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Research Paper

Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan

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Abstract

Background World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients. However, the data for the effect of education on disability status in dementia patients is lacking. The aim of this large-scale, population-based study was to analyze the effect of education on the disability status of elderly Taiwanese dementia patients by using (WHODAS 2.0).

Methods From the Taiwan Data Bank of Persons with Disability, we enrolled 7,698 disabled elderly (older than 65 years) patients diagnosed with dementia between July 2012 and January 2014. According to their education status, we categorized these patients with and without formal education (3,846 patients each). We controlled for the demographic variables through propensity score matching. The standardized scores of these patients in the six domains of WHODAS 2.0 were evaluated by certified interviewers. Student's *t* test was used for comparing the WHODAS 2.0 scores of dementia patients in the two aforementioned groups. Poisson regression was applied for analyzing the association among all the investigated variables.

Results Patients with formal education had low disability status in the domains of getting along and social participation than did patients without formal education. Poisson regression revealed that standardized scores in all domains of WHODAS 2.0— except self-care—were associated with education status.

Conclusions This study revealed lower disability status in the WHODAS 2.0 domains of getting along and social participation for dementia patients with formal education compared with those without formal education.

Keywords

Dementia, education, ICF, Taiwan, World Health Organization Disability Assessment

Schedule 2.0 (WHODAS 2.0)

Strengths and limitations of this study

- First large-scale, population-based study using WHODAS 2.0 to analyzing the effect of education on disability status in dementia patients.
- Propensity scores matching was applied for variables of demographic data to minimize the effect of potential confounders
- Stratification of the education levels and the dose effect of education status on disability severity among dementia patients were not presented in this study
- Dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires; therefore, their assessment was completed by proxies.
- Differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study could not be generalized to non-Taiwanese populations.

Introduction

The cognitive reserve hypothesis explains how individuals maintain cognitive function and resist pathological processes and clinical impairment of the brain[1]. Individuals with higher education levels are considered to have higher brain reserve and better compensation during progressive brain disease[2]. Thus, education is an crucial protective factor for dementia[1]. Studies have reported that the association between direct measures of brain pathology with neuropsychological test performance can be influenced by education level[3, 4]. Low education level has been reported to be a risk factor for dementia, especially Alzheimer disease[2, 5]. In a meta-analysis, individuals with low and medium levels of education had a 1.33-fold higher risk of dementia compared with individuals with a high education level[6]. In addition, a large-scale, population-based study reported the dose effect of education: individuals with a high education level have a low risk of dementia[7]. Cognitive decline usually accompanies the normal aging process, and a high education level can slow this decline[8, 9].

Dementia, a major cause of disability and mortality among elderly individuals,[10] can lead to functional decline and severely affect many activities of daily living. To comprehensively evaluate and quantify the disability status caused by dementia, an

objective assessment tool that evaluates activities of daily living, cognition, and social participation is essential. In 2001, the World Health Organization Disability Assessment Scale, Second Edition (WHODAS 2.0), was developed in accordance with the International Classification of Functioning, Disability, and Health (ICF). WHODAS 2.0 can be used for evaluating the functional disability caused by chronic diseases in elderly patients[11]. WHODAS 2.0 assesses the domains of self-care, life activities, cognition, getting along, and social participation, all of which are domains that dementia may compromise; therefore, WHODAS 2.0 is well-suited for evaluating disability in dementia patients.

Our previous studies confirmed that WHODAS 2.0 is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients[12, 13]. However, no large-scale, population-based studies have investigated the effect of education on disability status in dementia patients. Therefore, we investigated the effect of education on disability status in dementia patients by analyzing their using WHODAS 2.0 scores.

Methods

Data collection

Patients in the Taiwan Data Bank of Persons with Disability (TDPD) diagnosed with dementia between July 2012 and January 2014 were enrolled in this study. The TDPD was established in July 2012; around the same time, a new disability evaluation process, Disability Eligibility Determination Scale (DES-2012), was developed on the basis of the ICF framework[14]. In Taiwan, patients with stable disability after a disease event can apply for social welfare support. The DES-2012 evaluation process entails two stages and two independent and authorized specialists. In the first stage, the body function and body structure categories of the ICF are assessed in accordance with the standardized coding criteria of DES-2012 by a clinical physician specialized in the disease afflicting the patient; in addition, the physician assigns a diagnostic code to the disease in accordance with the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. In the second stage, the environmental categories of the ICF framework are assessed by a specialist, such as a physical therapist, occupational therapist, psychologist, or social worker. In addition, the specialist evaluates the patient's social participation status and restriction in life activities by using WHODAS 2.0 (traditional Chinese version). These specialists are authorized for DES-2012 evaluation only after receiving official training.

Patients and data collection

From the TDPD database, we included the data of elderly patients (older than 65 years of age) with dementia (ICD-9-CM 290.0–290.1, 294.1) and Alzheimer disease (ICD-9-CM 331.7–331.9). Demographic data— namely age, gender, residence status (community dwelling or institution dwelling), urbanization level (rural, suburban, urban), socioeconomic status (average, middle, and low), and education status (with and without formal education)—and the parameters of body functions and body structures (ICF categories) are recorded in the TDPD database. Among patients with dementia, disability was primarily caused by cognition-related ICF body function categories such as b110 (consciousness functions), b117 (intellectual functions), b122 (global psychosocial functions), b140 (attention functions), b144 (memory functions), and b164 (higher-level cognitive functions). The severity of impairment caused by each of these categories has clinical or objective definitions and is indicated by the qualifier following *b*: 1 = mild: 5%–24% impairment; 2 = moderate: 25%–49% impairment, 3 = severe: 50%–95% impairment, 4 = extreme: 96%–100% impairment. For example, b110.4 indicates extreme severity in the consciousness functions of the patient. This study was approved by the Joint Institutional Review Board at Taipei Medical University. Because this is a secondary data analysis study and because the data were analyzed

anonymously, informed consent was not required.

Outcome measurements

The WHODAS 2.0 scores recorded in the TDPD database were used as indicators of the disability status of the study patients. The scores are assigned by authorized specialists after they interview the patients (or their proxies if patients are unable to answer the WHODAS 2.0 questionnaire). WHODAS 2.0 has six domains and 36 items in total: domain 1 has six items on cognition; domain 2 has five items on mobility; domain 3 has four items on self-care; domain 4 has five items on getting along; domain 5 has four items on life activities and four items on work and school activities; domain 6 has eight items on social participation. The patients indicate their level of difficulty in performing activities related to each item in the past 30 days on a 5-point Likert scale (1 = no difficulty, 2 = mild difficulty, 3 = moderate difficulty, 4 = severe difficulty, 5 = extreme difficulty). The total score of all six domains are transformed to standardized scores ranging from 0 to 100, with higher scores indicating a higher severity of disability. Because we only enrolled dementia patients older than 65 years, we expected most of them to be retired or unemployed; hence, we excluded the four items in domain 5 pertaining to work and school activities. Thus, we analyzed the scores in the remaining 32 WHODAS 2.0 items.

The traditional Chinese version of WHODAS 2.0 is used in TDPD database; the intraclass correlation coefficient of this version of the questionnaire was found to be 0.80–0.89, and the internal consistency and reliability was found to be 0.73–0.99 (Cronbach's α)[15, 16] .Regarding missing data, the WHODAS 2.0 guidelines allow up to 30% of the items in each domain to be missing; the missing values can be adjusted using the mean of the available scores in that domain[17].

