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Does Size Matter in Australia?*

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We estimate the relationship between hourly wages and two aspects of body size: height and body mass index (BMI). We observe a height premium, with an additional 10 cm of height being associated with a 3 per cent increase in hourly wages for men. However, workers with higher BMI scores do not seem to earn lower wages. These results are largely unaffected by controlling for physical health, or (in the case of BMI) instrumenting with the BMI of biological family members. A survey of previous instrumental variables studies shows little indication of systematic biases, suggesting that OLS may provide a reasonable estimate of the causal impact of BMI on wages.

I Introduction

Over recent decades, a substantial literature has arisen on the relationship between body size and wages, focusing particularly on height and overweight. Although this issue has been studied for a variety of countries, we are not aware of any articles that have analysed the relationship between body size and wages in the Australian labour market. The issue is particularly salient given the well-documented rise in average body mass indices (BMIs) over recent decades. Between 1989–90 and 2004–05, the age-standardised proportion of overweight or obese Australian adults increased from 38 to 53 per cent (ABS, 2008).[1]

In this article, we exploit newly available data from the Household, Income and Labour Dynamics in Australia (HILDA) survey to analyse the relationship between height and wages and between overweight and wages for Australia. As well as providing the first results for Australia, we also take advantage of the fact that HILDA contains detailed questions on the health status of the respondent. This allows us to ask the question:

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[1] The increase was most striking among obese adults, with the proportion doubling from 9 to 18 per cent. The proportion of men classified as overweight or obese increased from 45 to 62 per cent, whereas the share of women who were overweight or obese rose from 32 to 45 per cent (ABS, 2008).

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controlling for self-reported physical health, do taller and slimmer workers earn more? In a companion article (Kortt & Leigh, 2009), we look at the socio-economic correlates of height and weight.

From a theoretical standpoint, why should body size affect wages? One possibility is that for particular jobs, body size has a direct productive payoff. For example, a taller shop assistant may be able to reach the top shelf without needing a ladder, whereas a slimmer construction worker may be able to move more rapidly around the building site. It is also possible that body size has an indirect impact on productivity. For example, taller and slimmer workers might exude greater confidence in dealing with customers and co-workers, perhaps because others have treated them more favourably in the past. The final possibility is that shorter and more overweight workers might be subject to discrimination from customers, co-workers, or employers.

Empirically, there is evidence from other countries that body size matters. Studies on overweight have found statistically significant relationships between BMI and wages in the USA (Register & Williams, 1990; Averett & Korenman, 1996; Pagan & Davila, 1997; Baum & Ford, 2004; Cawley, 2004; Han *et al*., 2009), the UK (Sargent & Blanchflower, 1994; Morris, 2006; Lindeboom *et al*., 2009), and other European countries (Sarlio-Lahteenkorva & Lahelma, 1999; Cawley *et al*., 2005; Brunello & D'Hombres, 2007; Lundborg *et al*., 2007; Garcia Villar & Quintana-Domeque, 2009). Studies on height and wages have found a positive relationship in Brazil (Thomas & Strauss, 1997), the UK (Harper, 2000; Case & Paxson, 2008; Case *et al*., 2009), and the USA (Loh, 1993; Persico *et al*., 2004; Case & Paxson, 2008).

To preview our findings, we observe a height premium, which is larger for men than for women. We find no BMI penalty for Australian adults. These results are largely unaffected by controlling for physical health, or (in the case of BMI) instrumenting with the BMI of co-resident biological family members.

II Data and Empirical Strategy

The data used in this article comes from the 2006 and 2007 waves of the HILDA survey, which are the only waves to have collected self-reported height and weight data. The major advantage of using HILDA is that it is one of the largest surveys in Australia to have detailed information on wages and body size as well as health status, as measured by the SF-36 health survey. For a detailed discussion of the quality of the height and weight data in HILDA, see Wooden *et al*. (2008). We are cognisant of the limitations of BMI as a measure of 'fatness' (for an excellent discussion, see Burkhauser & Cawley, 2008), but are not aware of better Australian datasets for our purposes at this time.

We restrict our sample to respondents aged 25–54, dropping those respondents who are not employed, self-employed, enrolled in full-time education, or who did not answer the SF-36 health survey. We also drop pregnant women from the sample. Wage observations below half the federal minimum wage are dropped, since we regard these as implausibly low.[2] Our sample comprises about one-fifth of the respondents in the 2006 and 2007 waves of the HILDA survey.

