Screening of Dementia
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Asia is the most populous region in the world and its rapidly growing societies are the sources of global development. However, aging of its population with increasing occurrence of diseases, of which dementia is the most prominent, is a major challenge to healthcare system. For example, there are 177 million people aged 65 and older living with dementia in China, expressing 20% of dementia patients worldwide. It has been estimated that the Chinese proportion of the elderly will reach 30.4% in 2050, which will include 100 million elderly people over 80 years of age [1]. Dementia prevalence in Asia, however, has previously been found to be lower than in Western populations [2]. Cultural differences could contribute to this. Dementia research in Chinese population has been primarily focused on Alzheimer’s disease and vascular dementia [2]. Most of our knowledge about dementia, however, comes from studies in Caucasian population. Early and accurate diagnosis of dementia is crucial in order to start with the treatment as early as possible. Intervention and treatment of dementia (AD-dementia) can be cost-effective, but the majority of patients are not diagnosed in a timely manner. Technology is now available that can enable earlier detection of cognitive loss associated with incipient dementia, offering the potential for earlier intervention and health care systems and resulting in a less financial burden to an individual and a society. In this special issue on screening of dementia, we focused on screening tests for the detection of very mild dementia. We have invited a few papers that address those topics accordingly.

One paper of this special issue gives a view on dementia screening in an outpatient department of a regional hospital in Taiwan by means of AD8 (ascertainment of dementia 8), a brief informal interview to screen dementia [3]. Screening people at the risk of dementia is a first and a major issue in screening of dementia. Another paper explores depression as a crucial public health issue in Taiwan. By means of brief tool, Epidemiological Studies Depression Scale (CES-D), to screen depression, a ratio of 16.4% of suspected depression patients compared to 13.3% aged patients out of all recruited patients was shown. This result may provide important information for a public health issue. In another paper, by means of AD8 consistent problems with thinking and/or memory were found in 56.8% participants, difficulty in remembering appointments was found in 47% participants, forgetting correct month or year was found in 40.9% of recruited participants in Taiwan, accordingly. Another paper presents the utility of informant AD8 for case finding of cognitive impairment in primary healthcare setting in Singapore. On a sample of 205 patients and their informants, AD8 was shown to be useful for case finding of cognitive impairment in the primary healthcare in one-third of adult patients. Another
paper shows efficacy of the Takeda Three Colors Combination (TTCC) test, a screening tool for detection of very mild AD-dementia in Japan. Despite a lower sensitivity, a TTCC test was accomplished within 2 minutes in all subjects, thus being a great potential for the use as an AD screening tool by general practitioners in communities worldwide. Another paper assesses the influence of education on the performance of Chinese version of the Montreal Cognitive Assessment (C-MoCA) compared to Mini-Mental State Examination (MMSE) in detecting amnestic mild cognitive impairment (aMCI) among rural population in Beijing community. C-MoCA showed modest accuracy and was no better than MMSE in detecting aMCI, most likely due to overwhelming effect of education relative to aMCI diagnosis on variations in C-MoCA performance. Finally, all presented cognitive tests show great potential for the use as screening tools for early and very mild dementia worldwide, being easy to apply and at a low cost in communities worldwide.

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References

Screening Dementia in the Outpatient Department: Patients at Risk for Dementia

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Received 4 July 2014; Revised 8 August 2014; Accepted 26 August 2014; Published 8 December 2014

Academic Editor: Huali Wang

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The targeted screening for individuals at the risks of having dementia would be crucial to the further public health issues for dementia. This study aimed to conduct a screening study in an outpatient department of a regional hospital to screen people who were at risk of developing comorbid dementia. Patients who visited Kaohsiung Municipal Ta-Tung Hospital (KMTTH) clinics during the period from June 1, 2013, to May 31, 2014, were invited to participate in this screening voluntarily. The trained interviewer collected all participants’ demographic characteristics and used the instrument of ascertainment of dementia 8 (AD8) to find out suspected dementia ones. The result showed a higher ratio (24.1%) of suspected dementia in the outpatient department of a hospital, 500 out of 2017 subjects, than that in the general population. The median (interquartile range) age was significantly higher in the suspected dementia participants (70, (62, 77)) compared to that in nonsuspected dementia ones (65, (60, 73)), and the probability of suspected dementia was significantly increasing with age ($P < 0.001$). Instead of screening dementia in general population, screening people at the risk of dementia could be the practicable and important issues in the care of dementia.

1. Introduction

Dementia is a major public health problem related to the aging population in developed countries. The aged population has increased rapidly in Taiwan, from 10.74% in 2010 to 11.53% in 2013 and is estimated to reach 20% in 2025 [1]. With the rapidly increasing aged population, the global prevalence of Alzheimer's disease (AD) is expected to dramatically increase by 2050, with Asia estimated to account for 59% of worldwide cases [2]. The increasing prevalence of cognitive impairment in the general population emphasizes the need for early intervention and treatment.

Conducting broad dementia screening in the general population is unreasonable because the prevalence rate of dementia and related disorders among people is too low to yield satisfactory results. However, because the risk of dementia increases substantially with age, approaching 45% among Americans aging 85 and older [3, 4], the targeted screening of at-risk individuals is reasonable.

In addition, according to the World Alzheimer Report from 2013 [5], people with dementia demonstrate a high level of use regarding health services and represent a large fraction of the healthcare costs attributed to the elderly population. Moreover, patients with dementia have an average of 2 to 8 additional chronic diseases (comorbidities) [6, 7]. These chronic diseases may accelerate progression towards a state of cognitive and functional impairment that lead to increased...
hospital visits and result in the underdiagnosis and under
treatment of dementia [8]. Similar to other clinically complex
circumstances, the presence of comorbidities in patients
with chronic diseases requires the careful consideration
[9] of possible conflicts between multiple treatments and
recommendations for these patients [10]. Patients who visit
outpatient departments are at a higher risk of developing
comorbid dementia because of their multiple underlying
diseases compared with those who do not [6]. In addition,
previous studies have indicated that most suspected dementia
patients visit primary physicians first instead of neurologists
[7, 11]. Therefore, identifying a high risk of dementia in people
who visit outpatient departments in all primary clinics is
crucial for early diagnosis and early treatment.

Kaohsiung Municipal Ta-Tung Hospital (KMTTH) is a
regional teaching hospital in Southern Taiwan, which was
established and founded on January 15, 1946, and origi-
nally named the "Kaohsiung Municipal Hospital." Currently,
KMTTH has 17 clinical departments (including internal
medicine, surgery, obstetrics/gynecology, pediatrics, ortho-
pedics, ophthalmology, otolaryngology, a radiation oncology
center, urology, dermatology, rehabilitation, psychiatry, fam-
cine medicine, occupational medicine, dentistry, a neurology
clinic, and preventive medicine) and 479 beds. On average,
KMTTH serviced approximately 40,000 clinic patients, 3,500
emergency visitors, and 7,000 acute ward admission patient-
days per month during 2013. As a regional teaching hos-
pital, the service regions of KMTTH include the Cianjin,
Hsingsin, and Yenche Districts with 3.88% Kaohsiung resi-
dents (107773/2778920), where the percentage of older people
in the population is high and growing (≥65 years: 22.39% in
these 3 districts versus 11.08% in Kaohsiung City) [12]. The
targeted screening of at-risk individuals in a hospital that
provides services for this aged population could be highly
effective in dementia care. Patients who visited the KMTTH
outpatient department were invited to participate in this
study by voluntarily undergoing screening for dementia using
the AD8 from June 1, 2013, to May 31, 2014. The methods and
results are detailed in the following section.

2. Material and Methods

2.1. Participants and Evaluation. Patients who had visited
KMTTH clinics (including the 17 clinical departments) during
the period from June 1, 2013, to May 31, 2014, were invited
to participate in the screening activity voluntarily. The trained
interviewer collected the information of the age, sex, and
living area of all participants. All procedures were approved
by the Kaohsiung Medical University Hospital Institutional
Review Board. All private information and information that
could be used to identify the participants were not recorded
during the screening process.

2.2. Cognitive Screening (Ascertainment of Dementia 8 (AD8)).
AD8 is a brief tool used to screen dementia that was
developed at Washington University in St. Louis [13] and is
capable of screening extremely mild dementia in the general
population; it is also used extensively in multiple countries,
including Taiwan, after validation [14]. If the score of AD8
is greater than or equal to 2, the person is considered to be
suspected of dementia, including extremely mild dementia
[14]. The AD8 can be conducted on the informant of patients
with dementia and the patients themselves with a similar dis-
criminative rate in differentiating patients with and without
dementia [15].

All the participants were interviewed face-to-face by the
trained interviewer to assess their cognitive function status
with the instrument of AD8. A participant was considered to
be suspected of dementia with a cut-off of total AD8 score
greater than or equal to 2.

2.3. Statistics. Data analysis was performed using SPSS soft-
ware (version 12.0.1 for Windows; SPSS Inc., Chicago, IL,
USA). All statistical tests were 2-tailed and P value of 0.05
was considered statistically significant. Wilcoxon rank sum
test, a nonparametric test (\( \alpha = 0.05 \)), was used to compare
the median (interquartile range) of age and total AD8 score
between patients of suspected and nonsuspected dementia.
We divided the continuous variable of age into 4 categories:
not elderly (<65 y old), young elderly (65–74 y old), old
elderly (75–84 y old), and "super-old" elderly patients (≥85 y
old) for easy comparison [14–17]. Kruskal-Wallis test was used
to compare the difference in the median of total AD8 score
among the age groups of all the suspected dementia patients.
The chi-square test was used to compare the proportion of
each reported subitem of the AD8 and gender between
the patients with suspected and nonsuspected dementia and
among the age groups (<65, 65–74, 75–84, and ≥85 years) of
all suspected dementia patients.

3. Results

We have recruited 2071 participants during their visit of clinic
at the outpatient department into the statistical analysis.
The medians (interquartile range) age of years and AD8
score were (66, (60, 74)) and (0, (0, 1)) the majority of
the participants were female (52.4%) (Table 1). A total of

| Table 1: Demographic characteristics of all the recruited partici-
| pants. |
|-----------------|-----------------|
| Number (N, %)   | 2071, 100%      |
| Age, years      | 66, (60, 74)    |
| (median, (IQR\(^{8}\)) )< 65 | 888, 42.9% |
| 65–74               | 667, 32.2% |
| 75–84               | 426, 20.6% |
| ≥85               | 90, 4.3% |
| Female (n, %)     | 1085, 52.4% |
| AD8 score (median, (IQR\(^{8}\)) )< 2 | 1571, 75.9% |
| ≥2               | 500, 24.1% |

\(^{8}\)IQR: Interquartile range.
Table 2: AD8 subitems for the nonsuspected and suspected dementia participants.

<table>
<thead>
<tr>
<th>AD8 subitems</th>
<th>Nonsuspected</th>
<th>Suspected</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1571</td>
<td>500</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>(N, %)</td>
<td>75.9%</td>
<td>24.1%</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>65, (60, 73)</td>
<td>70, (62, 77)</td>
<td></td>
</tr>
<tr>
<td>(median, IQR)</td>
<td></td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>719, 45.8%</td>
<td>169, 33.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>65–74</td>
<td>505, 32.1%</td>
<td>162, 32.4%</td>
<td></td>
</tr>
<tr>
<td>75–84</td>
<td>300, 19.1%</td>
<td>126, 25.2%</td>
<td></td>
</tr>
<tr>
<td>≥85</td>
<td>47, 3.0%</td>
<td>43, 8.6%</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>822</td>
<td>263</td>
<td>0.914</td>
</tr>
<tr>
<td>(n, %)</td>
<td>52.3%</td>
<td>52.6%</td>
<td></td>
</tr>
<tr>
<td>AD8 score</td>
<td>0, (0, 1)</td>
<td>3, (2, 4)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>(median, IQR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*AD8-1</td>
<td>21, 1.3%</td>
<td>137, 27.4%</td>
<td></td>
</tr>
<tr>
<td>*(n, %)</td>
<td>11, 71%</td>
<td>240, 48.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-3</td>
<td>87, 5.5%</td>
<td>254, 50.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-4</td>
<td>8, 0.5%</td>
<td>129, 25.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-5</td>
<td>25, 1.6%</td>
<td>180, 36.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-6</td>
<td>9, 0.6%</td>
<td>102, 20.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-7</td>
<td>17, 1.1%</td>
<td>192, 38.5%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>*AD8-8</td>
<td>227, 14.5%</td>
<td>422, 84.4%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Defined as a total AD8 score ≥2.
*Obtained by the Wilcoxon rank sum test.
IQR: interquartile range.
"Change" in each AD8 subitem (number and percentage in that area).

500 participants (24.1% of all the recruited participants) had suspected dementia with an AD8 score of greater than or equal to 2 (Table 1). The median of age (P < 0.001) and total AD8 score (P < 0.001) were significantly different between the groups of nonsuspected and suspected dementia, but the distribution of sex was similar between the two groups (P = 0.914) (Table 2).