Statistical analysis

Demographic variables, namely age (65–74 years, 75–85 years, and >85 years), socioeconomic status (average, middle, and low), residence status (community dwelling and institution dwelling), urbanization level (urban, suburban, and rural), and severity of dementia-related impairment (mild, moderate, severe, and extreme), were represented as numbers and percentages. To determine the effect of education status on dementia patients, we categorized the data into two groups on the basis of the education status of the patients (with and without formal education); the variables were controlled for through propensity scores matching.

Chi-square analysis was used for comparing the categorical variables of dementia-related disability between dementia patients with and without formal education. The standardized scores for both groups in the six domains of WHODAS

2.0 were compared using independent *t* tests. Subsequently, the association between the demographic variables and the standardized scores for all six domains in both groups were analyzed through a Poisson regression model. All statistical analyses were performed using SAS software (SAS Institute, Inc., Cary, NC), and $p < 0.05$ was considered statistically significant.

Results

After propensity score matching of the disabled dementia patients, the without formal education group comprised 3,849 patients (1,864 females and 1,985 males) and the with formal education group comprised 3,849 patients (1,879 females and 1,973 males). The distribution of the demographic variables of the two groups did not differ significantly (table 1).

According to our analysis, the without formal education group had higher WHODAS 2.0 scores in domain 4 (getting along) and domain 6 (social participation) compared with the with formal education group. By contrast, the scores in domain 1 (cognition), domain 2 (mobility), domain 3 (self-care), and domain 5 (life activities) and the standardized (summarized) WHODAS 2.0 scores did not differ significantly between the groups (table 2).

Poisson regression analysis revealed that the scores in all domains— except

domain 3—and the summarized scores of WHODAS 2.0 were associated with the education status. In addition, domains 1, 2, and 6 were found to be associated with the socioeconomic status. Moreover, gender, age, residence status, urbanization level, and disease severity were found to be associated with the scores of each domain as well as the summarized WHODAS 2.0 scores (table 3).

Discussion

Our study demonstrated that disabled dementia patients with formal education had higher scores in the domains of getting along and social participation than did those without formal education. However, no significant differences were noted in the domains of cognition, mobility, self-care, and life activities.

The cognitive reserve hypothesis states that a higher education level indicates a higher cognitive reserve and that it delays the onset of dementia[18, 19]; in other words, education has a protective effect on cognitive function in dementia. However, in this study, no differences in the disability status of the cognitive domain functions were observed between the with and without formal education groups. We hypothesize that irrespective of the education status of an individual, the cognitive function declines immediately on the onset of dementia. In start contrast to the cognitive reserve

hypothesis, a study reported that after cognitive decline, the onset of dementia is more rapid in persons with a higher education level[20]. Pathological changes to the brain may be slow during cognitive reservation; however, after the onset of cognitive decline, these changes can be rapid in people with a high education level because dementia is at an advanced stage when the symptoms manifest[21]. This pattern has been reported in previous studies that have stated that cognitive decline is more rapid after Alzheimer disease is diagnosed in highly educated patients[21, 22]. Our results are consistent with the aforementioned results; that is, cognitive decline is not influenced by the education status of an individual before the diagnosis of dementia.

In our study, the education status did not influence the patients' disability in the domains of mobility, self-care, and life activities. However, patients in the with formal education group exhibited lower disability status in the domains of getting along and social participation than did those in the without formal education group. This may be because these domains pertain to basic activities of daily life and are therefore not related to the education status, whereas the functional aspects of getting along and social participation require advanced skills that can be obtained through formal education. Social participation can offer and reinforce social roles and can provide a sense of belonging and self-esteem in later life[23]. Formal schooling can impart the

skills necessary for abstract thinking and socialization. Most elderly individuals in Taiwan are illiterate because of their lack of a formal education. Reading and communication skills obtained through education can ingrain in elderly individuals a stronger sense of social attachment and widen enlarge their social network.

Our study analyzed the effect of education on the disability status caused by dementia. The strength of this study lies in its use of a large-scale, population-based database; in addition, we controlled for possible confounding variables, increasing the validity of our results. However, the study has the following limitations. First, the education status was dichotomized solely on the basis of whether the patient received formal education. Therefore, future studies can explore stratification of the education levels and the dose effect of education status on disability severity among dementia patients. Second, the WHODAS 2.0 assessment was performed on the basis of the responses given by dementia patients or their caregivers, which might have underestimated the functioning disability for dementia patients with mild severity of disability and poor insights. Most dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires; therefore, their assessment was completed by proxies. In addition, the WHODAS 2.0 questionnaire only evaluated the disability condition of individuals in the past 30 days.

Only caregivers of severe dementia patients who were unable to communicate to the interviewers could accurately report the daily functioning of these patients. Nevertheless, to avoid the bias this may have caused, we controlled for the severity of dementia in both the study groups. Third, community environment, family support, and marriage status were not controlled for in this study. Nevertheless, we controlled for the urbanization level, residence status, and socioeconomic status, and these variables can represent the living environment and social resource of the disabled dementia patients. Finally, considering the differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study cannot be generalized to non-Taiwanese populations.

Conclusions

Dementia patients with a formal education had lower disability status in the WHODAS 2.0 domains of getting along and social participation compared with those without a formal education. Thus, disability status is influenced by the education status of the patient before the diagnosis of dementia and therefore formal education can help elderly individuals maintain stronger social interaction even after they develop dementia.

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Contributors: H-SW participated in the study design, conducted the data analysis, drafted the initial manuscript and approved the final manuscript as submitted. C-KH conducted the data analysis, drafted the manuscript and approved the final manuscript as submitted. C-WC contributed to the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. Y-CF reviewed and revised the manuscript, and approved the final manuscript as submitted. L-HF participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. RE designed and conceptualised the study, and approved the final manuscript as submitted. C-FH participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. L-TH participated in the study design, conducted the data analysis, revised manuscript and approved the final manuscript as submitted.

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Competing interests: None declared.

Ethics approval: The Institutional Review Board of Taipei Medical University approved this study

Data sharing statement: The data of this study is taken from the Taiwan Data Bank of Persons with Disability (TDPD) database. Requests for the data may be sent to

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Provenance and peer review: Not commissioned; externally peer reviewed.

