Psychiatry Research 265 (2018) 77–81

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Six-month longitudinal associations between cognitive functioning and distress among the community-based elderly in Hong Kong: A cross-lagged panel analysis

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ARTICLE INFO

Keywords:
Aging
Cognition
Distress
Depression
Anxiety
Cross-legged model

ABSTRACT

Although previous studies have extensively documented the cross-sectional relationship between cognitive impairment and psychological distress, findings relating to their longitudinal associations remains mixed. The present study examines the longitudinal associations and mutual influence between cognitive functioning and psychological distress across six months among community-dwelling elderly in Hong Kong. A total of 162 older adults (40 males; M_{age} = 69.8 years, SD = 6.4) were administered objective and subjective measures of cognitive functioning, as well as self-reported ratings of distress, at two time points six months apart. Using structural equation modeling, we tested the cross-lagged relationships between cognitive functioning and distress. Our cross-lagged model indicated that cognitive functioning at baseline significantly predicted subsequent psychological distress. However, distress was not significantly associated with subsequent cognitive functioning. Additionally, the objective and subjective measures of cognitive functioning were not significantly correlated. These findings suggested that distress may occur as a consequence of poorer cognitive functioning in elderly, but not vice versa. The lack of correlation between objective and subjective cognitive measures suggested that the participants may not have adequate insight into their cognitive abilities. The implications of these findings are discussed.

1. Introduction

The association between cognitive impairment and affective symptoms among older adults has been well established. While depressed and anxious elderly have been found to perform poorly in various cognitive domains (Elderkin-Thompson et al., 2007; Hogan, 2003; Nebes et al., 2000; Sheline et al., 2006; Wetherell et al., 2002), affective symptoms are suggested to be predictors of cognitive decline over time (Bielak et al., 2011; Chi and Chou, 2000; DeLuca et al., 2005; Sinoff and Werner, 2003).

In recent decades, bidirectional longitudinal studies have been carried out to examine their mutual influence. Yet, findings appear to be mixed. Some studies found depressive symptoms predicted subsequent cognitive decline but baseline cognition did not predict depression (Bunce et al., 2014; Panza et al., 2009; Zahodne et al., 2014). These results suggest depression is causally implicated in subsequent cognitive decline. However, other studies have obtained the reverse – cognitive functioning predicted subsequent depressive symptoms while these symptoms were not significantly related to subsequent cognitive decline (Jajodia and Borders, 2011; Perrino et al., 2008; Vinkers et al., 2004). These conflicting results may be explained by the methodological differences across studies, such as the age range and clinical characteristics of participants. A meta-analysis study showed that depression was also associated with cognitive deficits in people under 60 years old but the magnitude of the effect size tended to be larger at older ages (Christensen et al., 2001). Older adults with psychiatric diagnoses may present relatively different cognitive decline trajectories compared to their healthy counterparts (Jajodia and Borders, 2011).

We aimed to further investigate the relationship between psychological distress and cognitive functioning in the elderly and clarify the direction of influence with the use of a cross-lagged panel analysis. Cross-lagged panel design is a type of structural equation modeling that involves the analysis of data collected at two or more time points and estimates the association between variables while controlling for

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https://doi.org/10.1016/j.psychres.2018.04.045
Received 9 October 2017; Received in revised form 12 April 2018; Accepted 12 April 2018
Available online 13 April 2018

correlations within time points. On the basis of existing literature showing effects in both directions, we expected that there would be a reciprocal relationship between psychological distress and cognitive functioning across time. Specifically, we hypothesized that cognition at baseline would predict later distress and that baseline distress would predict cognitive functioning after 6 months.

Our study extends the current literature in several additional ways. First, while most studies used only objective global cognitive measures, such as the Mini–Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA), or standardized neurocognitive assessments to measure cognitive functions, we collected both objective and subjective measures to obtain a more comprehensive picture of cognitive functioning. Self-reported cognitive measures receive less emphasis, compared to objective measures, due to their reliability concerns. However, a growing body of research has documented the significant associations between self-reported cognitive decline and Alzheimer's disease biomarkers, such as cortical atrophy, cerebral hypometabolism, and amyloid deposition, even in the absence of objective cognitive impairment (Rabin et al., 2015).

Second, the current study included both depression and anxiety in the measurement of psychological distress. Previous related research, with a few exceptions (Bunce et al., 2012; DeLuca et al., 2005) examined either depressive or anxiety symptoms, but not both. Since there is a high comorbidity between depression and anxiety, it is important to consider both when investigating longitudinal associations between cognitive functioning and psychological distress.