The ratio of reported change for each subitem of the AD8 and total AD8 score were significantly different between people with nonsuspected and suspected dementia (P < 0.001 for the comparison of each AD8 subitem and total AD8 score) (Table 2). In the nonsuspected dementia group, subitems AD8-8 (consistent problems with thinking and/or memory) (14.5%), AD8-2 (reduced interest in hobbies/activities were frequently reported) (7.1%), and AD8-3 (repeats questions, stories, or statements) (5.5%) were the 3 most frequently reported "changes" among the AD8 subitems (Table 2). These frequently reported changes in the nonsuspected dementia group were similar to those reported in the suspected dementia group, in which AD8-8 (84.4%), AD8-2 (48.0%), and AD8-3 (50.8%) were frequently reported (Table 2), and the frequencies were higher in the suspected dementia group compared with those in the nonsuspected dementia group.

The ratio of patients with suspected dementia significantly increased with age to 18.9%, 24.3%, 29.6%, and 47.8% among the <65, 65–74, 75–84, and ≥85 age group categories (P for trend < 0.001), respectively (Table 3). The distribution of sex was not significantly different among the age groups (P = 0.124) of all suspected dementia participants, but the AD8 score was significantly different (P = 0.005). The AD8 score was the highest (median, (interquartile range): 4, (2, 5)) in the ≥85 age group and the lowest (median, (interquartile range): 3, (2, 4)) in the <65 age group. The ratio of reported change for each subitem of the AD8 and total AD8 score were significantly different among age groups, except for AD8-2 (reduced interest in hobbies/activities) (P = 0.385) and AD8-5 (forgets the correct month or year) (P = 0.220) (Table 3). Among the subitems of the AD8 with a significant difference among age groups (AD8-1, AD8-3, AD8-4, AD8-6, AD8-7, and AD8-8), the ≥85 age group had a higher ratio of reported change compared with that of the other age groups, except for AD8-8.

4. Discussion

In this study, a higher ratio (24.1%) of dementia was observed in the outpatient department of KMTTH clinics compared with that in the general population (13.6% in people who underwent general screenings and 8.0% for the age-adjusted prevalence of all-cause dementia) [18, 19] and the mean age was significantly higher in the suspected dementia participants compared with that of the participants without dementia. In addition, the ratio of dementia was determined to increase rapidly with old age.
For the general population, the results of a recent walk-in screening for dementia in Taiwan [18] indicated a 13.6% ratio of dementia, which was higher than that reported in previous studies. In addition, another nationwide population-based cross-sectional survey conducted in Taiwan indicated that the age-adjusted prevalence of all-cause dementia was increasing (8.0%) and old age, female gender, and a low educational level were significant associated factors [19]. Several differences exist between these 2 studies and this study. First, the people who underwent targeted screening in this study conducted in the outpatient department may be more at risk or exhibit more morbid conditions than the people in the previous 2 studies conducted in the general population. Second, the assessment tool used was different between one of the 2 recent studies and our study. We used the AD8 as the screening instrument, which is capable of being used to screen extremely mild dementia [13–15] and is more sensitive compared with other tools used previously (e.g., the minimental state examination) [16, 20, 21]. However, all 3 studies have demonstrated that the estimated number of people with dementia in Taiwan during the 2010s is rapidly increasing with the increase in the aged population (the proportion of people over 65 y of age increased from 6.8% in 1992 to 11.1% in 2012) [12], although different diagnostic criteria and study designs might have contributed to the variations in the epidemiological reports in these studies.

In addition, we determined that the AD8 score significantly increased with age and the "super-old" group (≥85 y) had a considerably higher proportion of participants with suspected dementia (47.8%) compared with those in the other age groups. This result was consistent with most of the previous studies that have indicated that cognitive function declines with age [22]. Furthermore, these suspected dementia patients should be monitored by their primary physicians because they will most likely develop dementia, based on the high sensitivity and specificity of the AD8 in screening dementia. Moreover, Taiwan was estimated to be an aged society (>14% elderly people) in 2017 and a "super-old" society (>20%) in 2025 according to the survey conducted by the Taiwan Alzheimer's Disease Association [23]. Therefore, detecting people who are at risk for dementia early with a highly sensitive tool is a crucial concern for healthcare units because early diagnosis may increase the beneficial effects of new therapies.

Each reported subitem of the AD8 was significantly different between the participants with suspected dementia and those without dementia, and the 3 most frequently reported AD8 subitems exhibited no significant difference (AD8-8, AD8-2, and AD8-3). However, the distribution of frequently reported AD8 subitems was different from that of the general population, in which AD8-8 (6.4%), AD8-2 (3.1%), and AD8-5 (3.0%) were the 3 most frequently reported in the group without dementia and AD8-8 (56.8%), AD8-7 (47.0%), and AD8-5 (40.9%) were the most frequently reported in the suspected dementia group [18]. Among the age groups of suspected dementia participants, the reported change of AD8 subitems was significantly different, except for AD8-2 (reduced interest in hobbies/activities) and AD8-5 (forgets the correct month or year). KMTTH is located in an urban but cultural community that contains more

Table 3: AD8 subitems based on age groups among the suspected dementia participants.

<table>
<thead>
<tr>
<th>Age group years</th>
<th>&lt;65 (N = 888)</th>
<th>65–74 (N = 667)</th>
<th>75–84 (N = 426)</th>
<th>≥85 (N = 90)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (n, %)</td>
<td>169 (18.9%)</td>
<td>162 (24.3%)</td>
<td>126 (29.6%)</td>
<td>43 (47.8%)</td>
<td></td>
</tr>
<tr>
<td>Sex female (%)</td>
<td>99 (58.9%)</td>
<td>83 (51.2%)</td>
<td>57 (45.2%)</td>
<td>24 (55.8%)</td>
<td>0.124</td>
</tr>
<tr>
<td>AD8 score (median, IQR)</td>
<td>3 (2, 4)</td>
<td>2 (2, 4)</td>
<td>3 (2, 4)</td>
<td>4 (2, 5)</td>
<td>0.005*</td>
</tr>
<tr>
<td>AD8-1</td>
<td>47, 28.0%</td>
<td>38, 23.6%</td>
<td>33, 26.2%</td>
<td>18, 41.9%</td>
<td></td>
</tr>
<tr>
<td>AD8-2</td>
<td>81, 48.5%</td>
<td>75, 46.3%</td>
<td>56, 44.4%</td>
<td>28, 65.1%</td>
<td>0.385</td>
</tr>
<tr>
<td>AD8-3</td>
<td>73, 43.7%</td>
<td>83, 51.6%</td>
<td>68, 54.4%</td>
<td>30, 69.8%</td>
<td>&lt;0.013</td>
</tr>
<tr>
<td>AD8-4</td>
<td>34, 20.4%</td>
<td>43, 26.5%</td>
<td>36, 28.6%</td>
<td>16, 37.2%</td>
<td>0.002</td>
</tr>
<tr>
<td>AD8-5</td>
<td>50, 29.8%</td>
<td>57, 35.2%</td>
<td>56, 44.4%</td>
<td>17, 39.5%</td>
<td>0.220</td>
</tr>
<tr>
<td>AD8-6</td>
<td>37, 22.2%</td>
<td>28, 17.3%</td>
<td>23, 18.3%</td>
<td>14, 32.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AD8-7</td>
<td>57, 33.9%</td>
<td>59, 36.7%</td>
<td>54, 42.9%</td>
<td>22, 51.2%</td>
<td>0.018</td>
</tr>
<tr>
<td>AD8-8</td>
<td>142, 84.5%</td>
<td>141, 87.0%</td>
<td>108, 85.7%</td>
<td>30, 69.77%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Defined as a total AD8 score of ≥2.
†Suspected dementia participants/total participants in this age group.
‡Female suspected dementia participants/suspected dementia participants in this age group.
§IQR: interquartile range.
*Obtained by the Kruskal-Wallis test.
**“Change” in each AD8 subitem (number and percentage in that area).
AD8-1: problems with judgment; AD8-2: reduced interest in hobbies/activities; AD8-3: repeating questions, stories, or statements; AD8-4: difficulty in learning how to use a tool, appliance, or gadget; AD8-5: forgetting the correct month or year; AD8-6: difficulty in handling complicated financial affairs; AD8-7: difficulty in remembering appointments; AD8-8: consistent problems with thinking and/or memory.
retired government employees and teachers, which may cause reduced fluctuation in the activities and living habits of the residents. Similarly, retired and aged people with a high education level and cultural background may meticulously arrange their schedule activities, causing them to note the date frequently. In this study, the "super-old" (≥85 years) participants all reported a higher proportion of AD8 subitems, except for AD8-8 (consistent problems with thinking and/or memory). Generally, the impairment of recent memory could be the initial presentation of extremely mild dementia, especially in people with Alzheimer's disease [24, 25]. We recruited few overall and suspected dementia participants in the "super-old" group and no clinical data on the subtype of dementia were obtained to explain this result. Therefore, further study on the various characteristics of elderly people may be required.

This study has some strength. First, this is the first study to target and screen at-risk patients in an outpatient department where they were usually neglected in a routine screening of dementia. Second, we use the AD8 as a screen tool that was capable of screening dementia at its very mild stage. However, this study has several limitations. First, the participants were not recruited using randomized sampling from the general population, which may influence the external generalization of the results. Second, the participants recruited from one single regional hospital cannot be applied to all hospitals and they may exhibit more morbid conditions than others do. Third, we had neither detailed information about comorbidities and education nor information on the further diagnosis to clarify whether he was dementia or not. However, the aim of this study was to screen at-risk people who visited the outpatient department of a hospital. The other goal of this study was to provide the primary physicians at the hospital with data on the high ratio of dementia patients who visited the outpatient department and suggest that they screen and diagnose these patients early because most dementia patients visit primary physicians instead of neurologists [7, II].

In conclusion, we observed a higher ratio (24.1%) of dementia in the outpatient department of a hospital than in the general population, and the ratio was confirmed to increase rapidly with age.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References


[23] The survey of institutional needs for dementia in Taiwan.


Research Article

Feasibility and Acceptability of the Informant AD8 for Cognitive Screening in Primary Healthcare: A Pilot Study

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Received 27 August 2014; Accepted 27 September 2014; Published 7 December 2014

Academic Editor: Görsev G. Yener

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Objectives. The utility of informant AD8 for case finding of cognitive impairment at primary healthcare settings is unknown and therefore its feasibility and acceptability for targeted screening at a primary healthcare clinic should be investigated. Methods. The informants of older adult patients attending a primary healthcare clinic in Singapore were administered the AD8. Positive screening findings were provided to patients’ primary care physicians for referrals to specialist memory clinics. The acceptability of AD8 was evaluated by collecting feedbacks from the informants and primary care physicians. Results. 205 patients and their informants were recruited. However, 6 (2.9%) informants were uncontactable, while the majority of the remaining 199 patients with completed AD8 (96.5%, n = 192) found it acceptable where 59 (29.6%) patients were deemed cognitively impaired (AD8 ≥ 2). Clinicians (100%, n = 5) found the AD8 helpful in facilitating referrals to memory clinics. However, most referral recommendations (81.4%, n = 48) were declined by patients and/or informant due to limited insight of implications of cognitive impairment. Conclusions. The AD8 can be easily administered and is well tolerated. It detected cognitive impairment in one-third of older adult patients and therefore may be useful for case finding of cognitive impairment in the primary healthcare.

1. Introduction

Dementia is a global public health priority [1] with increasing prevalence due to aging populations. The number of people aged 60 and older living with dementia has been estimated to be 24.3 million and is expected to double every 20 years by 2040 [2]. However, rates of unrecognized dementia in the primary healthcare setting were reported to range from 3.2% to 12% in 2003 [3] and have been found to be alarmingly higher at 81.3% in older adults (≥65 years old) residing in Indianapolis [4]. In that study, the authors concluded that most primary healthcare practices were ill prepared to provide dementia screening and diagnosis program. Whilst the prevalence of dementia in community-dwelling Singaporean older adults (≥50 years old) was reported to be 1.3% [5], the rate of unrecognized dementia in the primary healthcare setting in Singapore is unknown and requires investigation. Hence, it is important to establish an effective brief instrument to detect cognitive impairment in older adult patients in a primary healthcare setting.

Several brief cognitive instruments have been suggested for routine screening in primary care [6]. These included performance based instruments (Mini-Cog, the Memory Impairment Screen and General Practitioner Assessment of Cognition (GPCOG)) and informant based instruments (short Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), GPCOG, and the informant AD8). These instruments were recommended due to short administration time (<5 minutes), ease in administration which does not require highly trained personnel, and good psychometric
properties, as well as validation in a primary care or community setting. Of these instruments, the AD8 [7], a recently developed brief “Eight-item Interview to Differentiate Aging and Dementia” cognitive instrument, may be more suitable for case finding of cognitive impairment in Singapore primary healthcare clinics. It has demonstrated good discrimination for uncertain or questionable dementia [7] and consists of 8 questions which track the intraindividual functional decline attributed to cognitive deficits and is therefore less influenced by culture, education, gender, and age [8]. The AD8 follows a yes-no format with the total score based on “yes” response only which can be completed within approximately 3 minutes [7]. A previous study has proposed that the AD8 can be administered to either informants or patients in person or over the phone [9, 10]. However, our recent study at a memory clinic has found that the informant AD8 is superior to the patient AD8, and equivalent to the Minimental State Examination and the Montreal Cognitive Assessment in screening for mild cognitive impairment and dementia in memory clinic patients [11]. However, the utility of the informant AD8 for case finding of cognitive impairment in a primary healthcare setting has not been examined.