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Table 1 Demographic characteristics of elderly Taiwanese dementia patients with and without formal education (N = 7,698) after propensity score matching for gender, age, socioeconomic status, residence status, urbanization level, and severity of impairment

Variables	Literacy n=3,849		Illiteracy n=3,849		p value
	No.	%	No.	%	
Gender					0.784
Male	1985	51.57%	1973	51.26%	
Female	1864	48.43%	1876	48.74%	
Age					0.915
65-74	1035	26.89%	1048	27.23%	
75-84	1798	46.71%	1799	46.74%	
≧85	1016	26.40%	1002	26.03%	
Social Economic Status					0.938
Average	3764	97.79%	3765	97.82%	
middle low & low	85	2.21%	84	2.18%	
Residence					0.728
Community Dwelling	2940	76.38%	2927	76.05%	
Institution	909	23.62%	922	23.95%	
Urbanization level					0.859
Rural	556	14.45%	560	14.55%	
Suburban	1356	35.23%	1333	34.63%	
Urban	1937	50.32%	1956	50.82%	
Severity of impairment					0.973
Mild	759	19.72%	745	19.36%	
Moderate	1259	32.71%	1266	32.89%	
Severe	475	12.34%	470	12.21%	
Extreme	1356	35.23%	1368	35.54%	

Table 2 Overall disability (based on WHODAS II scores) in different domains between elderly Taiwanese dementia patients with and without formal education (N = 7,698)

Variables	Literacy n=3,849		Illiteracy n=3,849		P value
	Mean	SD	Mean	SD	
Domain 1	71.81	27.066	72.34	26.750	0.389
Domain 2	57.91	33.586	58.65	33.356	0.336
Domain 3	43.80	36.004	43.85	35.835	0.949
Domain 4	72.16	29.441	74.29	28.455	0.001*
Domain 5	79.45	32.437	80.22	32.240	0.297
Domain 6	51.39	26.664	52.63	26.226	0.039*
Summary	61.87	24.054	62.79	23.609	0.089

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

*Independent t test $P < 0.05$

Table 3. Poisson regression of WHODAS 2.0 scores for elderly Taiwanese dementia patients for analyzing the association of the WHODAS 2.0 scores for each domain and the summarized scores with various demographic variables

Variables (N=7,778)	Domain 1		Domain 2		Domain 3		Domain 4		Domain 5		Domain 6		Domain Summary	
Intercept	49.009	*	30.552	*	21.622	*	50.036	*	56.539	*	38.320	*	40.869	*
Education Status														
Literacy														
Illiteracy	1.006	*	1.011	*	0.999		1.028	*	1.009	*	1.023	*	1.014	*
Age														
65~74														
75~84	1.050	*	1.132	*	1.102	*	1.042	*	1.068	*	1.015	*	1.059	*
≧85	1.110	*	1.253	*	1.183	*	1.090	*	1.123	*	1.046	*	1.121	*
Socioeconomic status														
Average (Reference)														
Middle-low & Low	0.976	*	1.037	*	1.013		0.984		1.002		1.072	*	1.015	
Residence														
Community Dwelling (Reference)														
Institution	1.058	*	1.232	*	1.254	*	1.056	*	1.073	*	1.118	*	1.116	*
Urbanization level														
Rural (Reference)														
Suburban	0.985	*	0.999		0.975	*	0.997		0.999		0.970	*	0.987	*
Urban	0.993		0.991	*	0.938	*	1.012	*	1.002		0.953	*	0.983	*
Severity of disability														
Mild (Reference)														
Moderate	1.303	*	1.434	*	1.601	*	1.301	*	1.291	*	1.247	*	1.323	*
Severe	1.477	*	1.840	*	2.165	*	1.484	*	1.428	*	1.478	*	1.562	*
Extreme	1.669	*	2.007	*	2.376	*	1.666	*	1.472	*	1.614	*	1.715	*
Gender														
Male														
Female	0.985	*	0.978	*	0.966	*	0.945	*	0.969	*	0.943	*	0.965	*

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

* p value<0.05

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Pages	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported
Objectives	6	State specific objectives, including any prespecified hypotheses
Methods		
Study design	7	Present key elements of study design early in the paper
Setting	7	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	7	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	7*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	8	Describe any efforts to address potential sources of bias
Study size	7	Explain how the study size was arrived at
Quantitative variables	8,9	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	10	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	11	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	11	Report numbers of outcome events or summary measures
Main results	11	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	11,12	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	12	Summarise key results with reference to study objectives
Limitations	15	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	15	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	15	Discuss the generalisability (external validity) of the study results
Other information		
Funding	16	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan

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Research Paper

Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan

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Abstract

Background World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients. However, the data for the effect of education on disability status in dementia patients is lacking. The aim of this large-scale, population-based study was to analyze the effect of education on the disability status of elderly Taiwanese dementia patients by using (WHODAS 2.0).

Methods From the Taiwan Data Bank of Persons with Disability, we enrolled 7,698 disabled elderly (older than 65 years) patients diagnosed with dementia between July 2012 and January 2014. According to their education status, we categorized these patients with and without formal education (3,849 patients each). We controlled for the demographic variables through propensity score matching. The standardized scores of these patients in the six domains of WHODAS 2.0 were evaluated by certified interviewers. Student's *t* test was used for comparing the WHODAS 2.0 scores of dementia patients in the two aforementioned groups. Poisson regression was applied for analyzing the association among all the investigated variables.

Results Patients with formal education had low disability status in the domains of getting along and social participation than did patients without formal education. Poisson regression revealed that standardized scores in all domains of WHODAS 2.0— except self-care—were associated with education status.

Conclusions This study revealed lower disability status in the WHODAS 2.0 domains of getting along and social participation for dementia patients with formal education compared with those without formal education. For disabled dementia patients without formal education, community intervention of social participation should be implemented to maintain better social interaction ability.

Keywords

Dementia, education, ICF, Taiwan, World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0)

Strengths and limitations of this study

- First large-scale, population-based study using WHODAS 2.0 to analyzing the effect of education on disability status in dementia patients.
- Propensity scores matching was applied for variables of demographic data to minimize the effect of potential confounders
- Stratification of the education levels and the dose effect of education status on disability severity among dementia patients were not presented in this study
- Dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires; therefore, their assessment was completed by proxies.
- Differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study could not be generalized to non-Taiwanese populations.

Introduction

The cognitive reserve hypothesis explains how individuals maintain cognitive function and resist pathological processes and clinical impairment of the brain[1]. Individuals with higher education levels are considered to have higher brain reserve and better compensation during progressive brain disease[2]. Thus, education is an crucial protective factor for dementia[1]. Studies have reported that the association between direct measures of brain pathology with neuropsychological test performance can be influenced by education level[3, 4]. Low education level has been reported to be a risk factor for dementia, especially Alzheimer disease[2, 5]. In a meta-analysis, individuals with low and medium levels of education had a 1.33-fold higher risk of dementia compared with individuals with a high education level[6]. In addition, a large-scale, population-based study reported the dose effect of education: individuals with a high education level have a low risk of dementia[7]. Cognitive decline usually accompanies the normal aging process, and a high education level can slow this decline[8, 9].

Dementia, a major cause of disability and mortality among elderly individuals,[10] can lead to functional decline and severely affect many activities of daily living. To comprehensively evaluate and quantify the disability status caused by dementia, an

objective assessment tool that evaluates activities of daily living, cognition, and social participation is essential. The WHO (World Health Organization) Disability Action Plan was proposed to strengthen the collection of data on disability assessment and further identifying needs when planning healthcare services, and allocating medical resources during 2014 to 2021.[11] In 2001, the International Classification of Functioning, Disability, and Health (ICF) was developed to comprehensive evaluation impairments, activity limitations, participation restrictions, personal and environmental factors. Based on the ICF concept, the WHO developed an assessment tool named WHO Disability Assessment Schedule (WHODAS) and 2.0 Version (WHODAS 2.0) was published in 2010. WHODAS 2.0 can be used for evaluating the functional disability caused by chronic diseases in elderly patients[12]. WHODAS 2.0 assesses the domains of self-care, life activities, cognition, getting along, and social participation, all of which are domains that dementia may compromise; therefore, WHODAS 2.0 is well-suited for evaluating disability in dementia patients.

