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Gender differences in cognitive abilities among the elderly poor of Peru

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Gender Differences in Cognitive Abilities among the Elderly Poor of Peru

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Abstract

This paper analyses gender differences on cognitive abilities for the elderly poor in Peru. We use a unique and recent survey for the elderly individuals living in poverty in Peru (ESBAM) that includes cognitive tests and a comprehensive set of socio-demographics and subjective and objective health measures. We find significant differences in mental intactness in favour of males, and in episodic memory in favour of females. In contrast, there are not gender differences in an overall measure of cognition, but regional differences appear to matter in favour of urban localities. The sizeable associations of education and childhood nutrition quality with cognition confirm the long-term impacts of early life developments on current outcomes. Therefore, policies aimed at improving early childhood development are expected to have a positive impact in later-life.

Keywords: cognition, old age, gender differences, poverty, Peru
JEL Classification: H10, J14, J16, J24

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1 Introduction

The decline of cognitive abilities in old age is a well-documented fact in human biology and also in social sciences thanks to the emergence of large-scale and representative household surveys aimed at assessing the well-being of the elderly. As any other indicator of accumulated human capital, cognitive ability also depreciates at a certain rate. As noted by McFadden (2008) individuals can take some measures for cognitive maintenance or repair in order to delay or smooth cognitive depreciation. Working is an important protective measure against the accelerated decline of cognition in old age as shown by Rohwedder and Willis (2010). Apart from labour, some other factors such as education, health conditions and nutritional status are also important in explaining the stock of cognitive abilities and the rate of decline. Once all of these factors, which might have affected males and females differently during their lifetimes, are taken into account, one would not expect gender differences in cognition in later-life. Lee *et al*. (2014) report some studies suggesting that in developed countries there are not significant gender differences in cognitive functioning, while in developing countries there are important differences to the detriment of women. The usual explanation for this disparity in developing countries is rooted in important gender differences in educational attainment and nutrition in early childhood. These results lend support for calling for equalizing opportunities in accessing education between boys and girls as a vehicle to enhance cognition in old-age and to reduce disparities.

Cognitive impairments in old age make individuals less autonomous and less capable of making decisions, ranging from daily activities to more complex choices such as financial decisions. In addition, the relative size of the elderly population is growing in the majority of countries because of the demographic transition. More specifically, the proportion of elderly women is higher due to longer life expectancy for biological reasons. All of this might represent a major public health problem and require increasing public health expenditures.

Cognitive decline also indirectly affects other family members who have to allocate resources and time to take care of the elderly individual. In this scenario, individuals with larger cognitive impairments might represent a burden for the family. For poor households, this might be even more detrimental given their tight budget constraints. In this regard, the literature that focuses on gender differences in old-age cognition in developing countries and rural areas is scarce, although exceptions are Lei *et al*. (2012 and 2013) analysing Chinese data, and Lee *et al*. (2014) using Indian survey data. However, there is a lack of more studies focusing on the elderly poor of rural or developing countries. It is possible that among the poor, gender differences in the level of education, and health and nutrition indicators are less marked because all individuals are located at the bottom part of the distribution of such attributes. However, it is likely that gender differences in education and in the other variables are even more pronounced if cultural or economic reasons favouring boys over girls are more entrenched among the poor. In this paper we assess this empirical question by looking at the gender disparity in cognitive functioning among the elderly poor Peruvians from the Survey of Health and Well-being of the Elderly (ESBAM). This is a recent survey of poor individuals aged 65-80 in Peru and resembles, at least in some aspects, the leading surveys on old age such as the HRS and SHARE. Importantly, ESBAM includes questions on cognition and a large set of socio-demographic and subjective and objective health measures.

This paper contributes to the empirical literature on gender differences in old-age cognitive abilities by controlling for a comprehensive set of different confounders, such as schooling, sex, age, urbanity, ethnic group, community-level unobserved characteristics, and objective and subjective health indicators. In addition, we offer empirical evidence of gender difference in a Latin-American country where preferences against girls are supposedly less important than in Asian countries. After controlling for these attributes, we find that females perform better than males in some of the cognitive measurements. In comparison to males, females have better cognitive functioning in *episodic memory* (measured with immediate and delayed word recall) and *command* (a series of commands to be orderly followed by the interviewee) but weaker functioning in *orientation* and *drawing* ability. In an overall measure of *mental intactness* -that includes *orientation*, *command* and *drawing* scores- females perform worse than males. Furthermore, we find that educational attainment and variables related to childhood and actual nutritional status are strongly associated with the level of cognitive functioning. We present evidence of differential effects of education by sex, meaning that females could boost their cognitive abilities more than that of males if they were more educated.