The dependent variable is log hourly wages. We control for a quadratic in age, indicator variables for whether the respondent was born overseas and whether the respondent is Indigenous, and the occupational status of the respondent's father at the time when he or she was aged 14. In the 2006 wave, occupations are coded using the four-digit Australian Standard Classification of Occupations (ASCO 1997), whereas in the 2007 wave, occupations are coded using the four-digit Australian and New Zealand Standard Classification of Occupations (ANZSCO 2006). The father's occupational status scale, developed by researchers at the Australian National University, ranges from 0 (lowest-status occupations) to 100 (highest-status occupations). The scale takes account of the average education and income levels in an occupation (for more detail on the methodology, see Ganzeboom *et al*., 1992; Jones & McMillan, 2001). We use this as a proxy for the individual's socio-economic background.

There is some disagreement in the literature over whether one should also control for experience and education in a context such as this one. Although some studies looking at height have not controlled for these variables (see, e.g. Persico *et al*., 2004), studies focusing on BMI have typically

[2] In 2006, most respondents were interviewed between August and November 2006, when the federal minimum wage for workers aged 21 and over was \$12.70 per hour, so we drop those earning less than half the minimum wage (\$6.35). In 2007, most respondents were interviewed between August and November 2007, when the federal minimum wage for workers aged 21 and over was \$13.47 per hour, so we drop those earning less than \$6.75.

included them as covariates (see, e.g. Cawley, 2004). The central question is whether experience and education are a channel through which body size affects earnings (in which case one would not wish to control for them), or whether they are confounding variables that happen to be correlated with both body size and wages (in which case one would wish to control for them).[3] Here, we opt to control for experience and education, since this approach largely follows the previous literature; more readily permitting a comparison of our results with those from other countries.[4] Since previous studies have sometimes observed differences in the effect of body size on the wages of men and women, we show pooled results and specifications that are estimated separately for men and women. All summary statistics and regression results are population-weighted.

As measures of body size, we use self-reported height (in centimetres) and BMI (self-reported weight in kilograms divided by self-reported height in metres squared). To account for the possibility that underweight and overweight people may both be penalised in the labour market, we run regressions with BMI as a continuous variable and as a categorical variable. For the categorical measure of BMI, indicator variables were included for underweight (BMI < 18.5), overweight ($25 \leq$ BMI < 30), and obese (BMI ≥ 30). The reference group are respondents with a normal-range BMI score ($18.5 \leq$ BMI < 25).[5]

In some specifications, we also control for self-reported health status, measured through the SF-36 health survey. This 36-item survey is used to evaluate patients' health status across eight separate dimensions (Ware *et al*., 1993; Ohsawa *et al*., 2003). We focus here on four physical health dimensions: physical functioning, role–physical, bodily pain, and general health.

Our most extensive model (i.e. the specification shown in Table 3) is:

$$W_i = \alpha + \beta'\mathbf{S}_i + \gamma'\mathbf{X}_i + \lambda'\mathbf{H}_i + \varepsilon_i \qquad (1)$$

In Equation (1), W is the respondent's log hourly wage, $\mathbf{S}$ is a vector of body size measures, $\mathbf{X}$ is a vector of exogenous demographic controls (gender, age, age^2, born overseas, Indigenous, father's occupational status, experience, and education, plus a wave indicator), $\mathbf{H}$ is a vector of health status measures, and ε is an i.i.d. error term.[6] All results are estimated using ordinary least squares (OLS). Since we observe the same individuals over multiple waves, standard errors are clustered at the person level to account for within-person serial correlation. (We also experimented with using lagged body size or average body size, and found that this made little difference to our results.)

In Table 1, we report the summary statistics for the 3357 women and 3465 men in our sample. Among the women in our sample, 49 per cent are overweight or obese. Among men, 67 per cent are overweight or obese. These figures are slightly higher than the ABS estimates from the 2004–05 National Health Survey (ABS, 2008), though it should be borne in mind that our sample excludes individuals aged 18–24 and those who are not in employment.

III Associations between Body Size and Wages

In Table 2, we report the estimated association between log hourly wages and body size. To aid interpretation, we divide both height and BMI by 10, so the coefficients represent the marginal effect of a 10 cm increase in height, or a 10-point increase in BMI. For height (column 1), we observe results that are quite large, particularly for men. For women, each additional 10 cm of height is associated with a 2 per cent increase in hourly wages (statistically insignificant). For men, each additional 10 cm of height is associated with a 3 per cent increase in hourly wages. These effects are virtually unchanged when BMI is

[3] Neal and Johnson (1996) argue strongly that when looking at labour market discrimination, one should not control for education and experience (on this point, see also Heckman, 1998). However, both those studies have the advantage of being able to control for a measure of cognitive ability, which is not available in the HILDA dataset.