Our previous studies confirmed that WHODAS 2.0 is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients[13, 14]. However, no large-scale, population-based studies have investigated the effect of education on disability status in dementia patients.

Therefore, we investigated the effect of education on disability status in dementia patients by analyzing their using WHODAS 2.0 scores.

Methods

Data collection

Patients in the Taiwan Data Bank of Persons with Disability (TDPD) diagnosed with dementia between July 2012 and January 2014 were enrolled in this study. The TDPD was established in July 2012; around the same time, a new disability evaluation process, Disability Eligibility Determination Scale (DES-2012), was developed on the basis of the ICF framework[15]. In Taiwan, patients with stable disability after a disease event can apply for social welfare support. All the disabled people have the rights to apply the disability certification and they initiated the DES-2012 evaluation process. The DES-2012 evaluation process entails two stages and two independent and authorized specialists. In the first stage, the body function and body structure categories of the ICF are assessed in accordance with the standardized coding criteria of DES-2012 by a clinical physician specialized in the disease afflicting the patient; in addition, the physician assigns a diagnostic code to the disease in accordance with the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. In the second stage, the

environmental categories of the ICF framework are assessed by a specialist, such as a physical therapist, occupational therapist, psychologist, or social worker. In addition, the specialist evaluates the patient's social participation status and restriction in life activities by using WHODAS 2.0 (traditional Chinese version). These specialists are authorized for DES-2012 evaluation only after receiving official training. After the DES-2012 process completed, the data of each applied disabled patients were registered in the TDPD database.

Patients and data collection

From the TDPD database, we included the data of elderly patients (older than 65 years of age) with senile dementia (ICD-9-CM 290.0–290.1, 294.1) and Alzheimer disease (ICD-9-CM 331.7–331.9). Demographic data— namely age, gender, residence status (community dwelling or institution dwelling), urbanization level (rural, suburban, urban), socioeconomic status (average, middle, and low), and education status (with and without formal education)—and the parameters of body functions and body structures (ICF categories) are recorded in the TDPD database. Among patients with dementia, disability was primarily caused by cognition-related ICF body function categories such as b110 (consciousness functions), b117 (intellectual functions), b122 (global psychosocial functions),

b140 (attention functions), b144 (memory functions), and b164 (higher-level cognitive functions). The severity of impairment caused by each of these categories has clinical or objective definitions and is indicated by the qualifier following *b*: 1 = mild: 5%–24% impairment; 2 = moderate: 25%–49% impairment, 3 = severe: 50%–95% impairment, 4 = extreme: 96%–100% impairment. For example, b110.4 indicates extreme severity in the consciousness functions of the patient. This study was approved by the Joint Institutional Review Board at Taipei Medical University. Because this is a secondary data analysis study and because the data were analyzed anonymously, informed consent was not required.

Outcome measurements

The WHODAS 2.0 scores recorded in the TDPD database were used as indicators of the disability status of the study patients. The scores are assigned by authorized specialists after they interview the patients (or their proxies if patients are unable to answer the WHODAS 2.0 questionnaire). WHODAS 2.0 has six domains and 36 items in total: domain 1 has six items on cognition; domain 2 has five items on mobility; domain 3 has four items on self-care; domain 4 has five items on getting along; domain 5 has four items on life activities and four items on work and school activities; domain 6 has eight items on social participation. The patients indicate

their level of difficulty in performing activities related to each item in the past 30 days on a 5-point Likert scale (1 = no difficulty, 2 = mild difficulty, 3 = moderate difficulty, 4 = severe difficulty, 5 = extreme difficulty). The total score of all six domains are transformed to standardized scores ranging from 0 to 100, with higher scores indicating a higher severity of disability. Because we only enrolled dementia patients older than 65 years, we expected most of them to be retired or unemployed; hence, we excluded the four items in domain 5 pertaining to work and school activities. Thus, we analyzed the scores in the remaining 32 WHODAS 2.0 items. The traditional Chinese version of WHODAS 2.0 is used in TDPD database; the intraclass correlation coefficient of this version of the questionnaire was found to be 0.80–0.89, and the internal consistency and reliability was found to be 0.73–0.99 (Cronbach's α)[16, 17] .Regarding missing data, the WHODAS 2.0 guidelines allow up to 30% of the items in each domain to be missing; the missing values can be adjusted using the mean of the available scores in that domain[18].

Statistical analysis

Demographic variables, namely age (65–74 years, 75–85 years, and >85 years), socioeconomic status (average, middle, and low), residence status (community dwelling and institution dwelling), urbanization level (urban, suburban, and rural),

and severity of dementia-related impairment (mild, moderate, severe, and extreme), were represented as numbers and percentages. To determine the effect of education status on dementia patients, we categorized the data into two groups on the basis of the education status of the patients (with and without formal education); the variables were controlled for through propensity scores matching.

Chi-square analysis was used for comparing the categorical variables of dementia-related disability between dementia patients with and without formal education. The standardized scores for both groups in the six domains of WHODAS 2.0 were compared using independent *t* tests. Subsequently, the association between the demographic variables and the standardized scores for all six domains in both groups were analyzed through a Poisson regression model. All statistical analyses were performed using SAS software (SAS Institute, Inc., Cary, NC), and $p < 0.05$ was considered statistically significant.

Results

After propensity score matching of the disabled dementia patients, the without formal education group comprised 3,849 patients (1,864 females and 1,985 males) and the with formal education group comprised 3,849 patients (1,879 females and 1,973 males). The distribution of the demographic variables of the two groups did not

differ significantly (table 1).

According to our analysis, the without formal education group had higher WHODAS 2.0 scores in domain 4 (getting along) and domain 6 (social participation) compared with the with formal education group. By contrast, the scores in domain 1 (cognition), domain 2 (mobility), domain 3 (self-care), and domain 5 (life activities) and the standardized (summarized) WHODAS 2.0 scores did not differ significantly between the groups (table 2).

Poisson regression analysis revealed that the scores in all domains— except domain 3—and the summarized scores of WHODAS 2.0 were associated with the education status. In addition, domains 1, 2, and 6 were found to be associated with the socioeconomic status. Moreover, gender, age, residence status, urbanization level, and disease severity were found to be associated with the scores of each domain as well as the summarized WHODAS 2.0 scores (table 3).

Discussion

Our study demonstrated that disabled dementia patients with formal education had higher scores in the domains of getting along and social participation than did those without formal education. However, no significant differences were noted in the domains of cognition, mobility, self-care, and life activities.

The cognitive reserve hypothesis states that a higher education level indicates a higher cognitive reserve and that it delays the onset of dementia[19, 20]; in other words, education has a protective effect on cognitive function in dementia. However, in this study, no differences in the disability status of the cognitive domain functions were observed between the with and without formal education groups. We hypothesize that irrespective of the education status of an individual, the cognitive function declines immediately on the onset of dementia. In start contrast to the cognitive reserve hypothesis, a study reported that after cognitive decline, the onset of dementia is more rapid in persons with a higher education level[21]. Pathological changes to the brain may be slow during cognitive reservation; however, after the onset of cognitive decline, these changes can be rapid in people with a high education level because dementia is at an advanced stage when the symptoms manifest[22]. This pattern has been reported in previous studies that have stated that cognitive decline is more rapid after Alzheimer disease is diagnosed in highly educated patients[22, 23]. Our results are consistent with the aforementioned results; that is, cognitive decline is not influenced by the education status of an individual before the diagnosis of dementia. Another possible reason of no cognitive disability influence by education is caused by statistical method. In order to control the bias caused by different severity of dementia

between both groups, we matched the percentage of severity of both groups. This process could lead the domain 1 score no different between both groups because the severity of dementia mostly determined by degree of cognitive impairment.

