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HEIGHT AND COGNITION AT OLDER AGE: IRISH EVIDENCE

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Height and Cognition at Older Age: Irish Evidence

by

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Abstract: Previous research suggests that taller individuals have greater cognitive ability. The aim of this paper is to empirically investigate whether the relationship between height and cognition holds in later-life using data from the first wave of The Irish Longitudinal Study on Ageing. Seven novel measures of cognition are used. These measures capture important aspects of cognition which are more likely to decline in old age, such as cognitive flexibility, processing speed, concentration and attention. It is found that height is positively and significantly associated with cognition in later-life also when education and early-life indicators are controlled for. The finding that adult height is a marker for nutrition and health environment experienced in early-life is widely accepted in the literature. The findings of this paper suggest that height might have a greater value added, as it appears to be a useful measure of unobserved childhood experiences.

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1. Introduction

A small but growing body of research suggests that taller individuals earn more than their shorter counterparts (Persico et al., 2008; Heineck, 2009; Lundborg et al., 2014). In high-income countries, this height premium has been attributed to factors such as self-esteem, social dominance, and discrimination against shorter people.Case and Paxon (2008a) offer a different explanation: taller individuals earn more because they have greater cognitive ability. The authors argue that gestation and childhood are crucial periods for height growth. If foetuses and children are well-nourished and in good health, they will eventually reach the adult height set by their genetic potential. Children from taller families will be taller, and children from shorter families will be shorter, but there will be no effect of height on adult outcomes. Children who are, however, exposed to poor nutrition, disease or adversity *in utero* or early childhood, will not attain their full potential height. There is good evidence that cognitive and physical function develop together, so that children who do not reach their potential height also do not develop their full cognitive potential.

If it is true that taller individuals have greater cognitive ability, do they also exhibit greater cognitive ability as they age? Do the advantages offered by a better start in life follow adults into old age? To our knowledge, there are only three economics-based studies that have tested this hypothesis in western developed countries: Case and Paxon (2008b) and Guven and Lee (2013, 2015). These studies use data from the Health and Retirement Study in the US, the English Longitudinal Study on Ageing, and the Survey of Health, Ageing and Retirement in Europe. They find a positive and significant association between height and cognition in later-life. In particular, Guven and Lee (2013, 2015) find that this association remains even after controlling for education and childhood circumstances.

The present study contributes to the existing literature in several ways. First, it provides evidence on the height/cognition relationship in later-life using data from older Irish adults. Historically, Ireland suffered relatively poor economic conditions and high level of infectious diseases in comparison to other European countries. Second, it employs several measures of cognition which have three main advantages: i) they are novel in the context of other longitudinal studies on ageing; ii) they capture important aspects of cognition which are more likely to decline in old age, such as cognitive flexibility, processing speed, concentration and attention; iii) they are administered and scored by trained nurses. Due to data limitation, the previous three studies employed measures of word recall, verbal fluency or numeracy in face-to-face or telephone interviews. Third, this paper uses accurate anthropometric data to capture height. Evidence suggests that self-reported height, employed by Case and Paxon (2008b) and Guven and Lee (2015), is subject to over-reporting, which is often systematically related to age and socioeconomic status, and may lead to biased estimates of the height/cognition relationship (Maurer, 2010, p. 169).

2. Data

The dataset used is the first wave of The Irish Longitudinal Survey of Aging (TILDA), which was collected between October 2009 and July 2011. As explained in detail by Kearney et al. (2011), Cronin et al. (2013) and Whelan and Savva (2013), TILDA collects information on the economic, health and social aspects from a nationally representative sample of individuals aged 50+. A total of 8,175 respondents completed an interview in their home. Each respondent was also invisted to undertake an extensive health assessment, either in a dedicated centre or in their own home. All assessments were carried out by trained and qualified nurses. A total of 5,897 respondents underwent a health assessment.

3. Empirical Strategy

3.1 Model

The regression model is:

$$lnCog_i = \beta_0 + \beta_1 lnHeight_i + \sum_j \beta_j X_{ij} + u_i \quad (1)$$

where "*Cog"*, is a measure of cognition of individual "i" (i = 1,2,.., N);"*Height*" is the individual height; "X_j" is a set of other variables thought to impact om cognition; and "u" is and error term.

3.2 Measures of Cognition

A large part of TILDA health assessment is devoted to assessing cognition using pen-and-paper and computer-based tasks. Seven cognition measures are employed in this paper:

1] Montreal Cognitive Assessment (*MoCA*);

2] Colour Trail Task 1 (*CTT1*);

3] Colour Trail Task 2 (*CTT2*);

4] Mean Choice Reaction Time (*mean CRT*);

5] Choice Reaction Time variability (*sd CRT*);

6] Mean Sustained Attention to Response Task (*mean SART*);

7] Sustained Attention to Response Task variability (*sd SART*)

Full details of these tests are provided in Table 1.

