11	-0.20 to -0.02	0.013
	High-burden profile × time	-0.03	-0.15 to 0.10	0.656
Immediate recall	High-burden profile	-0.54	-0.87 to -0.21	0.001
	Time per year	-0.15	-0.20 to -0.10	<0.001
	High-burden profile × time	0.02	-0.04 to 0.09	0.509
Delayed recall	High-burden profile	-0.32	-0.73 to 0.09	0.125
	Time per year	0.08	0.02 to 0.14	0.013
	High-burden profile × time	-0.04	-0.12 to 0.04	0.287

Note: β coefficients were estimated from linear mixed-effects models with participant-specific random intercepts. Models were adjusted for baseline age, sex, marital status, educational attainment, smoking, alcohol consumption, hypertension, dyslipidemia, diabetes/hyperglycemia, and heart disease. Time was modeled continuously in years since the 2011 baseline. The coefficient for the high-burden profile represents the adjusted between-profile difference at baseline, and the profile-by-time interaction represents the between-profile difference in the annual rate of cognitive change. The low-burden profile was the reference group. N = 250; observations: global cognition, 632; immediate recall, 730; delayed recall, 707.

Figure 3. Adjusted predicted trajectories of cognitive outcomes according to multidimensional health profile.

Notes: Lines represent covariate-adjusted predicted values from the linear mixed-effects models, and shaded areas represent 95% confidence intervals. Predictions are shown in the observed study years (2011, 2013, 2015, and 2020).

Sensitivity analyses

Overall, the sensitivity analyses yielded findings broadly consistent with the primary analyses. When the longitudinal models were restricted to the 2011, 2013, and 2015 waves, the high-burden profile remained significantly associated with lower global cognition and immediate recall, whereas the association with delayed recall was directionally consistent but did not reach statistical significance. None of the profile-by-time interaction terms was statistically significant across the three cognitive outcomes (Supplementary Table S3). After further adjustment for 2011 baseline cognitive performance, the high-burden profile remained significantly associated with subsequent immediate and delayed recall, whereas the association with global cognition was attenuated and no longer statistically significant (Supplementary Table S4). When the six impairment indicators were summed as a cumulative impairment count, or recalculated after excluding visual impairment, a higher impairment count remained significantly associated with lower global cognition and immediate recall, whereas the association with delayed recall was directionally consistent but did not reach statistical significance. None of the burden-by-time interaction terms was statistically significant across the three cognitive outcomes (Supplementary Table S5). In models including all six individual indicators simultaneously, only IADL disability remained independently associated with all three cognitive outcomes (Supplementary Table S6), suggesting that IADL disability may be one of the profile components more closely associated with cognitive differences. In the model with global cognition as the outcome, adding a participant-specific random slope for time did not materially improve model fit, and the main estimates remained essentially unchanged (Supplementary Table S7).

Discussion

Using longitudinal data from CHARLS, we identified two multidimensional health profiles among participants with stroke: a low-burden profile and a high-burden profile. The high-burden profile was distinguished mainly by higher levels of ADL disability and IADL disability, accompanied by more depressive symptoms and abnormal sleep duration. After adjustment for relevant covariates, participants in this profile showed lower global cognition and immediate recall, whereas the difference in delayed recall was not statistically significant. We found no evidence of statistically significant profile-by-time interactions for any of the three cognitive outcomes. These findings indicate between-profile differences in cognitive performance, but not in the rate of cognitive change over time.

The identification of two latent profiles indicates heterogeneity in the co-occurrence of functional, psychological, sleep, and sensory problems among stroke survivors. This pattern is in line with evidence that poststroke health problems often co-occur in recognizable profiles, rather than appearing as isolated conditions [8, 9]. In the present sample, the high-burden profile was marked especially by ADL

disability and IADL disability, with higher probabilities of depressive symptoms and abnormal sleep duration. A person-centered LCA approach therefore captures how these problems co-occur within individuals rather than treating them as separate conditions. Its value here lies mainly in characterizing patterns of health burden, not in defining a clinical phenotyping tool.