Therefore, in this pilot study, we aimed to examine the feasibility and acceptability of the informant AD8 for case finding of cognitive impairment in a primary healthcare setting in Singapore. We hypothesize that (1) the informant AD8 can be efficiently administered to informants of older adult patients aged 60 and above; (2) the informant AD8 can be easily completed in a busy primary healthcare setting; (3) the informant AD8 is clinically relevant at the primary healthcare setting because it can facilitate referrals to a specialist memory clinic.

2. Methods

2.1. Participants. The study was conducted at the “Chronic Illness” clinic at Bukit Batok Polyclinic in Singapore between March 2012 and April 2012. Eligible patients are those who (1) were aged 60 and above, (2) provided consent, and (3) had an informant with sufficient language skills in English, Chinese, or Malay to complete the AD8. Reasons for declining participation were collected. Informants of recruited patients completed the AD8 independently or with assistance from a trained research psychologist at the waiting area of the clinic. The AD8 was also conducted over the phone for informants who were not present in the clinic. The time taken for test administration and demographic characteristics of patients and informants were collected. This study was approved by the local ethics committee and conducted in conformity with the Declaration of Helsinki. Written informed consent was obtained from all patients and their informants.

The AD8 is an eight-item questionnaire covering judgment, memory, and function. It was developed as an informant-rated measure to track intraindividual functional decline over the past several years attributed to cognitive impairment. It follows a yes-no format (“Yes, A change,” “No, No change,” and “N/A, do not know”) and takes approximately 3 minutes to complete [7]. The total score is the sum of the number of items with a response “Yes, A change.” The AD8 scores of 0-1 can be interpreted as normal cognition, while scores of ≥2 indicate impairment in cognition. A cutoff of 2 was selected according to recent studies in Singapore and a previous community-based study [10, 11]. Patients with the AD8 scores ≥2 were deemed to have cognitive impairment and thus classified as screen positive. The AD8 results of screen positive patients were provided to their attending primary care physicians for consideration of referral to a specialist memory clinic. The referral rate as well as reasons for declining referrals was recorded. The follow-up rate in the specialist memory clinic was tracked. Additionally, feedback of informants and primary care physicians on the informant AD8 was collected to determine acceptability and user-friendliness of this instrument.

2.2. Statistical Analyses. All statistical analyses were conducted using Statistical Package for the Social Sciences, Version 20.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistical analyses were conducted to examine the acceptability of the informant AD8. The average time of test administration was calculated. Between-group comparisons were performed using independent-sample t-tests for quantitative variables and bivariate analysis including Pearson chi-square tests for categorical variables. Multivariable logistic regression analyses were computed to test the association of all characteristics between groups. Analyses are considered significant when P < 0.05.

3. Results

The flow diagram of participation is shown in Figure 1. Approximately half of 787 patients (n = 375, 47.6%) attending the “Chronic Illnesses” clinic at the Bukit Batok Polyclinic were eligible for this study. Of those who were eligible, the majority were Chinese (n = 309, 82.4%) and female (n = 218, 58.1%) with a mean age of 71.4 ± 8.1 years. Major reasons for exclusion, in order of frequency, were (1) no identified informant (n = 290, 70.4%), (2) age younger than 60 years (n = 115, 27.9%), and (3) others (e.g., insufficient language skills or participated in this study before; n = 7, 1.7%). More than half of the eligible patients were accompanied by their informants (n = 216, 57.6%) and provided consent for participation (n = 205, 54.7%). The reasons for declining participation were (1) patients felt that screening for cognitive impairment was unnecessary (n = 84, 49.4%); (2) no consent was provided from either patient (n = 38, 22.4%) or their informants (n = 37, 21.8%); (3) patients were with a known diagnosis of dementia (n = 11, 6.5%).

The study participants’ characteristics are shown in Table 1. The participants had a mean age of 72.1 ± 8.7 years with low level of education of 5.8 ± 5.1 years. Most of these patients have multiple medical conditions (2.2 ± 1.1) with high frequency of vascular risk factors such as hypertension (75.9%), hyperlipidemia (74.7%), diabetes (44.7%), and stroke (12.1%). The majority were Chinese (n = 166, 81.0%), females (n = 123, 60%), and accompanied by informants to the clinic (n = 136, 66.3%), and were living with their family members (n = 92, 44.9%).

The informants’ characteristics are indicated in Table 2. Of the entire recruited sample, 199 (97.1%) informants with
Patients approached (n = 787) → Eligible (n = 375) → Consented (n = 205) → Completed (n = 199) → Screen positive (n = 59) → Not referred by primary care physician (n = 28) 
- Refusal (n = 170) → Screen negative (n = 140) → Incomplete due to uncontactable informant (n = 6) 
- Not eligible for study (n = 412) 
  - <60 years old (n = 115) 
  - No informant (n = 290) 
  - Insufficient language skills (n = 6) 
  - Participated before (n = 1) 

- Declined referral (n = 20) 
  - Not concerned about memory (n = 14) 
  - Perceive no available dementia treatment (n = 3) 
  - Lack of financial support (n = 3) 
- Accepted referral (n = 11) 

Figure 1: Study inclusion flow chart.

a mean age of 52.9 ± 13.9 years and a mean of 10.5 ± 4.2 years of formal education completed the AD8 with a mean time taken of 2.7 ± 1.4 minutes. The remaining 6 (2.9%) informant AD8 were incomplete due to uncontactable informants. Most of the informants were females (n = 136, 68.3%) and Chinese (n = 158, 79.4%) and were living with participants (n = 161, 80.9%) with very frequent contact (n = 161, 80.9%). Among the informants, 108 (54.3%) were adult children of the patients, 72 (36.2%) were patients’ spouses, 19 (9.5%) were others (e.g., relatives, close friends, and paid caregivers). The majority of the informants required assistance in completing the AD8 (n = 90, 45.2%), while a third of the informants were able to complete it over the phone (n = 63, 31.7%), and approximately a quarter of informants could complete it independently (n = 46, 23.1%) at a busy primary healthcare clinic. Among informants who were present at the clinic, a small minority (n = 7, 5.1%) found it unacceptable to complete the AD8 while waiting with patients for medical consultation.

Approximately one-third of patients were screen positive with the scores of informant AD8 ≥ 2 (n = 59, 29.6%). The characteristics of screen positive and screen negative patients...
are shown in Table 3. Independent-sample *t*-tests showed significant mean differences in years of education (*t*(196) = 2.3, *P* = 0.021), composite number of medical conditions (*t*(197) = −2.2, *P* = 0.027), and the AD8 total scores (*t*(197) = −21.0, *P* < 0.001) between these two groups. The screen positive participants had significantly less education and more medical conditions (particularly stroke prevalence), as well as higher AD8 scores than screen negative patients. Furthermore, relative to the screen negative patients, there were more screen positive patients accompanied by informants to the clinic (28, 58.3%) were not referred to a specialist memory clinic by primary care physicians, whilst a substantial number of patients (20, 41.7%) declined referral to a specialist memory clinic due to (1) limited insight into the health implications of cognitive impairment in patients and their families (14, 29.2%) and (2) others (e.g., perceive no available dementia treatment or lack of financial support; 6, 12.5%). Only a minority of patients (11, 18.6%) accepted the referral recommendation to a specialist memory clinic. Of these, approximately one-third (3, 27.3%) actually attended a memory clinic where one patient was diagnosed with cognitive impairment and the other two patients were diagnosed to have dementia.

Although a relatively small number of primary care physicians (5) completed the satisfaction survey on the usefulness of the informant AD8, all of these physicians considered the informant AD8 helpful in facilitating a referral to specialist memory clinics.

<table>
<thead>
<tr>
<th>Table 1: Patient characteristics.</th>
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<tr>
<td>Mean age (mean ± sd)</td>
<td>72.1 ± 8.7</td>
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<tr>
<td>Years of education (mean ± sd)</td>
<td>5.8 ± 5.1</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
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<td>123 (60.0)</td>
</tr>
<tr>
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<td>82 (40.0)</td>
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<td>Indian</td>
<td>12 (5.9)</td>
</tr>
<tr>
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<td>Living situation</td>
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<td>Composite number of medical conditions (mean ± sd)</td>
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<tr>
<td>TIA</td>
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<td>Years of education (mean ± sd)</td>
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<td>Average AD8 administration time (minutes) (mean ± sd)</td>
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<td>Occasionally (&lt;once per week)</td>
<td>7 (3.5)</td>
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Table 3: Characteristics of screen positive and screen negative patients.

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<th>Screen negative (n = 140)</th>
<th>P value</th>
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<td>82 (58.6)</td>
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<td>22 (37.3)</td>
<td>58 (41.4)</td>
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<td>Ethnicity (n, %)</td>
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<td>111 (79.3)</td>
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<td>15 (10.7)</td>
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<td>0 (0.0)</td>
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<td>Others</td>
<td>0 (0.0)</td>
<td>2 (1.4)</td>
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<td>Language (n, %)</td>
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<td>71 (50.7)</td>
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<td>Living situation (n, %)</td>
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<td>Others</td>
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<td>Often (once per week)</td>
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<td>Occasionally (&lt;once per week)</td>
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<tr>
<td>Accompanied by informant (n, %)</td>
<td>50 (84.7)</td>
<td>86 (61.4)</td>
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</tr>
<tr>
<td>AD8 total scores (mean ± sd)</td>
<td>3.9 ± 1.8</td>
<td>0.4 ± 0.5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Memory endorsement by informant (n, %)</td>
<td>38 (64.4)</td>
<td>19 (13.6)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

4. Discussion

To the best of our knowledge, this is the first AD8 feasibility study conducted in a primary healthcare setting.

The contributions of this pilot study are threefold. First, we have demonstrated that the informant AD8 can be efficiently administered to informants of older adults (≥60 years old) attending a primary healthcare clinic. Second, the informant AD8 can be easily completed in a busy primary healthcare setting. Third, the informant AD8 is clinically relevant at the primary healthcare setting because it can facilitate referrals to a specialist memory clinic.

Our finding that the informant AD8 is feasible and acceptable to patients and informants in a primary healthcare
5. Conclusion

The informant AD8 can be easily administered and is well tolerated by patients attending a busy primary healthcare clinic in Singapore. It could detect cognitive impairment in one-third of older adult patients accompanied by their informants who endorse memory changes in patients, therefore could be well suited for case finding of cognitive impairment in the primary healthcare setting.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Authors’ Contribution

YanHong Dong designed the study, obtained the funding, performed statistical analysis, interpreted the data, and drafted the paper. Tuck Seng Cheng collected data and assisted with statistical analyses and provided revision of the paper. Keith Yu Kei Tsou provided onsite supervision of the study and revised the paper. Qun Lin Chan revised the paper. Christopher Li-Hsian Chen provided overall supervision of the study, interpreted the data, and provided critical revision of the paper.

Acknowledgments

The authors are indebted to the research team from NUHS Memory Ageing and Cognition Center for data collection. This study is funded by a donation from Lundbeck Singapore and Singapore National Medical Research Council (NMRC/CG/NUHS/2010). YanHong Dong was a recipient of the NMRC fellowship training award during this study.

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The Takeda Three Colors Combination Test: A Screening Test for Detection of Very Mild Alzheimer’s Disease

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Received 5 August 2014; Revised 23 September 2014; Accepted 24 September 2014; Published 19 October 2014

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Background. Alzheimer’s disease (AD) is the most common type of dementia and is prevalent worldwide. It is expected that AD, for which aging is a risk factor, will increase in the future. Because early detection of AD has become increasingly important, promoting demand for screening tests with adequate sensitivity. In this study, we examined the usefulness of the Takeda Three Colors Combination Test (TTCC) for screening of the very mild AD and amnestic mild cognitive impairment (aMCI).

Methods. 154 senior persons participated in the research: 55 with very mild AD, 45 with aMCI, and 54 control group. The TTCC, which was a colored cards configuration memory task, was examined for sensitivity and specificity. Results. The sensitivity of the TTCC was 76% and 47% for the very mild AD and aMCI groups, and the specificity was 83%. Conducting TTCC (including instruction and evaluation) was accomplished within 2 minutes for all subjects. Conclusion. The TTCC is useful screening test for early detection of AD. Furthermore, administration time is short and requires no special training or skills. Thus, we believe the TTCC shows great potential for use as an AD screening test by a general practitioner in communities worldwide.

1. Introduction

Alzheimer’s disease (AD) is the most common type of dementia and is prevalent worldwide [1, 2]. The risk factor of AD is aging [3]. With an increase of the elderly population as reported by the United Nations [4], it is expected that the AD population will only grow in the future. Although treatment for AD has yet to be established, medications such as acetylcholinesterase inhibitors can delay the progress or improve symptoms of AD in its early stages and are readily available. With a projected increase in the AD population and rising awareness of early intervention measures, early detection has become an increasingly important issue, generating demand for screening tests with higher sensitivity.