The rest of the paper is organized as following. Section 2 describes the dataset and variables used in the empirical analysis. Section 3 discusses the empirical strategy. Section 4 reports and discuses the results. Section 5 presents a conclusion.

2 Data

2.1 The Survey of Health and Well-being of the Elderly

The Survey of Health and Well-being of the Elderly (ESBAM) is a unique and recent survey collected by the National Institute of Statistics of Peru (INEI) in December 2012 whose primary sample is composed of individuals between the ages of 65 and 80 and living in conditions of poverty. The survey collects information about socio-economic conditions, subjective well-being, expectations, beliefs and several subjective and objective health related questions. Furthermore, ESBAM includes socio-economic questions at the household level and for each household member. All information is collected face-to-face by trained interviewers, while specialized technicians collect data on anthropological measures, arterial pressure and blood samples of the elderly. This dataset is the baseline for the evaluation of *Pension 65*, which is a recent non-contributory pension program administrated by the Ministry of Development and Social Inclusion of Peru (MIDIS).

The data was gathered in Peru's twelve departments (half of the total) where MIDIS had already completed the census of socio-economic variables intended to update its targeting score system SISFOH[1]. SISFOH's threshold score serves to classify a household as extreme poor, non-extreme poor or non-poor. The population under study in ESBAM are rural and urban individuals between 65 and 80 years old, and living in households classified by SISFOH as poor. The sampling selection is probabilistic, independent in each department, stratified in rural/urban areas and carried out in two steps (first selecting census units or villages and then households). After dropping 65 individuals who did not answer the questionnaire for the elderly (persons with severe impairments like blindness and deafness) and the exclusion of respondents with missing values in relevant variables for the regressions, the final sample size is composed of 3947 individuals (Table 1).

Table 1. Sample composition in ESBAM

	Male			Female			Total		
Age group	Rural (%)	Urban (%)	Total (n)	Rural (%)	Urban (%)	Total (n)	Male (%)	Female (%)	Total (n)
65-67	56.0	44.0	441	67.3	32.7	591	42.7	57.3	1032
68-70	54.9	45.1	421	68.2	31.8	478	46.8	53.2	899
71-73	53.5	46.5	383	65.5	34.5	400	48.9	51.1	783
74-76	59.0	41.0	268	67.7	32.3	368	42.1	57.9	636
77-80	56.3	43.7	247	64.0	36.0	350	41.4	58.6	597
Total	55.7	44.3	1760	66.7	33.3	2187	44.6	55.4	3947

Source: Authors' elaboration on the base of ESBAM.

2.2 The cognitive score

ESBAM uses a reduced version of the mini–mental state examination (MMSE) (Folstein *et al.*, 1975) to evaluate the cognitive functioning of the elderly. ESBAM is similar to the adapted version used in the Survey on Health and Well-being of Elders (SABE) implemented

[1] A score is assigned to each household. The score is constructed on the base of an algorithm (carried out with principal component analysis) that uses variables such as material conditions of the house, assets, incomes, education level, household size, and occupation,.

during the early 2000s in seven capital cities of Latin America and the Caribbean. The goal of the reduced MMSE form is to attenuate the strong bias of education in performing the test, which is relevant for our sample of elderly poor who report low literacy rates (28% are illiterate).

The score of cognitive functioning is computed with five questions dealing with different aspects of cognitive abilities. The first question measures *orientation* and asks about the day of the month, month, year and the day of week. Each correct answer receives one point. The second question measures *immediate recall*; three words are mentioned and the respondent has to repeat them immediately, albeit in any order. These words are again asked later (forth question) in order to measure *delayed recall*. A point is given for each word that is correctly answered. The third question is a *command* of three actions that the respondent must follow orderly: "I will give a piece of paper. Take this with your right hand, bend in half with both hands and place on your legs". Each correct action receives one point. In the fifth question the respondent receives a point if she is able to replicate (*drawing*) a picture of two intersected circles, provided that the circles do not cross more than half. After summing up all the obtained points the overall cognitive score is divided into two main components. The first component is *episodic memory* and is computed by adding the correct points obtained in both questions on word memory (0 to 6 points). The second component of cognition is a measure of *mental intactness* which sums up the correct points obtained in the remaining questions (0 to 8 points). Table 2 reports the distribution of points for each test and the mean score for each component of cognition.