[4] There is some evidence from an Australian twin study that education has a causal effect on body size (Webbink *et al*., 2008), rather than the other way around. Consistent with this, the coefficient on the BMI score is negative and statistically significant in most specifications if we omit education from our regressions.

[5] The collection of anthropometric data by self-report has often been shown to be subject to error (Spencer *et al*., 2002). One possibility is to adjust for this error, using the equations proposed in Hayes *et al*. (2008). Doing this has very little impact on our results.

[6] We code years of education as the highest year of completed schooling if the respondent has no post-school qualifications (less than 8 years is coded as 8 years). Post-school qualifications are coded into years as follows: masters/doctorate = 17 years; graduate diploma/certificate = 16 years; bachelor degree = 15 years; diploma = 12 years; and certificate = 12 years.

TABLE 1
Summary Statistics

	Persons		Women		Men	
	Mean	SD	Mean	SD	Mean	SD
Height (cm)	171.45	10.38	164.22	7.71	178.16	7.67
BMI	26.67	5.18	26.14	5.74	27.16	4.56
Underweight	0.01	0.11	0.02	0.14	0.01	0.07
Normal weight	0.41	0.49	0.49	0.50	0.32	0.47
Overweight	0.36	0.48	0.28	0.45	0.44	0.50
Obese	0.22	0.41	0.21	0.4	0.23	0.42
Log hourly wage	3.18	0.41	3.11	0.38	3.24	0.42

Note: Sample size is 3357 women and 3465 men. All statistics are population-weighted.

TABLE 2
Wages and Body Size

	Dependent variable is log hourly wage			
	[1]	[2]	[3]	[4]
Panel A: Persons				
Height (cm)/10	0.022 [0.008]***			0.022 [0.008]***
BMI score/10			0.001 [0.011]	0.004 [0.011]
Underweight		–0.032 [0.059]		
Overweight		0.025 [0.014]*		
Obese		–0.001 [0.015]		
Observations	6822	6822	6822	6822
R^2	0.22	0.22	0.22	0.22
Panel B: Women				
Height (cm)/10	0.015 [0.011]			0.015 [0.011]
BMI score/10			–0.004 [0.014]	–0.003 [0.014]
Underweight		0.001 [0.071]		
Overweight		–0.01 [0.017]		
Obese		0.025 [0.021]		
Observations	3357	3357	3357	3357
R^2	0.22	0.22	0.22	0.22
Panel C: Men				
Height (cm)/10	0.028 [0.011]**			0.029 [0.011]**
BMI score/10			0.008 [0.018]	0.012 [0.018]
Underweight		–0.175 [0.064]***		
Overweight		0.045 [0.021]**		
Obese		–0.023 [0.023]		
Observations	3465	3465	3465	3465
R^2	0.2	0.2	0.2	0.2

Note: Heteroskedasticity-robust standard errors, clustered at the person level, in brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 per cent levels, respectively. All estimates are population-weighted. All regressions control for age, age^2, indicator variables for whether the respondent was born overseas and whether the respondent is Indigenous, the ANU occupational status of the respondent's father at the time when he or she was aged 14, an indicator for whether the occupational status variable is missing, years of actual experience, and years of education. Panel A also includes an indicator variable for the respondent's gender.

added to the model (column 4). To put this into context, the average height of men in our sample is 178 cm (5 feet 10 inches). A male who is 183 cm (6 feet) tall is at the 75th percentile of the height distribution, and would be expected to earn a wage premium of 1.5 per cent. The average annual earnings of men in our sample is $63 200, so at the mean, another 5 cm of additional height is worth $948 per year.

For BMI categories (column 2), the effects are close to zero and mostly statistically insignificant. Pooling men and women, overweight workers earn 3 per cent more (only statistically significant at the 10 per cent level), whereas the coefficients on underweight and obese are insignificant in the persons specification. For women, the coefficients for overweight and obesity are close to zero and statistically insignificant. Surprisingly, we find that overweight men receive a wage premium of 5 per cent. (Below, we analyse the possibility that this may reflect socio-economic biases.) We also find that underweight men suffer an extremely large wage penalty (18 per cent). The underweight estimate, however, should be regarded with some caution, since only 22 of the 3465 male observations in our sample fall into the underweight category. Perhaps to the disappointment of Wallis Simpson,[7] we do not observe any significant impact of being underweight on the hourly wages of women.

In column 3 of Table 2, we allow BMI to enter linearly, and find that the coefficient on the BMI score is always statistically insignificant, and the point estimates are very close to zero. Importantly, the standard errors on our BMI score estimates are sufficiently small that we can reject (at the 95 per cent level) the hypothesis that a 10-point increase in BMI is associated with a wage rise of more than 4 per cent or a wage drop of more than 3 per cent. Graphical comparisons of a linear fit with a locally weighted regression (available upon request) show divergence only for very low or high BMI scores. Accordingly, we are inclined to prefer the null result from the linear BMI specification, and regard the statistically significant underweight and overweight coefficients for men in the BMI indicators specification (column 2) as potentially spurious.