AD dysfunction is not readily identifiable in the early stage and is difficult to recognize by patients themselves or their families and so early consultation with a medical specialist is all too rare. Moreover, a majority of the world’s elderly live in developing countries, a trend which is likely to continue [5], meaning that the greater part of AD patients will be living in developing countries [6] where there exists a lack of specialists in dementia. Given this global situation, it is necessary to come up with a means to conduct early detection of AD by a general practitioner (GP), someone in the community to whom patients have easy access. At present, the rate of general screening tests conducted by GPs is reported to be low [7] as too much time and advance training are required. What is needed then is a simple screening test with high sensitivity: one that a busy GP can use for early detection of AD.

Most screening tests up to now include questions which measure the patient’s language skills, often assuming the patient has had formal education [8]. There are people in many parts of the world, however, who are illiterate or lack years of formal education. Also, considering the elderly can be easily fatigued, screening tests must be brief and the content motivating for the examinee. It is suggested that an AD screening test for use internationally (a) facilitates early detection, (b) requires no special training to administer, (c) poses no burden or strain on the examinee, (d) is
accomplished in a short time, (e) is easy to evaluate, and (f) is neutral in terms of the examinee's literacy, education, and culture.

With these conditions in mind, Takeda et al. [9] have developed the Takeda Three Colors Combination Test (TTCC), an easier and quicker screening test for dementia. The TTCC task requires the examinee to reconstruct a figure in a procedure described as follows. First, the examinee is shown a figure composed of three square, colored cards (red, blue, and yellow) for five seconds. The figure is hidden. The examinee then performs an interference task (the reverse-backward testing). The examinee then arranges three cards to match the model shown previously. If the examinee makes the same figure as the model, he or she is regarded as normal. If he or she is unable to make the same figure, AD is suspected. It also demonstrates high discriminative power for mild AD with a sensitivity of 85% and specificity of 87%. In regard to reliability, the retest showed a high value in both concordance rate (88%) and correlation coefficient ($\varphi = 0.76$).

However, Takeda et al. [9] had never conducted a study focusing on very mild AD, that is, the early stage of AD. To detect AD early, a powerful screening test for very mild AD is needed. On the other hand, the previous studies by Takeda et al. [9] did not discuss sensitivity of the TTCC for mild cognitive impairment (MCI). MCI is classified into several types, and amnestic MCI (aMCI) is thought to lead to AD. To prevent AD and implement early intervention, screening tests are required to selectively detect MCI. Therefore, the present study was designed to assess the efficacy of the TTCC for early detection of AD. Patients with either very mild AD or aMCI were enrolled in the study. The symptoms of very mild AD and aMCI are often similar; thus, we also discuss whether very mild AD and aMCI can be detected using reverse-backward presentation of figures (an interference task of TTCC).

2. Methods and Materials

2.1. Subjects. The subjects were 154 persons (men and women) divided into three groups: very mild AD, aMCI, and control group (Table 1). The inclusion criteria was being aged 60 years or over. Exclusion criteria were psychiatric diseases, delirium, verbal incomprehension including aphasia, and neurological disease. The people in the very mild AD group ($n = 55$) met the probable AD criteria of National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer’s Disease and Related Disorders Association (NINCDS-ADRDA) [10], scoring more than 21 on a Mini-Mental State Examination (MMSE) [11], and received a Clinical Dementia Rating (CDR) [12] of 0.5 in all 6 areas. The people in the aMCI group ($n = 45$) met the Petersen’s criteria [13], scoring more than 24 on MMSE, and received a CDR of 0.5 in “memory” and a CDR of 0 in other areas. The control group ($n = 54$) comprised people who had no complaint of memory lapse, were not diagnosed as dementia, scored 28 or greater on a MMSE, and scored 0 on a CDR. We explained the object and methods of the research to the subjects (or their families) and obtained their consent in advance of their participation. The Ethics Board of Tottori University School of Medical Sciences approved all procedures.

Comparing the average value of age in 1-way ANOVA, the control group was significantly younger than other groups ($F = 20.6, P \leq 0.001$). There were no significant differences in gender ($\chi^2 = 0.13, n.s.$) among groups using the Chi square test (group [3] $\times$ gender [2]). Comparing the average value of MMSE scores for 1-way ANOVA, the control group was significantly higher than other groups, and the aMCI group was significantly higher than very mild AD group ($F = 144.6, P \leq 0.001$).

2.2. The TTCC Featured the Following

Procedures

1. Show examinee three wooden colored cards (red, blue, and yellow, each five centimeters square and five millimeters thick) and confirm that the examinee can distinguish the colors.

2. Explain to the examinee as follows: “I’ll show you a figure for five seconds, please remember it. I’ll ask you to make the same figure from memory later using these three cards. Do you understand?” If the examinee understands, hide the cards and proceed to the next step. If the examinee does not understand, explain again.

3. Present the card showing the three colored squares in a certain arrangement (model: one of 3 models was shown to the examinee; Figure 1) for five seconds and then hide it quickly. Ask the examinee to repeat

![Figure 1: The arrangement of three colored squares that should be remembered and reproduced later after an interference task using three wooden colored cards. One of 3 models was shown to the examinee.](image-url)
The sets of numbers immediately in reverse sequence ("4-1-7", "5-2-4-9").

(4) After the examinee has done this, stack the three cards and hand them to the examinee. Ask the examinee “Please make the same figure I showed you earlier.” Allow one minute to complete the task.

**Conditions for Stopping the Test.** Stop the test under either of the following conditions.

(1) The examinee is not able to complete the arrangement within one minute following instruction.

(2) The examinee completes the arrangement within one minute following instruction.

**Evaluation.** If the examinee succeeded in making exactly the same figure as the model, he or she is evaluated as being normal. If the arrangement of the color cards differs from the model, AD is suspected. Evaluation does not include accuracy of the recitation in reverse of number sets.

Any of the following cases is also regarded as incorrect.

(1) The cards are overlapped.

(2) The top square is placed off-center, such that the ratio of the lengths of the bottom side contacting the two lower squares exceeds 1.5.

(3) Cards are arranged more than five millimeters apart.

**2.3. Statistical Analysis.** The TTCC was conducted on all examinees, in the following order: TTCC, MMSE, and CDR. The examiner was not told which group the examinees belonged to. With TTCC, we allotted "1" to a correct response and "0" to an incorrect response as dummy variables. Because a significant difference for age was obtained in each group, the differences among the very mild AD, aMCI, and control group were examined by logistic regression analysis to adjust for age factor using “TTCC results” as a dependent variable and “group” and “age” as independent variables. The difference of the reverse-backward testing between the very mild AD group and aMCI group was examined by a Chi square test.

**Conducting TTCC (including instruction and evaluation) was accomplished within 2 minutes for all subjects. No refusal or resistance to this test was observed among any of the subjects.**

**4. Discussion**

In the present study, we examined the usefulness of TTCC for screening of very mild AD and aMCI. The results of logistic regression analysis show that patients with very mild AD tend to respond incorrectly to TTCC 16 times as often as examinees evaluated as normal when the rate of their incorrect response is 1. As for the power of the TTCC to detect very mild AD, sensitivity was 76%, and the specificity was 83%. The lower sensitivity compared with results of an earlier study [9] is likely due to the fact that subjects in the present study were very mild AD compared with the mild AD examinees of the former study. However, the sensitivity value of the present study can be compared favorably with those of other screening tests [14–16] from previous research where many of the subjects had moderate to severe dementia, conceivably giving those tests high sensitivity values. Because the present study did not involve moderate and severe patients, the sensitivity is considered satisfactory. Takeda et al. [9] claim that the relatively high sensitivity for AD shown in the screening is explained by TTCC's fidelity in detecting impairment in recent memory and space perception, both of which are seen at the early stage of AD [17, 18]. They suggest that sufficient screening tests can be made with fewer test items if those
items test for cognitive dysfunctions which appear in the early stage of AD. MMSE, used widely to screen for dementia, shows poor sensitivity to the early stage or when the condition is mild [19], a limitation which can be seen when sensitivity falls to as much as 54% [20] for dementia groups scoring more than 20. Since the subjects in the very mild AD group of the present study scored more than 21 in MMSE, with some over the cutoff point, TTCC’s sensitivity to very mild AD is considered to be quite high.

The results of logistic regression analysis suggest that patients with aMCI tend to respond incorrectly to TTCC 4.4 times as often as examinees evaluated as normal when the rate of their incorrect response is 1. However, we found that sensitivity of the TTCC test for aMCI was only 47%. This result indicates that the TTCC test is not a reliable tool for aMCI screening. However, the percentage of patients who recover from aMCI within 2–5 years is approximately 40% [21, 22]; accordingly, we believe that recovered patients should be excluded from the screening tests to selectively detect aMCI that is likely to progress to AD. Deterioration in recent memory and visual-spatial cognitive functions is considered a risk factor for progression from MCI to AD [18]. According to this notion, the TTCC test may be useful for detection of possible aMCI because this test evaluates recent memory and visual-spatial cognitive functions. More research is required to determine whether TTCC test results can be used to detect aMCI that is likely to progress to AD.

When we compared the results of the interference task between the very mild AD and the aMCI groups, no significant differences were found in reverse-backward testing with 3 and 4 figures. This finding indicates that it is difficult to distinguish very mild AD and aMCI using the interference task of TTCC. The reverse-backward tests assess attention function; therefore, the results of this study show that there are no remarkable differences in attention function between patients with very mild AD and those with aMCI.

Screening tests for dementia used worldwide include the Rapid Dementia Screening Test (RDST), the Memory Impairment Screen (MIS), and the Montreal Cognitive Assessment (MoCA), which are simple, convenient, and reliable methods, with high sensitivity [14, 15, 23]. There are four differences between TTCC and these tests. (1) TTCC can detect patients’ deteriorated functions, which are initial symptoms of very mild AD. Patients with AD often develop deterioration in recent memory and visual-spatial cognitive functions at an early stage [17, 18]. However, except for TTCC, none of the existing tests contain an evaluation item to assess the deterioration in both recent memory and visual-spatial cognitive functions. (2) TTCC consists of only one task. To screen people for dementia, the conventional methods require examinees to perform several tasks. Elderly people get tired easily; therefore, to encourage them to undergo an examination, it is preferable that the screening test consists of the smallest possible number of tasks. Therefore, TTCC can be useful because it requires only one task. (3) The duration of TTCC examination is comparatively short. Patients had to traditionally spend 4–15 min to complete all screening procedures from beginning till evaluation; however, TTCC can be finished within 2 min. According to a previous study [24], the average duration of consultation in Europe is 10.7 min. TTCC can be the most convenient testing method for doctors who need to diagnose dementia as early as possible. (4) TTCC is easily to perform. There are no data on conventional screening tests that investigate the percentage of examinees who drop out in the middle of a test. Our study demonstrated that all patients completed the TTCC task without any refusal. This finding suggests that TTCC is a stress-free screening method.

In conclusion then the TTCC is useful screening test for early detection of AD. The content of the test itself is extremely simple and unbiased in regard to examinee literacy. The equipment is cheap. Administration time is short and requires no special training or skills. And Takeda and Tajime [25] revealed that educational attainment of the persons did not affect the performance of the TTCC. For these reasons, we believe the TTCC shows great potential for use as an AD screening test by GP in communities worldwide.

Finally, we must discuss questions that remain to be answered. To begin with, it is noted that TTCC is a simplified screening test and as such cannot be used on its own to diagnose AD. Tasks for the present study were structured to be free from literacy and cultural affects, with the aim of making TTCC suitable for use in developing countries where a large number of senior people and patients with AD are found. We have yet to administer tests in these regions, however. In order to study its effectiveness, TTCC must be administered in countries worldwide, including developing countries.

5. Conclusions

The TTCC is useful screening test for early detection of AD. Furthermore, administration time is short and requires no special training or skills. Thus, we believe the TTCC shows great potential for use as an AD screening test by a general practitioner in communities worldwide.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The authors would like to deeply thank the staff of Tottori Seikyo Hospital for help with this study. This work is supported by Grants-in-Aid for Scientific Research (C) from the Ministry of Education, Culture, Sports, Science, and Technology of Japan: 26380928.

References


Research Article

A Community-Based Walk-In Screening of Depression in Taiwan

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Received 19 May 2014; Accepted 2 July 2014; Published 15 July 2014

Academic Editor: Jianjun Jia

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Depression is a crucial public health problem because of its relatively high association with suicidal attempts, prolonged social isolation, poor physical health, and dementia. However, the available data and study on the prevalence of depression in Taiwan were mostly completed within the previous 1 to 2 decades, and these studies were limited to certain areas or populations. Little is known regarding the current status of depression in Taiwan. We used a brief tool, the Center for Epidemiological Studies Depression Scale (CES-D), to screen depression in 4 areas among the general and aged population. The results showed a higher CES-D score in the southern area among general (mean ± SD: 7.8 ± 8.4) or aged participants (mean ± SD: 7.2 ± 8.0) compared with other areas. The ratio of suspected depression patients was 16.4% of all recruited participants and 13.3% of aged participants. These results may provide information for this public health issue.