Table 2. Scores by type of cognitive test

Question type	Points on correct answers (%)						Mean
	0	1	2	3	4	total	score
Episodic memory							5.06
Word memory immediate recall	0.68	1.57	13.55	84.19		100.00	2.81
Word memory delayed recall	6.59	10.74	33.67	49.00		100.00	2.25
Mental intactness							6.62
Orientation	2.25	7.14	16.92	30.43	43.25	100.00	3.05
Command following	0.53	3.70	21.26	74.51		100.00	2.70
Drawing	12.72	87.28				100.00	0.87
Total							11.69

Source: Authors' elaboration on the base of ESBAM.

The cognition questions in ESBAM and our cognitive components share some similarities with those employed by Lei *et al*. (2012 and 2013) using the China Health and Retirement Longitudinal Study (CHARLS). They form an index of episodic memory by averaging the scores of immediate and delayed recall from a list of 10 words. Their second measure of mental intactness (ranges from 0 to 11) includes the following items: mathematical reasoning (up to 5 continuing subtractions of 7 from 100), a variable indicating whether the respondent needed any explanation or aid, orientation questions (month, day, year, day of the week and season) and ability to replicate a drawing. Although our cognitive measures are not directly comparable with CHARLS because of different sample selection and questions, they are closely related. Table 3 shows gender differences in cognitive functioning conditioning in regard to age. Although there are not statistically significant differences between females and males with respect to the measure of *episodic memory*, females report statistically significant lower levels of *mental intactness*. Note that within *mental intactness*, there are only significant gender differences in the components of *orientation* and *drawing* but not in *command*. Table 3 also captures the deterioration of cognitive functioning with age.

Table 3. Gender differences in cognitive scores by age

Episodic memory					
Age group	Number of Observations	Overall	Female	Male	F-M
65-69	1635	5.234	5.253	5.219	0.035
70-74	1300	5.031	4.995	5.063	-0.068
75-80	1012	4.829	4.782	4.861	-0.078
All	3947	5.063	5.053	5.072	-0.019

Mental intactness

Age group	Number of Observations	Orientation			
		Overall	Female	Male	F-M
65-69	1635	3.201	2.888	3.454	-0.566***
70-74	1300	2.982	2.610	3.323	-0.712***
75-80	1012	2.903	2.553	3.141	-0.588***
All	3947	3.053	2.712	3.327	-0.615***

Age group	Number of Observations	Command			
		Overall	Female	Male	F-M
65-69	1635	2.721	2.736	2.709	0.026
70-74	1300	2.695	2.676	2.713	-0.036
75-80	1012	2.662	2.667	2.658	0.009
All	3947	2.697	2.699	2.696	0.002

Age group	Number of Observations	Drawing			
		Overall	Female	Male	F-M
65-69	1635	0.905	0.848	0.950	-0.102***
70-74	1300	0.862	0.799	0.920	-0.122***
75-80	1012	0.835	0.756	0.889	-0.133***
All	3947	0.873	0.809	0.924	-0.115***

Age group	Number of Observations	Total mental intactness			
		Overall	Female	Male	F-M
65-69	1635	6.827	6.471	7.114	-0.643***
70-74	1300	6.540	6.085	6.956	-0.870***
75-80	1012	6.400	5.976	6.688	-0.713***
All	3947	6.623	6.220	6.947	-0.728***

The last column reports the t-test of mean differences between sexes. *p<0.1 **p<0.05 ***p<0.01.

3 Empirical Strategy

3.1 Model specification

We use OLS estimation to measure gender differences in cognition among elderly individuals. The inclusion of a large set of controls (schooling, sex, age, urbanity, ethnic group, district-level fixed effects, and in particular, objective health indicators) to estimate cognitive ability help us to reduce a potentially omitted variable bias. We estimate the following equation:

$$c_i = \alpha_0 + \beta D_i^{fem} + \delta X_i + \alpha_d + \varepsilon_i \quad (1)$$

Where c_i corresponds to one of the cognitive scores mentioned above (standardized with mean equal to zero and standard deviation equal to one) of individual i; D_i^{fem} is a dummy variable for whether the individual is female; X_i is a vector of exogenous variables; α_d are district fixed effects (district of residence of individual *i*); and ε_i is an error term. The coefficient on our variable of interest, D_i^{fem}, indicates the effect of being female on cognitive functioning conditional on all the other attributes.