Lastly, we also include both height and BMI score in the regression (column 4), and find that the coefficients are very similar to the specifications in which the two variables enter separately. Although the R^2 statistics are around 0.2, very little of this is due to the inclusion of height and BMI. In all specifications shown in Table 2, the partial R^2 on the body size variables is less than 0.01, indicating that body size can explain less than 1 per cent of the wage variation between adults of the same gender, age, and ethnicity.

As noted above, a number of previous studies that have looked at the relationship between hourly wages and BMI scores have found a statistically significant relationship for women (although the evidence for men is weaker and mixed). This raises the puzzle as to why there appears to be no association for men or women in Australia. One possibility is that there is no discrimination in the Australian labour market against overweight workers. Another possibility is that being overweight is so common that it has ceased to carry a wage penalty (this theory suggests that the wage penalty should also have attenuated in other countries). It is also conceivable that BMI is a less accurate measure of fatness in Australia than in other countries (on this point, see Burkhauser & Cawley, 2008), perhaps because Australians are more muscular than people from other countries.[8] A final possibility is that overweight Australian workers do suffer a wage penalty, but that this causal effect is cancelled out by high-wage workers also being more likely to become overweight (e.g. due to longer hours or because they eat richer foods). We address this possibility in Section IV below.

Much of the public health literature on body size has focused on the relationship between obesity and health risks. Being overweight or obese is a risk factor for many medical conditions, including Type 2 diabetes, hypertension, coronary heart disease, elevated cholesterol levels, depression, musculoskeletal disorders, gallbladder disease, and several cancers (Bray, 1992; Pi-Sunyer, 1996). It is therefore useful to consider the extent to which health status affects the relationship between body size and wages.

To measure health, we include four summary measures of physical health status derived from the self-reported SF-36 health survey (the physical functioning, role-physical, bodily pain, and general health indices). These regressions effectively allow us to ask the question: holding physical health constant, how much do height and BMI affect wages?

[7] Wallis Simpson, the Duchess of Windsor, famously noted that, 'A woman cannot be too rich or too thin.'

[8] We are grateful to John Cawley for this flattering suggestion.

TABLE 3
Wages and Body Size, Controlling for Health Status

	Dependent variable is log hourly wage			
	[1]	[2]	[3]	[4]
Panel A: Persons				
Height (cm)/10	0.023 [0.008]***			0.023 [0.008]***
BMI score/10			0.006 [0.011]	0.009 [0.011]
Underweight		–0.032 [0.059]		
Overweight		0.028 [0.013]**		
Obese		0.005 [0.016]		
Observations	6822	6822	6822	6822
R^2	0.23	0.23	0.22	0.23
Panel B: Women				
Height (cm)/10	0.016 [0.011]			0.016 [0.011]
BMI score/10			–0.001 [0.014]	0 [0.014]
Underweight		–0.001 [0.071]		
Overweight		–0.008 [0.017]		
Obese		0.03 [0.021]		
Observations	3357	3357	3357	3357
R^2	0.22	0.22	0.22	0.22
Panel C: Men				
Height (cm)/10	0.029 [0.011]**			0.030 [0.011]***
BMI score/10			0.014 [0.018]	0.018 [0.018]
Underweight		–0.183 [0.064]***		
Overweight		0.048 [0.020]**		
Obese		–0.018 [0.023]		
Observations	3465	3465	3465	3465
R^2	0.2	0.21	0.2	0.2

Note: Heteroskedasticity-robust standard errors, clustered at the person level, in brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 per cent levels, respectively. All estimates are population-weighted. All regressions control for age, age^2, indicator variables for whether the respondent was born overseas and whether the respondent is Indigenous, the ANU occupational status of the respondent's father at the time when he or she was aged 14, an indicator for whether the occupational status variable is missing, years of actual experience, and years of education. Panel A also includes an indicator variable for the respondent's gender. Physical health status is proxied by four SF-36 indices: physical functioning, role-physical, bodily pain, and general health.