In our study, the education status did not influence the patients' disability in the domains of mobility, self-care, and life activities. However, patients in the with formal education group exhibited lower disability status in the domains of getting along and social participation than did those in the without formal education group. This may be because these domains pertain to basic activities of daily life and are therefore not related to the education status, whereas the functional aspects of getting along and social participation require advanced skills that can be obtained through formal education. Social participation can offer and reinforce social roles and can provide a sense of belonging and self-esteem in later life[24]. Formal schooling can impart the skills necessary for abstract thinking and socialization. Most elderly individuals in Taiwan are illiterate because of their lack of a formal education. Although there were statistical less disability score of social participation and getting alone with people in such large sample sized study, there were only 2 points difference of standardized score between these two groups. Formal education experience could lead individuals to learn the items of social participation and getting alone people domains such as

joining community activities, dealing with people, maintaining a friendship, etc. Reading and communication skills obtained through education can ingrain in elderly individuals a stronger sense of social attachment and widen enlarge their social network.

Our study analyzed the effect of education on the disability status caused by dementia. The strength of this study lies in its use of a large-scale, population-based database; in addition, we controlled for possible confounding variables, increasing the validity of our results. However, the study has the following limitations. First, the education status was dichotomized solely on the basis of whether the patient received formal education. Therefore, future studies can explore stratification of the education levels and the dose effect of education status on disability severity among dementia patients. Second, the WHODAS 2.0 assessment was performed on the basis of the responses given by dementia patients or their caregivers, which might have underestimated the functioning disability for dementia patients with mild severity of disability and poor insights. Most dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires; therefore, their assessment was completed by proxies. In addition, the WHODAS 2.0 questionnaire only evaluated the disability condition of individuals in the past 30 days.

Only caregivers of severe dementia patients who were unable to communicate to the interviewers could accurately report the daily functioning of these patients. Nevertheless, to avoid the bias this may have caused, we controlled for the severity of dementia in both the study groups. Third, community environment, family support, and marriage status were not controlled for in this study. Besides, the cognitive demands in life and occupation cannot be obtained of our database. Nevertheless, we controlled for the urbanization level, residence status, and socioeconomic status, and these variables can represent the living environment and social resource of the disabled dementia patients for minimizing these confounding factors. Finally, considering the differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study cannot be generalized to non-Taiwanese populations.

Conclusions

Dementia patients with a formal education had lower disability status in the WHODAS 2.0 domains of getting along and social participation compared with those without a formal education. Thus, disability status is influenced by the education status of the patient before the diagnosis of dementia and therefore formal education can help elderly individuals maintain stronger social interaction even after they

develop dementia. Regarding public health aspects, community intervention of social participation should be implemented for elderly dementia patients especially those without formal education experience to maintain better social interaction ability. Our study provided the education influence on disability status after the event of dementia diagnosis. Detailed investigation of association between education level and social participation among dementia patients is recommended in the future.

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Contributors: H-SW participated in the study design, conducted the data analysis, drafted the initial manuscript and approved the final manuscript as submitted. C-KH conducted the data analysis, drafted the manuscript and approved the final manuscript as submitted. C-WC contributed to the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. Y-CF reviewed and revised the manuscript, and approved the final manuscript as submitted. L-HF participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. RE designed and conceptualised the study, and approved the final manuscript as submitted. C-FH participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. L-TH participated in the study design, conducted the data analysis, revised manuscript and approved the final manuscript as submitted.

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Ethics approval: The Institutional Review Board of Taipei Medical University approved this study

Data sharing statement: The data of this study is taken from the Taiwan Data Bank of Persons with Disability (TDPD) database. Requests for the data may be sent to peter_liou@s.tmu.edu.tw

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Table 1 Demographic characteristics of elderly Taiwanese dementia patients with and without formal education (N = 7,698) after propensity score matching for gender, age, socioeconomic status, residence status, urbanization level, and severity of impairment

Variables	Literacy n=3,849		Illiteracy n=3,849		p value
	No.	%	No.	%	
Gender					0.784
Male	1985	51.57%	1973	51.26%	
Female	1864	48.43%	1876	48.74%	
Age					0.915
65-74	1035	26.89%	1048	27.23%	
75-84	1798	46.71%	1799	46.74%	
≧85	1016	26.40%	1002	26.03%	
Dementia type					0.007
Senile Dementia	3373	87.63%	3448	89.58%	
Alzheimer Disease	476	12.37%	401	10.42%	
Social Economic Status					0.938
Average	3764	97.79%	3765	97.82%	
middle low & low	85	2.21%	84	2.18%	
Residence					0.728
Community Dwelling	2940	76.38%	2927	76.05%	
Institution	909	23.62%	922	23.95%	
Urbanization level					0.859
Rural	556	14.45%	560	14.55%	
Suburban	1356	35.23%	1333	34.63%	
Urban	1937	50.32%	1956	50.82%	
Severity of impairment					0.973
Mild	759	19.72%	745	19.36%	
Moderate	1259	32.71%	1266	32.89%	
Severe	475	12.34%	470	12.21%	
Extreme	1356	35.23%	1368	35.54%	

Table 2 Overall disability (based on WHODAS II scores) in different domains between elderly Taiwanese dementia patients with and without formal education ($N = 7,698$)

Variables	Literacy n=3,849		Illiteracy n=3,849		P value
	Mean	SD	Mean	SD	
Domain 1	71.81	27.066	72.34	26.750	0.389
Domain 2	57.91	33.586	58.65	33.356	0.336
Domain 3	43.80	36.004	43.85	35.835	0.949
Domain 4	72.16	29.441	74.29	28.455	0.001*
Domain 5	79.45	32.437	80.22	32.240	0.297
Domain 6	51.39	26.664	52.63	26.226	0.039*
Summary	61.87	24.054	62.79	23.609	0.089

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

*Independent t test $P < 0.05$

Table 3. Poisson regression of WHODAS 2.0 scores for elderly Taiwanese dementia patients for analyzing the association of the WHODAS 2.0 scores for each domain and the summarized scores with various demographic variables

Variables (N=7,778)	Domain 1		Domain 2		Domain 3		Domain 4		Domain 5		Domain 6		Domain Summary	
Intercept	49.009	*	30.552	*	21.622	*	50.036	*	56.539	*	38.320	*	40.869	*
Education Status														
Literacy														
Illiteracy	1.006	*	1.011	*	0.999		1.028	*	1.009	*	1.023	*	1.014	*
Age														
65~74														
75~84	1.050	*	1.132	*	1.102	*	1.042	*	1.068	*	1.015	*	1.059	*
≧85	1.110	*	1.253	*	1.183	*	1.090	*	1.123	*	1.046	*	1.121	*
Socioeconomic status														
Average (Reference)														
Middle-low & Low	0.976	*	1.037	*	1.013		0.984		1.002		1.072	*	1.015	
Residence														
Community Dwelling (Reference)														
Institution	1.058	*	1.232	*	1.254	*	1.056	*	1.073	*	1.118	*	1.116	*
Urbanization level														
Rural (Reference)														
Suburban	0.985	*	0.999		0.975	*	0.997		0.999		0.970	*	0.987	*
Urban	0.993		0.991	*	0.938	*	1.012	*	1.002		0.953	*	0.983	*
Severity of disability														
Mild (Reference)														
Moderate	1.303	*	1.434	*	1.601	*	1.301	*	1.291	*	1.247	*	1.323	*
Severe	1.477	*	1.840	*	2.165	*	1.484	*	1.428	*	1.478	*	1.562	*
Extreme	1.669	*	2.007	*	2.376	*	1.666	*	1.472	*	1.614	*	1.715	*
Gender														
Male														
Female	0.985	*	0.978	*	0.966	*	0.945	*	0.969	*	0.943	*	0.965	*

