

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

Shih-Wei Huang,^{1,2} Wen-Chou Chi,³ Chia-Feng Yen,⁴ Kwang-Hwa Chang,^{5,6} Hua-Fang Liao,^{7,8} Reuben Escorpizo,^{9,10} Feng-Hang Chang,⁵ Tsan-Hon Liou^{1,2}

To cite: Huang S-W, Chi W-C, Yen C-F, *et al.* Does more education mean less disability in people with dementia? A large cross-sectional study in Taiwan. *BMJ Open* 2017;7:e013841. doi:10.1136/bmjopen-2016-013841
 ▶ Prepublication history and additional material are available. To view please visit the journal (<http://dx.doi.org/10.1136/bmjopen-2016-013841>).

K-HC and T-HL contributed equally.

Received 11 August 2016
 Revised 15 March 2017
 Accepted 17 March 2017

ABSTRACT

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

Methods From the Taiwan Data Bank of Persons with Disability, we enrolled 7698 disabled elderly (older than 65 years) patients diagnosed with dementia between July 2012 and January 2014. According to their education status, we categorised these patients with and without formal education (3849 patients each). We controlled for the demographic variables through propensity score matching. The standardised 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 patients with dementia in the two aforementioned groups. Poisson regression was applied for analysing 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 standardised 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 patients with dementia with formal education compared with those without formal education. For patients with disability and dementia without formal education, community intervention of social participation should be implemented to maintain better social interaction ability.

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

Strengths and limitations of this study

- ▶ First large-scale, population-based study using WHO Disability Assessment Schedule 2.0 to analysing the effect of education on disability status in patients with dementia.
- ▶ Propensity scores matching was applied for variables of demographic data to minimise the effect of potential confounders.
- ▶ Stratification of the education levels and the dose effect of education status on disability severity among patients with dementia were not presented in this study.
- ▶ Patients with dementia 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 generalised to non-Taiwanese populations.

Thus, education is a 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's 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 ageing 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



CrossMark

For numbered affiliations see end of article.

Correspondence to

Dr Tsan-Hon Liou;
peter_liou@s.tmu.edu.tw

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 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 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 patients with dementia.

Our previous studies confirmed that WHODAS 2.0 is a feasible tool for assessing functional disability and analysing the risk of institutionalisation among elderly patients with dementia.^{13 14} However, no large-scale, population-based studies have investigated the effect of education on disability status in patients with dementia. Therefore, we investigated the effect of education on disability status in patients with dementia by analysing 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 authorised specialists. In the first stage, the body function and body structure categories of the ICF are assessed in accordance with the standardised coding criteria of DES-2012 by a clinical physician specialised 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 authorised for DES-2012 evaluation only after receiving official training. After the DES-2012 process completed, the data of each applied patients with disability 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), urbanisation 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 analysed 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 authorised 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 standardised scores ranging from 0 to 100, with higher scores indicating a higher severity of disability. Because we only enrolled patients with dementia 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 analysed 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), urbanisation 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 patients with dementia, we categorised 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 patients with dementia with and without formal education. The standardised 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 standardised scores for all six domains in both groups were analysed 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 (Version 9.4; SAS Institute, Cary, NC, USA), and $p < 0.05$ was considered statistically significant.

RESULTS

After propensity score matching of the disabled patients with dementia, the without formal education group comprised 3849 patients (1864 females and 1985 males) and the with formal education group comprised 3849 patients (1879 females and 1973 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 standardised (summarised) 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 summarised 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, urbanisation level and disease severity were found to be associated with the scores of each domain as well as the summarised WHODAS 2.0 scores (table 3).

DISCUSSION

Our study demonstrated that patients with disability and dementia 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 hypothesise that irrespective of the education status of an individual, the cognitive function declines immediately on the onset of dementia. In stark 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's 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. 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

Table 1 Demographic characteristics of elderly Taiwanese patients with dementia with and without formal education (n=7698) after propensity score matching for gender, age, socioeconomic status, residence status, urbanisation level and severity of impairment

Variables	Literacy n=3849		Illiteracy n=3849		p Value
	n	%	n	%	
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's disease	476	12.37	401	10.42	
Social economic status					0.938
Average	3764	97.79	3765	97.82	
Middle low and 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	
Urbanisation 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 patients with dementia with and without formal education (n=7698)

Variables	Literacy n=3849		Illiteracy n=3849		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.