After estimating equation 1, we further analyse gender differentials using interactions between the gender dummy and the other covariates in the regression. The aim is to explore whether cognition is associated with each covariate differently by gender. Thus, we estimate the following equation:

$$c_i = \alpha_0 + \beta D_i^{fem} + \delta_1 D_i^{fem} X_i + \delta_2 X_i + \alpha_d + \varepsilon_i \quad (2)$$

In equation 2, the interaction term indicates whether the effect of the covariate on cognitive functioning differs by gender.

3.2 Control variables

In addition to socio-demographic variables such as age, sex, urban/rural residence, ethnic group and schooling, we include district-level fixed effects to capture unobservable characteristics at the local level, such as labour market conditions, community deprivation of health and basic services, and healthy environments.. Furthermore, we include objective health indicators collected in ESBAM that are expected to affect cognitive skills such as haemoglobin, arm-span and chronic diseases related to mental health. We use haemoglobin (measured from extracted respondents' blood samples) in order to consider the effect of anaemia, which is linked to an increase in the risk of dementia through low oxygen levels affecting brain connections and hence reducing memory and thinking abilities and damaging neurons (Hyung Hong et al., 2013). According to WHO norms, haemoglobin levels should be roughly between 12 g/dL to 16g/dL. Aanemia can affect an important number of the elderly because old age is associated with diet monotony, less intestinal mobility and the intake of energy. The inclusion of this variable is aimed at measuring the effect of current nutritional status.

Moreover, it is recognized that cognition performance among the elderly is positively related with nutrition quality acquired in childhood. Case and Paxon (2008) find a strong correlation between height at early life (<3 years) and adulthood, so that this last variable can indicate the nutrition and health experienced at early life. In addition to these authors, Guven and Lee (2013a, 2013b) and Lei *et al*. (2012 and 2013) also use respondent's height to find that better nutrition in childhood is positively associated with cognitive ability development. Height is not measured in ESBAM because of well-known limitations of taking this measure in old-age individuals (height shrinking, difficulty to stand straight, etc.). Instead, we use arm-span, which is considered a better measure in old-age individuals and is highly correlated with height (Kwok and Whitelaw, 1991; Kwok *et al*., 2002; De Lucia *et al*., 2002). The evidence for Latin America shows a significant positive relation between height and cognitive functioning in old age (e.g. Yount *el al*. (2009) for Guatemala; and Maurer (2010) for 7 capital cities using the SABE data).

We also control for some mental related chronic diseases that might affect cognition status. For example, it has been found in longitudinal studies that depression exacerbates the risk of cognitive decline among the elderly (Chodosh *et al*., 2007; Dotson *et al*., 2008). We will use a dummy variable indicating whether the respondent reported any of the following diseases diagnosed by a doctor: depression, cerebral haemorrhage and nervous system disorders, Alzheimer or memory loss. About one fifth of our sample reported at least one of these disorders.

We include a dummy variable indicating consumption of tobacco, either in the present or in the past. In this respect, neurological evidence (Cervilla *et al*., 2000) suggest that smoking seems to be a risk factor for cognitive impairment in old-age individuals, and that moderate alcohol drinking is preventive. A dummy variable indicating retirement[2] is also added as a control in light of the so-called "mental retirement" effect (Rohwedder and Willis, 2010). This means that an individual who leaves work for retirement might be more likely to face an acceleration in his cognitive decline trend because retirement is, generally, less stimulating than work for cognitive maintenance.

Schooling is an important factor associated with cognition abilities in later-life. For instance, Glymour *et al*. (2008) report a significant and positive effect of education on memory among the elderly. A recent study by Banks and Mazzonna (2012), based on a regression discontinuity design, supports the hypothesis that an increase in compulsory education affected old-age cognitive abilities in England. In our sample, more than one-fourth of total elderly are illiterate (28.4 percent) and almost 80 percent have not even completed primary school.