2. Methods

2.1. Measures

Cognitive functioning was assessed objectively via the Mini–Mental State Examination (MMSE; Folstein et al., 1975); and subjectively via the Cognitive Self-Report Questionnaire (CSRQ; Spina et al., 2006). A validated Chinese version of the Mini–Mental State Examination was used (Chiu et al., 1994). The MMSE consisted of a number of brief tasks assessing orientation, attention, calculation, recall, language and ability to follow instructions. The MMSE was scored on a 30-point scale, and higher scores corresponded to better cognitive status. The CSRQ consisted of 20 items, each assessed on a five-point Likert scale (1 = *Always* and 5 = *Never*), measuring impairments in the social and cognitive domains over the past two weeks.[1] The possible range of scores lies from 10 to 50 for both subscales. Higher CSRQ scores relate to worse functional outcomes. The CSRQ demonstrated good internal consistency ($\alpha = 0.91$) and 2-month test–retest reliability ($r = 0.85$).

The Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983) was used to assess the level of distress in our participants. The HADS consisted of two subscales of seven items each – anxiety (HADS-a) and depression (HADS-d). Each item was scored from 0 to 3. The HADS has demonstrated excellent sensitivity and specificity in classifying mood and anxiety disorder cases in a local older adult population (Lam et al., 1995). Higher scores on the HADS corresponded to worse outcomes.

2.2. Participants and procedures

The participants of this study were from a no-contact control group of a parent intervention study conducted in Hong Kong. In the intervention study, subjects were randomly assigned into 3 groups – training, active control and no-contact control group. Recruitment procedures and inclusion criteria have been described in detail elsewhere (Leung et al., 2015). For the present study, cognitive functioning and distress symptoms were measured at baseline and six months later. This study was approved by the Institutional Review Board of a university and hospital, and conducted in accordance with the ethical standards laid out in the 1964 Declaration of Helsinki and its later amendments.

Within the no-contact control group, 162 participants were included in the study. At baseline, this sample consisted of 40 males and 122 females with a mean age of 69.82 years (SD = 6.40) and an average of 8.03 years of education (SD = 4.03). The prevalence of mild cognitive impairment in the cohort studied was 18%. Diagnosis was made by a clinical psychologist, according to the criteria outlined by Petersen (2004). These diagnosed cases also fulfilled the DSM-5 criteria of Mild Neurocognitive Disorder. A total of 101 participants followed through with assessments at the second time point; the remaining 61 were lost to follow up and assumed to be missing at random. There were no significant differences in age, gender, education or all outcome measures, including MMSE, CSRQ and HADS between participants who completed assessments at both time points and those lost in follow up ($p > 0.05$).

2.3. Statistical analysis

A cross-lagged panel analysis was carried out via structural equation modeling to examine the relationship between cognition and distress. In this model, age, gender and education were included as covariates at time 1. MMSE and CSRQ scores were loaded on to the 'Cognition' latent variable, and HADS-a and HADS-d scores were loaded on to the 'Distress' latent variable. Longitudinal invariance of these latent variables was assumed. Robust maximum likelihood was used for parameter estimation. These analyses were carried out with the R package lavaan (Rosseel, 2012). Model fit indices were determined by Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and standardized root mean square residual (SRMR). CFI and TLI values greater than 0.95 were considered a very good fit. RMSEA values of less than 0.05 were considered good (Browne and Cudeck, 1993). SRMR values less than 0.08 are indicative of an acceptable model (Hu and Bentler, 1999). Correlations between variables were examined using Pearson correlation coefficients. Statistical significance was set at $p < 0.05$.

3. Results

The descriptive statistics and bivariate Pearson correlations of the continuous variables are presented in Table 1. The mean MMSE scores appeared to be fairly stable across two time points. However, on individual level, older adults did show some meaningful changes in their own scores, with some exhibiting increases and others showing decreases over six months. We examined the change of each participant's MMSE scores across the two time points by subtracting each participant's MMSE T1 score from T2 score and calculated the variability of the score difference. It showed that the SD of the change in MMSE scores across all participants was 2.33. Given that change was positive for some and negative for others, the overall mean scores across all participants remained to be fairly flat. Cognitive change may therefore be masked. CSRQ scores, on the other hand, increased on average over time. Higher CSRQ scores were significantly associated with HADS. But MMSE was not correlated with CSRQ at both time points.

The fit indices indicated good fit for the proposed model as shown in Fig. 1 (CFI = 0.969; TLI = 0.955; RMSEA = 0.047; SRMR = 0.055). In general, the estimates of the cross-lagged model with education included as a covariate (see supplementary materials) were similar to the model without the education covariate. However, the inclusion of the additional education covariate significantly worsened the fit of the model ($\Delta\chi^2 = 56.19$, $\Delta df = 10$, $p < 0.001$). Furthermore, education did not significantly predict any of the baseline latent variables. Given these results, the better fitted and more parsimonious model (without

[1] The hearing subscale was not used as it was irrelevant to the objectives of the current study.