For cognitive outcomes, the high-burden profile was associated with lower global cognition and immediate recall after covariate adjustment, while the delayed recall difference was not statistically significant. These findings are broadly consistent with previous longitudinal evidence. In the Survey of Health, Ageing and Retirement in Europe (SHARE), latent class analysis identified distinct multimorbidity patterns, and the group with the highest comorbidity burden had the poorest cognitive function [19]. Evidence from three large longitudinal cohorts also showed that multimorbidity was associated with a higher risk of memory-related disorders, with functional and sensory impairments identified as important mediators [20]. Although multimorbidity, frailty, and the present multidimensional health profiles are not identical constructs, these findings suggest that greater overall health burden tends to coexist with poorer cognitive performance. After additional adjustment for baseline cognitive performance in 2011, the association with global cognition was attenuated and no longer statistically significant, whereas the associations with immediate recall and delayed recall persisted. A similar pattern was observed in a multicenter prospective study of stroke patients, in which baseline frailty was associated with cognitive impairment at 3 months, but the association was attenuated and no longer statistically significant after adjustment for baseline Mini-Mental State Examination (MMSE) score [11]. The persistence of the associations with immediate and delayed recall after adjustment for baseline cognition suggests that baseline cognitive differences do not fully account for these memory findings, whereas the association with global cognition was more sensitive to such adjustment. We found no evidence of significant differences between the two multidimensional health profiles in the long-term rates of change in global cognition, immediate recall, or delayed recall. This finding should not be interpreted as evidence that the cognitive trajectories were identical. The absence of significant profile-by-time interactions instead indicates that the observed between-profile differences in cognitive level were not accompanied by detectable differences in subsequent rates of change. A longitudinal analysis of SHARE data similarly found that the group with the highest comorbidity burden had the poorest cognitive function, whereas the osteoarthrosis pattern showed the fastest decline in immediate and delayed episodic memory [19]. In stroke research, a pooled analysis of 14 population-based cohorts found that incident stroke was associated with acute declines in global cognition and several cognitive domains, but accelerated poststroke decline was not observed in the memory domain [21]. By contrast, a longitudinal study using the English Longitudinal Study of Ageing (ELSA) and the Health and Retirement Study (HRS) identified six-year multimorbidity trajectories and reported faster memory decline in the moderate-increasing and rapid-increasing groups, with the rapid-increasing group also showing steeper decline in global cognition and other domains [22]. This difference may partly reflect how exposure was defined. Studies of increasing multimorbidity burden capture changes in health status over time, whereas our profiles were based on a single baseline assessment. A profile derived from a single baseline assessment may

therefore be more strongly associated with differences in cognitive level than with subsequent cognitive change. Their relationship with long-term cognitive trajectories remains to be clarified in larger studies.

Several factors may help explain why the high-burden profile showed poorer cognitive performance. ADL disability and IADL disability were the most prominent distinguishing features of the two profiles, and IADL disability was the only indicator that remained significantly associated with all three cognitive outcomes when the six indicators were entered simultaneously into the model. IADLs, such as shopping, managing finances, and taking medications, require memory, attention, planning, and executive function. This finding may partly account for the stronger association of the high-burden profile with cognitive level than with subsequent cognitive change. A prospective multicenter study of stroke survivors found that cognitive performance was associated with subsequent change in IADL, and that combined assessment of cognition and physical performance predicted IADL change better than either measure alone [23]. Another longitudinal study across four population-based cohorts showed that newly emerging IADL impairment predicted faster subsequent decline in global cognition, whereas baseline IADL impairment was not significantly associated with subsequent cognitive slope [24]. These longitudinal findings suggest that IADL disability and cognition may have a bidirectional relationship, although the present study did not directly test mediation or directionality. The association may also extend beyond functional disability, because the high-burden profile combined functional limitations with psychological, sleep, and sensory problems. A systematic review and meta-analysis found that lower intrinsic capacity, defined as the composite of an individual's physical and mental capacities, was associated with subsequent impairment in both basic activities of daily living (BADL) and IADL [25]. Educational attainment and cognitive reserve may provide another partial explanation. A systematic review in the stroke field reported that cognitive reserve-related factors, including higher educational attainment and bilingualism, were associated with better poststroke cognitive and functional outcomes [26]. In our study, however, the main associations persisted after adjustment for education, suggesting that educational differences alone may not fully explain the cognitive differences between the two profiles.