1. Introduction

Depression is a crucial public health problem because of its relatively high prevalence in the general population [1] and its empirically established association with suicide attempts, prolonged social isolation, and poor physical health [2, 3]. Depression also has a profound effect on well-being, daily functioning, and excessive use of health services [4]. Depression in a community may imply the potential effect of well-being in the general population. Moreover, the aged population has been increasing recently. Several observational studies have reported evidence that depression is a critical issue for those working with older adults, particularly for those working with older adults with Alzheimer's disease (AD) [5–7]. Depression affects numerous older adults [8] and has been associated with poor cognitive function [9]. Depression and dementia may be related in several aspects. First, depressive symptoms often occur among patients with dementia. Second, depression may be a reaction to early cognitive deficits. Third, depression can impair cognitive function, leading to a “pseudo-dementia” presentation. Finally, depression may be a risk factor or early symptom of dementia [5, 7] and its treatment has been associated with improved cognitive and functional status of patients with AD [10–12]. Knowledge of the current prevalence of depression, thus, might have crucial clinical and research implications on dementia.
Currently available data and studies on the prevalence of depression in Taiwan were mostly completed within the previous 1 to 2 decades [13, 14]. These studies [15–17] were also conducted sporadically and separately in a localized area of Taiwan with various study designs [18, 19] and psychometrics; therefore, compiling these data to reflect the overall condition of depression in Taiwan is difficult. These published studies did not have sufficient data to reflect the current status of the aged population [20]. Therefore, little is known of the current status of depression in the general and aged population in Taiwan.

The Center for Epidemiological Studies Depression Scale (CES-D), developed by Radloff (1977), is a brief tool used to screen depression, to assess depressive symptoms both clinically [21] and in the community [3, 22]. Since its publication in 1977, the scale has become one of the most frequently used self-report depressive symptom scales and has been shown to have acceptable psychometric properties, including desirable internal consistency, optimal test-retest reliability, high correlations with significant life events, and clinical diagnosis of depression [1, 3, 23]. CES-D is capable of screening mild depression in the general population and has been used extensively in other countries, including Taiwan, after its validation [24]. A person whose CES-D screening results exceed 16 is considered to have depression [3].

The Mentality Protection Center (MPC) is a nonprofit institution that was established under the Fo Guang Shan Compassion Foundation in 2008 to provide medical and charitable services to the general population worldwide through the hundreds of Fo Gunag Shan branches. Collaborating with the Fo Guang Shan branches scattered in urban, suburban, and rural areas in Northern, Central, Southern, and Eastern Taiwan, the MPC launched the dementia, depression, and sleep disorder-screening projects for older adult populations from 2011 to 2013. All the screening results were recruited to the MPC headquarters for statistical analyses.

2. Material and Methods

2.1. Interviewer Training. All of our interviewers are senior nurses or other medical-related specialists. Before administering the CES-D, they undergo a series of training courses on depression-related and medical related topics and must practice administering the CES-D to the general population by interning with experienced interviewers and physicians. All of the interviewers are MPC volunteers and have completed all walk-in screenings in this project in Taiwan.

2.2. Walk-In Screening. The MPC in Taiwan is composed of 59 branches, which are scattered in Northern, Central, Southern, and Eastern Taiwan and distributed in urban, suburban, and rural areas in each part of Taiwan. From March 1, 2010, to April 30, 2013, 53 walk-in screenings were conducted among these 59 branches of the MPC. Each screening at each branch lasted 1 day to provide medical and charitable services to the general population as well as screening for dementia using AD8 [25], depression using the Chinese version of the CES-D (Center for Epidemiologic Studies-Depression) scale [26, 27], and sleep disorders using the Pittsburgh Sleep Quality Index PSQI [28]. For all 53 screenings of the general population, 7 screenings were conducted in the northern part, 19 in the central part, 24 in the southern part, and 3 in the eastern parts of Taiwan.

2.3. Center for Epidemiological Studies Depression Scale. The CES-D was used to measure the levels of depressive symptoms among adults. The CES-D consists of 16 negative affect and 4 positive affect items, such as “I felt depressed,” “I felt lonely,” and “I was happy.” Participants were asked regarding the number of days they experienced depressive symptoms during the previous week. Each item was accompanied by a standard 4-point Likert-scale of potential responses: 1: none, 2: 1 or 2 days a week, 3: 3 or 4 days per week, and 4: 5 days or more per week. Persons scoring more than 16 points on the CES-D scale were considered as having depression [3]. In the scale, 4 items that described positive affect were reversed before conducting our analysis. The Chinese version of this scale has been validated [29] and extensively used in studies of Chinese adults.

2.4. Participants and Evaluation. All participants were volunteers who joined the screening activity without any reward. The CES-D, AD8, and PSQI were administered to people after identifying their age, sex, and residence location. The participant was suspected of depression if his/her CES-D total score was greater than 16. All procedures were approved by the Kaohsiung Medical University Hospital Institutional Review Board (IRB). All information related to privacy or that could be identified was not recorded during the screening process.

2.5. Statistics. Data analysis was performed using SPSS (version 12.0.1 for Windows, SPSS Inc., Chicago, IL, USA). All statistical tests were 2-tailed, and an alpha of 0.05 was taken to indicate significance. Analysis of variance (ANOVA) was used to compare the difference of group mean for age and for CES-D total score among the 4 areas of Taiwan for all participants and for all suspected depression persons. The chi-square test was used to compare the proportion of suspected depression persons and sex between the 4 areas of Northern, Central, Southern, and Eastern Taiwan and among suspected depression participants.

3. Results

In total, 1612 participants, 131 in Northern, 494 in Central, 718 in Southern, and 269 in Eastern Taiwan were recruited with a mean age of 62.9 ± 14.4 years. The mean age was significantly different among the 4 areas (P < .001). The age of participants in Eastern Taiwan was older (mean ± SD: 69.8 ± 11.9) than that in the other 3 areas (Table 1). Participants were predominantly female; however, no significant difference existed in sex proportion (P = .634), although it was higher in the northern area (72.5%), compared with the other areas (Table 1). Among the total population, the mean ± SD of the CES-D score was 7.1 ± 8.7, with a significant difference
between the 4 areas ($P = .012$). The highest CES-D score was in the southern area (mean ± SD: 7.8 ± 8.4), and the lowest score was in the eastern area (mean ± SD: 5.8 ± 9.4) (Table 1).

Among the ≥65-year-old participants, 772 participants, including 67 in Northern, 166 in Central, 359 in Southern, and 180 in Eastern Taiwan were recruited with a mean ± SD age of 74.8 ± 6.6 years. The mean age significantly differed among the 4 areas ($P < .001$). The age of participants in Eastern Taiwan was higher (mean ± SD: 76.5 ± 6.7) than in the other 3 areas (Table 2). Participants were predominantly female, but no significant difference existed in sex proportion ($P = .953$), although it was higher in the southern area (67.5%) compared with the other areas (Table 2). Among the ≥65-year-old participants, the mean of the CES-D score was 6.0 ± 8.2, with significant differences among the 4 areas. The highest CES-D score was in the southern area (mean ± SD: 7.2 ± 8.0), and the lowest score was in the central area (mean ± SD: 4.5 ± 6.7) (Table 2).

Among the total participants, the ratio of suspected depression participants did not significantly differ among the 4 areas ($P = .675$), nor was there a significant difference with respect to sex ($P = .154$) or the mean CES-D score ($P = .067$) (Table 3). The ratio of suspected depression patients was 16.4% of all recruited participants, with a mean CES-D score of 2.3 ± 7.0, mean age of 58.4 ± 16.8 years, and predominantly female 66.8% (Table 3). The mean age among the 4 areas significantly differed ($P < .001$) among the total population with respect to suspected depression. The participants were older in the eastern area (mean ± SD: 67.8 ± 14.7) and younger in the central area (mean ± SD: 51.4 ± 15.2) (Table 3).

Among the ≥65-year-old participants, the ratio of suspected depression participants was nonsignificantly different among the 4 areas ($P = .128$) as well as age ($P = .315$) and the mean CES-D score ($P = .141$) (Table 4). Among the ≥65-year-old participants, the ratio of suspected depression patients was 13.3% of all aged participants, with a mean CES-D score of 23.0 ± 7.4, mean age of 75.0 ± 7.1 years, and predominantly female 65.1% (Table 4). The sex ratio among the 4 areas significantly differed ($P = .048$) among the ≥65-year-old population with suspected depression. The ratio was highest in the eastern area (73.1%) and lowest in the central area (33.3%).

### 4. Discussion

This study provides updated information of the current status of depression among the general Taiwanese population and compares the difference among the 4 areas in Taiwan. Most of our recruited participants were female, both in the total population and in the ≥65-year-old population. Such results might partially indicate that females are more inclined to participate in social facilities than males, particularly for those featured with religion. Among the total or aged population, the CES-D score was significantly higher in the southern area. Despite our new findings of the higher proportion of depression in Southern Taiwan, no updated related studies address this issue. Further studies using randomized sampling are necessary to clarify such issues.

We also observed that the mean ages of all recruited and aged populations were significantly older in the eastern area,

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### Table 1: Demographic characteristics of all recruited participants.

<table>
<thead>
<tr>
<th></th>
<th>Northern</th>
<th>Central</th>
<th>Southern</th>
<th>Eastern</th>
<th>$P$ value</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Number (n, %)</td>
<td>131</td>
<td>494</td>
<td>718</td>
<td>269</td>
<td>1612</td>
<td>100%</td>
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<tr>
<td>Age, years (mean ± SD)</td>
<td>65.2 ± 12.3</td>
<td>58.2 ± 13.7</td>
<td>63.0 ± 14.8</td>
<td>69.8 ± 11.9</td>
<td>&lt;0.001</td>
<td>62.9 ± 14.4</td>
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<td>Sex (Female/n, %)</td>
<td>95</td>
<td>320</td>
<td>484</td>
<td>186</td>
<td>1085</td>
<td>69.0%</td>
</tr>
<tr>
<td>CES-D score (mean ± SD)</td>
<td>7.1 ± 9.7</td>
<td>6.8 ± 8.5</td>
<td>7.8 ± 8.4</td>
<td>5.8 ± 9.4</td>
<td>0.012</td>
<td>7.1 ± 8.7</td>
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</table>

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### Table 2: Demographic characteristics of recruited aged participants.$^a$

<table>
<thead>
<tr>
<th></th>
<th>Northern</th>
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<th>Southern</th>
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<tbody>
<tr>
<td>Number (n, %)</td>
<td>67</td>
<td>166</td>
<td>359</td>
<td>180</td>
<td>772</td>
<td>100%</td>
</tr>
<tr>
<td>Age, years (mean ± SD)</td>
<td>75.2 ± 6.7</td>
<td>73.1 ± 6.5</td>
<td>74.6 ± 6.4</td>
<td>76.5 ± 6.7</td>
<td>&lt;0.001</td>
<td>74.8 ± 6.6</td>
</tr>
<tr>
<td>Sex (Female/n, %)</td>
<td>43</td>
<td>106</td>
<td>239</td>
<td>119</td>
<td>507</td>
<td>66.6%</td>
</tr>
<tr>
<td>CES-D score (mean ± SD)</td>
<td>5.0 ± 8.3</td>
<td>4.5 ± 6.7</td>
<td>7.2 ± 8.0</td>
<td>5.5 ± 9.3</td>
<td>0.002</td>
<td>6.0 ± 8.2</td>
</tr>
</tbody>
</table>

$^a$Age ≥65 y/o participants.
compared to the other areas in Taiwan. Such findings resulted from the status that the prevalence of the aged population in the eastern area is actually higher than the other areas, according to the recent "Report on the Survey of Citizens’ Life Status in the Taiwan Area" published by the government, which indicates that 11.5% of the population in Taiwan is aged, with 10.76% in the northern area, 11.79% in the central area, 12.39% in the southern area, and 13.41% in the eastern area, as of 31 December, 2013 [30].

These suspected depressed patients, CES-D ≥16, were also predominantly female, which is similar to previous studies that found gender differences in depression prevalence, with women experiencing major depression approximately twice as often as men [31–34]. Several risk factors have been studied, which might account for gender differences in depression prevalence, including gender differences in hormones, socialization, coping style to stressful life events, and cultural influences [35, 36].

The mean age of these suspected depression participants was also significantly higher in the eastern area, which may result from the higher prevalence of the aged population in this area. Among the total population, the prevalence of suspected depression was 16.4%, which was higher than the prevalence screening of 8.9% among the more 15-year-old population in 2002 [37]. Certain studies have announced the rising incidence of depression since the early 20th century [31]. Several reasons may account for this, such as various study designs and tools, although most studies have indicated substantial socioeconomic changes.

Among the aged population, the prevalence of suspected depression was 13.3%. A previous study [38] showed 15.3% depressive neurosis and 5.9% major depression in the older adult community; however, other studies have found the prevalence of geriatric depression to be approximately 20.0% [39]. A comparison of these studies is difficult because of differences in research methodology, study population, diagnostic criteria, and instruments used [38]. These suspected depressed patients among the aged population were also predominantly female, except in the central area, which recruited fewer female participants in all recruited and suspected depressed participants among the 4 areas.