Table 3 shows the results of this specification. In all specifications, the coefficients in Tables 2 and 3 are very similar, indicating that there is very little evidence that self-reported health affects the returns to height or weight. (Even the positive coefficient on overweight men and the negative coefficient on underweight men are of similar size in both tables.) Taken together, these results suggest that to the extent that body size is associated with wages, most of the effect is not occurring via the impact of body size on physical health (at least as measured by the self-reported health status data available to us). This leaves open the possibility that shorter workers are subject to labour market discrimination. Our findings, however, are also consistent with other hypotheses, such as the teen socialisation theory that Persico *et al*. (2004) proposed in the case of height and wages.[9]

IV Addressing Potential Endogeneity

To what extent should these associations be interpreted as the causal impact of height and BMI on wages? The two major concerns are: reverse causality (i.e. body size might itself be a

[9] Persico *et al*. (2004) found that an individual's height in his or her teen years essentially determines the returns to height. They observed that about half of the wage differential due to height was accounted for by participation in school-sponsored non-academic activities, such as sporting activities and other clubs.

Table 4
Sensitivity Test: Omitting Father's Occupational Status

	Dependent variable is log hourly wage		
	[1] With father's occupational status	[2] Without father's occupational status	[3] Ratio [2]/[1]
Height (cm)/10	0.022 [0.008]***	0.026 [0.008]***	1.2
BMI score/10	0.004 [0.011]	0.003 [0.011]	0.8
Observations	6822	6822	
R^2	0.22	0.22	

Note: Heteroskedasticity-robust standard errors, clustered at the person level, in brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 per cent levels, respectively. All estimates are population-weighted and include both males and females. All regressions control for respondent's gender, age, age^2, indicator variables for whether the respondent was born overseas and whether the respondent is Indigenous, years of actual experience, and years of education. Specification in column 1 also controls for the ANU occupational status of the respondent's father at the time when he or she was aged 14, and an indicator for whether the occupational status variable is missing (the results are identical to those shown in column 4 of Table 2).

function of wages) and bias from unobservables (i.e. both body size and wages are affected by some other factor, such as socio-economic status or genetic attributes). These issues are of more concern in the case of BMI than height, but could potentially apply to both variables.[10] As noted in the previous section, even though we find no significant relationship between BMI and wages, it is possible that this null result reflects offsetting effects, in which higher BMI scores reduce wages, but higher wages also increase BMI.

In this article, we address endogeneity concerns in three ways. Our first approach – which is primarily relevant for understanding the causal impact of height on wages – focuses on the concern that unobservable factors may be affecting both body size and wages. One way of gauging how large such unobservables would have to be is to see the impact on the body size coefficients of omitting the observable control for family background: the father's occupational status.[11] Table 4 re-estimates the regressions without this control. When father's occupational status is omitted, the height coefficient increases by 20 per cent, whereas the weight coefficient drops by 20 per cent. This implies that adding father's occupational status to the regression reduces the impact of height on wages by one-fifth. Assuming that the omitted unobservables are uncorrelated with father's occupational status, this analysis suggests that they would need to have an impact five times larger than father's occupational status in order for them to entirely account for the observed association between height and wages.

Our second strategy for addressing endogeneity – which is relevant to understanding the impact of BMI on wages – is to instrument the respondent's BMI with the average BMI of their biological family members. This approach, which is similar to the use of sibling BMI by Cawley (2004), has previously been implemented by Atella *et al.* (2008) and Brunello & D'Hombres (2007). Its purpose is to allow us to identify a source of variation in BMI that is primarily due to an individual's genetic propensity to become overweight. To the extent that biological family members share some of the respondent's genes, the BMI of biological family members provides a proxy for the genetic component of BMI.

[10] In particular, reverse causality is unlikely in the case of height, which is fixed from an early age. According to Roche and Davila (1972), the median age at which growth in stature ceases is 21 for men and 17 for women. From ages 18–21, the median height increase in males is just 1 cm. Because most adults have stopped growing in height at a time when they have little or no labour market experience, it is improbable that wages have an impact on height. (From age 40 onwards, individuals tend to shrink in height very slightly, but we know of no evidence that this is related to wages.)

[11] The idea that the amount of selection on the observed variables provides a guide to the amount of selection on the unobservables is formalised in Altonji *et al.* (2005). We do not apply their approach here, due to the non-binary nature of the selection problem.