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

* p value<0.05

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Pages	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported
Objectives	6	State specific objectives, including any prespecified hypotheses
Methods		
Study design	7	Present key elements of study design early in the paper
Setting	7	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	7	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	7*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	8	Describe any efforts to address potential sources of bias
Study size	7	Explain how the study size was arrived at
Quantitative variables	8,9	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	10	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	11	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	11	Report numbers of outcome events or summary measures
Main results	11	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	11,12	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	12	Summarise key results with reference to study objectives
Limitations	15	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	15	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	15	Discuss the generalisability (external validity) of the study results
Other information		
Funding	16	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan

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Research Paper

Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan

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Abstract

Background World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients. However, the data for the effect of education on disability status in dementia patients is lacking. The aim of this large-scale, population-based study was to analyze the effect of education on the disability status of elderly Taiwanese dementia patients by using (WHODAS 2.0).

Methods From the Taiwan Data Bank of Persons with Disability, we enrolled 7,698 disabled elderly (older than 65 years) patients diagnosed with dementia between July 2012 and January 2014. According to their education status, we categorized these patients with and without formal education (3,849 patients each). We controlled for the demographic variables through propensity score matching. The standardized scores of these patients in the six domains of WHODAS 2.0 were evaluated by certified interviewers. Student's *t* test was used for comparing the WHODAS 2.0 scores of dementia patients in the two aforementioned groups. Poisson regression was applied for analyzing the association among all the investigated variables.

Results Patients with formal education had low disability status in the domains of getting along and social participation than did patients without formal education. Poisson regression revealed that standardized scores in all domains of WHODAS 2.0— except self-care—were associated with education status.

Conclusions This study revealed lower disability status in the WHODAS 2.0 domains of getting along and social participation for dementia patients with formal education compared with those without formal education. For disabled dementia patients without formal education, community intervention of social participation should be implemented to maintain better social interaction ability.

Keywords

Dementia, education, ICF, Taiwan, World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0)

Strengths and limitations of this study

- First large-scale, population-based study using WHODAS 2.0 to analyzing the effect of education on disability status in dementia patients.
- Propensity scores matching was applied for variables of demographic data to minimize the effect of potential confounders
- Stratification of the education levels and the dose effect of education status on disability severity among dementia patients were not presented in this study
- Dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires; therefore, their assessment was completed by proxies.
- Differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study could not be generalized to non-Taiwanese populations.

Introduction

The cognitive reserve hypothesis explains how individuals maintain cognitive function and resist pathological processes and clinical impairment of the brain[1]. Individuals with higher education levels are considered to have higher brain reserve and better compensation during progressive brain disease[2]. Thus, education is an crucial protective factor for dementia[1]. Studies have reported that the association between direct measures of brain pathology with neuropsychological test performance can be influenced by education level[3, 4]. Low education level has been reported to be a risk factor for dementia, especially Alzheimer disease[2, 5]. In a meta-analysis, individuals with low and medium levels of education had a 1.33-fold higher risk of dementia compared with individuals with a high education level[6]. In addition, a large-scale, population-based study reported the dose effect of education: individuals with a high education level have a low risk of dementia[7]. Cognitive decline usually accompanies the normal aging process, and a high education level can slow this decline[8, 9].

Dementia, a major cause of disability and mortality among elderly individuals,[10] can lead to functional decline and severely affect many activities of daily living. To comprehensively evaluate and quantify the disability status caused by dementia, an

objective assessment tool that evaluates activities of daily living, cognition, and social participation is essential. The WHO (World Health Organization) Disability Action Plan was proposed to strengthen the collection of data on disability assessment and further identifying needs when planning healthcare services, and allocating medical resources during 2014 to 2021.[11] In 2001, the International Classification of Functioning, Disability, and Health (ICF) was developed to comprehensive evaluation impairments, activity limitations, participation restrictions, personal and environmental factors. Based on the ICF concept, the WHO developed an assessment tool named WHO Disability Assessment Schedule (WHODAS) and 2.0 Version (WHODAS 2.0) was published in 2010. WHODAS 2.0 can be used for evaluating the functional disability caused by chronic diseases in elderly patients[12]. WHODAS 2.0 assesses the domains of self-care, life activities, cognition, getting along, and social participation, all of which are domains that dementia may compromise; therefore, WHODAS 2.0 is well-suited for evaluating disability in dementia patients.

Our previous studies confirmed that WHODAS 2.0 is a feasible tool for assessing functional disability and analyzing the risk of institutionalization among elderly dementia patients[13, 14]. However, no large-scale, population-based studies have investigated the effect of education on disability status in dementia patients.

Therefore, we investigated the effect of education on disability status in dementia patients by analyzing their using WHODAS 2.0 scores.

Methods

Data collection

Patients in the Taiwan Data Bank of Persons with Disability (TDPD) diagnosed with dementia between July 2012 and January 2014 were enrolled in this study. The TDPD was established in July 2012; around the same time, a new disability evaluation process, Disability Eligibility Determination Scale (DES-2012), was developed on the basis of the ICF framework[15]. In Taiwan, patients with stable disability after a disease event can apply for social welfare support. All the disabled people have the rights to apply the disability certification and they initiated the DES-2012 evaluation process. The DES-2012 evaluation process entails two stages and two independent and authorized specialists. In the first stage, the body function and body structure categories of the ICF are assessed in accordance with the standardized coding criteria of DES-2012 by a clinical physician specialized in the disease afflicting the patient; in addition, the physician assigns a diagnostic code to the disease in accordance with the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. In the second stage, the

environmental categories of the ICF framework are assessed by a specialist, such as a physical therapist, occupational therapist, psychologist, or social worker. In addition, the specialist evaluates the patient's social participation status and restriction in life activities by using WHODAS 2.0 (traditional Chinese version). These specialists are authorized for DES-2012 evaluation only after receiving official training. After the DES-2012 process completed, the data of each applied disabled patients were registered in the TDPD database.

