Postprint: Socioeconomic Status in Middle-Aged and Older Adults Mediates the Association Between Parental Education in Childhood and Cognitive Function in the Guangzhou Biobank Cohort Study

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Abstract

Background Currently, cognitive impairment has become one of the risk factors for disability and death among older adults. Some studies have found a correlation between parental literacy and cognitive function, while research on the mediating role of socioeconomic status (SES) between the two is relatively scarce.

Objective To explore the mediating effect of SES between childhood parental literacy (CPL) and cognitive function in middle-aged and older adults.

Methods Data were derived from the third phase baseline data of the "Guangzhou Biobank Cohort Study" (GBCS). A total of 8,891 Guangzhou residents aged $ $50 years recruited were selected as study subjects. Questionnaires were used to collect data on general demographic characteristics, SES, lifestyle, CPL, health status, and cognitive function. Pearson correlation analysis was used to explore the correlations among CPL, SES, and cognitive function. The association between CPL and cognitive function was analyzed using multivariate linear regression models, while the associations with MCI and MMI were analyzed using Logistic regression models. R 4.1.1 software was used to analyze the mediating effects of SES and its representative indicators (education level, annual household income, occupation) between CPL and cognitive function.

Results The prevalence of mild cognitive impairment among study subjects was 12.60% (1,120/8,891). Correlation analysis results showed that childhood

parental literacy was positively correlated with SES (rs=0.312, P<0.001), cognitive function (rs=0.306, P<0.001), and short-term memory function (rs=0.218, P<0.001). SES was also positively correlated with cognitive function (rs=0.337, P<0.001) and short-term memory function (rs=0.240, P<0.001). Multivariate linear regression and Logistic regression analysis results showed that after adjusting for relevant variables, compared with the group where both parents were illiterate, the groups with one literate parent and both parents literate had higher cognitive function [β(95%CI)=1.00(0.84~1.14), 1.46(1.30~1.62)] and short-term memory function [β(95%CI)=0.44(0.33~0.56), 0.64(0.52~0.77)] (P<0.001), and had reduced risks of MCI [OR(95%CI)=0.48(0.41~0.57), 0.27(0.22~0.34)] and MMI [OR(95%CI)=0.65(0.56~0.74), 0.50(0.43~0.59)] (P<0.001), with significant trends (P for trend<0.001). The proportions of mediating effects of SES and its representative indicators education level, annual household income, and occupation between CPL and cognitive function were 21.77% (18.79%~24.77%), 18.44% (15.49%~21.50%), 6.56% (5.08%~8.24%), and 6.67% (5.07%~8.34%), respectively, and between CPL and short-term memory function were 25.51% (21.10%~30.61%), 23.65% (19.25%~29.03%), 7.03% (5.14%~9.85%), and 7.02% (4.74%~9.68%), respectively.

Conclusion Socioeconomic status, particularly education level, may partially mediate the association between childhood parental literacy and cognitive function. Strengthening early education and improving socioeconomic status, especially education level, will help delay and prevent the occurrence of cognitive impairment in middle-aged and older adults.

Full Text

The Mediation Effect of Socioeconomic Status in the Association Between Childhood Parental Literacy and Cognitive Function in Middle-aged and Older Adults: Evidence from the Guangzhou Biobank Cohort Study