Given the characteristics of our sample, it is not surprising that Table 4 reports large gender differences in education attainment. For instance, half of the female population is illiterate, while this is the case for one-tenth of the male population. Moreover, nearly 90 and 70 percent of females and males, respectively, have not even completed primary education.

[2] We treat both retirees and unemployed as retired. In our sample, 71 percent are working, 28 percent are retired and only 1 percent is unemployed.

Table 4. Distribution of education attainment by gender and age groups (percentage)

Education level		Female				Male			
	All	All	65-69	70-74	75-80	All	65-69	70-74	75-80
Illiterate	28.4	50.2	45.5	54.6	51.8	10.8	9.7	10.6	12.8
Incompleted primary	50.8	39.3	40.3	35.9	42.8	60.0	55.6	65.1	61.0
Completed primary	13.9	7.7	9.3	7.9	4.4	18.9	19.6	16.6	20.6
Incompleted secondary	3.6	1.9	3.7	0.6	0.5	5.0	7.4	3.4	3.2
Completed secondary or higher	3.3	1.0	1.2	1.0	0.5	5.2	7.7	4.3	2.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Observations	3947	1760	730	621	409	2187	905	679	603

Under the same reasoning of disparities in the access of resources, particularly in the past, when the individuals of our sample acquired most of their human capital, we include controls for ethnic groups. Thus, we use a dummy variable for whether the respondent's mother tongue is indigenous (Quechua, Aymara or other indigenous tongue) or in contrast, Spanish.

4 Results

4.1 Main results

Columns 1-5 of Table 5 show the OLS estimations of the previously described cognitive scores in standardized form. Columns 6 and 7 report summary measures that we will discuss further. Each regression includes district-level fixed effects and robust standard errors. As mentioned before, our primary variable of interest is the dummy for female, which is statistically significant across each cognitive measure, although the direction of the effect differs. Looking at the overall measures of *episodic memory* and *mental intactness,* it is revealed that females have better performance in the former, but they perform worse than males in the latter. In terms of magnitude, females have a score in *memory intactness* that is 0.17 standard deviations larger than the one of males with similar characteristics. Furthermore, we find different results within the *mental intactness* dimension. Females perform worst than males in *orientation* and *drawing* (0.20 and 0.13 SD, respectively), but better in the command component (0.06 SD). Interestingly, the direction of these results in *episodic memory* and *mental intactness* are similar to those in Lei *et al*. (2012 and 2013) who analyse gender disparities in cognition among Chinese individuals aged 45 and over.

Table 5: OLS estimation of the cognitive z-score

Variable	Episodic memory	Mental intactness				Overall	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total	Orientation	Command	Drawing	Total	Additive	PCA
Female	0.167***	-0.203***	0.061*	-0.127***	-0.157***	-0.011	0.012
	(0.039)	(0.037)	(0.037)	(0.037)	(0.036)	(0.036)	(0.036)
Age	-0.027***	-0.022***	-0.003	-0.018***	-0.022***	-0.029***	-0.029***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
Mother tongue is indigenous	0.059	0.063	0.037	0.001	0.063	0.073	0.083
	(0.082)	(0.071)	(0.085)	(0.070)	(0.072)	(0.073)	(0.076)
Urban	0.151**	0.014	0.052	0.085	0.052	0.117*	0.128*
	(0.077)	(0.066)	(0.075)	(0.075)	(0.069)	(0.071)	(0.075)
Retired	-0.108***	-0.131***	-0.065*	-0.089**	-0.146***	-0.154***	-0.153***
	(0.040)	(0.037)	(0.037)	(0.043)	(0.036)	(0.036)	(0.037)
Uncompleted primary education	0.245***	0.794***	0.116***	0.528***	0.767***	0.636***	0.601***
	(0.043)	(0.041)	(0.039)	(0.046)	(0.039)	(0.039)	(0.040)
Completed primary education	0.425***	0.943***	0.163***	0.559***	0.906***	0.825***	0.779***
	(0.058)	(0.051)	(0.055)	(0.055)	(0.050)	(0.051)	(0.052)
Uncompleted secondary education	0.440***	0.931***	0.280***	0.637***	0.963***	0.871***	0.846***
	(0.081)	(0.077)	(0.079)	(0.064)	(0.071)	(0.070)	(0.068)
Completed secondary educ. or higher	0.479***	0.988***	0.310***	0.606***	1.011***	0.923***	0.866***
	(0.094)	(0.084)	(0.095)	(0.071)	(0.081)	(0.083)	(0.083)
Arm span (z-score)	0.032*	0.033**	0.047***	0.053***	0.056***	0.054***	0.067***
	(0.018)	(0.015)	(0.017)	(0.018)	(0.016)	(0.016)	(0.017)
Haemoglobin (z-score)	0.037**	0.050***	0.014	-0.009	0.041**	0.047***	0.036**
	(0.018)	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)
Mental disorders	-0.218***	-0.098**	-0.118***	-0.117***	-0.150***	-0.217***	-0.222***
	(0.045)	(0.040)	(0.043)	(0.044)	(0.042)	(0.043)	(0.044)
Smoking	0.023	-0.013	-0.093**	-0.073*	-0.066*	-0.030	-0.029
	(0.042)	(0.037)	(0.041)	(0.040)	(0.036)	(0.036)	(0.036)
Constant	1.660***	1.091***	0.155	0.962***	1.093***	1.645***	1.607***
	(0.280)	(0.262)	(0.257)	(0.290)	(0.255)	(0.253)	(0.258)
District-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3947	3947	3947	3947	3947	3947	3947
R-squared	0.20	0.35	0.28	0.23	0.37	0.34	0.32