Patients and data collection

From the TDPD database, we included the data of elderly patients (older than 65 years of age) with senile dementia (ICD-9-CM 290.0–290.1, 294.1) and Alzheimer disease (ICD-9-CM 331.7–331.9). Demographic data— namely age, gender, residence status (community dwelling or institution dwelling), urbanization level (rural, suburban, urban), socioeconomic status (average, middle, and low), and education status (with and without formal education)—and the parameters of body functions and body structures (ICF categories) are recorded in the TDPD database. Among patients with dementia, disability was primarily caused by cognition-related ICF body function categories such as b110 (consciousness functions), b117 (intellectual functions), b122 (global psychosocial functions),

b140 (attention functions), b144 (memory functions), and b164 (higher-level cognitive functions). The severity of impairment caused by each of these categories has clinical or objective definitions and is indicated by the qualifier following *b*: 1 = mild: 5%–24% impairment; 2 = moderate: 25%–49% impairment, 3 = severe: 50%–95% impairment, 4 = extreme: 96%–100% impairment. For example, b110.4 indicates extreme severity in the consciousness functions of the patient. This study was approved by the Joint Institutional Review Board at Taipei Medical University. Because this is a secondary data analysis study and because the data were analyzed anonymously, informed consent was not required.

Outcome measurements

The WHODAS 2.0 scores recorded in the TDPD database were used as indicators of the disability status of the study patients. The scores are assigned by authorized specialists after they interview the patients (or their proxies if patients are unable to answer the WHODAS 2.0 questionnaire). WHODAS 2.0 has six domains and 36 items in total: domain 1 has six items on cognition; domain 2 has five items on mobility; domain 3 has four items on self-care; domain 4 has five items on getting along; domain 5 has four items on life activities and four items on work and school activities; domain 6 has eight items on social participation. The patients indicate

their level of difficulty in performing activities related to each item in the past 30 days on a 5-point Likert scale (1 = no difficulty, 2 = mild difficulty, 3 = moderate difficulty, 4 = severe difficulty, 5 = extreme difficulty). The total score of all six domains are transformed to standardized scores ranging from 0 to 100, with higher scores indicating a higher severity of disability. Because we only enrolled dementia patients older than 65 years, we expected most of them to be retired or unemployed; hence, we excluded the four items in domain 5 pertaining to work and school activities. Thus, we analyzed the scores in the remaining 32 WHODAS 2.0 items. The traditional Chinese version of WHODAS 2.0 is used in TDPD database; the intraclass correlation coefficient of this version of the questionnaire was found to be 0.80–0.89, and the internal consistency and reliability was found to be 0.73–0.99 (Cronbach's α)[16, 17] .Regarding missing data, the WHODAS 2.0 guidelines allow up to 30% of the items in each domain to be missing; the missing values can be adjusted using the mean of the available scores in that domain[18].

Statistical analysis

Demographic variables, namely age (65–74 years, 75–85 years, and >85 years), socioeconomic status (average, middle, and low), residence status (community dwelling and institution dwelling), urbanization level (urban, suburban, and rural),

and severity of dementia-related impairment (mild, moderate, severe, and extreme), were represented as numbers and percentages. To determine the effect of education status on dementia patients, we categorized the data into two groups on the basis of the education status of the patients (with and without formal education); the variables were controlled for through propensity scores matching.

Chi-square analysis was used for comparing the categorical variables of dementia-related disability between dementia patients with and without formal education. The standardized scores for both groups in the six domains of WHODAS 2.0 were compared using independent *t* tests. Subsequently, the association between the demographic variables and the standardized scores for all six domains in both groups were analyzed through a Poisson regression model. We adopt the Poisson regression model for identifying the association of category variables (demographic variables and type of dementia) and the WHODAS 2.0 scores (continuous variables). All statistical analyses were performed using SAS software (SAS Institute, Inc., Cary, NC), and $p < 0.05$ was considered statistically significant.

Results

After propensity score matching of the disabled dementia patients, the without formal education group comprised 3,849 patients (1,864 females and 1,985 males)

and the with formal education group comprised 3,849 patients (1,879 females and 1,973 males). The distribution of the demographic variables of the two groups did not differ significantly (table 1).

According to our analysis, the without formal education group had higher WHODAS 2.0 scores in domain 4 (getting along) and domain 6 (social participation) compared with the with formal education group. By contrast, the scores in domain 1 (cognition), domain 2 (mobility), domain 3 (self-care), and domain 5 (life activities) and the standardized (summarized) WHODAS 2.0 scores did not differ significantly between the groups (table 2).

Poisson regression analysis revealed that the scores in all domains— except domain 3—and the summarized scores of WHODAS 2.0 were associated with the education status. In addition, domains 1, 2, and 6 were found to be associated with the socioeconomic status. Moreover, gender, age, residence status, urbanization level, and disease severity were found to be associated with the scores of each domain as well as the summarized WHODAS 2.0 scores (table 3).

Discussion

Our study demonstrated that disabled dementia patients with formal education had higher scores in the domains of getting along and social participation than did those

without formal education. However, no significant differences were noted in the domains of cognition, mobility, self-care, and life activities.

The cognitive reserve hypothesis states that a higher education level indicates a higher cognitive reserve and that it delays the onset of dementia[19, 20]; in other words, education has a protective effect on cognitive function in dementia. However, in this study, no differences in the disability status of the cognitive domain functions were observed between the with and without formal education groups. We hypothesize that irrespective of the education status of an individual, the cognitive function declines immediately on the onset of dementia. In start contrast to the cognitive reserve hypothesis, a study reported that after cognitive decline, the onset of dementia is more rapid in persons with a higher education level[21]. Pathological changes to the brain may be slow during cognitive reservation; however, after the onset of cognitive decline, these changes can be rapid in people with a high education level because dementia is at an advanced stage when the symptoms manifest[22]. This pattern has been reported in previous studies that have stated that cognitive decline is more rapid after Alzheimer disease is diagnosed in highly educated patients[22, 23]. Our results are consistent with the aforementioned results; that is, cognitive decline is not influenced by the education status of an individual before the diagnosis of dementia.

Another possible reason of no cognitive disability influence by education is caused by statistical method. In order to control the bias caused by different severity of dementia between both groups, we matched the percentage of severity of both groups. This process could lead the domain 1 score no different between both groups because the severity of dementia mostly determined by degree of cognitive impairment.

In our study, the education status did not influence the patients' disability in the domains of mobility, self-care, and life activities. However, patients in the with formal education group exhibited lower disability status in the domains of getting along and social participation than did those in the without formal education group. This may be because these domains pertain to basic activities of daily life and are therefore not related to the education status, whereas the functional aspects of getting along and social participation require advanced skills that can be obtained through formal education. Social participation can offer and reinforce social roles and can provide a sense of belonging and self-esteem in later life[24]. Formal schooling can impart the skills necessary for abstract thinking and socialization. Most elderly individuals in Taiwan are illiterate because of their lack of a formal education. Although there were statistical less disability score of social participation and getting alone with people in such large sample sized study, there were only 2 points difference of standardized

score between these two groups. Formal education experience could lead individuals to learn the items of social participation and getting alone people domains such as joining community activities, dealing with people, maintaining a friendship, etc. Reading and communication skills obtained through education can ingrain in elderly individuals a stronger sense of social attachment and widen enlarge their social network.