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Abstract

Background Cognitive impairment is one of the serious risk factors leading to disability and death in the elderly. Some studies have found an association between parental literacy and cognitive function, but research on mediating role of socioeconomic status (SES) between the two is relatively scarce. **Objective** To examine the mediating role of SES between childhood parental literacy (CPL) and late-life cognitive function. **Methods** Based on the baseline data in phase 3 of Guangzhou Biobank Cohort Study (GBCS), 8,891 Guangzhou residents aged 50 and above were included. Data on general demographic characteristics, SES, lifestyle, CPL, health conditions, and cognitive function were collected. R 4.1.1 software was used to analyze the mediating effects of SES and its representative indicators (education, family income, and occupation) between CPL and cognitive function. Pearson correlation analysis was employed to examine the associations among CPL, SES, and cognitive function. Multivariable linear regression was used to examine the association between CPL and cognitive function, and logistic regression model was used to examine the associations of CPL with MCI and MMI. **Results** The prevalence of mild cognitive impairment among the study subjects was 12.60% (1,120/8,891). Correlation analysis showed that childhood parental literacy was positively correlated with SES (rs=0.312, P<0.001), cognitive function (rs=0.306, P<0.001), and short-term memory function (rs=0.218, P<0.001); and SES was positively correlated with cognitive function (rs=0.337, P<0.001) and short-term memory function (rs=0.240, P<0.001). After adjustment for covariates, multivariable linear and logistic regression analysis showed that, compared with both parents couldn' t read/write, only father/mother could read/write and both parents could read/write were associated with higher cognitive function [β(95%CI)=1.00(0.84~1.14), 1.46(1.30~1.62)] and short-term memory function [β(95%CI)=0.44(0.33~0.56), 0.64(0.52~0.77)] (all P<0.001), and the risks of MCI [OR(95%CI)=0.48(0.41~0.57), 0.27(0.22~0.34)] and MMI [OR(95%CI)=0.65(0.56~0.74), 0.50(0.43~0.59)] (P<0.001) were lower, the increases and decreases exhibit a certain trend (P-trend<0.001). The proportions of the mediating effects of SES and its representative indicators (education, family income, and occupation) between CPL and cognitive function were 21.77% (18.79%~24.77%), 18.44% (15.49%~21.50%), 6.56% (5.08%~8.24%) and 6.67% (5.07%~8.34%), respectively, and were 25.51% (21.10%~30.61%), 23.65% (19.25%~29.03%), 7.03% (5.14%~9.85%) and 7.02% (4.74%~9.68%), respectively, between CPL and short-term memory function. **Conclusion** SES, mainly education, may partially mediate the association between childhood parental literacy and cognitive function. Strengthening early education and socioeconomic status (especially education) could help delay and prevent the occurrence of cognitive impairment in middle and old age.

Keywords Cognitive function; Childhood parental literacy; Socioeconomic status; Middle-aged and older people; Guangzhou Biobank Cohort Study; Mediation effects

Introduction

With global population aging intensifying, health issues among older adults have become increasingly prominent. Cognitive impairment and dementia are closely associated with disability and mortality in the elderly [**?**]. Cognitive impairment refers to varying degrees of functional decline in one or more cognitive domains due to various causes [**?**]. The global prevalence of mild cognitive impairment (MCI) exceeds 15% [**?**], and there are over 55 million people with dementia worldwide, a number expected to double by 2050 [**?**]. In China, the prevalence of MCI among adults is approximately 15.5% [**?**], with about 20% of MCI patients progressing to dementia over time [**?**]. Cognitive impairment and dementia not only affect the quality of life of middle-aged and older patients but also impose heavy economic burdens on society and families, representing a critical public health issue that urgently needs to be addressed. Therefore, early identification and intervention of potential risk factors for cognitive decline are crucial for delaying and preventing the onset of cognitive impairment and dementia in middle-aged and older adults.

Research indicates that both childhood parental literacy (CPL) [**?**, **?**] and socioeconomic status (SES) [**?**, **?**, **?**] are closely associated with cognitive function. However, few studies have examined whether the association between CPL and cognitive function is mediated by SES and what the magnitude of this mediating effect might be. Therefore, this study utilizes baseline data from Phase 3 of the "Guangzhou Biobank Cohort Study" (GBCS) to explore the correlations among CPL, SES, and cognitive function among middle-aged and older adults in Guangzhou from a life-course perspective. Furthermore, it analyzes the mediating effects of SES and its representative indicators (education level, annual family income, and occupation) in the association between CPL and cognitive function in middle-aged and older adults, aiming to provide scientific evidence for preventing and delaying cognitive impairment and dementia by focusing on modifiable factors.

Methods

Study Design and Participants

The GBCS is an ongoing population-based prospective cohort study collaboratively conducted by Guangzhou Twelfth People' s Hospital, the University of Hong Kong, and the University of Birmingham [**?**]. Participants were recruited from the Guangzhou Elderly Health and Happiness Association, the largest civic organization for older adults in Guangzhou with branches in all districts of the city. The GBCS baseline survey was conducted from September 2003 to January 2008, with participants recruited in three phases. Phase 3 baseline survey recruited 10,088 individuals and added the Mini-Mental State Examination (MMSE) to assess multiple dimensions of cognitive function based on the Delayed 10-Word Recall Test (DWRT). This study selected participants recruited in Phase 3 for analysis. Inclusion criteria were: Guangzhou residents aged 50

years and above who voluntarily participated and could travel to Guangzhou Twelfth People' s Hospital for questionnaire surveys and free physical examinations. Exclusion criteria were: individuals with mental or psychological disorders who could not communicate normally, those unable to complete questionnaires, those without CPL, SES, MMSE, or DWRT data, and those with missing values for relevant covariates. Ultimately, 8,891 middle-aged and older adults were included. This study was reviewed and approved by the Guangzhou Medical Ethics Committee (Approval No. 2017002). All participants understood the study content, voluntarily enrolled, and provided informed consent.

