Cognitive Status in Adults from the Mexican Health and Aging Study: What are we actually measuring?

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Introduction

It is projected that by 2050 Latin America will be the region in the world with the highest percentage of adults over 65 years of age. (Wong R and Palloni A 09). This demographic expansion comes with increased awareness on conditions that affect older adults, especially those that have a high social and economic cost to society. This is the case of dementia, a clinical condition that is very costly economically and socially. (10) Even though dementia diagnosis is mostly clinical, researchers have turned to tools available through population-based studies to better understand cognition and measure cognitive decline. Unfortunately, not all studies use the same tools and among those that do, there are questions on how cultural and social factors may affect comparability across subjects or across societies.(Glosser et al. 93, Shih, Lee, and Das 11)

Researchers have used different methodologies to overcome these limitations. Some researchers modify cognitive assessment scales to better fit the population under study. (Bird HR et al. 87, Glosseret al. 93, Shihet al. 11) Other researchers break down the tools into cognitive domains and analyze these domains separately to identify cognitive profiles based on variations observed in the domains. (Matallana et al. 11, Shihet al. 11) These approaches however, raise questions on whether changing the cut-off points or breaking up a tool into components alters how the tools operate and their validity.

Moreover, the majority of cognitive function tests available are affected by education level. (Black et al. 99, Matallanaet al. 11, Uhlmann RF and Larson EB 91) Both within and across age cohorts of older adults, there is large variability in education levels in Latin America. (Kinsella K and Wan H 09) Compared to other regions, the percentage of illiterate older adults is quite high(Kinsella K and Wan H 09), making administration and interpretation of cognitive tests a challenge. Apart from the cultural issues, researchers are also concerned with what is measured with the cognitive function tools available, beyond what can be captured by educational level. Dementia and cognitive impairment are not the same. However, cognitive impairment increases the risk of developing dementia and presents a unique opportunity to assess the effect of preventive measures. (Langa et al. 09, Plassman et al. 11)

Several authors have reported that Mexico is undergoing an epidemiological transition characterized by a sharp increase in prevalence of non-communicable chronic conditions while acute communicable diseases persist. (Palloni and McEniry 07, Wong R and Palloni A 09) Additionally, poor institutional support and weak economic conditions translate into low overall education and poor health conditions that affect cognitive function in older life. (Wong R and Palloni A 09) Using data from the Mexican Health and Aging study, researchers have reported a prevalence of dementia between 7% and 11% depending on the methodology used to analyze the data. (Mejia et al. 06, Mejia et al. 07) However, these rates only provide a general overview of the cognitive status of Mexican adults.

To better understand the cognitive status of older adults in developing societies with vastly heterogeneous educational achievement, this study will analyze the distribution of older Mexican adults across different cognitive domains and identify how education is associated with each domain. We will then correlate each domain to the overall score of the Cross-Cultural Cognitive Evaluation (CCCE) and determine which domain, if any, is most related to health outcomes. The full paper motivates the analysis and provides full descriptive and multivariate results, as well as a discussion of the implications for cognitive tools used in population-based studies.

Methods

Study Population

Data for this study is derived from the Mexican Health and Aging Study (MHAS). The MHAS is nationally representative of about 13 million Mexicans in 2001. The MHAS was designed to examine the aging process and evaluate the impact of disease on health, function, and mortality of adults over the age of 50 that resided in Mexico in 2001, as well as their spouse or partner, in both urban and rural areas. Two waves of data are collected so far: baseline in 2001 and follow-up, in 2003. A total of 15,186 completed the baseline interview for a response rate of 90.1%. All interviews were conducted in Spanish. Survey instruments have been translated and are publicly available along with the databases (Mexican Health and Aging Study 09).

This paper uses data from both waves of the study. The sample analyzed is of adults 60 years and older with complete information on cognition and education at baseline and follow-up. Evaluation of cognitive function obtained through proxy interviews was not included in this study.

Cognitive Function

Cognitive function was assessed using the screening portion of the Cross-Cultural Cognitive Evaluation (CCCE). The CCCE was developed as a brief and sensitive tool for the diagnosis of dementia in the community. It consists of an initial screening portion designed to be administered in the field by individuals without medical training. The second portion of the CCCE was designed to increase the specificity of the tool and was designed to be administered by trained medical personnel. This second portion was not included in the MHAS study. All tasks included in the CCCE are accepted as indicators of cognitive function and the effect of literacy and level of education is supposed to be negligible.(Glosseret al. 93)

Five tasks measuring four cognitive domains make up the screening portion of the CCCE. The tasks are: construction, construction recall, verbal learning, verbal recall and visual scanning. Construction is measured by presenting two geometrical figures and asking respondents to copy the figures within 90 seconds. Construction recall is measured by asking respondents to remember the figures they copied and draw them in a blank piece of paper; three minutes are allowed to complete this task. This task was administered after the verbal tasks. Verbal learning is measured by asking respondents to listen to a list of eight words and repeat them. Three consecutive trials are administered and the number of recalled words is recorded. For verbal recall, individuals were then asked to

remember as many of the words of the provided list; this task was administered after the visual scanning task to allow a delay. The last task, visual scanning, is measured by asking respondents to circle all figures that are identical to an indicated model in a provided disorganized display. Respondents are given 60 seconds for this task.