Table 1
Means, standard deviations, and correlations.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. Age	69.82	6.40											
2. Education	8.03	4.03	−0.08										
3. $MMSE_{T1}$	26.65	2.51	−0.16*	0.37***									
4. CSRQ-c_{T1}	26.98	5.23	−0.04	−0.1	−0.07								
5. CSRQ-s_{T1}	24.06	5.57	−0.02	−0.08	−0.14	0.61***							
6. HADS-a_{T1}	4.48	2.96	−0.21**	−0.01	−0.05	0.34***	0.45***						
7. HADS-d_{T1}	4.06	2.69	−0.02	−0.16*	−0.16*	0.35***	0.51***	0.55***					
8. $MMSE_{T2}$	26.8	2.51	−0.09	0.4***	0.55***	0.04	−0.05	−0.01	−0.12				
9. CSRQ-c_{T2}	27.86	5.19	−0.12	−0.18	−0.03	0.58***	0.54***	0.32**	0.2*	−0.04			
10. CSRQ-s_{T2}	25.42	5.28	0.04	−0.24*	−0.17	0.47***	0.73***	0.49***	0.4***	−0.1	0.61***		
11. HADS-a_{T2}	4.74	3.08	0.01	−0.21*	−0.12	0.34***	0.47***	0.56***	0.37***	−0.07	0.37***	0.58***	
12. HADS-d_{T2}	4.18	2.96	0.06	−0.22*	−0.08	0.18	0.49***	0.37***	0.41***	−0.15	0.26**	0.58***	0.65***

Note. *M* = mean; *SD* = standard deviation; MMSE = Mini–Mental State Examination; CSRQ-c = Cognitive Self-Report Questionnaire - cognitive subscale; CSRQ-s = Cognitive Self-Report Questionnaire - social subscale; HADS-a = Hospital Anxiety and Depression Scale - anxiety subscale; HADS-d = Hospital Anxiety and Depression Scale - depression subscale; T1 = baseline; T2 = six months follow up; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

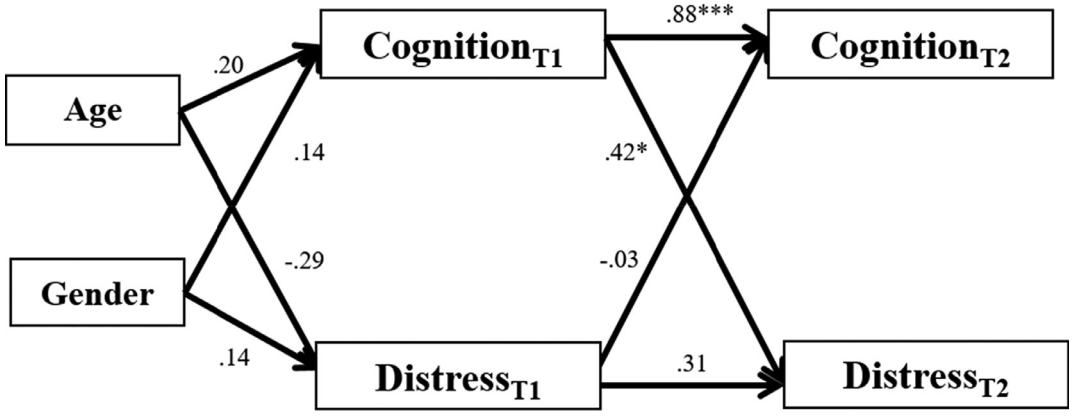

Fig. 1. Maximum likelihood estimation of the cognition (including scores in Mini–Mental State Examination and Cognitive Self-Report Questionnaire - cognitive and social subscales) and distress (including scores in Hospital Anxiety and Depression Scale - anxiety and depression subscales) cross-lagged models with age and gender included as covariates. Straight lines represent regression paths. T1 = baseline; T2 = six month follow up. $^{*}p < 0.05$, $^{***}p < 0.001$.

education) was adopted and reported henceforth.

The results of the cross-lagged model are presented in Fig. 1. In this model, neither age nor gender significantly predicted cognition or distress at baseline. There was a significant cross-lagged effect in this model. Specifically, cognition at baseline predicted distress at six months follow-up, while controlling for distress at baseline ($p = 0.014$). However, the reverse effect was not significant; distress at baseline did not significantly predict subsequent cognitive functioning while controlling for baseline cognition ($p = 0.874$). The autoregressive path, which refers to the follow up measurement being regressed on its baseline score, was significant for cognition ($p < 0.001$), but the autoregressive path for distress was not significant ($p = 0.131$).