TABLE 5
Instrumental Variable Results

	Dependent variable is log hourly wage		
	[1] OLS – full sample	[2] OLS – restricted sample	[3] IV
Panel A: Persons			
BMI score/10	0.001 [0.011]	0.003 [0.019]	–0.052 [0.070]
Observations	6822	1996	1996
R^2 (centred R^2 in IV specification)	0.22	0.24	0.23
F-statistic on excluded instrument			57.36 (P < 0.01)
Panel B: Women			
BMI score/10	–0.004 [0.014]	–0.009 [0.023]	0.024 [0.073]
Observations	3357	1115	1115
R^2 (centred R^2 in IV specification)	0.22	0.24	0.24
F-statistic on excluded instrument			42.90 (P < 0.01)
Panel C: Men			
BMI score/10	0.008 [0.018]	0.030 [0.032]	–0.184 [0.152]
Observations	3465	881	881
R^2 (centred R^2 in IV specification)	0.20	0.22	0.17
F-statistic on excluded instrument			15.08 (P < 0.01)

Note: Heteroskedasticity-robust standard errors, clustered at the person level, in brackets. ***, **, and * denote statistical significance at the 1, 5, and 10 per cent levels, respectively. All estimates are population-weighted and include both males and females. All regressions control for respondent's gender, age, age^2, indicator variables for whether the respondent was born overseas and whether the respondent is Indigenous, the ANU occupational status of the respondent's father at the time when he or she was aged 14, an indicator for whether the occupational status variable is missing, years of actual experience, and years of education. Specifications in column 1 are the same as those in column 3 of Table 2. In column 3, respondent BMI is instrumented using the average BMI of biological family members who resided with the respondent in one or more waves of the HILDA survey.

If the results in Tables 2 and 3 reflect the offsetting impacts of BMI on wages and vice versa, then using plausibly exogenous variation in BMI should provide an unbiased (or at least less biased) estimate of the impact of BMI on wages.

A good instrument should be correlated with the endogenous variable of interest (in this case, BMI), but uncorrelated with any other determinant of the dependent variable (in this case, wages). The latter condition is known as the exclusion restriction. One can imagine instances in which our instrument would fail to satisfy the exclusion restriction. For example, the HILDA survey does not contain a measure of ability. If ability is genetic, and if ability causes people to have higher wages and lower BMI scores, then the BMI of biological family members will not satisfy the exclusion restriction.[12] However, other instruments for BMI also have their limitations. For example, child BMI will fail the exclusion restriction if low wages cause parents to feed their children fattier foods; family structure will fail the exclusion restriction if birth order and sibling gender have a direct impact on life outcomes; genetic markers will fail the exclusion restriction if they are correlated with genes that influence wages; and regional food prices may fail the exclusion restriction if they are driven by demand rather than supply. (Below, we compare the OLS and IV estimates obtained using these various approaches.)

Table 5 shows the results from our IV strategy. Since the BMI of biological family members is only available for about one-quarter of respondents, we first estimate the OLS specification on this sub-sample (column 2) and compare it with the results for the full sample (column 1, which is the same as the results in column 3 of Table 2). The BMI coefficient is quite similar in both specifications. We then run an IV regression, using the average BMI of biological family members as the instrument. Although the F-statistic on the excluded instrument is high, the BMI results remain statistically insignificant for women, men, and in

[12] Previous researchers have sought to test this hypothesis in various ways. For example, Cawley (2004) found reassuringly little correlation of sibling BMI with ability-related outcomes such as years of education and IQ, whereas Lindeboom *et al*. (2009) observed a lower correlation between parent obesity and child obesity among adopted children (suggesting that the channel is mostly genetic rather than environmental).

the pooled specification. This result suggests that even the component of BMI variation which is most likely to come from genes does not have a significant impact on wages.

A drawback of IV approaches for dealing with endogeneity is that they are most useful for analysing the relationship between continuous BMI score and wages, and are less well-suited to estimating the effect of BMI indicators (underweight, normal weight, overweight, and obese).[13] This leaves open the question of how we should interpret the significant coefficients on underweight and overweight for men. As noted above, graphical comparisons suggest that the relationship between BMI and wages for men is approximately linear across most of the data. Accordingly, our inclination is to place more weight on the null result from the BMI score regression than on the regression using BMI indicators.

A third way of addressing endogeneity concerns – which is relevant to understanding the impact of BMI on wages – is to review what is known about the extent of OLS bias in other IV studies. If our failure to find a relationship between BMI score and wages is due to offsetting biases, then this may manifest itself in a systematic relationship between OLS and IV coefficients in previous studies.

Table 6 sets out 28 point estimates from nine articles (including the present study) that have used instrumental variables to test the impact of BMI on wages or earnings. For each of these studies, we can observe the degree of bias in the OLS estimate by observing the ratio and difference of the BMI coefficients in the OLS and IV specifications. Of the 28 point estimates, 4 of the OLS estimates are smaller than their comparable IV estimates, whereas 24 are larger. The disparities between the estimates are sometimes very large, with the IV estimate occasionally being of a different sign, and sometimes an order of magnitude larger or smaller.

