Effects of demographic and environmental variables on cognitive performance in a rural community sample of elderly people living in Southern Italy

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ABSTRACT. Background and aims: The aim of our study was to understand how demographic and environmental factors may be associated with cognitive functions in a rural population of Southern Italy, with a very high percentage of elderly persons with little formal education. Materials and methods: From the population registry of San Marcellino (province of Caserta), out of 1089 persons aged over 60 years, a random sample of 300 residents received a door-to-door visit. Two hundred and twenty-six subjects were judged as not having significant cognitive impairment, on the basis of their personal history and Clinical Dementia Rating score (<1). They were administered the Mini Mental State Examination (MMSE). Results: A positive statistically significant correlation was observed between MMSE score and education, but not between MMSE score, age and gender. Normative data showed that 90% of the normal population from this area had an adjusted MMSE score of more than 25, a value far below the traditional cut-off score of 23/24 for diagnosis of dementia. Subjects living with their families showed better performance than persons living alone or only with spouses. Conclusions: This finding is consistent with other epidemiologic surveys, and suggests the possible role of ecological and environmental factors in preventing or compensating cognitive decline, at least in persons coming from homogeneous rural areas. Low social demands in a protective family environment do not stimulate high intellectual performance, and signs of dementia may not be recognized by persons living in this context until the patient reaches a severe stage of disease.


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INTRODUCTION

In the last two decades, community studies have given important contributions to knowledge of normal and pathological cognitive decline in elderly populations. In these studies, assessment of cognitive functions was performed by means of tests of mental status, which are easy to administer and reproducible on a large scale. Among these, the one most frequently used was the Mini Mental State Examination (MMSE) (1-11), which has been adopted in combination with other neuropsychological tests (12-15) to screen for cognitive disorders in epidemiologic investigations and to follow cognitive changes in clinical trials.

Previous studies have shown that performance rates using the MMSE are strongly influenced by demographic factors, such as age and education (16-24), so as to require normative data to correct scores to account for these sensitive variables. Illiteracy, in particular, is a potent source of distortion, giving rise to possible overestimation of cognitive decline in the elderly (20, 21, 24), as well as the role of the environment on cognitive performance (8, 20, 23, 24). However, these data have sometimes been discordant, since some studies showed that MMSE scores were not greatly affected by different levels of education (9, 10). In epidemiologic studies performed worldwide, it was suggested that performance on the MMSE varies greatly among countries, and that normative correction cannot be applied to all communities (2, 8, 24, 25).

In this study, we examined performance rates on the MMSE in a community sample of elderly people in Southern Italy, to better understand how demographic and environmental characteristics are associated with cognitive functions in a population characterized by a very high percentage of elderly persons with little formal education. In
particular, we investigated whether a well-established social network in a "low-demand" neighborhood could compensate for little education and possible initial cognitive decline. The investigation is part of a door-to-door two-phase area study, aimed at detecting and following up an elderly rural community sample suffering from dementia.

MATERIALS AND METHODS

Materials

From the population registry of a rural community of Southern Italy (San Marcellino, province of Caserta), we selected all residents aged over 60 years (1089 persons). All subjects were given a progressive number according to alphabetic order of names and included in a computerized data sheet. These numbers were then randomized by the computer and the first 363 subjects (one-third of the whole aged population) were selected for inclusion in the study. Sixty-three out of 363 persons (about 20%) were not evaluated because they had moved to another domicile, or refused the interview. The remaining 300 subjects, still representative of the aged people of the community (27.5%) received a door-to-door visit by a team which included a medical doctor (specializing Geriatrics) and specially trained lay persons (students in their 5th year of the course for a full degree in Psychology). Data from the social network were also collected. Informed consent to use data was obtained from all persons after the interview was fully completed.

Methods

Individual visits consisted of a semi-structured interview aimed at obtaining data from medical history, clinical evaluation of general geriatric conditions, and formal assessment of mental status and functioning. All 300 persons also received a Clinical Dementia Rating (CDR) (26).

We decided to use the MMSE, but not to apply its correction parameters as done in previous Italian studies (16, 17), nor to apply arbitrary cut-off values (16), in view of the specific characteristics of the sample (i.e., the very low level of mean education) and the risk of overestimating cognitive impairment. According to this approach, subjects were judged as having significant cognitive impairment not on the MMSE score, but on the basis of their personal history, clinical evaluation and a CDR score equal to or greater than 1. This pre-screening yielded 226 normal subjects who had normative MMSE scores specific for the study group. Among these 226 subjects, 104 were men and 122 were women; mean age was 70.1 (±6.43, SD). Mean age for men was 70.8 years (SD=6.53) and for women 69.5 (SD=6.43).