Note: Robust standard errors in parentheses. * p<0.1 ** p<0.05 *** p<0.01.

Regarding other socio-demographic variables, the effect of age on each cognitive measure is negative (about 0.02 SD) and seems stable across the cognitive measures, with the exception of the command component where its coefficient is much smaller and not significant. There is not a significant effect of the mother tongue on cognition. Furthermore, the inclusion of this variable also helps to control for any bias in the reading and understanding of the survey questions during the interview. Living in an urban area is only significant and positive in the regression for episodic memory.

Retirement is always statistically significant and negatively associated with each measure of cognition. Retirement is associated with a decrease of 0.11 SD and 0.15 SD in the overall measures of episodic memory and mental intactness, respectively. As expected, the role of education on cognitive performance is remarkable. The reference category for the education variables is being illiterate, so that simply moving to the level of uncompleted primary education can raise the performance in *episodic memory* by 0.25 SD and in *mental intactness* by 0.77 SD. The estimated coefficients of each level of education reveal that the impact of education is more important in *orientation* and less important in *command*. As we mentioned above, females have significantly less education than males; therefore, we can conjecture that the test of *command* is capturing some abilities more present in females than in males. Another possibility is that the type of daily activities performed by females is more protective of certain areas of cognition, in contrast to physical work, which is the main activity of working males in our sample (about 87 percent of working elderly males work in agriculture, cattle and construction, while this figure is 68 percent for working females).

In regard to nutritional status we report a positive and statistically significant association of the standardized arm-span (a better measure than height in the old-age population) with each cognitive measure. As discussed before, the effect of arm-span is indicative of the influence of childhood nutrition in cognitive ability development. Recall that arm-span is highly correlated with height and that this has been found to be associated with cognitive development in adulthood (Case and Paxon, 2008). The effect of arm-span in cognition ranges from 0.03 SD to 0.06 SD, which is in line with the recent empirical literature concerning the long-term effects of childhood development on current outcomes.

Moreover, the effect of current nutritional status in cognition is measured with the level of haemoglobin. We find a positive and statistically significant association of this variable with the overall measures of *episodic memory* and *mental intactness* (in both cases of 0.04 SD). However, within *mental intactness*, the effect of haemoglobin is only significant and positive for the component of *orientation* (0.05 SD). As expected, mental health related diseases is negatively associated with each cognitive measure, which is noticeably sizable in the case of *episodic memory*. (-0.22 SD).

There is also evidence of a negative and significant association between smoking and the overall measure of *mental intactness* (in particular with the *command* and *drawing* components) this, however, is not the case with *memory*. Similarly, Guven and Lee (2013b) do not find a significant association between smoking (past or present) with *memory*, but they show a negative relationship between smoking and *verbal fluency* when analysing SHARE data for European individuals aged 50 and over.