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 socialisation. 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 along with people in such large sample-sized study, there were only two-point difference of standardised score between these two groups. Formal education experience could lead individuals to learn the items

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

Variables (n=7778)	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 and 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	*
Urbanisation 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's 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.

of social participation and getting along with people domains such as joining community activities, dealing with people, maintaining a friendship, etc. Reading and

communication skills obtained through education can engrain in elderly individuals a stronger sense of social attachment and widened their social network.

Our study analysed 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 patients with dementia. Second, the WHODAS 2.0 assessment was performed on the basis of the responses given by patients with dementia or their caregivers, which might have underestimated the functioning disability for patients with dementia with mild severity of disability and poor insights. Most patients with dementia 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 patients with dementia 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 urbanisation level, residence status and socioeconomic status, and these variables can represent the living environment and social resource of the patients with disability and dementia for minimising 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 generalised to non-Taiwanese populations.

CONCLUSIONS

Patients with dementia 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 patients with dementia 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 patients with dementia is recommended in the future.

Author affiliations

- ¹Department of Physical Medicine and Rehabilitation, Shuang Ho Hospital, Taipei, Taiwan
- ²Department of Physical Medicine and Rehabilitation, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan
- ³School of Occupational Therapy, College of Medicine, Chungshan Medical University, Taichung, Taiwan
- ⁴Department of Public Health, Tzu Chi University, Hualien, Taiwan
- ⁵Graduate Institute of Injury Prevention and Control, Taipei Medical University, Taipei, Taiwan
- ⁶Department of Physical Medicine and Rehabilitation, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan
- ⁷Chinese Association of Early Intervention Profession for Children with Developmental Delays, Hualien City, Taipei, Taiwan
- ⁸School and Graduate Institute of Physical Therapy, College of Medicine, Chungshan Medical University, Taipei, Taiwan
- ⁹Department of Rehabilitation and Movement Science, College of Nursing and Health Sciences, University of Vermont, Burlington, Vermont, USA
- ¹⁰Swiss Paraplegic Research, Nottwil, Switzerland

Acknowledgements The authors thank Pei-Hsin Chen and Kai-Hsiang Chuang for their help in manuscript preparation.

Contributors HSW participated in the study design, conducted the data analysis, drafted the initial manuscript and approved the final manuscript as submitted. CKH conducted the data analysis, drafted the manuscript and approved the final manuscript as submitted. CWC contributed to the study design, reviewed and revised the manuscript and approved the final manuscript as submitted. YCF reviewed and revised the manuscript and approved the final manuscript as submitted. LHF 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. CFH participated in the study design, reviewed and revised the manuscript and approved the final manuscript as submitted. LTH participated in the study design, conducted the data analysis, revised manuscript and approved the final manuscript as submitted.

Funding This study was funded by the Taipei Medical University and Shuang Ho hospital (no. 105TMU-SHH-05) and supported by the Ministry of Health and Welfare, Taiwan (98M8178, 99M4080, 99M4073, 100M4145, 101M4100, 102M4018, and 103M03F4037).

Competing interests None declared.

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

Provenance and peer review Not commissioned; externally peer reviewed.

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.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

© Article author(s) (or their employer(s) unless otherwise stated in the text of the article) 2017. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

REFERENCES

1. Jones RN, Manly J, Glymour MM, *et al.* Conceptual and measurement challenges in research on cognitive reserve. *J Int Neuropsychol Soc* 2011;17:593–601.
2. Stern Y, Gurland B, Tatemichi TK, *et al.* Influence of education and occupation on the incidence of Alzheimer's disease. *Jama* 1994;271:1004–10.
3. Dufouil C, Alperovitch A, Tzourio C. Influence of education on the relationship between white matter lesions and cognition. *Neurology* 2003;60:831–6.