This study has several strengths. Using data from the nationally representative CHARLS cohort, we characterized multidimensional health profiles across functional, psychological, sleep, and sensory domains. This approach allowed us to describe health heterogeneity at the person level while preserving the co-occurrence of multiple poststroke problems. Repeated cognitive assessments further allowed comparison of both cognitive level and rate of cognitive change across profiles. The main findings were also examined through several sensitivity analyses. Limitations should be acknowledged. First, stroke was identified based on participants' self-report of a physician diagnosis, and detailed clinical information on stroke subtype, severity, lesion location, and neuroimaging findings were unavailable. This limited our ability to adjust for these stroke-specific characteristics or conduct clinically stratified analyses. Second, the latent class indicators were largely based on self-reported or self-rated measures, which may be subject to reporting bias and correlated measurement error. Depressive symptoms may further affect perceptions of functional and health status and thereby influence self-reported assessments. Third, the multidimensional health profiles were derived only from baseline indicators, so

profile transitions over time could not be evaluated. Finally, the relatively small sample size may have limited statistical power, especially for detecting profile-by-time interaction effects. The findings on cognitive change should therefore be tested in larger samples with richer clinical and longitudinal health information.

Conclusions

Two multidimensional health profiles were identified among participants with stroke in CHARLS. The high-burden profile was characterized mainly by higher ADL disability and IADL disability, together with more depressive symptoms and abnormal sleep duration, and was associated with poorer cognitive performance. We found no evidence of a different long-term rate of cognitive change between the two profiles. Further studies are needed to clarify how changes in multidimensional health status over time relate to cognitive trajectories after stroke.

Abbreviations

ADL
Activities of daily living
IADL
Instrumental activities of daily living
CES-D-10
10-item Center for Epidemiologic Studies Depression Scale
CHARLS
China Health and Retirement Longitudinal Study
LCA
Latent class analysis
AIC
Akaike information criterion
BIC
Bayesian information criterion
AvePP
Average posterior probability
OCC
Odds of correct classification
CI
Confidence interval

Declarations

Ethics approval and consent to participate

The China Health and Retirement Longitudinal Study (CHARLS) was approved by the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015), and written informed consent was obtained from all participants in the original survey. The study was conducted in accordance with the Declaration of Helsinki. The present study was a secondary analysis of publicly available, de-identified CHARLS data and involved no additional contact with participants or collection of identifiable personal information.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Noteβ

coefficients were estimated from linear mixed-effects models with participant-specific random intercepts. Models were adjusted for baseline age, sex, marital status, educational attainment, smoking, alcohol consumption, hypertension, dyslipidemia, diabetes/hyperglycemia, and heart disease. Time was modeled continuously in years since the 2011 baseline. The coefficient for the high-burden profile represents the adjusted between-profile difference at baseline, and the profile-by-time interaction represents the between-profile difference in the annual rate of cognitive change. The low-burden profile was the reference group. N = 250; observations: global cognition, 632; immediate recall, 730; delayed recall, 707.

Notes

Continuous variables are presented as mean (SD), and categorical variables as n (%), unless otherwise indicated. P values were calculated using Student’s two-sample t test for continuous variables and Pearson’s chi-square test for categorical variables. For cognitive measures, the effective sample size is reported because of missing values.

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Author Contribution

J.D. designed the study, curated and analyzed the data, prepared the figures, and wrote the original manuscript. C.B. and X.L. provided methodological guidance, contributed to interpretation of the findings, and critically revised the manuscript. X.L. supervised the study. All authors reviewed and approved the final manuscript.

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Data Availability

The data supporting the findings of this study are publicly available through the China Health and Retirement Longitudinal Study (CHARLS) website (http://charls.pku.edu.cn/en).

