

Education and marriage synergistically protect oldest old against severe cognitive impairment

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Abstract

Background It is hypothesized that education and marriage are resilience factors protective against senile dementia.

Methods We investigated the resilience of elderly persons from dementia by considering the interactions between educational levels and marriage status. Four sociodemographic variables (age, sex, educational level, and marital status) were collected from 1177 elderly Chinese participants, for whom the mini-mental state examination score (MMSE score) was measured and severe cognitive impairment (MMSE score = 0) was identified.

Results Lower educational level coupled with being widowed caused a greater risk of severe cognitive impairment (relative risk [RR] 1.48; 95% confidence interval [CI] 1.20-1.82; $p < 0.001$) for high-age elderly participants (age range: ≥ 80) than those low-age counterparts (age range: ≥ 60 and < 80). By contrast, higher educational level coupled with being married leveled this age-related risk of cognitive loss (RR 0.91; 95% CI 0.65-1.27; $p = 0.62$). Further findings suggest that synergistically cognitive protection effect for education and marriage was only observed among high-age elderly persons, instead of among low-age ones.

Conclusions Being well-educated and being married synergistically protected delayed cognitive function for elderly people. However, longevity is a prerequisite for realizing this benefit.

Background

Benefiting from advances in science and technology, humans today have a higher probability of living longer than their predecessors [1]. However, in comparison to the acceleration of an aging population, they also have to face the challenges of increased morbidity, such as the dramatic increase in the number of dementia patients worldwide, essentially doubling every 20 years [2,3]. It is urgent for global researchers to understand the mechanisms of the pathological evolution of senile dementia to identify risk factors and develop preventive measures. Active management of senile dementia is necessary to maintain a sustainable future for human societies, since aging societies are an inevitable demographic trend [4].

Cognitive impairment and dementia make it difficult or impossible for elderly individuals to cope with daily activities. According to a hypothesis proposed by Stern [5], a relatively rich cognitive reserve is critical to understanding resiliency from the progressive evolution of the neuropathology of dementia. Factors contributing to the construction of an adequate cognitive reserve will help delay the arrival of senile dementia, while, a lack of these factors constitutes increasing risks. In addition to genetic factors [6], a growing number of modifiable factors have been related to senile dementia, such as occupational complexity [7–9], educational attainment [10–12], marital status [13], socioeconomic status [14], and social networks [15–18].

Just recently, a data analysis report integrating six longitudinal studies demonstrated that older individuals with high educational attainment and high socioeconomic status have remarkably longer non-cognitively impaired life expectancies as opposed to those with low educational attainment and low socioeconomic status [19]. This observation suggests that education and socioeconomic status are synergistic resilience factors against the onset of senile dementia. Based on these implications, we sought to further explore the possibility of a synergistic cognitive protection via education and another resilience factor, marriage, among elderly people. Compared to those of higher social and economic status, it is considered normative for ordinary people to sustain a marriage that is regarded as one of the strongest interpersonal relationships in an individual's social network. Education can enable people to be more rational and to make higher-quality decisions in their lives [20]. But we should not ignore the strong emotional needs of elderly persons [21]. In this study, we aim to prove that both rationality and emotion are indispensable for elderly people to maintain their ability to live independently during the twilight of their lives.

Methods

Ethical statement

The ethics committee of Ningbo College of Health Sciences (NBWY-010) approved this study. Prior to enrolment in the study, all participants or their guardians were informed of the research plan and signed a written statement of informed consent. The only prerequisite for a guardian to sign the informed consent on behalf of a participant was that the participant could not sign the consent form independently due to an impaired cognitive function. After completing the study, each participant received a gift worth less than 20 RMB.

Participant characteristics

From July 2018 to September 2018, our research team visited professional pension institutions to recruit elderly participants aged 60 years or older. For each participant, four sociodemographic variables (age, sex, educational level, and marital status) were collected by the researchers and verified by checking the electronic medical records of the visited professional pension institution. All participants were divided into two groups by age: low-age elder people group (age range: ≥ 60 and < 80) and high-age elder people group (age range: ≥ 80). Low educational levels were classified for participants who were illiterate or had only completed elementary or junior high school education. Those who completed high school or some college education were labeled as having a high educational level. Five marital statuses of elderly people were recorded, including single, widowed, divorced, married, and cohabitating with others. Single and divorced elderly persons and those cohabitating with others were excluded from the study. Accompanied by a trained researcher, each participant was required to complete the mini-mental state examination (MMSE). The MMSE testing was used as an identification of mild cognitive impairment and dementia,

rather than as a clinical diagnostic indicator [22]. Elderly people that obtained a MMSE score of zero were identified to have severe cognitive impairment.