Assessment of Variables

Cognitive Function Both the MMSE and DWRT are widely used for cognitive function assessment due to their reliability and feasibility [**?**, **?**]. The MMSE includes four dimensions: orientation, memory, attention and calculation, and language ability, comprising 11 items with scores ranging from 0 to 30. Higher scores indicate better cognitive function, and scores below 25 were defined as MCI [**?**]. The DWRT assesses short-term memory function through a delayed recall test of 10 words, with scores ranging from 0 to 10. Higher scores indicate better short-term memory function, and scores below 5 were defined as mild short-term memory impairment (MMI) [**?**].

Childhood Parental Literacy In the study population, opportunities for formal education were generally limited, and the ability to read/write was a primary indicator of literacy. This study used childhood parental literacy (CPL) as the independent variable [**?**], categorized into three groups: both parents illiterate (score 0), one parent literate (score 1), and both parents literate (score 2). The score range was 0-2, with higher scores indicating higher CPL.

Socioeconomic Status SES is a comprehensive concept that cannot be fully captured by a single indicator. This study used three indicators—education level, annual family income, and occupation—to measure SES. These three indicators are interrelated yet distinct, reflecting different facets of socioeconomic status among middle-aged and older adults [**?**]. Based on previous studies [**?**, **?**], education level was dichotomized as junior high school and below (score 0) versus high school and above (score 1); annual family income was dichotomized as <30,000 yuan (score 0) versus $ $30,000 yuan (score 1); and occupation was dichotomized as manual labor or other (score 0) versus non-manual labor (score 1). The sum of these three scores constituted the SES score (range 0-3), with higher scores indicating higher SES. Education level, annual family income, occupation, and overall SES were analyzed as mediating variables in the associations between CPL and cognitive function/short-term memory function.

Covariates This study also included general demographic characteristics (sex, age, marital status), lifestyle factors (smoking status, alcohol consumption, phys-

ical activity), and health status (BMI, cardiovascular disease, diabetes, self-rated health, depressive symptoms) as covariates. Physical activity was categorized into insufficient, moderate, and active groups based on activity days and metabolic energy values using the International Physical Activity Questionnaire short form [**?**]. BMI was calculated as weight (kg) divided by height (m) squared. Self-rated health was assessed through the question: "Overall, how would you rate your health status?" Responses of "very good" or "good" were classified as good self-rated health, while responses of "poor" or "very poor" were classified as poor self-rated health. Depressive symptoms were evaluated using the previously validated Chinese version of the 15-item Geriatric Depression Scale (GDS-15), which contains 15 items scored from 0 to 15. Higher scores indicate more severe depressive symptoms, with scores <5 considered normal and $ $5 indicating depressive symptoms [**?**].

Statistical Analysis

Statistical analysis was performed using SPSS 25.0 software. Categorical data were described as frequencies (percentages) and compared using chi-square tests. Continuous data were normally distributed and described as means (standard deviations), compared between two groups using independent samples t-tests. Pearson correlation analysis was used to explore correlations among CPL, SES, and cognitive function. Multivariable linear regression models were used to examine the association between CPL and cognitive function, while logistic regression models were used for associations with MCI and MMI. Mediation effect analysis was conducted using the "mediation" and "bootstrap" packages in R 4.1.1 software. Sensitivity analysis was further performed by excluding participants with poor cognitive and short-term memory function (scores below the 5th percentile). A 95% confidence interval (CI) that did not include 0 indicated a statistically significant mediating effect. Statistical significance was set at $P<0.05$.

Results

Participant Characteristics

A total of 8,891 middle-aged and older adults were included in this study, comprising 2,226 men (25.0%) and 6,665 women (75.0%), with a mean age of 59.8$±$7.7 years. Among them, 7,771 had normal cognitive function and 1,120 had MCI. The two groups showed statistically significant differences in age, sex, marital status, childhood parental literacy, education level, annual family income, occupation, alcohol consumption, physical activity, poor self-rated health, and prevalence of depressive symptoms ($P<0.05$). No significant differences were observed in BMI, smoking status, or diabetes prevalence between the two groups ($P>0.05$). For short-term memory function, 7,085 participants had normal function and 1,806 had MMI. The two groups showed statistically significant differences in age, sex, marital status, childhood parental literacy,

education level, annual family income, occupation, smoking status, alcohol consumption, physical activity, poor self-rated health, and prevalence of depressive symptoms (P<0.05). No significant differences were observed in BMI or prevalence of cardiovascular disease and diabetes between the two groups (P>0.05). See Table 1 .

Correlation Analysis

Correlation analysis revealed that childhood parental literacy was positively correlated with SES (rs=0.312, P<0.001), cognitive function (rs=0.306, P<0.001), and short-term memory function (rs=0.218, P<0.001). SES was also positively correlated with cognitive function (rs=0.337, P<0.001) and short-term memory function (rs=0.240, P<0.001). See Table 2 .