The results of this study could also provide information regarding the prevalence of mood disorder, anxiety, and depression in Taiwan, because depression and anxiety disorders are highly interrelated and frequently overlap [40].

This study has several strengths. First, we used the same interviewers to administer the CES-D instrument in all screenings to reduce interrater differences for the study results. Secondly, we used the same instrument, CES-D, to avoid biases from various assessment tools used in different screening sites. Third, we recruited participants from Northern, Central, Southern, and Eastern Taiwan to reflect the overall status of depression in Taiwan, which would be more objective, compared with other published studies limited

### Table 3: Demographic characteristic of participants suspected depression* among all recruited participants.

<table>
<thead>
<tr>
<th>Recruited subjects</th>
<th>Northern (N = 131)</th>
<th>Central (N = 494)</th>
<th>Southern (N = 718)</th>
<th>Eastern (N = 269)</th>
<th>P value</th>
<th>Total (N = 1612)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (n, %)</td>
<td>21</td>
<td>75</td>
<td>127</td>
<td>42</td>
<td>0.675</td>
<td>265</td>
</tr>
<tr>
<td>Age, years (mean ± SD)</td>
<td>56.4 ± 14.8</td>
<td>51.4 ± 15.2</td>
<td>59.7 ± 17.1</td>
<td>67.8 ± 14.7</td>
<td>&lt;0.001</td>
<td>58.4 ± 16.8</td>
</tr>
<tr>
<td>Sex (Female/n, %)</td>
<td>17</td>
<td>43</td>
<td>87</td>
<td>26</td>
<td>0.154</td>
<td>173</td>
</tr>
<tr>
<td>CES-D score (mean ± SD)</td>
<td>25.2 ± 10.6</td>
<td>23.3 ± 6.6</td>
<td>22.3 ± 6.0</td>
<td>25.1 ± 7.8</td>
<td>0.067</td>
<td>23.2 ± 7.0</td>
</tr>
</tbody>
</table>

*a Defined as CES-D total score ≥16.

### Table 4: Demographic characteristic of participants suspected depression* among aged participants*.

<table>
<thead>
<tr>
<th>Recruited subjects</th>
<th>Northern (N = 67)</th>
<th>Central (N = 166)</th>
<th>Southern (N = 359)</th>
<th>Eastern (N = 180)</th>
<th>P value</th>
<th>Total (N = 772)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (n, %)</td>
<td>6</td>
<td>15</td>
<td>56</td>
<td>26</td>
<td>0.128</td>
<td>103</td>
</tr>
<tr>
<td>Age, years (mean ± SD)</td>
<td>74.3 ± 8.9</td>
<td>73.4 ± 7.0</td>
<td>74.5 ± 7.0</td>
<td>77.2 ± 6.8</td>
<td>0.315</td>
<td>75.0 ± 7.1</td>
</tr>
<tr>
<td>Sex (Female/n, %)</td>
<td>4</td>
<td>5</td>
<td>39</td>
<td>19</td>
<td>0.048</td>
<td>67</td>
</tr>
<tr>
<td>CES-D score (mean ± SD)</td>
<td>25.8 ± 13.9</td>
<td>21.7 ± 5.6</td>
<td>21.9 ± 6.2</td>
<td>25.5 ± 8.3</td>
<td>0.141</td>
<td>23.0 ± 7.4</td>
</tr>
</tbody>
</table>

*a Defined as CES-D total score ≥16; * Age ≥65 y/o participants.
to a certain area [15, 16, 18, 19]. However, this study has several limitations. First, we used a nonrandom sample of the population, such that the results cannot reflect the prevalence and incidence of current depression in Taiwan. Secondly, we used the CES-D alone, without other information to provide a clinical diagnosis of each suspected depression patient. However, the CES-D has been validated with reliable sensitivity and specificity in screening depression [24], and this study was focused on screening, not diagnosing, depression. Third, this study used a “walk-in” screening, which means that only persons who could partake in our screening program were recruited. A person who was dependent or could not be included in our screening sites was not allowed to join the screening program, so that our results would underestimate the actual status of depression prevalence.

This was a screening study with certain limitations and strengths, but with extensive coverage of Taiwan. We suggest a future study using randomized sampling to examine the prevalence and incidence of depression in Taiwan.

Conflict of Interests

All of the authors have no conflicts of interests in the paper.

Acknowledgments

The authors deeply appreciate all the work done by the medical volunteers of Mentality Protection Center and funds from the Fo Guang Shan Compassion Foundation.

References


The Influence of Education on Chinese Version of Montreal Cognitive Assessment in Detecting Amnesic Mild Cognitive Impairment among Older People in a Beijing Rural Community

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Received 27 March 2014; Accepted 26 April 2014; Published 28 May 2014

Academic Editor: Yuan-Han Yang

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To assess the influence of education on the performance of Chinese version of Montreal cognitive assessment (C-MoCA) in relation to the mini-mental state examination (MMSE) in detecting amnesic mild cognitive impairment (aMCI) among rural-dwelling older people, C-MoCA and MMSE was administered and diagnostic interviews were conducted among community-dwelling elderly in two villages in Beijing. The performance of C-MoCA and MMSE in detecting aMCI was evaluated by the area under the ROC curve (AUC). Effect size of education on variations in C-MoCA scores was estimated with general linear model. Among 172 study participants (24 cases of aMCI and 148 normal controls), the AUC of C-MoCA was 0.72 (95% CI = 0.62–0.81, cutoff = 20/21), compared to AUC of MMSE of 0.74 (95% CI = 0.64–0.84, cutoff = 26/27). The performance of both C-MoCA and MMSE was especially poorer among those with low (0–6 years) education. After controlling for gender and age, education ($\eta^2 = 0.204$) had a surpassing effect over aMCI diagnosis ($\eta^2 = 0.052$) on variations in C-MoCA scores. Among rural older people, the MoCA showed modest accuracy and was no better than MMSE in detecting aMCI, especially in those with low education, due to the overwhelming effect of education relative to aMCI diagnosis on variations in C-MoCA performance.

1. Introduction

It is estimated that 44 million people worldwide are currently living with dementia, with the numbers doubling every 20 years [1]. As the world’s most populous country with the largest aging population, China faces an extraordinary challenge of Alzheimer’s disease (AD) and other age-related cognitive disorders. Currently a crucial area of research and clinical interest with the focus on secondary prevention of dementia is the detection of early AD and mild cognitive impairment (MCI).

MCI is a prodromal syndrome of AD and dementia characterised as cognitive impairment beyond normal ageing, with minimal or no decline in activities of daily living (ADL). It appears that approximately 10% to 15% of the subjects of MCI evolve to AD each year [2]. The mini-mental state examination (MMSE) is widely used as a brief cognitive screening instrument for the detection of dementia but has limited sensitivity in detecting early cognitive impairment. The Montreal cognitive assessment (MoCA) was developed as a brief screening instrument for MCI and mild Alzheimer disease (AD) to address the known limitations of the MMSE [3]. According to earlier studies, the MoCA has shown excellent performance in discriminating aMCI from normal cognition among old people, with reported AUCs ranging between 0.82 and 0.95, sensitivity from 78% to 97%, and
specificity from 60% to 87% [3–6]. Most of these earlier studies have evaluated the MoCA among urban-dwelling elderly with generally better education in socioeconomically developed countries.

Cognitive performance as measured by the MMSE is known to be influenced by education [7], and appropriate cutoffs are frequently employed to adjust for differences in educational levels. An emerging number of studies especially of populations living in less developed economies increasingly suggest that MoCA is also influenced by education level, thus requiring varying cutoffs to be employed because of cultural and language differences [4, 8–15]. However, few of these studies provided estimates of the effect sizes due to MoCA relative to education or systematically evaluated the MoCA's test performance separately for better and less educated groups. At the same time, a limited amount of data have emerged to suggest that the MoCA may not show good test performance at least in some subpopulations [12].

To date, few studies have evaluated the MoCA's test performance among rural people. Over 38% of the population of China lives in rural areas, most of whom are lowly educated. We thus investigated the performance of the Chinese version of MoCA (C-MoCA) in detecting aMCI among elderly persons in a rural community, a majority of whom have low level of education. We evaluated the relative effect sizes of education and aMCI on variations in the MoCA scores and compared their test performance among those with less (0–6 years) education and those with more (7–12 years) education. At the same time, the MMSE was evaluated in the same manner for comparison.

2. Methods

2.1. Subjects. Individuals with aMCI and cognitively healthy individuals were recruited from participants in a cross-sectional study designed to assess common psychological problems of Chinese older persons. This study was supported by the projects in the National Science and Technology Pillar Program during the Eleventh Five-Year Plan Period. The target sample size was 300 and the actual sample size was 360 considering the 20% nonresponse rate. A total of 360 community-dwelling elderly aged ≥60 years were randomly sampled from two villages in Haidian District, Beijing. The villages are not far from each other with similar folk customs and environmental conditions. Two hundred and five individuals (response rate: 56.9%) completed the interview and neuropsychological assessment, and were independently diagnosed as aMCI or cognitively normal. A total of 172 cases (24 cases of aMCI and 148 cognitively normal controls) were included in this analysis. All participants provided informed written consent. This study was approved by local ethical committee.

2.2. Diagnostic Criteria. Clinical diagnostic interviews were conducted by trained psychiatrists and diagnosis of aMCI was made according to the methods described previously [16]. Briefly, the operational diagnostic criteria of aMCI were defined as follows: (1) the global cognitive function was in keeping with normal cognition, (2) the patient complained of memory deterioration, or the relatives and doctors thought the patient had memory impairment, and the duration of the symptom was less than 3 months, (3) the ability of daily life and social function was declining; the total score of activities of daily living (ADL) was not more than 18, (4) the rank score of global deterioration scale (GDS) was 2 to 3, (5) the score of clinical dementia rating (CDR) was 0.5, (6) the score of Auditory Verbal Learning Test of World Health Organization-battery of cognitive assessment instrument for elderly (WHO-BCAI-AVLT) was no more than mean score -1.5 SD, (7) did not meet DSM-IV criteria for the diagnosis of dementia, and (8) Hachinski ischemic score (HIS) was less than 4.

The exclusion criteria were as follows: (1) mixed dementia and vascular dementia; the HIS was not less than 4, (2) other neurodegenerative disease, such as Parkinson’s disease (PD), frontotemporal dementia (FTD), dementia with Lewy bodies (DLB), cognitive dysfunction and dementia induced by the traumatic brain injuries, tumor, and infection, (3) cognitive dysfunction induced by the endocrine system disease such as thyroid hypofunction and adrenocortical insufficiency, (4) cognitive dysfunction and dementia induced by the serious diseases related to cardiovascular, respiratory, hepatic, renal, or hematopoietic system, (5) cognitive dysfunction and dementia induced by epilepsy, (6) cognitive dysfunction and dementia induced by alcohol, drug, and psychotropic drugs, and (7) cognitive dysfunction and dementia induced by other physical and chemical factors.

The criteria of normal control (NC) were defined as follows: (1) cognitive function was normal, (2) no serious physical diseases, and (3) could cooperate to complete relevant examination.

2.3. Neuropsychological Assessment. The battery of neuropsychological tests conducted by trained psychologists included MMSE and C-MoCA.

The MMSE is a widely used, standardized screening test used to evaluate general cognitive functioning and takes less than 20 minutes to complete. MMSE has a maximum score of 30 points involving different cognitive domains: orientation of three words (3 point), subtracting serial sevens from 100 (5 points), language testing by naming objects (2 points), repeating a sentence (1 point), and comprehension tested by complying with a three-step command (3 points) and copying a spatially arranged design of figures (1 point) [17].

The C-MoCA measures eight cognitive domains on a single page, which are scored within a range of 0–30 points (higher scores indicating better function). The items are visuospatial abilities and executive function (cube drawing: 1 point, clock drawing: 3 points, trail-making test: 1 point), naming (3 points), attention, concentration, and working memory (digit span: 2 points, cancelation: 1 point; subtraction: 3 points), sentence repetition (2 points), verbal fluency (1 point), abstract ability (2 points), short-term memory (delayed recall: 5 points), and orientation (time orientation: 3 points and space orientation: 3 points). The C-MoCA used in the study is available at http://www.mocatest.org. Items in the C-MoCA are identical to the English version of MoCA with the exception of several cultural and linguistic modifications.
Table 1: Demographic characteristics of participants and mean C-MoCA and MMSE.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Amnesic MCI (N = 24)</th>
<th>Normal control (N = 148)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>67.17 ± 6.59</td>
<td>67.66 ± 7.16</td>
<td>0.752</td>
</tr>
<tr>
<td>Female, N (%)</td>
<td>19 (79.2%)</td>
<td>83 (56.1%)</td>
<td>0.043</td>
</tr>
<tr>
<td>Education, mean (SD)</td>
<td>6.17 ± 1.24</td>
<td>6.96 ± 0.49</td>
<td>0.230</td>
</tr>
<tr>
<td>Manual job, N (%)</td>
<td>22 (91.7%)</td>
<td>136 (91.9%)</td>
<td>0.611</td>
</tr>
<tr>
<td>Current smoking, N (%)</td>
<td>4 (16.7%)</td>
<td>53 (35.8%)</td>
<td>0.100</td>
</tr>
<tr>
<td>Current alcohol drinking, N (%)</td>
<td>3 (12.5%)</td>
<td>39 (26.4%)</td>
<td>0.201</td>
</tr>
<tr>
<td>MMSE, mean ± SD</td>
<td>24.1 ± 1.22</td>
<td>26.5 ± 0.44</td>
<td>0.000</td>
</tr>
<tr>
<td>C-MoCA, mean ± SD</td>
<td>18.3 ± 1.56</td>
<td>21.5 ± 0.73</td>
<td>0.001</td>
</tr>
</tbody>
</table>

C-MoCA: the Chinese version of Montreal cognitive assessment.
MMSE: mini-mental state examination.
ROC curve: receiver operating characteristic curve.
AUC: area under receiver operating characteristic curve.