As well as the biases having little systematic pattern, the IV estimates also tend to have much larger standard errors than the OLS estimates. Discussing this issue, Cawley (2004; 465–468) concludes: 'A Hausman test indicates that the hypothesis that OLS and IV coefficients are equal cannot be rejected for any of the six race-gender groups. In other words, any endogeneity of weight does not appreciably affect the OLS estimates and OLS should be preferred to IV since OLS results in lower standard errors.' When we tabulate the results from Cawley (2004) and eight subsequent IV studies of BMI and wages, his conclusion seems to have stood up well. In our view, the preferred estimates from our article should be the OLS estimates, whose standard errors are considerably tighter than the IV estimates. As in the case of estimating the wage returns to schooling, it appears that the 'naïve' OLS estimate is quite close to the truth.[14]

V Conclusion

To answer the question posed by our title, body size does indeed seem to matter in the Australian labour market. We find that taller workers earn significant wage premiums, with the results being strongest for men. However, we find no significant relationship between BMI score and wages. Our results are very similar when controlling for a detailed set of self-reported physical health measures.

The height premium we observe in Australia is smaller than in the USA and the UK. For women, we estimate that another 10 cm of height is associated with a 2 per cent increase in hourly wages. This is approximately equivalent to the wage returns from an additional third of a year of education, or another 4 years of labour market experience.[15] By contrast, Case & Paxson (2008) find that women in the UK and the USA gain a wage premium of 5–8 per cent for each additional 10 cm of height. For men, we estimate that another 10 cm of height is associated with a 3 per cent increase in hourly wages (equivalent to half a year of education or 2 years of experience). By contrast, Case & Paxson (2008) estimate that UK and US men who are 10 cm taller receive a 4–10 per cent hourly wage premium (see also Persico *et al.*, 2004, who find similar results for white men in the UK and the USA).

[13] With a single instrument, we can only focus on one endogenous variable at a time. Thus while we could in theory use the BMI of biological family members to instrument for one of the four BMI categories, such an approach would require us to assume that the other three BMI categories were exogenously determined. (This critique also applies to the approach in Lundborg *et al.*, 2007; Atella *et al.*, 2008; Lindeboom *et al.*, 2009.)

[14] For surveys of the literature on IV and OLS returns to schooling, see e.g. Ashenfelter *et al.* (1999); Card (1999); Krueger and Lindahl (2001).

[15] In the specifications shown in Table 2, column 4, we estimate that an additional year of education raises hourly wages by 7.3 per cent for women and 8.2 per cent for men, while an additional year of experience raises hourly wages by 0.6 per cent for women and 1.6 per cent for men.

TABLE 6
Estimating OLS Bias from Various IV Studies of BMI and Wages

Each coefficient is from a separate regression of log wages/earnings on BMI divided by 10 (or a dummy for overweight/obese if indicated)

Study	β OLS	β IV	OLS Bias: β (IV) / β (OLS)	OLS Bias: β (IV) – β (OLS)	Is OLS < IV?
Atella *et al*. (2008)					
Instrument: Average BMI of biological family members					
European women – obese	–0.050***	–0.065*	1.300	–0.015	No
European women – overweight	–0.030***	–0.186*	6.200	–0.156	No
European men – obese	0.000	–0.337**	N/A	–0.337	No
European men – overweight	0.020***	–0.061	–3.050	–0.081	No
Brunello & D'Hombres (2007)					
Instrument: Average BMI of biological family members					
European women	–0.03***	–0.08**	2.667	–0.050	No
European men	0.04***	–0.13***	–3.250	–0.170	No
Cawley (2004)					
Instrument: Sibling BMI					
US white women	–0.100***	–0.170***	1.700	–0.070	No
US white men	–0.010	–0.130	13.000	–0.120	No
US black women	–0.030**	–0.020	0.667	0.010	Yes
US black men	0.060**	–0.030	–0.500	–0.090	No
US Hispanic women	–0.060**	–0.120	2.000	–0.060	No
US Hispanic men	–0.060**	–0.090	1.500	–0.030	No
Cawley *et al*. (2005)					
Instrument: Parents' and children's BMI					
US women	–0.118***	–0.802***	6.797	–0.684	No
US men	0.081***	0.310	3.827	0.229	Yes
Instrument: Parents' BMI					
German women	–0.133***	–0.022	0.165	0.111	Yes
German men	–0.033	–0.119	3.606	–0.086	No
Kortt & Leigh (this study)					
Instrument: Average BMI of biological family members					
Australian women	–0.004	0.024	–6.000	0.028	Yes
Australian men	0.008	–0.184	–23.000	–0.192	No
Lindeboom *et al*. (2009)					
Instrument: Parents' obesity status					
UK women – obese	0.006	–0.046	–7.667	–0.052	No
UK men – obese	0.019	–0.309	–16.263	–0.328	No
Lundborg *et al.* (2007)					
Instrument: Whether or not the respondent had only sisters					
European women – obese	–0.090**	–0.120	1.333	–0.030	No
Instrument: Whether or not the respondent was an only child					
European men – obese	–0.020	–0.860	43.000	–0.840	No
Norton & Han (2008)					
Instruments: Sibling BMI and genetic markers					
US women	0.046	–0.050	–1.087	–0.096	No
US men	0.012	0.001	0.083	–0.011	No