Statistical analysis

All data are expressed using the mean \pm SD (Standard Deviation). The software Graphpad Prism version 6.0 (GraphPad Software, Inc., La Jolla, CA, USA) was used to perform Fisher's exact test following by relative risk (RR) of SCI calculation, Student's *t*-test, and one-way analysis of variance (ANOVA) test. Differences were only considered to be significant at $p < 0.05$.

Results

The percentage of widowhood was significantly high among high-age elderly people

We collected sociodemographic information from a total of 1177 Chinese elderly people that were living in professional pension institutions and evaluated their cognitive functioning levels using the MMSE test (Table S1). More than 60% of the elderly people aged 80 years or older (Table 1). The low mean MMSE score of the low-age elderly people was still impressive, although the MMSE-evaluated cognitive functioning of the low-age elderly people was noticeably better than that of the high-age elderly people ($p < 0.001$). There was no difference in the proportion of people with high education between the two groups. No participant reported marital status of 'single', 'divorced', or 'cohabitating with others'. In the low-age elderly people group, about 57% of the participants were widowed. Comparably, seven of ten high-age elderly people were widowed. Significant difference between the two groups was found in this percentage ($p < 0.001$). We did not find gender-specific difference on the percentage of widowed people within the high-age elderly people group. The percentage of widowed men was 70.7% and the percentage of widowed women was 71.8%.

Higher educational level and being married decreased the age-related risk of severe cognitive impairment

We evaluated the influence of education and marriage on the incidence of severe cognitive impairment. Widowhood rather than being married significantly increased the age-related risk of severe cognitive impairment (RR 1.46; 95% confidence interval [CI] 1.23–1.74; $p < 0.001$, Table 2). Compared with well-educated elderly people, poor-educated elderly people had a higher age-related risk of severe cognitive impairment (RR 1.36; 95% CI 1.17–1.59; $p < 0.001$, Table 3). When education and marriage were assessed jointly, age-related risk of severe cognitive impairment was completely offset by higher educational level coupled with being married (RR 0.91; 95% CI 0.65–1.27; $p = 0.67$, Table 4). However, those poor-educated

and widowed elderly people had the highest age-related risk of severe cognitive impairment (RR 1.48; 95% CI 1.20–1.82; $p < 0.001$, Table 4).

Well-educated and married high-age elderly people appear resilient to senile dementia

To assess the cognitive impact of education and marriage, participants were further divided into four subgroups, low educational level and being widowed (LW), low educational level and being married (LM), high educational level and being widowed (HW), and high educational level and being married (HM). No significant difference was observed in the MMSE score among the four subgroups of low-age elderly people (Fig. 1A). Comparably, the mean MMSE score of HM elderly people was obviously higher than that of the LW counterparts ($p < 0.01$, Fig. 1B). Further comparisons between the corresponding subgroups in the two age groups revealed obvious age-related cognitive decline in LW, LM, and HW elderly people rather than HM elderly persons.

Discussion

By dividing the participants recruited for this study into two groups, significant differences were observed for the proportion of widowed people rather than the proportion of those with high levels of education. Consistent with previous studies in the United States and South Korea [23,24], our finding suggests a higher risk of severe cognitive impairment among unmarried elderly persons as opposed to those who are married. In our study, only one of three most common unmarried statuses (single, divorced, and widowed) was investigated since our survey indicated that single and divorced elderly persons were rare compared to those who were widowed. Brenowitz and his colleagues found that only the widowed, rather than the single or divorced, held a significant risk for mild cognitive impairment, where the incidence rates for mild cognitive impairment among older married individuals were used as a baseline [25]. Therefore, it is reasonable to suggest that widowed older persons should be investigated separately rather than in conjunction with single or divorced elderly people. Despite women have longer life expectancies than men [26], we found that high-age elderly men and women had similar high widowhood rates. This finding suggests that it is more difficult to continue marriage at an advanced age than to extend life itself for both long-lived men and women. Therefore, marital status is more important for their cognitive ability maintenance than for the younger elderly persons.