2.4. Statistical Analyses. ROC curve analysis was used to evaluate the performance of MMSE and MoCA in discriminating aMCI from cognitive healthy controls. Independent t-test, chi-square test, and rank sum test were used to analyze the differences between two educational groups (primary education group: 0–6 years and secondary education group: 7–12 years) (Figure 2). The relative effect sizes of age, gender, education, and aMCI on variations in C-MoCA scores were estimated from analysis of variance in general linear model. Variations of C-MoCA and MMSE scores were assessed by partial eta squared (η²). SPSS for Windows version 17.0 was used for statistical analyses.

3. Results

3.1. Demographic Characteristics. There were no significant differences between aMCI group and NC group in age, education, physical job, smoking, and drinking; only women were proportionately more in the aMCI group (P < 0.05, Table 1). However, there were no gender differences in performance scores on the C-MoCA. The mean C-MoCA scores (adjusted for age, education, and aMCI diagnosis) in men (20.6 ± 0.53) were not significantly different from those in women (19.7 ± 0.42, Table 2).

3.2. Variations of C-MoCA Scores by Education and aMCI Status. Table 3 shows the regression estimates of the independent associations of gender, age, education, and aMCI status with C-MoCA and MMSE scores. Similar patterns of relationships with gender, age, education, and aMCI status were observed for both C-MoCA and MMSE scores. There were significant differences in mean scores of C-MoCA by educational groups and aMCI status. The adjusted mean C-MoCA score associated with 0–6 years of education was significantly lower by 3.7 points (P < 0.001) than that with 7–12 years of education. The mean scores of C-MoCA were significantly lower by 2.5 points in the aMCI group than in the control group (P < 0.001, Table 2). Notably, lower education showed considerably larger partial eta squared (η² = 0.204) to variations in C-MoCA scores than aMCI diagnosis (η² = 0.052). Thus, while the individual variables except for gender were significantly independent predictors of C-MoCA scores, they differ in their effect sizes.

3.3. ROC Curve of MMSE and C-MoCA. As shown in Table 1 and Figure 1, overall, the AUC of C-MoCA in discriminating between aMCI and cognitively normal controls was 0.72 (95% CI: 0.62–0.81), with optimal sensitivity of 0.75 and specificity of 0.62 using a cutoff of 20/21. In comparison, the AUC of MMSE was 0.74 (95% CI: 0.64–0.84), with optimal sensitivity of 0.83 and specificity of 0.56 using a cutoff of 26/27. There was no significant difference in AUC’s between the C-MoCA and MMSE.

3.4. C-MoCA and MMSE ROCs by Educational Groups. Table 3 shows the mean scores and test performance parameters of C-MoCA and MMSE scores by educational groups. As expected, within each educational stratum, the mean C-MoCA and MMSE scores were significantly lower in aMCI...
Table 2: Unadjusted and adjusted mean C-MoCA and MMSE scores by gender, education, and aMCI diagnosis.

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>C-MoCA</td>
<td>MMSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unadjusted mean (SD)</td>
<td>Adjusted mean ± SE</td>
<td>Unadjusted mean (SD)</td>
<td>Adjusted mean ± SE</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>70</td>
<td>21.5 (4.1)</td>
<td>21.6 ± 0.53</td>
<td>26.4 (2.4)</td>
<td>25.6 ± 0.35</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>102</td>
<td>20.7 (4.7)</td>
<td>19.7 ± 0.42</td>
<td>26.0 (3.1)</td>
<td>25.2 ± 0.28</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less (0–6 years)</td>
<td>78</td>
<td>18.5 (4.4)</td>
<td>18.3 ± 0.47</td>
<td>24.6 (3.1)</td>
<td>24.3 ± 0.31</td>
<td></td>
</tr>
<tr>
<td>More (7–12 years)</td>
<td>94</td>
<td>23.2 (3.4)</td>
<td>21.9 ± 0.48</td>
<td>27.5 (1.9)</td>
<td>26.5 ± 0.32</td>
<td></td>
</tr>
<tr>
<td>Amnesic MCI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24</td>
<td>18.3 (3.7)</td>
<td>18.9 ± 0.72</td>
<td>24.1 (2.9)</td>
<td>24.4 ± 0.48</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>148</td>
<td>21.5 (4.5)</td>
<td>21.3 ± 0.29</td>
<td>26.5 (2.7)</td>
<td>26.4 ± 0.19</td>
<td></td>
</tr>
</tbody>
</table>

C-MoCA: the Chinese version of Montreal cognitive assessment.
MMSE: mini-mental state examination.
Amnesic MCI: amnesic mild cognitive impairment.

Table 3: Regression estimates of relative contributions of age, education, and aMCI diagnosis to C-MoCA scores.

<table>
<thead>
<tr>
<th></th>
<th>C-MoCA</th>
<th></th>
<th></th>
<th>MMSE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Regression coefficient</td>
<td>SE</td>
<td>t</td>
<td>P</td>
<td>η²</td>
</tr>
<tr>
<td>Male (versus female)</td>
<td>0.91</td>
<td>0.55</td>
<td>1.647</td>
<td>0.101</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Age, per year</td>
<td>−0.23</td>
<td>0.04</td>
<td>−5.871</td>
<td>0.0001</td>
<td>0.171</td>
<td></td>
</tr>
<tr>
<td>0–6 years education (versus 7–12 years)</td>
<td>−3.61</td>
<td>0.55</td>
<td>−6.536</td>
<td>0.0001</td>
<td>0.204</td>
<td></td>
</tr>
<tr>
<td>Amnesic MCI (versus normal control)</td>
<td>−2.34</td>
<td>0.77</td>
<td>−3.014</td>
<td>0.003</td>
<td>0.052</td>
<td></td>
</tr>
</tbody>
</table>

participants than in NC participants except for C-MoCA mean scores in the 0–6 years educational group. In this group, there was only a 1.4 point difference in mean C-MoCA scores between aMCI and NC participants, which was not statistically significant.

Test performance of the C-MoCA was better in the 7–12 years educational group (AUC = 0.79; sensitivity of 0.89 and specificity of 0.64 at cutoff 22/23) and poorer in the 0–6 year educational group (AUC = 0.60; sensitivity of 67% and specificity of 49% at cutoff 18/19). In comparison, C-MoCA did not show better test performance characteristics than the MMSE. While its test performance was marginally better than the MMSE in the better educated group, it was marginally poorer for the low level educational group.

4. Discussion

In a large majority of previously published reports, the C-MoCA has shown high detection accuracy, sensitivity, and specificity at various cutoffs for detecting MCI, including in patients performing in the normal range on the MMSE [3]. Our evaluation among community-dwelling elderly with generally lower education in two rural villages in China, however, showed that the AUC (0.72) of the C-MoCA is lower than in previous studies, which generally reported AUCs in the 0.80s or 0.90s. Most previously published studies evaluating the MoCA have either been conducted on urban-dwellers or did not report urban-rural differences.

For example, our results may be contrasted with the high AUC (0.88), sensitivity (77%), and specificity (90%) reported among elderly urban-dwellers in Shanghai [18].

Our findings are supported by preliminary data from two recent studies. An earlier study of the MoCA reported modest accuracy (AUC: 0.71 with sensitivity of 68.7% and specificity 63.9% at a lowered cutoff score 22 [14]. This is a study in Beijing involving a large heterogeneous population sample which includes the sample of rural elderly persons in this study. However, data in another study of Singapore Chinese elderly persons also indirectly show modest accuracy of MoCA for MCI detection (AUC < 0.77), sensitivity of 96% but specificity of 30% at cutoff of 25/26. Furthermore, we found that the C-MoCA appeared not to have an advantage over MMSE in discriminating between aMCI and normals. This concurs with the previously published study in north China [14].

Our results showed lower mean C-MoCA's test scores associated with low education, confirming observations from an increasing number of studies that education influences the C-MoCA test scores. Estimates of the influence of education on MoCA scores and its heterogeneity of effect in different populations are not well documented. Crude comparisons of published data suggest that these estimates of education effect varied across different populations. In this study, there was a (unadjusted) 5-point difference in mean C-MoCA score between low and higher education groups (Table 4). This is comparable to the mean score of MoCA in a Portuguese population [4], which was approximately 4 points lower for primary (less than 6 years) education compared to higher educated groups, whereas the Los Angeles Chinese
Table 4: C-MoCA and MMSE of aMCI and normal controls and test performance by educational groups.

<table>
<thead>
<tr>
<th></th>
<th>Less (0–6 years) education</th>
<th>More (7–12 years) education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amnesic MCI (n = 15)</td>
<td>Normal control (n = 63)</td>
</tr>
<tr>
<td></td>
<td>17.3 ± 2.04</td>
<td>18.7 ± 1.15</td>
</tr>
<tr>
<td>C-MoCA, mean (SD)</td>
<td></td>
<td>0.266</td>
</tr>
<tr>
<td></td>
<td>20.0 ± 2.46</td>
<td>23.52 ± 0.68</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amnesic MCI (n = 9)</td>
<td>Normal control (n = 85)</td>
</tr>
<tr>
<td></td>
<td>23.1 ± 1.63</td>
<td>25.7 ± 1.63</td>
</tr>
<tr>
<td>MMSE, mean (SD)</td>
<td>0.039</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>27.6 ± 0.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-MoCA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUC ± SE</td>
<td>0.60 ± 0.14</td>
<td>0.79 ± 0.17</td>
</tr>
<tr>
<td>Cutoff</td>
<td>18/19</td>
<td>22/23</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.67</td>
<td>0.89</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.49</td>
<td>0.64</td>
</tr>
<tr>
<td>MMSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUC ± SE</td>
<td>0.67 ± 0.14</td>
<td>0.77 ± 0.16</td>
</tr>
<tr>
<td>Cutoff</td>
<td>25/26</td>
<td>27/28</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.67</td>
<td>0.78</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.51</td>
<td>0.62</td>
</tr>
</tbody>
</table>

The P values were calculated using Student's t-test for continuous variables.

AUC: area under receiver operating characteristic curve.

The study showed only a 2.6-point difference in MoCA scores between 1–6 years and 7–11 years education groups [15]. These comparisons, however, do not take into account population differences in age and the great heterogeneity in population characteristics across studies. More studies of the effect of education vis-à-vis MCI diagnosis on variations in MoCA scores and their heterogeneity of effects across different populations should be conducted.

Various studies have determined different MoCA cutoffs in discriminating MCI from normal but mostly without educational stratification [8–15]. A minority of studies that reported educational stratifications of MoCA cutoffs determined lower MoCA cutoffs for elderly persons with low education but with wide differentials in cutoff points. For example, in the Los Angeles Chinese study, this was lowered by 2 points from 22/23 for middle level education (7–11 years) to 20/21 for low level education (0–6 years) [15]. In our study, we lowered the differential by 4 points from 22/23 for higher (7–12 years) education to 18/19 for low (0–6 years) education. Another Chinese population study determined even wider differential of MoCA cutoffs, from 24/25 for 7 or more years of education to 19/20 for 1–6 years of education and 13/14 for no education [10].

The observed wide variations in MoCA test performance across different studies may be due to linguistic and cultural differences between the original English version and indigenous versions of the MoCA, the lower education level of populations in developing countries, and the strong effect of education on MoCA scores. Previous studies do not provide sufficient information to assess the relative effect of education vis-à-vis MCI diagnosis on MoCA test scores and the influence of education on MoCA test performance. Our study showed that in multivariate analysis controlling for gender and age, low education (0–6 years) was associated with an adjusted 3.6-point lower C-MoCA score whereas aMCI diagnosis was associated with a 2.4-point lower C-MoCA score. Uniquely, our data thus indicated that education had an overwhelmingly surpassing effect than MCI diagnosis on C-MoCA test scores, at least among rural elderly persons. Further studies should be conducted in heterogeneous population samples to document the relative effect of education and MCI diagnosis.