Our study analyzed the effect of education on the disability status caused by dementia. The strength of this study lies in its use of a large-scale, population-based database; in addition, we controlled for possible confounding variables, increasing the validity of our results. However, the study has the following limitations. First, the education status was dichotomized solely on the basis of whether the patient received formal education. Therefore, future studies can explore stratification of the education levels and the dose effect of education status on disability severity among dementia patients. Second, the WHODAS 2.0 assessment was performed on the basis of the responses given by dementia patients or their caregivers, which might have underestimated the functioning disability for dementia patients with mild severity of disability and poor insights. Most dementia patients with extreme severity had limited ability to communicate with the interviewer and thus could not respond to the questionnaires;

therefore, their assessment was completed by proxies. In addition, the WHODAS 2.0 questionnaire only evaluated the disability condition of individuals in the past 30 days. Only caregivers of severe dementia patients who were unable to communicate to the interviewers could accurately report the daily functioning of these patients. Nevertheless, to avoid the bias this may have caused, we controlled for the severity of dementia in both the study groups. Third, community environment, family support, and marriage status were not controlled for in this study. Besides, the cognitive demands in life and occupation cannot be obtained of our database. Nevertheless, we controlled for the urbanization level, residence status, and socioeconomic status, and these variables can represent the living environment and social resource of the disabled dementia patients for minimizing these confounding factors. Finally, considering the differences in education system and medical care system as well as the racial and cultural differences among countries, the results of this study cannot be generalized to non-Taiwanese populations.

Conclusions

Dementia patients with a formal education had lower disability status in the WHODAS 2.0 domains of getting along and social participation compared with those without a formal education. Thus, disability status is influenced by the education

status of the patient before the diagnosis of dementia and therefore formal education can help elderly individuals maintain stronger social interaction even after they develop dementia. Regarding public health aspects, community intervention of social participation should be implemented for elderly dementia patients especially those without formal education experience to maintain better social interaction ability. Our study provided the education influence on disability status after the event of dementia diagnosis. Detailed investigation of association between education level and social participation among dementia patients is recommended in the future.

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Contributors: H-SW participated in the study design, conducted the data analysis, drafted the initial manuscript and approved the final manuscript as submitted. C-KH conducted the data analysis, drafted the manuscript and approved the final manuscript as submitted. C-WC contributed to the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. Y-CF reviewed and revised the manuscript, and approved the final manuscript as submitted. L-HF participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. RE designed and conceptualised the study, and approved the final manuscript as submitted. C-FH participated in the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted. L-TH participated in the study design, conducted the data analysis, revised manuscript

and approved the final manuscript as submitted.

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Competing interests: None declared.

Ethics approval: The Institutional Review Board of Taipei Medical University approved this study

Data sharing statement: The data of this study is taken from the Taiwan Data Bank of Persons with Disability (TDPD) database. Requests for the data may be sent to peter_liou@s.tmu.edu.tw

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Table 1 Demographic characteristics of elderly Taiwanese dementia patients with and without formal education (N = 7,698) after propensity score matching for gender, age, socioeconomic status, residence status, urbanization level, and severity of impairment

Variables	Literacy n=3,849		Illiteracy n=3,849		p value
	No.	%	No.	%	
Gender					0.784
Male	1985	51.57%	1973	51.26%	
Female	1864	48.43%	1876	48.74%	
Age					0.915
65-74	1035	26.89%	1048	27.23%	
75-84	1798	46.71%	1799	46.74%	
≧85	1016	26.40%	1002	26.03%	
Dementia type					0.007
Senile Dementia	3373	87.63%	3448	89.58%	
Alzheimer Disease	476	12.37%	401	10.42%	
Social Economic Status					0.938
Average	3764	97.79%	3765	97.82%	
middle low & low	85	2.21%	84	2.18%	
Residence					0.728
Community Dwelling	2940	76.38%	2927	76.05%	
Institution	909	23.62%	922	23.95%	
Urbanization level					0.859
Rural	556	14.45%	560	14.55%	
Suburban	1356	35.23%	1333	34.63%	
Urban	1937	50.32%	1956	50.82%	
Severity of impairment					0.973
Mild	759	19.72%	745	19.36%	
Moderate	1259	32.71%	1266	32.89%	
Severe	475	12.34%	470	12.21%	
Extreme	1356	35.23%	1368	35.54%	

Table 2 Overall disability (based on WHODAS II scores) in different domains between elderly Taiwanese dementia patients with and without formal education ($N = 7,698$)

Variables	Literacy n=3,849		Illiteracy n=3,849		P value
	Mean	SD	Mean	SD	
Domain 1	71.81	27.066	72.34	26.750	0.389
Domain 2	57.91	33.586	58.65	33.356	0.336
Domain 3	43.80	36.004	43.85	35.835	0.949
Domain 4	72.16	29.441	74.29	28.455	0.001*
Domain 5	79.45	32.437	80.22	32.240	0.297
Domain 6	51.39	26.664	52.63	26.226	0.039*
Summary	61.87	24.054	62.79	23.609	0.089

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

*Independent t test $P < 0.05$

Table 3. Poisson regression of WHODAS 2.0 scores for elderly Taiwanese dementia patients for analyzing the association of the WHODAS 2.0 scores for each domain and the summarized scores with various demographic variables

Variables (N=7,778)	Domain 1		Domain 2		Domain 3		Domain 4		Domain 5		Domain 6		Domain Summary	
Intercept	49.142	*	30.513	*	21.658	*	50.164	*	56.685	*	38.470	*	40.960	*
Education Status														
Literacy														
Illiteracy	1.006	*	1.011	*	0.999		1.028	*	1.009	*	1.022	*	1.013	*
Age														
65~74														
75~84	1.050	*	1.132	*	1.102	*	1.042	*	1.068	*	1.015	*	1.059	*
≧85	1.109	*	1.253	*	1.183	*	1.090	*	1.122	*	1.046	*	1.121	*
Socioeconomic status														
Average (Reference)														
Middle-low & Low	0.976	*	1.037	*	1.013		0.983		1.002		1.072	*	1.015	
Residence														
Community Dwelling (Reference)														
Institution	1.057	*	1.232	*	1.253	*	1.055	*	1.073	*	1.118	*	1.116	*
Urbanization level														
Rural (Reference)														
Suburban	0.985	*	0.999		0.975	*	0.997		0.999		0.970	*	0.987	*
Urban	0.993		0.991	*	0.938	*	1.011	*	1.001		0.953	*	0.983	*
Severity of disability														
Mild (Reference)														
Moderate	1.302	*	1.434	*	1.601	*	1.300	*	1.290	*	1.246	*	1.322	*
Severe	1.475	*	1.841	*	2.164	*	1.483	*	1.426	*	1.476	*	1.561	*
Extreme	1.668	*	2.008	*	2.375	*	1.665	*	1.471	*	1.613	*	1.714	*
Gender														
Male														
Female	0.985	*	0.978	*	0.966	*	0.945	*	0.969	*	0.943	*	0.965	*
Dementia type														
Senile Dementia														
Alzheimer Disease	0.986	*	1.007		0.991		0.986	*	0.986	*	0.979	*	0.988	*

Domain 1, understanding and communication; Domain 2, Getting around; Domain 3, self-care; Domain 4, getting along with people; Domain 5, life activities; Domain 6, participation in society

* p value<0.05

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Pages	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported
Objectives	6	State specific objectives, including any prespecified hypotheses
Methods		
Study design	7	Present key elements of study design early in the paper
Setting	7	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	7	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	7*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	8	Describe any efforts to address potential sources of bias
Study size	7	Explain how the study size was arrived at
Quantitative variables	8,9	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	10	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	11	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	11	Report numbers of outcome events or summary measures
Main results	11	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	11,12	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	12	Summarise key results with reference to study objectives
Limitations	15	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	15	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	15	Discuss the generalisability (external validity) of the study results
Other information		
Funding	16	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.