For elderly persons with mild cognitive impairment, living in a professional pension institution is not as cost-effective compared to living at home [27]. But through dialogue, we learned that avoiding becoming a burden to their children, rather than economic efficiency, was the main reason many elderly participants chose institutional care. Concern over cognitive decline is the leading reason why older people choose institutional care [28]. Our observation indicates that cognitive functioning among elderly people living in professional pension institutions was generally poor. This finding is consistent with the assertions of Werner and Segel-Karpas, where concerns over dementia may be due to signs of dementia [28]. Other

possible explanations for this is that a shift from familiar surroundings to a new residence in an unfamiliar place might have a negative impact on cognitive functioning [29]. Subsequently, weak interpersonal relationships established in institutions can hardly replace the strong emotional support that comes from marriage. The substitution of strong interpersonal relationship with multiple weak interpersonal relationships has been proven harmful to cognitive functioning [25]. Nevertheless, our results suggest that maintaining married status in old age is still beneficial to maintaining cognition compared with being widowed, even if there are deficiencies in professional pension institutions.

Results of a recent study show that cognitive decline is not inevitable among at-risk elderly persons if continuous lifestyle interventions can be adopted [30]. Compared with other high-age people, married high-age participants with high levels of education were identified as being protective against severe cognitive impairment; this finding was consistent with previous studies [31,32]. Segmentation of the participants implies that married low-age elderly people with high levels of education have the lowest risk of suffering from severe cognitive impairment when they are over 80 years old. Our results suggest that in this subpopulation, the demographical indicators of education and marriage demonstrate a synergistic prevention pattern against severe cognitive impairment. However, it should be noted that such a lower risk was only the result of comparison with the high-age group. Compared with other people in the low-age group, these people did not show a lower rate of severe cognitive impairment.

There are some limitations to this study. First, the sample size of this study is small and we only focused on the elderly people living in professional pension institutions, and we did not investigate the elderly persons living at home. Therefore, the main conclusion identifying an age-related education-marriage synergetic relationship should be considered with caution and is in needs of further validation by larger-scale panel studies. Second, clinical diagnoses of severe cognitive impairment were not used in the study. Relying solely on the MMSE measures may possibly result in the misclassification of research participants. Third, because this is a cross-sectional study, it is difficult to determine the exact role of education-marriage synergy on delaying cognitive decline in elderly people from the perspective of individualization. Fourth, additional factors related to cognitive decline including cardiovascular and cerebrovascular diseases, tobacco and alcohol use, and life style were not evaluated or used for data segmentation in this study.

Conclusions

This cross-sectional study reveals that education alone does not sufficiently address the complexity of protective factors against age-related cognitive decline. Maintaining the integrity of marriage is also necessary for ensuring behavioral independence in the late stage of older life. This age-related synergy between education and marriage against cognitive decline suggests that a stable and strong interpersonal relationship is important for the growing subpopulation of long-lived elderly people with high levels of education. The benefits of marriage become more apparent as people get older. Nowadays, an increasing number of well-educated women are choosing to live independently rather than marry over

considerations of economic independence. This may disrupt the collaborative impact between education and marriage. Further comparative studies are needed to investigate the potential impact of this trend on senile dementia.

Declarations

List of abbreviations

MMSE: mini-mental state examination

Ethics approval and consent to participate

The ethics committee of Ningbo College of Health Sciences (NBWY-010) approved this study. Prior to enrolment in the study, all participants or their guardians were informed of the research plan and signed a written statement of informed consent.

Consent for publication

Not applicable

Availability of data and material

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

NS and RJ conceived and designed the study. NS, CG, TS, XD, LL and PY collected and analyzed the data. NS drafted the manuscript. All of the authors read and approved the final manuscript.

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Not applicable

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Tables

Table 1. Participant characteristics.

Characteristics	Low age (n = 432)	High age (n = 745)
Age (years) mean (SD)	71.5 (5.6)	86.9 (4.7)
Sex (male/female, n)	223/209	278/467
Educational level (low/high, n)	297/135	532/213
Marital status (widowed/married, n)	246/186	529/216
MMSE score (mean, SD)	7.8 (9.0)	5.1 (7.3)

Table 2. Influence of marriage on the incidence of severe cognitive impairment.

Marital status	Low age (SCI/non-SCI)	High age (SCI/non-SCI)	RR (95% CI)	<i>p</i> value
Widowed	95/151	298/231	1.46 (1.23-1.74)	< 0.001
Married	89/97	115/101	1.11 (0.92-1.35)	0.32

SCI: severe cognitive impairment.

Table 3. Influence of education on the incidence of severe cognitive impairment.

Educational level	Low age (SCI/non-SCI)	High age (SCI/non-SCI)	RR (95% CI)	<i>p</i> value
Low	122/175	298/234	1.36 (1.17-1.59)	< 0.001
High	62/73	115/101	1.18 (0.94-1.47)	0.15

SCI: severe cognitive impairment.

Table 4. Joint influence of marriage and education on the incidence of severe cognitive impairment.