Construction measures visuospatial ability, verbal learning and recall measure verbal memory, construction recall measures visual memory and visual scanning measures psychomotor speed. Each task was analyzed separately to observe the population distribution for each task. Scores for each task were dichotomized as "pass" or "fail"; respondents scoring below the 10^{th} percentile for the population distribution for each task fell under "fail" for that task. Additionally, respondents that failed in two or more task were considered to have cognitive impairment.

Independent Variables

The following variables are included as independent variables: age (continuous), gender, education (continuous), area of residence (rural vs. urban) and health conditions (only communicable diseases, only non-communicable diseases, both communicable and non-communicable, or neither). Population distribution for each cognitive task is analyzed for each of these variables.

Results

In Table 1 the sample is stratified by the five cognitive tasks and the distribution is analyzed by the independent variables. Overall failure rates were highest for the construction recall task (61.9%) and lowest for the verbal learning task (11.2%). Prevalence of cognitive impairment was 26.7%. In general, adults over 80 years fail more tasks compared to those between 60 and 79 years of age. Thus, the percentage of individuals over 80 with cognitive impairment is almost three times as high compared to that of adults 60-69 (53.1% vs. 18.7%). More women than men fail construction, construction recall, and visual scanning. Conversely, more men fail both verbal tasks. Compared to respondents with 7 or more years of education, a higher percentage of respondents with no education fail in every task. Construction recall is the task where more respondents fail regardless of education level. Verbal recall is the task where the least number of respondents with no education fail (20.2%), while verbal learning is the task where the least number of respondents with seven or more years of education fail (1.2%). The percentage of older adults with cognitive impairment is also higher for those with no education, where almost half of respondents have cognitive impairment, and it progressively decreases by education level.

To further analyze the role of education on cognition, each task and the overall cognition score were correlated with education level. The correlation coefficients show that construction recall is the task most highly correlated with education level (Correlation coefficient= -0.249, $p < .0001$) while verbal recall was the task least correlated with education level (Correlation Coefficient= -0.117, $p<.0001$). The overall cognition score was moderately correlated with education level (Correlation coefficient= -0.242, $p < .0001$).

Table 2 shows the odds ratios of failing each task and having cognitive impairment by each variable obtained from logistic regression analysis. Two models were calculated for each task. The first

model includes only education; the second model (full model) adds age, gender, marital status, area of residence and type of disease. From the first model more years of education decrease the risk of failing in every task. A 29% decrease in risk of failing is observed for construction, 20% for verbal learning and visual scanning, 13% for construction recall and 12% for verbal recall. Similarly, more years of education decreases the risk of cognitive impairment by 22%. In the full model, education remains a protective factor against failure for all cognitive tasks as well as cognitive impairment. Additionally, older age increases the risk of failing in all cognitive tasks. Women are at higher risk of failing in the following tasks: construction, construction recall, visual scanning and overall cognitive impairment. Conversely, men are at higher risk of failing both verbal tasks. Furthermore, having both communicable and non-communicable diseases increases the odds of failing the construction recall task. Finally, living in a rural area decreases the risk of failing the visual scanning task by 35%.

Conclusions

Sociodemographic characteristics as well as medical conditions affect the risk of failing different cognitive task in older Mexican Adults. Education plays a key role in the results obtained in the different task. The CCCE seems to be heavily influenced by education which poses questions on whether other cognitive tasks should be measured in populations with very low levels of educational achievement such as the older Mexican population. Further analysis will evaluate how the different cognitive tasks relate to health outcomes and will aim to better explain the effect of education on failure in cognitive tasks and cognitive impairment overall.

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Table 1. Distribution of Cognitive Tasks and Cognitive Impairment by Independent Variables