Table 6
(*Continued*)

Each coefficient is from a separate regression of log wages/earnings on BMI divided by 10 (or a dummy for overweight/obese if indicated)

Study	β OLS	β IV	OLS Bias: β (IV) / β (OLS)	OLS Bias: β (IV) – β (OLS)	Is OLS < IV?
Shimokawa (2008)					
Instrument: Food prices					
Chinese women	–0.028	–0.805	28.750	–0.777	No
Chinese men	0.007	–0.016	–2.286	–0.023	No
Instrument: Children's weight					
Chinese women	–0.038	–0.163	4.289	–0.125	No
Chinese men	0.032	–0.869*	–27.156	–0.901	No
Mean (excluding overweight/obese)	–0.018	–0.173	0.289	–0.155	
Median (excluding overweight/obese)	–0.019	–0.105	1.084	–0.078	
		Number of studies in which OLS < IV:			4
		Number of studies in which OLS > IV:			24

Note: BMI coefficients reported in this table represent the coefficient on BMI/10 (i.e. the marginal effect on log wages of a 10-point increase in BMI), whereas coefficients for Atella *et al*. (2008), Lindeboom *et al*. (2009), and Lundborg *et al*. (2007) represent the effect on log wages of being overweight/obese. Mean and median estimates are unweighted, and only use the 20 BMI coefficients, not the 8 overweight/obese coefficients. The above numbers can be found in the following tables: Atella *et al*. (2008), Tables 2, 3, and 9; Brunello & D'Hombres (2007), Table 3 and A2; Cawley (2004), Tables 5 and 6; Cawley *et al*. (2005), Table 2; Kortt & Leigh (this study), Table 5; Lindeboom *et al*. (2009), Tables 2 and 5 (respondents aged 42); Lundborg *et al*. (2007), Tables 9 and 10; Norton & Han (2008), Tables V and VI; Shimokawa (2008), Tables 4 and 5.

Our finding that higher BMI scores are not systematically related to lower wages is at odds with the results for most other countries. For men, women, and in a pooled specification, a 10-point increase in BMI is always associated with less than a 1 per cent change in hourly wages, and the coefficient is never statistically significant. In an OLS specification, pooling men and women, we can reject (at the 95 per cent level) the hypothesis that a 10-point increase in BMI is associated with a wage change larger than ±2 per cent. By contrast, Cawley (2004) finds that among white men and women in the USA in 1981–2000, a 10-point increase in BMI is associated with a 1–10 per cent wage penalty in the OLS specification, and a 13–17 per cent wage penalty in the IV specification. For German respondents observed in 2002, Cawley *et al*. (2005) estimate that a 10-point increase in BMI is associated with a 3–13 per cent wage penalty in the OLS specification, and a 2–12 per cent wage penalty in the IV specification.[16]

We account for potential endogeneity in three ways. The first strategy is primarily aimed at the observed relationship between height and wages. Here, we explore the impact on our results of dropping a key observable variable – father's occupational status. Under the assumption that the unobservables are not correlated with this variable, this exercise provides some sense of how large the unobservables bias would have to be in order to entirely account for our observed effects. This suggests that unobservables would have to have about five times as large an effect on the height coefficient as father's occupational status in order for the unobservables bias to fully explain the association between height and wages.

The second and third endogeneity exercises are focused on better understanding the absence of a relationship between BMI and wages. We instrument the respondent's BMI with the BMI of their biological family members as a way of identifying that portion of BMI variation that is driven by genetics. As in the OLS specification, we find coefficients on BMI that are insignificant and mostly close to zero. We then analyse nine IV studies (including the present study) of BMI and wages and find considerable variation in the difference between comparable OLS and IV estimates. Assuming that these results can be applied to

[16] We regard Cawley (2004) as the leading study of BMI and wages for the USA, and Cawley *et al*. (2005) as the leading study of BMI and wages for Germany. However, a few other estimates have found a *positive* association between BMI and wages (see Table 6).

modern-day Australia, they suggest that our null result for BMI is unlikely to be driven by offsetting effects. This provides us with further reassurance that while there are wage returns to height in Australia, there are no systematic wage penalties to having a higher BMI.

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