According to previous studies on the Italian population (17), subjects were divided into four classes of education: illiterates (0 years of schooling), 1-5 years, 6-10 years, and 10 years. One hundred and ninety-six subjects (more than 85% of the whole population) had less than 6 years of schooling ("elementary") and, of those, 64 (28.3%) had had no formal education. A medium-to-high study level was achieved in only 9/226 persons. Mean years of schooling were 3.91 (SD=3.29) for men and 3.43 (SD=3.28) for women. Unlike the criteria adopted by Grigoletto et al. (17), the large proportion of illiterates in our sample led us to put them in a separate class.

Statistical analysis

The effects of demographic variables on cognitive performance were checked by standard multiple regression analysis (dependent variable: MMSE scores; independent variables: age, sex, education). The level of significance was fixed at p=0.0167, based on a Bonferroni criterion by considering an overall 0.05 level for each measure, divided by the three independent variables. We decided to include only the three principal demographic variables in the analysis, in order to better compare results from our sample with those of other studies in the Italian population (16,17).

NORMS were also expressed as values rounded to the nearest integer at p=10 (10th centile), as a function of the sensitive variable.

The effect of family condition (i.e., living alone, only with spouse, in the family) on performance on the MMSE was evaluated by way ANOVA and post-hoc test (Scheffé).

Computation was carried out using the StatView 4.5 statistical package (Abacus Concepts Inc., Berkeley, CA, USA) running on a Macintosh personal computer.

RESULTS

Table 1 shows the mean values (±SD) of MMSE scores according to the four education levels, with mean ages. The mean MMSE score for the whole population was 22.013 (SD=4.70).

As expected, the lowest mean score was observed at the lowest education level, and the highest in the 9 persons who had had 10 years of schooling.

Table 1: Mean (±SD) scores on MMSE by classes of education.

<table>
<thead>
<tr>
<th>Classes of education (years of schooling)</th>
<th>None</th>
<th>1-5 years</th>
<th>6-10 years</th>
<th>&gt;10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>71.90</td>
<td>69.64</td>
<td>66.62</td>
<td>71.78</td>
</tr>
<tr>
<td>Mean MMSE</td>
<td>19.33</td>
<td>22.38</td>
<td>25.47</td>
<td>26.77</td>
</tr>
<tr>
<td>SD</td>
<td>4.59</td>
<td>4.36</td>
<td>3.65</td>
<td>2.17</td>
</tr>
</tbody>
</table>
who had been to school for more than 10 years. Regression analysis had an R² of 0.248, with an intercept of 25.873. A strong positive effect of education on cognitive performance was observed (coefficient=0.673, t=7.873, p<0.0001). Unexpectedly, age (years) and sex variables were not related to MMSE scores (t=-1.795, p=0.074; t=-0.976, p=0.33 respectively). According to the results of regression analysis, norms included only the education variable (Fig. 1). Whole data showed that 90% of the normal population from this area achieved a MMSE score of more than 16.20, this statement having a probability of 95% of being true. Therefore, both if the arbitrary cut-off score of 24 had been used, and if correction parameters from normative Italian studies had been applied (16), a large proportion of our subjects could have been diagnosed as cognitively impaired. This was not the case, as subjects were all considered normal after careful examination and lived normal lives in their neighborhood.

The significant effect of family condition on MMSE scores was observed (F=9.339, p=0.0025). The post-hoc test showed worse performance in subjects living alone, compared with both persons living with their family (p=0.009) and with spouses (p<0.05).