3.3 Measure of Height

In TILDA, height (cm) is measured in the health assessment. One potential issue with taking height measurements of older people is that there could be shrinkage as a result of bone density loss, which may be more pronounced for individuals with some health problems. However, the respondents were still relatively young (average age = 61.1 years) when height was measured.

3.4 Control variables

Controls for age, sex, education and childhood circumstances are also included. Education is a potential pathway linking height and cognition in later-life. Childhood circumstances likely are the most relevant factors affecting both height and cognition. Education is measured in years of schooling completed (*School*). Childhood circumstances are based on retrospective self-reports of whether: there were no/very few books in the respondent's home (*NoBooks*); the respondent was in fair/poor health (*PoorHealth)* or grew up in a poor family (*PoorFam*); the respondent's mother/father never worked outside the home (*MotherNotWork*; *FatherNotWork);* there were no features, such as no fixed bath and no central heating, in the repondent's home (*NoFeature*); and household size (*HouseholdSize).* As the questions relative to *NoBook, NoFeature* and *HouseholdSize* were added in the third wave of TILDA, essentially the sample includes individuals who participated at both Wave 1 and Wave 3 with no missing observations on the variables of interest. The final sample includes 4,456 respondents. Descriptive statistics are available in Table 2.

3. Regression Results

For ease of exposure, the natural logarithm of height and of all seven cognition variables is taken so that the association between height and cognition is an elasticity. The transformed scores of *CTT1*, *CTT2*, *mean CRT*, *sd CRT*, *mean SART* and *sd SART* are then multiplied by "-1". A higher value of these transformed variables suggests a higher level of cognition, which makes interpretation of the estimates more intuitive.

The estimated height elasticities with respect to the seven different measures of cognition are reported in Table 3. A number of interesting results emerge. First, the height elasticity is positive and significant with respect to all seven cognition variables (Panel 1). For example, a 1% increase in height is associated with 0.46% increase in the *MoCA* score or a

0.72% increase in the *CTT1* score. Second, the height elasticity is still positive and significant when education is controlled for, although it is now smaller in magnitude (Panel 2). Third, the inclusion of a large battery of childhood variables has a modest effect on the size of the height elasticity (Panel 3). The associations of height, education and childhood characteristics with cognition are presented in Table A1 in Appendix.

Conclusions

This paper found that height is correlated with those aspects of cognition which are more likely to decline in old-age, such as cognitive flexibility, processing speed, concentration and attention.

Retrospective self-assessments of early-life conditions displayed statistically significant associations with later-life cognition, but only had a moderate impact on the estimated height elasticity. The finding that adult height is a marker for nutrition and health in early-life is widely accepted in the literature. The findings of this paper suggest that height and retrospectively assessed early-life conditions might capture different aspects of early-life circumstances and that anthropometric markers are a useful complement to such retrospective information. Compared to the other measures, height also has the clear advantage of not suffering from recall bias.

The association between height and later-life cognition decreased substantially once education was controlled for. This result confirms the findings of the previous literature that education is likely to be an important pathway in the relationship between early-life conditions and later-life cognition.

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Table 1: Description of Cognitive Tests

Cognitive Test	*Instruction [Cognitive Component Assessed]*	*Scoring*
Montreal Cognitive Assessment (MoCA)	30-item scale measuring global cognition [attention, concentration, memory, language, visuoconstructional skills, calculations, orientation, executive function and conceptual thinking]	Minimum = 0; maximum = 30
Color Trails Test (CTT1 and CTT2)	Draw line connecting circles numbered 1–25 in consecutive order [visual scanning and processing speed] and alternating between pink and yellow circles [visual scanning, attention and mental flexibility]	Time taken to complete the task (seconds)
Choice Reaction Time (CRT)	Depress a button on keyboard and wait for a stimulus (yes/no) to appear on screen. Press corresponding yes/no button on keyboard in response; 100 repetitions [concentration and processing speed]	Mean and standard deviation (sd) of time taken to release the button in response to the stimulus (milliseconds)
Sustained Attention to Response Task (SART)	Repeating sequence of numbers from 1 to 9 for 4 minutes. Click in response to each number except 3 [arousal, attention, processing speed, executive function]	Mean and sd of time taken for each key press in response to digits 1, 2, 4-9 (milliseconds)

Table 2: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
MoCa	25.40	3.13	7.00	30.00
CTT1	53.28	23.16	14.16	231.03
CTT2	106.49	39.25	30.09	529.22
Mean CRT	505.34	143.04	258.97	2850.68
Sd CRT	122.03	158.45	25.47	2259.14
Mean SART	375.75	97.99	130.38	867.83
Sd SART	115.55	70.29	21.56	482.62
Height	166.01	9.10	136.00	194.30
Age	61.12	8.87	29.00	92.00
Male	0.433	0.496	0	1
School	12.21	2.90	6.00	25.00
PoorFam	0.192	0.394	0	1
MotherNotWork	0.693	0.461	0	1
FatherNotWork	0.067	0.249	0	1
PoorHealth	0.061	0.240	0	1
NoBooks	0.381	0.486	0	1
NoFeature	0.103	0.304	0	1
HouseholdSize	7.19	2.80	1.00	50.00