Marital status /Educational level	Low age (SCI/non-SCI)	High age (SCI/non-SCI)	RR (95% CI)	<i>p</i> value
Widowed/Low	67/111	218/174	1.48 (1.20-1.82)	< 0.001
Married/High	34/33	35/41	0.91 (0.65-1.27)	0.62

SCI: severe cognitive impairment.

Figures

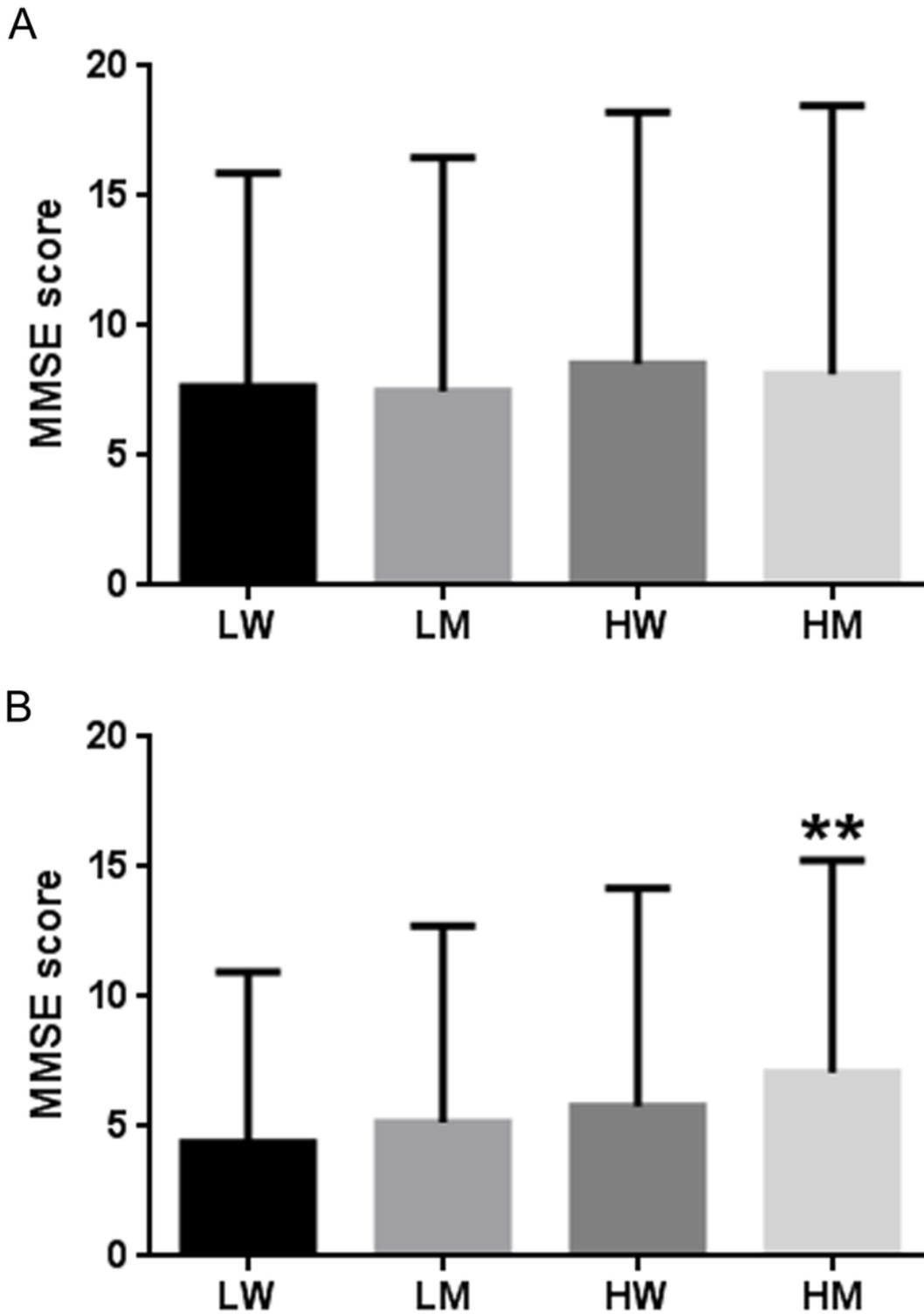


Figure 1

Influence of education and marital status on the cognitive functioning of participants. A. Inter-group comparison of low-age elderly participants. B. Inter-group comparison of high-age elderly participants. LW: low educational level and being widowed; LM: low educational level and being married; HW: high educational level and being widowed; HM: high educational level and being married; MMSE: mini-mental state examination. ** $p < 0.01$, compared with LW.

Supplementary Files

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