**DISCUSSION**

The MMSE is a widely recognized instrument for detecting cognitive impairment, although it has important limitations when used as a screening tool in general population assessment. As a matter of fact, the Molina Project investigated a random sample of 1367 community-dwelling individuals (>65 years old) in a rural, low-education community sample and found poor sensitivity of MMSE scores (49%) with acceptable specificity (92%) for detecting dementia (25). Similarly, a study by Kulal et al. (27), in a registry of 150 consecutive subjects with cognitive complaints, indicated a similarly low sensitivity level (63%) and good specificity (96%) in the standard cut-off of <24 on the MMSE scores. Other studies in the USA, such as those from the Mayo Clinic (28) and North Manhattan (29), and from other developed countries in Northern Europe with a generally high level of education, consistently found low sensitivity and good specificity in detecting dementia in a general population setting. In old persons living the community of Gironde (France) Gagnon found that 85% of the subjects were false-positive for diagnosis of dementia (30). Even in a general medical ward, the MMSE alone cannot yield a diagnosis for dementia and delirium (30). Studies in countries where illiteracy or a very low education level are highly prevalent, also showed the limitations of the MMSE, as well as of other neuropsychological tests in the investigation of elderly people. In Shanghai, a significant increase in low scores on the MMSE was observed in those who had never gone to school, reflecting the lack of formal education and the need to use different models of investigations in these populations (2). The distribution of MMSE scores of women aged 70-79 years from a rural area of Cambridgeshire (U.K.), showed that increasing age, lower socio-economic group, and lower education were all associated with lower MMSE scores. Of these, only increasing age was significantly related to an increase in the diagnosis of dementia (3). The limitations of the MMSE were also observed by O'Connor in a British community survey (5), also in association with other tests, such as the Cambridge Mental Disorders of the Elderly Examination (CAMDEX). In a comprehensive review by Tombaugh, MMSE scores were affected by age, education, and cultural background. The author suggested that the MMSE should not be used as a diagnostic tool to identify dementia (8). All these studies showed the inconsistency of the MMSE in evaluating subjects in the general population, and have given little information on the possible causes for the low scores, other than poor education. However, the latter was not consistent in two studies (9, 10). Our study confirms the role of education level in cognitive performance in elderly subjects and supports previous evidence also in Italian populations (16, 17). Elderly subjects may be considered as being at risk of dementia only due to lack of formal education or illiteracy, because the assessment method does not take into consideration different social and geographic environments, even in the case of the same linguistic group.

Regression analysis did not show the significant influence of age on MMSE scores, although most of the previous normative studies had found the negative effect of age. This finding may partially depend on the specific door-to-door setting adopted in this study. Since elder-

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**Figure 1** - Norms of MMSE (cut-off values at 10th centile) in four classes of schooling.
ly people perform better on the MMSE at home (31), and since spatial orientation and memory subset are known to be lower in the elderly (32), our home-based assessment may have reduced the influence of items on orientation, contributing to partially masking cognitive impairment.

A second interpretation points out the possible role of ecological and environmental factors: a "low-demand" neighborhood with a well-established social network, still very common in the rural areas of Southern Italy, may play a role in preventing or compensating "physiological" cognitive decline. Also, the lack of influence of gender may depend on the low level of education in both sexes. In this context, a social network where orientation and other types of performance, such as arithmetic or drawing capability, are not required, may maintain normal behavior and cognitive ability for a long time even in those who have initial signs of dementia. In fact, dementia may be interpreted, in a behavioral perspective, as resulting from a critical discrepancy between the demands made by the environment and the availability of cognitive resources with which to cope with them. This insight again alerts clinicians in diagnosing dementia in particular neighborhoods: assessment mainly focusing on mental status could lead to overestimation of dementia, and evaluation mainly focusing on social functioning may lead to underestimation. In our study, we did not find any influence of age on MMSE scores, a result similar to that observed by Heeren (6), who investigated elderly people aged over 85 years free of any psychiatric or neurological disease.

Among these environmental factors, the effect of family condition should also be taken into account. Subjects living with their families achieved better MMSE scores than those living alone or with their spouses only. Our data support recent findings from a study in an urban Swedish community (33, 34), in which the authors report that individuals living alone and those without any close social ties had a higher risk of developing dementia, suggesting that an extensive social network seems to protect against dementia. Our results show that a relationship between cognitive decline and family network can also be identified in normal elderly people from an environment very far from those investigated in the Kuopio cohort project (33, 34). Probably normal low social demands, as occurs in rural areas of Southern Italy, may delay identification of signs and symptoms of dementia and help patients to live in an adequate setting provided by social relationships.

CONCLUSIONS

Our results lead us to conclude that the "classic" cut-off value of 23-24 on the MMSE (also as a result of correction factors) may seriously contribute to the diagnosis of dementia in a large proportion of persons without significant problems in everyday functioning. This issue partially shifts the problem of diagnosing dementia from the individual to the environment. Environmental and family factors should always be taken into account when assessing persons suspected of dementia using the MMSE, particularly individuals with very low education levels coming from rural areas. Moreover, dementia should be diagnosed in these persons only when a very severe stage of disease has been reached, when social discrepancy will be noted even in a poor environment.

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