Cognitive function in the oldest old: women perform better than men

E van Exel, J Gussekloo, A J M de Craen, A Bootsma-van der Wiel, P Houx, D L Knook, R G J Westendorp

Abstract

Objective—Limited formal education is associated with poor cognitive function. This could explain sex differences in cognitive function in the oldest old. Whether limited formal education explains differences in cognitive function between elderly women and men was explored.

Methods—The Leiden 85-plus Study is a population-based study investigating all 85 year old inhabitants of Leiden with an overall response rate of 87%. A sample of 599 participants were visited at their place of residence. The mini mental state examination was completed by all participants. Cognitive speed and memory were determined with four neuropsychological tests in participants with a mini mental state examination score higher than 18 points.

Results—The proportion of women with limited formal education was significantly higher than that of men (70% vs 53%, p=0.001), but women had better scores for cognitive speed and memory than men (p<0.05). After adjustment for differences in limited formal education and the presence of depressive symptoms, the odds ratio for women to have a higher cognitive speed than men was 1.7 (95% CI; 1.0 to 2.6), and for them to have a better memory the odds ratio was 1.8 (95%CI; 1.2 to 2.7).

Conclusion—Women have a better cognitive function than men, despite their lower level of formal education. Limited formal education alone, therefore, cannot explain the differences in cognitive function in women and men. These findings support the alternative hypothesis that biological differences, such as atherosclerosis, between women and men account for the sex differences in cognitive decline.

Keywords: elderly people; cognition; sex; education; depression

The impressive body of knowledge on cognitive function that has been accumulated leaves many questions on the effect of sex on cognitive function unresolved. One explanation for a possible effect of sex on cognitive function could be that more elderly women have received a limited formal education than men. A limited formal education is associated with less cognitive function. The “brain reserve capacity theory” argues that subjects with less cognitive function—that is, less brain reserve capacity—are more likely to surpass the threshold beyond which cognitive decline becomes clinically apparent. An alternative explanation could be that different biological mechanisms cause differences on cognitive function in elderly men and women.

By measuring cognitive speed and memory, cognitive function in elderly persons can reliably be assessed. Cognitive speed, consisting of attention span and processing speed, is the most sensitive measure because age related cognitive decline first manifests itself by a decline in attention span and processing speed. In old persons memory remains relatively intact until late stages of cognitive decline, whereas cognitive speed declines more rapidly.

We measured cognitive speed and memory in a population based sample of women and men aged 85 years. Our aim was to explore whether there is an effect of sex on cognitive function and whether differences in formal education explain differences between elderly women and men. If this hypothesis is true we would expect women to have a poorer cognitive function than men because of the limited formal education they have received.

Methods

SUBJECTS AND PROCEDURES

The Leiden 85-plus Study is a population based study of inhabitants of Leiden, The Netherlands. Since 1997, all members of the 1912 to 1914 birth cohort were enrolled in the study in the month of their 85th birthday. Those who were eligible for the study were informed about the study by mail. Then they were contacted by telephone, or were visited at home to ask for informed consent. When the subjects were severely cognitively impaired, informed consent was obtained from a guardian. The study was approved by the medical ethics committee of the Leiden University Medical Centre.

Sociodemographic characteristics and living arrangements were obtained for all subjects eligible to participate in the study. The mini mental state examination was administered to screen for cognitive impairment. Subjects were classified as severely cognitively impaired defined by a mini mental state examination score of 18 points or lower. Education was divided into two levels: a lower education level, including participants without schooling or with primary school education only (with a maximum of 6 years of schooling), and those with a higher education level (equivalent to more than 6 years of schooling). Because depression could lead to cognitive impairment, we used the geri-
Multivariate odds ratios were obtained by logistic regression analysis, adjusting for unequal distributions of the number of depressive symptoms and level of education, between men and women. In all analyses speed and memory, as dichotomised variables, were the dependent variables. Sex, level of education, and the presence of depressive symptoms were the independent variables.

Results

Between September first 1997 and September first 1999, 705 inhabitants of Leiden reached the age of 85 years and were eligible to participate in the study. Fourteen inhabitants died before they could be enrolled. The response rate was 87% and a total of 599 subjects (397 women, 202 men) participated. There were no significant differences between the 92 non-respondents and the 599 respondents for various demographic characteristics apart from a slightly skewed sex ratio (72 women refused whereas 61 was expected, p=0.02).

Table 1 shows the demographic and clinical characteristics of the participants. Women were significantly more institutionalised (p=0.01), more often widowed (p=0.001), and had a lower formal education level than men (p=0.001). The median score on the mini mental state examination was 26 points and similar in women (interquartile range 21 to 28) and men (interquartile range 23 to 28). Significantly more women than men (20% vs 9%) had severe cognitive impairment, defined as a mini mental state examination score of 18 points or lower. The distribution of depressive symptoms was similar in women and men.