It would appear that the MoCA was designed to be free of the ceiling effect to improve on the MMSE to detect mild cognitive impairment and early dementia. It does this by increasing difficulty in the item responses (increasing failure rates) thus shifting response scores toward lower values to the left, at the same time making the distribution normal.
Figure 2: Receiver operating characteristic curve of MMSE and C-MoCA in different education groups. The ROC curves were used to detect the amnesic MCI for different education groups: (a) for 0–6 years of education group and (b) for 7–12 years of education group. C-MoCA: the Chinese version of Montreal cognitive assessment. MMSE: mini-mental state examination.

Figure 3: Frequency distribution of C-MoCA scores by aMCI status and education groups. (a) The 0–6 years of education group; (b) the 7–12 years of education group. NC: the participants for normal control; aMCI: the participants for amnesic mild cognitive impairment.

(Figure 3). However, this may have increased the tendency for greater floor effects for low cognitive functioning individuals, including those with MCI as well as less educated individuals. It would appear, therefore, that, in populations with large proportions of poorly educated individuals, the low cognitive functioning of MCI due to an underlying brain pathology becomes indistinct with the low cognitive functioning associated with low education. This happens when low cognitive functioning associated with low education is more profound in some population groups such as rural people with poorer quality education.

For practical purposes, the Chinese version of MoCA appears to be satisfactory for detecting MCI among better educated Chinese elderly persons, as shown in this study (AUC = 0.79), as well as in previous studies of the Chinese MoCA in urban elderly populations in Shanghai and Beijing.
There is grave concern about using the C-MoCA among less educated Chinese elderly, at least those living in rural villages, given the serious problems of low power of detection and missed diagnoses. More research is needed to develop cognitive screening tools that are universally appropriate for all population groups including rural people. Our study had several limitations. The sample size was small. Hence, these results may be viewed as only preliminary, pending further larger studies. Another limitation is that the study used secondary data from surveys in the National Science and Technology Pillar Program designed to assess common psychological problems of Chinese older persons. The primary research objective was not to evaluate the C-MoCA for detecting amnesic mild cognitive impairment. The C-MoCA and MMSE were among a large number of scales used, and psychological pressure and fatigue could possibly influence the detection utility of the C-MoCA, although they were administered first in line with other scales.

5. Conclusion

The Chinese version of MoCA has modest accuracy and is not better than the MMSE in detecting mild cognitive impairment especially among rural-dwelling Chinese older persons with low education. Education exerts a stronger influence than MCI diagnosis on variations in MoCA scores, and this is likely to adversely affect its test performance among lowly educated individuals.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

This study was supported by National Science and Technology Pillar Program of China (2009BA177B03), Beijing Committee of Science and Technology (Z11107058811103), Natural Science Foundation of China (30971044, 81171018), Committee of Science and Technology (Z111107058811103), Beijing Science and Technology Pillar Program designed to assess common psychological problems of Chinese older persons. The primary research objective was not to evaluate the C-MoCA for detecting amnesic mild cognitive impairment. The C-MoCA and MMSE were among a large number of scales used, and psychological pressure and fatigue could possibly influence the detection utility of the C-MoCA, although they were administered first in line with other scales.

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References

Alzheimer’s disease (AD) has increased in its prevalence due to the increasing aged population. Currently there is no updated data on the prevalence of dementia including its very mild stage in Taiwan. Under the extensive coverage of Mentality Protection Center (MPC), Fo Guang Shan Compassion Foundation, the volunteers of MPC have conducted the medicine-related services and the screening of dementia by AD8 (ascertainment of dementia 8) that can screen the dementia even at its very mild stage in general population in all Taiwan. From 2011 to 2013, in total, 2,171 participants, 368 in the northern, 549 in the central, 877 in the southern, and 377 in the eastern part, were recruited with the mean age being 66.9 ± 10.2 years old. The ratio of suspected dementia patients, AD8 score greater than or equal to 2, was 13.6% of all recruited participants with their mean AD8 score being 2.9 ± 1.3, mean age being 69.4 ± 10.8 years old, and female predominance being 73.0%. Although this is a screening study, it has extensive coverage of all Taiwan and the use of AD8 is capable of screening very mild dementia. A further study with a randomized sampling to examine the prevalence and incidence of dementia including its very mild stage is encouraged.

1. Introduction

Alzheimer’s disease (AD) is the main cause of dementia in Taiwan [1]. At present, most available data and studies regarding the prevalence of AD in Taiwan were completed in the past two decades [2–7], and these studies were limited to certain areas, Kaohsiung city, Kinmen county, Taipei city, or Ilan city, which do not provide an overall understanding of dementia in Taiwan [1]. Moreover, the aged population has been increasing steadily in recent years. These published studies did not have sufficient data to reflect current status of the aged population. These published studies also did not sufficiently detect dementia at the very mild stage, and did not address the very mild stage of dementia. To date, little is known about the current status of dementia in the general population in Taiwan.

AD8 is a brief tool used to screen dementia, which was developed from Washington University in St. Louis [8], which is capable of screening very mild dementia in a general population and is used extensively in other countries, including Taiwan [9]. If the screening result of AD8 is 2, the individual would be considered having dementia including very mild dementia [9]. AD8 can be administered to an informant of demented patients and the patient himself with a similar discriminative rate to help with differentiating demented from nondemented subjects [10].

The Mentality Protection Center (MPC) is a nonprofit institution and was established under Compassion Foundation Fo Guang Shan in 2008 to provide medical and charitable services to the general population in the world through hundreds of branches of Fo Guang Shan. Working together with the branches of Fo Guang Shan, scattered throughout
urban, suburban, and rural areas in each of the northern, central, southern, and eastern parts of Taiwan, the MPC has launched dementia-screening projects to assist the elderly population regarding screening for dementia by utilizing AD8 from 2011 to 2013. The screening project, including dementia, depression, and sleep disorder, was administrated to the voluntary walk-in aged population in these branches if they were aware of the medical service and the dementia-screening project. All of the screening results were recruited to the MPC headquarter for the statistical analyses.

2. Material and Methods

2.1. The Training of Interviewers. All of our interviewers were senior nurses or other medical-related specialists. Before their administration of AD8 to the elderly population, they had to receive a series of training courses with regard to dementia-related and medical-related topics and to practice the administration of AD8 with the general population by working with experienced interviewers and physicians with internships. All of the interviewers were volunteers of MPC and completed walk-in screenings in this project in Taiwan.

2.2. Walk-In Screening. There are 59 branches of the Mentalty Protection Center in Taiwan. All of these branches are scattered throughout the northern, central, southern, and eastern parts of Taiwan and distributed in urban, suburban, and rural areas in each part of Taiwan. From March 1, 2010 to April 30, 2013, 53 walk-in screenings were conducted at these 59 branches of MPC. Every screening in a branch had to last for 1 day to provide the medical and charitable service to the general elderly population and the screening of dementia by AD8 [9], depression by Center for Epidemiologic Studies-Depression (CES-D) scale [11], and sleep disorder by Pittsburgh Sleep Quality Index (PSQI) [12]. For all 53 screenings, 7 screenings were conducted in the northern part, 19 in the central part, 24 in the southern part, and 3 in the eastern part of Taiwan to the general population if they were older than 50 years old. Every walk-in participant was voluntary to join and complete all screens.

2.3. Participants and Evaluations. All participants voluntarily joined the screening activity without any reward. CES-D, AD8, and PSQI were administrated to individuals after identifying age, gender, and living area. The individual was considered as suspected dementia if his/her AD8 total score was greater than 2. Using these existed data for the statistical analyses was approved by the Kaohsiung Medical University Hospital Institutional Review Board (IRB). All the information related to the privacy or that can be identified was not recorded during the screening process.

2.4. Statistics. Data analysis was performed using SPSS (version 12.0.1 for Windows, SPSS Inc., Chicago, IL, USA). All statistical tests were two-tailed and an alpha of 0.05 was taken to indicate significance. Analysis of variance (ANOVA) was used to compare the difference of group mean for age and for AD8 total score among the four areas of Taiwan for all participants and for all suspected dementia individuals. t-test was used to compare the group mean of age and of AD8 total score between suspected dementia and nondemented individuals. Chi-square test was used to compare the proportion of each reported subitem of AD8 and gender between suspected dementia and nondementia subjects and among four areas, the northern, central, southern, and eastern parts of Taiwan.

3. Results

In total, 2,171 participants, 368 in the northern, 549 in the central, 877 in the southern, and 377 in the eastern part, were recruited with the mean age 66.9 ± 10.2 years old. The mean age was significantly different among four areas (P < 0.001). The age of participants from the eastern area were older, 70.0 ± 10.0 years old, than the other three areas (Table 1). Participants were predominantly female, and there were no significant differences with regard to gender proportion (P = 0.485) although it was higher in the southern area (71.5%), compared to others (Table 1). For the proportion of reported change in each subitem of AD8, there was a significant difference in AD8-2 (reduced interest in hobbies and other activities) among the 4 areas (P = 0.024), where the eastern area had a higher proportion (10.9%). Similarly, there was a significant difference in AD8-3 (repeating of questions, stories, or statements) (P < 0.001) among the 4 areas, where the northern area had a higher proportion (13.6%). In the general population, the top two frequently reported items were AD8-8 (consistent problems with thinking and/or memory) (13.3%), followed by AD8-5 (forgetting correct month or year) (8.2%) (Table 1).

The mean age between suspected demented (69.4 ± 10.8) and nondemented subjects (66.6 ± 10.0) was significantly different (P < 0.001). The ratio of suspected demented subjects was not significantly different among the four areas (P = 0.854) as well as age (P = 0.162), gender (0.383), and mean AD8 total score (P = 0.658) (Table 2). In general, the ratio of suspected dementia patients was 13.6% of all recruited participants with their mean AD8 score being 2.9 ± 1.3, mean age being 69.4 ± 10.8 years old, and female predominance being 73.0% (Table 2).

Ratio of reported change for each subitem of AD8 and AD8 total score were significantly different between suspected demented and nondemented group (P < 0.001 for each comparison of AD8 subitem and AD8 total score) (Table 3). In nondemented group, the AD8-2 (consistent problems with thinking and/or memory (6.4%)), AD8-8 (reduced interest in hobbies/activities were frequently reported (3.1%)), and AD8-5 (forgetting correct month or year (3.0%)) were the top 3 frequently reported change in AD8 subitems (Table 3). Alternatively, these proportions of AD8 subitems in nondemented subjects, in part, were similar to those in suspected demented subjects where the AD8-8 (consistent problems with thinking and/or memory (56.8%)), AD8-7 (difficulty in remembering appointments (47.0%)), and AD8-5 (forgetting correct month or year (40.9%)) were frequently reported (Table 3).
### 4. Discussion

This study provides updated information on the current status of dementia and the frequently reported presentations for mild dementia of Taiwan. Although the study design did not utilize a randomized sampling method to examine the prevalence and incidence of dementia in Taiwan, it provided information of dementia coming from four areas, the northern, central, southern, and eastern parts of Taiwan, for an overall examination for dementia and reported the frequently reported complaints and symptoms of dementia, including very mild dementia.

Prevalence studies of dementia in Taiwan were mostly conducted 2 decades ago [2–7], which cannot reflect our current status. Importantly, those studies were also done sporadically and separately in a localized area of Taiwan with different study designs and various psychometrics so it was not easy to have this data put together to reflect the condition of dementia for all of Taiwan. Meanwhile, some of those studies were not capable of reflecting the status of very mild dementia, CDR0.5 [13], that was less reported and addressed in those studies [2–7].

Most of our recruited participants were female predominant with a mean age of 66.9 ± 10.2 years old. Such results might, in part, be related to a female predominance for people aged greater than 50 years old in Taiwan [14], and females might be more inclined to participate in this social facility as compared with male, especially with regard to religion.

For the significant discrepancies in reported change of the AD8 subitem, the proportion of AD8-3 (repeats questions,
that of our previously reported mean age, the age of these suspected demented subjects was younger than were predominant in the prevalence of AD [19]. The mean anxiety and stress will cause people to have memory problems which should be more objective when compared to other published studies in limited areas [2–7] in order to more accurately reflect and report on the status of dementia in Taiwan. On the other hand, this study involves a number of limitations that need to be addressed. Firstly, this study did not involve randomized sampling of the general population and as a result our study cannot reflect the real prevalence and incidence of current dementia in Taiwan. Secondly, we only used AD8 without other laboratory data or imaging data to provide the clinical diagnosis of each suspected demented patient; however, AD8 has been validated as being reliable in terms of sensitivity and specificity in screening dementia [9] and this study focused on the screening, not the diagnosing of dementia. Third, the study was a walk-in screening. This means that only the individuals who could independently walk into or be brought into our branches for screening were recruited. If he/she was independent or could not be brought into our screening sites, he/she might not join the screening process so that our current study may therefore underestimate the real status of the prevalence of dementia.

This was a screening study performed with some limitations and strengths, but did involve extensive coverage of all Taiwan and the use of AD8 was capable of screening very mild dementia. A further study with a randomized sampling to examine the prevalence and incidence of dementia with its subtypes in Taiwan is encouraged.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

We deeply appreciate all the work done by medical volunteers of Mentality Protection Center and funds from Compassion Foundation Fo Guang Shan.

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