Other studies have found similar evidence to the one in our sample. Females from our sample of elderly poor Peruvians perform better than males in some cognitive abilities. For example, Lei *et al*. (2013) find that Chinese males are better in mental intactness, and females are better in episodic memory. Evidence from developed countries, where gender disparities in education are lower, also shows that females have better scores in episodic memory but worse scores in orientation, which is a component of mental intactness. In this regard, some authors cite a higher cognitive aptitude of females for episodic memory, whereas males are better on tasks that involve spatial recognition (Lewin *et al*., 2001; Hertlitz and Yonker, 2002).

Finally, the last two columns of Table 5 explore different methods to aggregate the different cognitive ability scores. Two options are considered: the first measure is a score equivalent to the total sum of points obtained in each cognitive test, and the second option is a score predicted from Principal Component Analysis (PCA). Both measures are standardized to have mean zero and standard deviation equal to 1. Given that the estimated coefficients are similar in magnitude and significance between the two columns, our results do not seem to be driven by the way the scores are aggregated.

Overall, cognition is not associated with gender, conditional on the full set of controls. The overall score hides the gender differences in episodic memory and mental intactness. However, we find that individuals in urban areas have better cognition, which lend support to the existence of persistent differences between urban and rural localities, the latter ones being more likely to suffer from inadequate infrastructure, public services, education, health, market access, etc. It is striking that even in our sample of poor individuals, it is found that regional differences matter.

4.2 Models with interaction effects

We further analyse the results of previous section with the inclusion of interactions between gender and the other covariates (equation 2). This specification explores whether the variables associated with cognition present gender differentials, which is of particular interest to assessing why elderly males and females perform differently in each cognitive measure. Table 6 reports the OLS results.

Table 6: OLS estimation of the cognitive z-score with interaction effects

Variable	Episodic memory	Mental intactness			
	(1)	(2)	(3)	(4)	(5)
	Total	Orientation	Command	Drawing	Total
Female	1.099**	-0.635	0.350	0.483	-0.217
	(0.541)	(0.495)	(0.491)	(0.566)	(0.482)
Age	-0.021***	-0.023***	-0.001	-0.012***	-0.021***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
Age*Female	-0.014*	0.004	-0.004	-0.012	-0.001
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)
Mother tongue is indigenous	0.022	0.160**	-0.002	-0.010	0.117
	(0.088)	(0.074)	(0.089)	(0.073)	(0.075)
Mother tongue is indigenous*Female	0.062	-0.197***	0.092	0.036	-0.101
	(0.073)	(0.064)	(0.070)	(0.073)	(0.063)
Urban	0.151*	-0.015	0.046	0.054	0.020
	(0.082)	(0.072)	(0.079)	(0.078)	(0.073)
Urban*Female	-0.001	0.052	0.017	0.032	0.054
	(0.066)	(0.062)	(0.062)	(0.068)	(0.059)
Retired	-0.182***	-0.142**	-0.066	-0.128**	-0.164***
	(0.062)	(0.056)	(0.058)	(0.059)	(0.056)
Retired*Female	0.123	0.009	0.013	0.074	0.030
	(0.080)	(0.074)	(0.074)	(0.084)	(0.073)
Uncompleted primary education	0.218***	0.652***	0.183***	0.347***	0.646***
	(0.078)	(0.075)	(0.068)	(0.081)	(0.072)
Completed primary education	0.435***	0.763***	0.221***	0.381***	0.752***
	(0.087)	(0.081)	(0.080)	(0.087)	(0.079)
Uncompleted secondary education	0.452***	0.701***	0.367***	0.480***	0.789***
	(0.110)	(0.105)	(0.103)	(0.093)	(0.098)
Completed secondary education or higher	0.485***	0.851***	0.369***	0.474***	0.901***
	(0.113)	(0.104)	(0.113)	(0.095)	(0.101)
Uncompl. primary educ.*Female	0.057	0.170*	-0.098	0.258***	0.148*
	(0.093)	(0.091)	(0.083)	(0.100)	(0.087)
Compl. primary educ.*Female	-0.080	0.326***	-0.064	0.291**	0.286***
	(0.123)	(0.111)	(0.112)	(0.116)	(0.109)
Uncompl. secondary educ.*Female	-0.060	0.504***	-0.162	0.243*	0.368***
	(0.163)	(0.154)	(0.161)	(0.130)	(0.141)
Compl. secondary educ. or higher*Female	-0.042	0.150	-0.033	0.191	0.144
	(0.282)	(0.240)	(0.223)	(0.227)	(0.248)
Arm span (z-score)	0.028	0.038**	0.063***	0.061***	0.068***
	(0.022)	(0.019)	(0.022)	(0.020)	(0.019)
Arm span (z-score)*Female	0.009	-0.009	-0.038	-0.017	-0.026
	(0.033)	(0.030)	(0.033)	(0.034)	(0.031)
Haemoglobin (z-score)	0.023	0.058***	0.018	-0.010	0.048**
	(0.022)	(0.021)	(0.020)	(0.020)	(0.019)
Haemoglobin (z-score)*Female	0.030	-0.020	-0.008	0.010	-0.015
	(0.033)	(0.031)	(0.029)	(0.034)	(0.030)
Mental disorders	-0.182***	-0.117**	-0.158***	-0.149***	-0.188***
	(0.059)	(0.051)	(0.055)	(0.053)	(0.052)
Mental disorders*Female	-0.065	0.032	0.083	0.054	0.071
	(0.085)	(0.075)	(0.077)	(0.083)	(0.077)
Smoking	0.031	-0.007	-0.103**	-0.098**	-0.071*
	(0.044)	(0.038)	(0.044)	(0.042)	(0.038)
Smoking*Female	-0.060	-0.067	0.076	0.253**	0.041
	(0.130)	(0.120)	(0.117)	(0.114)	(0.111)
Constant	1.252***	1.310***	-0.003	0.761**	1.144***
	(0.356)	(0.327)	(0.334)	(0.332)	(0.319)
District-level fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	3947	3947	3947	3947	3947
R-squared	0.21	0.36	0.28	0.23	0.37