Association Between Childhood Parental Literacy and Cognitive Function

Using childhood parental literacy as the independent variable (scored as: both parents illiterate=0, one parent literate=1, both parents literate=2) and cognitive function (MMSE score) (actual value), short-term memory function (DWRT score) (actual value), MCI (no=0, yes=1), and MMI (no=0, yes=1) as dependent variables, multivariable linear regression and logistic regression analyses were performed. After adjusting for general demographic characteristics (sex, age, marital status), socioeconomic status (education level, annual family income, occupation), lifestyle factors (smoking, alcohol consumption, physical activity), and health status (BMI, cardiovascular disease, diabetes, self-rated health, depressive symptoms), results showed that compared with the group where both parents were illiterate, the groups with one literate parent and both literate parents had higher cognitive function (MMSE scores) and short-term memory function (DWRT scores) (P<0.001), and lower risks of MCI and MMI (P<0.001). These increases and decreases exhibited significant trends (P-trend<0.001). See Table 3 .

Mediation Effect Analysis

After adjusting for the aforementioned covariates, the mediating effects of SES and its representative indicators—education level, annual family income, and occupation—between childhood parental literacy and cognitive function (MMSE score) were all statistically significant (P<0.001), accounting for 21.77% (18.79%-24.77%), 18.44% (15.49%-21.50%), 6.56% (5.08%-8.24%), and 6.67% (5.07%-8.34%) of the total effect, respectively. Consistent results were obtained for short-term memory function (DWRT score), with mediating effects accounting for 25.51% (21.10%-30.61%), 23.65% (19.25%-29.03%), 7.03% (5.14%-9.85%), and 7.02% (4.74%-9.68%), respectively. See Table 4 . The mediation pathways from childhood parental literacy → SES → cognitive function and short-term memory function in middle-aged and older adults are shown in Figure 1 [Figure 1: see original paper].

Sensitivity Analysis

After excluding participants with poor cognitive and short-term memory function (scores below the 5th percentile), sensitivity analysis results showed that compared with the group where both parents were illiterate, the groups with one literate parent and both literate parents had higher cognitive function levels (MMSE scores), with β (95%CI) values of 0.56 (0.44-0.67) and 0.92 (0.79-1.04), respectively, and lower risks of MCI (MMSE<25), with OR (95%CI) values of 0.51 (0.42-0.61) and 0.33 (0.26-0.42), respectively (P<0.001), with P-trend<0.001. Consistent results were obtained for short-term memory function (DWRT score) and MMI, with β (95%CI) values of 0.23 (0.13-0.33) and 0.37 (0.27-0.48), and OR (95%CI) values of 0.71 (0.59-0.85) and 0.59 (0.48-0.73), respectively (P<0.001), with P-trend<0.001.

Discussion

This study utilized large-sample data from the Guangzhou Biobank natural population cohort to analyze the association between childhood parental literacy and cognitive function/short-term memory function in middle-aged and older adults. Relevant covariates were considered and adjusted, and findings were cross-validated using two cognitive assessment scales (MMSE and DWRT), yielding objective and reasonable results. Furthermore, the mediating roles of education level, annual family income, occupation, and overall SES were examined. However, this study has several limitations. First, the independent variable (childhood parental literacy) was obtained through self-report, which may be subject to recall bias. This study excluded individuals with mental or psychological disorders who could not communicate normally, which may partially reduce errors from recall bias. The consistent results from sensitivity analysis after further excluding participants with poor cognitive and short-term memory function also support this. Second, genetic factors that may influence cognitive function were not considered and should be examined in future research.

In summary, childhood parental literacy is positively associated with cognitive function and short-term memory function in middle-aged and older adults, and SES and its representative indicators (education level, annual family income, and occupation) partially mediate these associations. From a life-course perspective and considering individual, family, and societal levels, implementing measures to strengthen early education and improve socioeconomic status in middle and old age (particularly education level) may help delay and prevent the onset of cognitive dysfunction in middle-aged and older adults.

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Author Contributions

Chai Zhihao was responsible for data cleaning, analysis, and manuscript writing and revision; Zhang Weisen was responsible for data collection, research conceptualization, guidance on manuscript writing and review, and final version revision; Luo Jiaoling was responsible for data analysis and manuscript writing; Zhu Feng, Zhu Tong, Jin Yali, Pan Jing, Lu Yingjun, and Jiang Chaoqiang were responsible for data collection and manuscript review and revision.

Conflict of Interest

The authors declare no conflict of interest.

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