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Figures

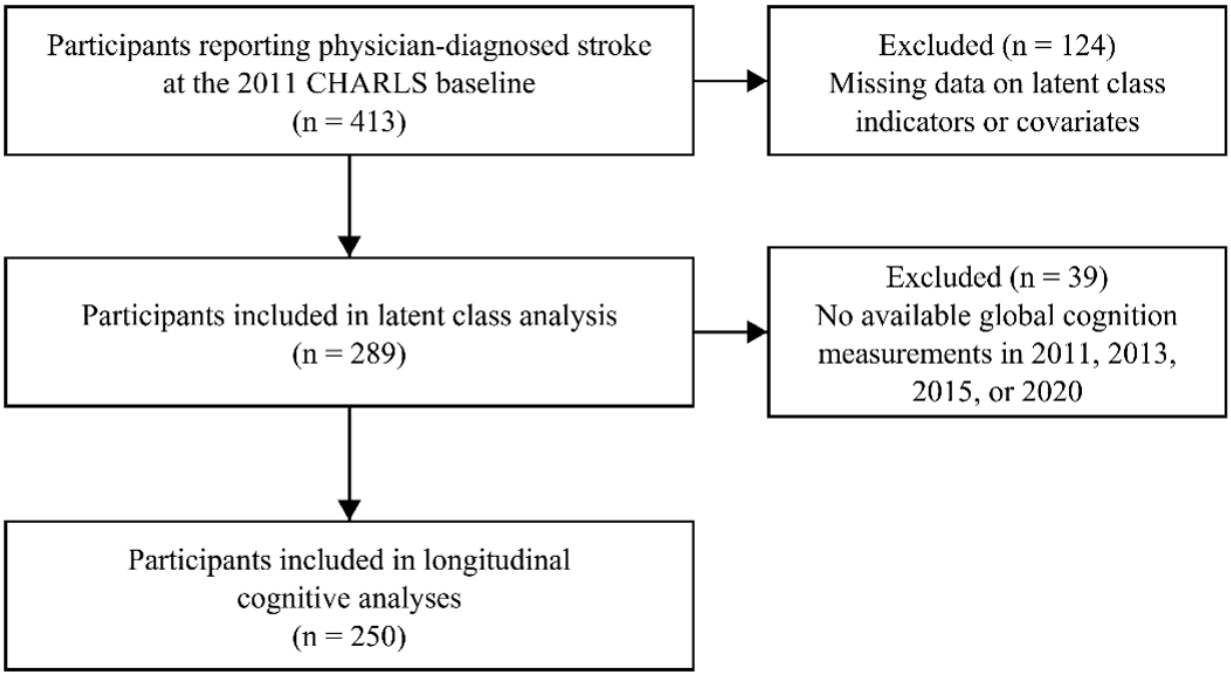

Figure 1

Flowchart of participant selection for the latent class and longitudinal cognitive analyses.