4. Bennett DA, Wilson RS, Schneider JA, *et al.* Education modifies the relation of AD pathology to level of cognitive function in older persons. *Neurology* 2003;60:1909–15.
5. Qiu C, Bäckman L, Winblad B, *et al.* The influence of education on clinically diagnosed dementia incidence and mortality data from the Kungsholmen Project. *Arch Neurol* 2001;58:2034–9.
6. Caamaño-Isorna F, Corral M, Montes-Martínez A, *et al.* Education and dementia: a meta-analytic study. *Neuroepidemiology* 2006;26:226–32.
7. Brayne C, Ince PG, Keage HA, *et al.* ECLIPSE Collaborative Members. Education, the brain and dementia: neuroprotection or compensation? *Brain* 2010;133:2210–6.
8. Evans DA, Beckett LA, Albert MS, *et al.* Level of education and change in cognitive function in a community population of older persons. *Ann Epidemiol* 1993;3:71–7.
9. Lyketsos CG, Chen LS, Anthony JC. Cognitive decline in adulthood: an 11.5-year follow-up of the Baltimore Epidemiologic Catchment Area study. *Am J Psychiatry* 1999;156:58–65.
10. Ritchie K, Lovestone S. The dementias. *Lancet* 2002;360:1759–66.
11. Gutenbrunner C, Negrini S, Kiekens C, *et al.* The global disability action plan 2014–2021 of the world health organisation (WHO): a major step towards better health for all people with disabilities. chance and challenge for physical and rehabilitation medicine (PRM). *Eur J Phys Rehabil Med* 2015;51:1–4.
12. Chang KH, Liao HF, Yen CF, *et al.* Association between muscle power impairment and WHODAS 2.0 in older adults with physical disability in Taiwan. *Disabil Rehabil* 2015;37:712–20.
13. Huang SW, Chang KH, Escorpizo R, *et al.* Functioning and disability analysis by using WHO Disability Assessment Schedule 2.0 in older adults Taiwanese patients with dementia. *Disability and rehabilitation* 2015:1–12.
14. Huang SW, Chang KH, Escorpizo R, *et al.* Using the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) for predicting institutionalization of patients with dementia in Taiwan. *Medicine* 2015;94:e2155.
15. Chiu WT, Yen CF, Teng SW, *et al.* Implementing disability evaluation and welfare services based on the framework of the International Classification of Functioning, Disability and Health: experiences in Taiwan. *BMC Health Serv Res* 2013;13:416.
16. Chiu TY, Yen CF, Chou CH, *et al.* Development of traditional Chinese version of World Health Organization Disability Assessment Schedule 2.0 36-item (WHODAS 2.0) in Taiwan: validity and reliability analyses. *Res Dev Disabil* 2014;35:2812–20.
17. Yen CF, Hwang AW, Liou TH, *et al.* Validity and reliability of the Functioning Disability Evaluation Scale-Adult Version based on the WHODAS 2.0--36 items. *J Formos Med Assoc* 2014;113:839–49.
18. Ustün TB, Chatterji S, Kostanjsek N, *et al.* Developing the World Health Organization Disability Assessment Schedule 2.0. *Bull World Health Organ* 2010;88:815–23.
19. Farfel JM, Nitrini R, Suemoto CK, *et al.* Very low levels of education and cognitive reserve: a clinicopathologic study. *Neurology* 2013;81:650–7.
20. Barnes DE, Tager IB, Satariano WA, *et al.* The relationship between literacy and cognition in well-educated elders. *J Gerontol A Biol Sci Med Sci* 2004;59:390–395.
21. Hall CB, Derby C, LeValley A, *et al.* Education delays accelerated decline on a memory test in persons who develop dementia. *Neurology* 2007;69:1657–64.
22. Stern Y, Albert S, Tang MX, *et al.* Rate of memory decline in AD is related to education and occupation: cognitive reserve? *Neurology* 1999;53:1942–7.
23. Wilson RS, Li Y, Aggarwal NT, *et al.* Education and the course of cognitive decline in alzheimer disease. *Neurology* 2004;63:1198–202.
24. Berkman LF, Glass T, Brissette I, *et al.* From social integration to health: Durkheim in the new millennium. *Soc Sci Med* 2000;51:843–57.