Table 3: Height elasticity with respect to cognition measures (1) to (7)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ln(MoCA)	-ln(CTT1)	-ln(CTT2)	-ln(mean CRT)	-ln(sd CRT)	-ln(mean SART)	-ln(sd SART)
Panel 1: Regressors are: age, sex, ln(height)							
	0.459***	0.724***	0.896***	0.397***	1.139***	0.268**	0.715***
	(7.1)	(4.7)	(6.3)	(4.0)	(4.5)	(2.3)	(2.9)
Panel 2: Regressors are: age, sex, ln(height), education							
	0.348***	0.539***	0.686***	0.321***	0.972***	0.214*	0.458*
	(5.7)	(3.6)	(5.1)	(3.3)	(3.9)	(1.9)	(1.9)
Panel 3: Regressors are: age, sex, ln(height), education, childhood circumstances							
	0.335***	0.481***	0.658***	0.312***	0.966***	0.226**	0.438*
	(5.5)	(3.3)	(5.0)	(3.2)	(3.8)	(2.0)	(1.8)
N	4,456	4,456	4,456	4,456	4,456	4,456	4,456

Notes: *** p< 0.01; ** p<0.05; * p<0.10. Parameter estimates and standard errors are adjusted for the complex study design

Appendix A

Table A1: Regression results, full model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ln(MoCA)	-ln(CTT1)	-ln(CTT2)	-ln(mean CRT)	-ln(sd CRT)	-ln(mean SART)	-ln(sd SART)
Ln(Height)	0.335***	0.481***	0.658***	0.312***	0.966***	0.226**	0.438*
	(5.5)	(3.3)	(5.0)	(3.2)	(3.8)	(2.0)	(1.8)
Age	-0.00263***	-0.0175***	-0.0138***	-0.00418***	-0.0125***	-0.00478***	-0.0181***
	(-7.7)	(-24.5)	(-22.3)	(-9.1)	(-9.7)	(-9.0)	(-16.2)
Male	-0.0236***	-0.106***	-0.0820***	-0.0490***	-0.0321	0.0327**	0.0892***
	(-3.4)	(-6.5)	(-5.8)	(-4.5)	(-1.1)	(2.5)	(3.5)
School	0.00966***	0.0149***	0.0174***	0.00660***	0.0144***	0.00494***	0.0218***
	(12.2)	(7.2)	(9.8)	(5.0)	(4.4)	(3.5)	(7.1)
PoorFam	0.0117*	0.00475	0.00458	0.00470	0.0609**	0.00654	-0.00661
	(1.9)	(0.3)	(0.4)	(0.5)	(2.5)	(0.7)	(-0.3)
MotherNotWork	0.00780	-0.00315	-0.000888	-0.00777	0.00556	-0.000674	0.0104
	(1.5)	(-0.2)	(-0.08)	(-1.0)	(0.3)	(-0.08)	(0.6)
FatherNotWork	-0.0255***	-0.0575**	-0.0456**	-0.0267*	-0.0589*	-0.0511***	-0.0820**
	(-2.7)	(-2.4)	(-2.3)	(-1.9)	(-1.8)	(-3.1)	(-2.5)
PoorHealthChild	-0.0105	-0.0687***	-0.0145	-0.00453	-0.0321	0.0266	-0.0127
	(-0.9)	(-2.7)	(-0.7)	(-0.3)	(-0.9)	(1.6)	(-0.4)
NoBooks	-0.0369***	-0.0633***	-0.0607***	-0.0160**	-0.0480**	-0.00750	-0.0537***
	(-7.5)	(-4.9)	(-5.4)	(-2.1)	(-2.2)	(-0.8)	(-2.8)
NoFeatures	-0.0328***	-0.104***	-0.126***	-0.0507***	-0.186***	-0.0389***	-0.144***
	(-3.5)	(-5.3)	(-7.0)	(-3.6)	(-4.8)	(-2.8)	(-4.7)
HouseholdSize	-0.00192**	-0.000208	-0.00447***	-0.00222*	-0.00335	-0.00239	-0.00704**
	(-2.1)	(-0.1)	(-2.6)	(-1.8)	(-1.0)	(-1.6)	(-2.4)
Constant	1.589***	-5.385***	-7.240***	-7.566***	-8.853***	-6.810***	-5.947***
	(5.1)	(-7.1)	(-10.7)	(-14.9)	(-6.8)	(-11.6)	(-4.8)
R-sq	0.151	0.256	0.271	0.077	0.096	0.062	0.162
N	4,456	4,456	4,456	4,456	4,456	4,456	4,456

Notes: *** p< 0.01; ** p<0.05; * p<0.10. Parameter estimates and standard errors are adjusted for the complex study design