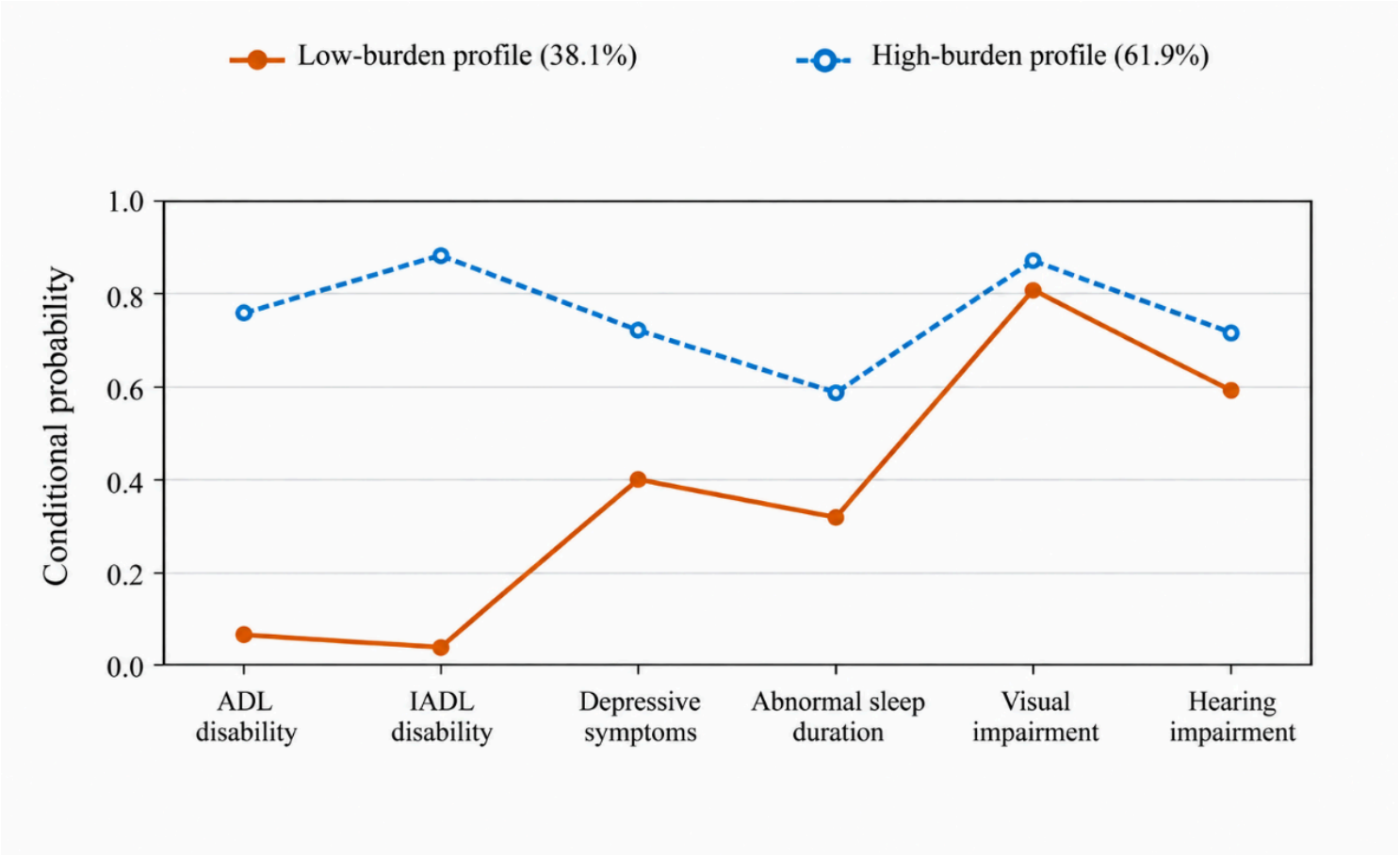

Figure 2

Conditional probabilities of latent class indicators according to multidimensional health profiles.

Notes: Conditional probabilities for the low-burden versus high-burden profiles were ADL disability, 6.4% vs 76.0%; IADL disability, 3.6% vs 88.3%; depressive symptoms, 40.0% vs 72.1%; abnormal sleep duration, 31.8% vs 58.7%; visual impairment, 80.9% vs 87.2%; and hearing impairment, 59.1% vs 71.5%. Percentages in parentheses in the legend indicate class proportions. ADL, activities of daily living; IADL, instrumental activities of daily living.

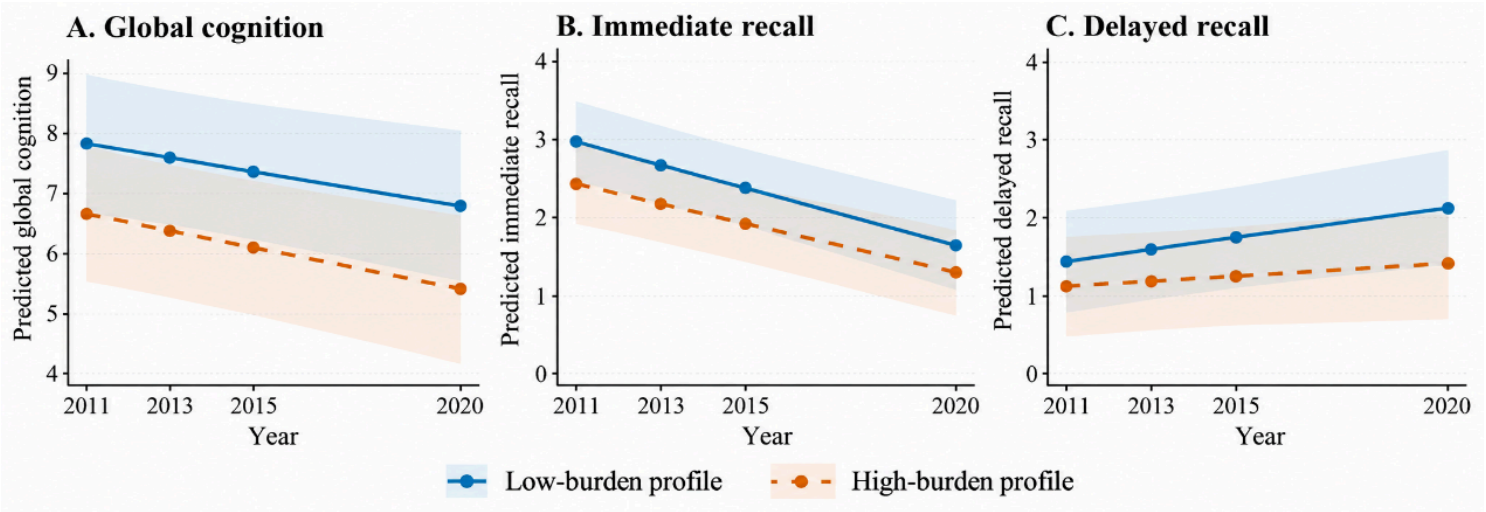

Figure 3

Adjusted predicted trajectories of cognitive outcomes according to multidimensional health profile. Notes: Lines represent covariate-adjusted predicted values from the linear mixed-effects models, and shaded areas represent 95% confidence intervals. Predictions are shown in the observed study years (2011, 2013, 2015, and 2020).

Supplementary Files

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