Three hundred and sixteen women and 184 men had a mini mental state examination higher than 18 points or more and were further characterised for cognitive function using the neuropsychological tests. In 27 women (8.5%) and 27 men (14.7%) the neuropsychological tests to measure cognitive speed and memory...
could not be completed. 18 subjects did not complete the tests because of visual impairment, 20 subjects refused to execute the neuropsychological tests, and 16 subjects did not understand the instructions as given by the research nurse, due to cognitive impairment. There were no demographic or clinical differences between the participants who were able and those who were unable to complete the neuropsychological tests (data not shown).

Table 2 presents the data on cognitive speed for women and men. Women completed the Stroop test more rapidly than men (p=0.01). The median test score on the letter digit test was similar for women and men. Table 3 presents data on memory. Women remembered more words than men on the immediate word learning test (p<0.001). Women had the same test score as men on the delayed word learning test. Participants with a higher level of education had significantly higher scores on the tests measuring cognitive speed (p<0.001). Participants without depressive symptoms scored significantly better on all tests (p<0.001). The effects of formal education and depression on cognitive function were similar in women and men (data not shown).

To further explore the sex differences in cognitive function we categorised participants as having a good or poor cognitive function based on test scores dichotomised around the median. Good cognitive speed was found in 33% of the women and 29% of the men. Forty one per cent of the women and 29% of the men had a good memory. Table 4 shows the crude and adjusted odds ratios for good cognitive speed and memory in men versus women. Odds ratios were obtained in participants with a mini mental state examination score>18 points. The differences between women and men became more apparent and statistically significant after adjustment for unequal distributions of depressive symptoms and formal education. Marital status could not explain the differences between the sexes. Similar odds ratios were obtained when the sample was further restricted to participants with mini mental state examination scores between 28 and 30 points (data not shown). When we evaluated all participants with a mini mental examination score between 0 and 30 points, attributing a poor cognitive speed or memory to those who for cognitive reasons were unable to perform the neuropsychological tests, we obtained similar crude odds ratios.

**Discussion**

The aim of the present study was to explore whether there is an effect of sex on cognitive function and whether a limited formal education explains differences in cognitive function between elderly women and men. We found that women have a better cognitive function than men, despite their lower level of formal education. This effect is far greater than the sex differences that are generally reported at an earlier age. We therefore conclude that limited formal education alone cannot explain the differences in cognitive function in men and women. These findings support our alternative hypothesis that biological differences between men and women could account for the sex differences in cognitive impairment.

Previous studies have described associations between limited formal education, poor cognitive function, and susceptibility to develop dementia. Within the Leiden 85-plus Study, participants with low levels of education also had poorer test scores on the neuropsychological tests. We have earlier reported that elderly persons with poor cognitive function are characterised by an accelerated decline in cognitive function. In line with the “brain reserve theory” these persons are thus more likely to develop dementia. However, the brain reserve theory cannot explain the sex differences in cognitive decline as elderly women have better preserved cognitive function than men.

The neuropsychological tests that were used in the present study could not be administered to participants with severe cognitive impairment. To ascertain that our findings also hold when the population is studied as a whole, we attributed a poor cognitive speed or memory to those who for cognitive reasons were unable to perform the neuropsychological tests. The results were not affected. We also studied the
subgroup of participants who were clinically free from cognitive impairment—that is, mini mental state examination scores from 28 to 30 points. We again found that women had a better cognitive speed and memory.

It is tempting to speculate that biological mechanisms, such as atherosclerosis, could account for the sex differences in cognitive decline. Cerebrovascular disease, a late stage of systemic atherosclerosis, is highly prevalent among elderly persons. Several studies have suggested that atherosclerosis causing subclinical, ischaemic events in the brain contribute to cognitive decline at old age. In this respect it is noteworthy that the accelerated increase in cardiovascular disease at old age starts some 10 years later in women than in men. This delay is reflected by the difference in life expectancy between men and women. The greater life expectancy for women indicates that in comparison with men, elderly women of the same age are relatively free from cardiovascular disease. We hypothesise that the relative absence of cardiovascular disease may explain the better cognitive functioning of old women. Several population based studies have shown that the prevalence of dementia in women older than 80 is higher than that in men. The higher prevalence of dementia can be explained by the finding that the mortality in patients with dementia is lower in women than that in men. The lower mortality in women who have dementia, explains why we found a higher proportion of women with severe cognitive impairment among the oldest.

In conclusion, our study shows that despite a lower level of education women have better cognitive function than men. Differences in the level of education in women and men cannot explain the differences in cognitive function. The better cognitive function in women is more likely to be explained by a biological mechanism, such as atherosclerosis.

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