Note: Robust standard errors in parentheses. * p<0.1 ** p<0.05 *** p<0.01.

The differential effect of age by sex is only statistically significant and negative in the measure of *episodic memory*, meaning that older females are doing worse than older males in this cognitive measure. Indigenous mother tongue only penalizes females in *orientation*. There are not statistically significant differential effects of education on *episodic memory* and *command*, but we find significant effects on *orientation*, *drawing* and the overall measure of *mental intactness*. These effects can be of a large magnitude. For example, focussing on the overall measure of *mental intactness*, an illiterate male (all the rest remaining constant) has a score 0.22 SD higher than an illiterate female, but this gap is reduced to 0.07 SD when both have completed secondary education. Smoking has significant differential effects only for the measure of drawing, and indicates that smoking affects males more adversely than females. The rest of the variables do not show differential effects by sex in any of the cognitive measures. As expected, long-term and short-term nutritional status plays an important role in predicting cognitive functioning in old age, but they do not appear to be different between men and women. It seems that policies directed to improve the nutritional status of children and the elderly are important to enhance the cognitive reserve in old-age, and that policies giving more educational opportunities to girls can help to close the gap in cognitive functioning.

5 Conclusions

In this paper we have reported important gender differences in a range of different cognitive abilities in a sample of elderly individuals living in poverty in Peru. After controlling for a comprehensive set of variables related to cognition, we report that females are better off than males when one looks at the cognitive measure of *episodic memory*. At the same time, females are worse off in the overall measure of *mental intactness*. However, within this last measure we detect that females perform better than males in the *command* component (related to following a series of orders). So, females are better in *memory* and *command*, but males are better in *orientation* and in the *drawing* measure, the other two measures included in the overall *mental intactness* dimension. In contrast to what one would expect for elderly individuals living in conditions of poverty, females are not always worse than males in terms of cognitive functioning. The assessment of an overall measure of cognition that includes all the cognitive tests reveals that gender does not matter in cognition but regional differences do. This lends support to persistent differences between urban and rural localities.

The sizeable effects of education on cognition, together with the reported results of positive associations between the quality of childhood nutrition and cognitive abilities, confirm the long-term impacts of early life developments on current outcomes. Therefore, policies directed to improving early childhood development are expected to have a positive impact in later-life. Two other covariates with a major influence in old-age cognition are current nutritional state (measured with haemoglobin levels) and the existence of diseases related to mental health. In this case, public policies directed to the current elderly poor group might have an important impact on their well-being. For instance, raising the quality of nutritional intake and medically attending to chronic mental diseases may be relevant for delaying cognitive decline in old-age.

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