	COGNITIVE TASKS										COGNITIVE IMPAIRMENT	
	Construction		Construction Recall		Verbal Learning		Verbal Recall		Visual Scanning		Not	
	Passed	Failed	Passed	Failed	Passed	Failed	Passed	Failed	Passed	Failed	Impaired	Impaired
Age												
60-69	88.1%	11.9%	44.3%	55.7%	93.8%	6.2%	90.3%	9.7%	93.3%	6.7%	81.3%	18.7%
70-79	79.8%	20.2%	31.3%	68.7%	83.7%	16.3%	81.4%	18.6%	85.7%	14.3%	65.0%	35.0%
80+	63.3%	36.7%	20.4%	79.6%	75.6%	24.4%	72.0%	28.0%	68.4%	31.6%	46.9%	53.1%
p-value	*0.000*		*0.000*		*0.000*		*0.000*		*0.000*		*0.000*	
Gender												
Male	88.1%	11.9%	44.7%	55.3%	87.2%	12.8%	84.4%	15.6%	89.5%	10.5%	76.3%	23.7%
Female	78.8%	21.2%	32.1%	67.9%	90.2%	9.8%	86.7%	13.3%	87.7%	12.3%	70.6%	29.4%
p-value	*0.000*		*0.000*		*0.000*		*0.000*		*0.000*		*0.000*	
Education												
0 years	63.6%	36.4%	20.8%	79.2%	79.5%	20.5%	79.8%	20.2%	77.2%	22.8%	50.4%	49.6%
1-5 years	88.6%	11.4%	38.1%	61.9%	91.5%	8.5%	86.2%	13.8%	93.0%	7.0%	77.4%	22.6%
6 years	96.3%	3.7%	46.8%	53.2%	94.2%	5.8%	87.9%	12.1%	93.4%	6.6%	87.4%	12.6%
7+ years	97.6%	2.4%	64.3%	35.7%	98.8%	1.2%	96.1%	3.9%	96.5%	3.5%	95.0%	5.0%
p-value	*0.000*		*0.000*		*0.000*		*0.000*		*0.000*		*0.000*	
Area of Residence												
Rural	78.5%	21.5%	34.6%	65.4%	87.7%	12.3%	86.5%	13.5%	86.1%	13.9%	68.8%	31.2%
Urban	88.8%	11.2%	42.2%	57.8%	90.1%	9.9%	84.5%	15.5%	91.5%	8.5%	78.6%	21.4%
p-value	*0.000*		*0.000*		*0.000*		*0.000*		*0.000*		*0.000*	
Health Conditions												
Communicable	83.1%	16.9%	46.0%	54.0%	86.3%	13.7%	82.3%	17.7%	89.1%	10.9%	68.6%	31.4%
Non-Communicable	84.4%	15.6%	37.9%	62.1%	90.1%	9.9%	86.1%	13.9%	89.4%	10.6%	74.8%	25.2%
Both	85.3%	14.7%	33.6%	66.4%	88.0%	12.0%	83.6%	16.4%	84.1%	15.9%	75.5%	24.5%
Neither	82.1%	17.9%	38.7%	61.3%	87.5%	12.5%	85.7%	14.3%	88.5%	11.5%	71.6%	28.4%
p-value	*0.321*		*0.049*		*0.277*		*0.370*		*0.283*		*0.905*	

	4,707	**828**	**2,188**	**3,275**	**5,608**	**528**	**5,367**	**769**	**5,031**	**511**	**4,118**	**1,199**
Total Sample	83.3%	16.7%	38.1%	61.9%	88.8%	11.2%	85.6%	14.4%	88.6%	11.4%	73.3%	26.7%

Table 2. Logistic Regressions predicting failure in Cognitive Tasks and Cognitive Impairment

	Construction		Construction Recall		Verbal Learning		Verbal Recall		Visual Scanning		Overall- Cognitive Impaired	
	Odds Ratio (SE)		Odds Ratio (SE)		Odds Ratio (SE)		Odds Ratio (SE)		Odds Ratio (SE)		Odds Ratio (SE)	
Education (years)	0.73*	(0.01)	0.88*	(0.01)	0.83*	(0.02)	0.89*	(0.01)	0.84*	(0.02)	0.80*	(0.01)
Age	1.07*	(0.01)	1.06*	0.00	1.07*	(0.01)	1.07*	(0.01)	1.08*	(0.01)	1.07*	(0.01)
Sex (Female=1)	1.86*	(0.16)	1.48*	(0.09)	0.72*	(0.07)	0.82***	(0.07)	1.36**	(0.14)	1.29*	(0.10)
Area if Residence (Urban=1)	0.89	(0.08)	0.93	(0.06)	0.95	(0.09)	1.02	(0.09)	0.73**	(0.07)	0.89	(0.07)
Type of Disease (Ref= Neither)												
Only Communicable	1.42	(0.37)	1.28	(0.26)	1.04	(0.31)	0.86	(0.23)	1.39	(0.41)	1.14	(0.27)
Only Non-Communicable	1.06	(0.10)	1.07	(0.07)	0.89	(0.09)	0.88	(0.08)	0.88	(0.10)	0.95	(0.08)
Both	1.06	(0.17)	1.14	(0.13)	0.84	(0.16)	0.86	(0.13)	1.10	(0.19)	0.91	(0.12)
Number of obs	5,404		5,335		5,987		5,987		5,415		5,194	
Pseudo R-Square	0.160		0.080		0.100		0.060		0.110		0.13	
LR chi2	733.840		609.830		341.030		286.050		353.390		710.25	
Prob>chi2	0.000		0.000		0.000		0.000		0.000		0.000	

Note: *** p<0.05, ** p<0.01, * p<0.001