4. Discussion

The present study examined the longitudinal associations and mutual influences between cognitive functioning and distress over a six-month period. Our cross-lagged model indicated that cognitive functioning significantly predicted subsequent distress, but not vice versa. The data did not support our hypothesis of reciprocal relationship but, our findings are consistent with those of previous cross-lagged studies (Jajodia and Borders, 2011; Perrino et al., 2008; Vinkers et al., 2004).

Our results suggest that distress develops as a consequence of objective-subjective cognitive functioning. Speculatively, cognitive decline may impair older adults' capacity in maintaining optimal psychological and daily functioning. As previous research has shown, age-related cognitive impairment may hinder one's ability to regulate emotions, consequently leading to distress (Heisel et al., 2002). Aging has also been associated with slower mental processing speed, poorer memory and executive functioning (Harada et al., 2013). These age-related changes may compromise one's daily functioning in a noticeable manner, subsequently leading to distress.

Moreover, our data showed that the objective measure of cognition did not correlate significantly with participants' subjective ratings. This suggests that the elderly may not have good insight into their actual cognitive abilities. They may either overestimate or underestimate their level of cognitive functioning. While overestimating their cognitive abilities may lead to the lack of danger awareness and lower motivation for treatment (Starkstein et al., 2007), underestimating may give rise to older adults' concern about the adverse consequences of cognitive impairment, such as the decrease in control over independent living (Quine and Morrell, 2007), which may in turn hamper their self-efficacy and lead to distress (Choi and Twamley, 2013). In the present cultural context, the impact of elderly underestimating their cognitive functioning may be particularly negative as children are expected to take care of their aged parents under the central Chinese value of filial piety. According to a qualitative study in Hong Kong, the thought of becoming a burden to the family is one major concern among early demented-elderly who were aware of their cognitive decline (Mok et al., 2007). Those who subjectively underestimate their cognitive functioning may perceive themselves as a burden to their family which further contributes to their distress. Thus, enhancing the insight of the elderly is crucial.

Our study found that psychological distress did not predict subsequent cognition over the six-month period. This is somewhat inconsistent with some previous studies which showed that depression

predicts subsequent cognitive decline (Bunce et al., 2014; Chodosh et al., 2007; Köhler et al., 2010). Nevertheless, we speculate that the influence of distress on cognition may not be apparent within the relatively shorter study period in the current study.

It should be noted that, in our analyses, the autoregressive path for cognition was significant while that of distress was not. This suggests that cognition was relatively more stable throughout the six-month period as compared to distress levels. This is expected since mood is subjected to the influence of everyday experiences.

Our findings underscore the need for mental health professionals to enhance older adults' sense of self-efficacy and insight into their cognitive functioning. Interventions, especially group interventions which aim at promoting various aspects of functioning, such as improving physical health, cognitive performance and social skills, are able to assist older adults in adapting to challenges of aging and reducing the risk of developing mental illness (Blazer, 2002). To improve insight, the provision of regular but brief cognitive check-ups could be considered to benchmark subjective perceptions of ability against more objective measures. Cognitive restructuring techniques may also be used to facilitate more accurate and flexible information processing regarding their cognitive concerns, which may, in turn, produce improvements in mood (Cox and D'Oyley, 2011). In view of the possible difficulties with applying these cognitive strategies to cognitively impaired individuals, these strategies should be adapted appropriately for use in the elderly population. For example, repeated summarizing of information, or other aids, may be needed to enhance its encoding, especially among older adults with poor working memory and attention span (Evans, 2007).

The current study has a number of limitations. Firstly, the sample size was relatively small. Hence the current study may not have adequate power in detecting cross-lagged effects which are typically small in magnitude (Kenny, 1975). Secondly, the use of MMSE as a measure of cognitive functioning is associated with some problems, such as ceiling effects and the inadequate sensitivity in detecting subtle cognitive impairment (Spencer et al., 2013). Thirdly, participants were assessed at two time points which was only six months apart. Although more time points that span over a few years will provide more information about the longitudinal relationship between cognitive functioning and affective symptoms, our findings serve as the basis for future studies to consider setting repeated assessment intervals over a longer period to capture the trajectory of change in more detail.

To the best of our knowledge, the current study is the first to examine the longitudinal associations between objective-subjective cognition and psychological distress in older adults over a six-month period. Our results suggested that baseline cognition predicted subsequent distress, but distress did not significantly influence subsequent cognitive functioning. Taken together, these results suggest that psychological distress appears to manifest as a consequence of poorer cognitive functioning.

Conflicts of interest

None.

Acknowledgments

This work is supported by funding from The University of Hong Kong May Endowed Professorship and the KKHo International Charitable Foundation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.04.045.

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