BMI, Height and the Transition to Adulthood

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Background

- Widespread evidence of a connection between height, BMI and socio-economic success. See Tyrrell *et al.*, *British Medical Journal, 2016* A study of 119669 people using the Biobank.

- Looked at white British people aged 40-69. Used genetic information finding a connection between genetically induced height, earnings and education for men, and an adverse relationship between genetically induced BMI and household earnings for women.

- Wotton *et al.*, *British Medical Journal, 2018* found a causal connection between BMI and subjective satisfaction with health, but not with satisfaction with other aspects of life. Effect present in both men and women.

- A range of international studies has shown similar effects without using the presence of genes as instruments. For example Magnusson *et al.* *International Journal of Epidemiology* found height predicted subsequent educational attainment of Swedish men.

This study

- Explore relationship between height and BMI observed as teenagers and subsequent experience as young adults.
- Focus on health, mental state, qualifications and income.
- Look for statistical relationships controlling for family background- (social class and household income of household at age 16-18)

Understanding Society: the Data Source

- A panel survey of 50,000 people which started in 2010, building on the much smaller British Household Panel Survey. The sample had decayed to 42,000 in wave 7. Self-reported data on height and BMI are collected in the first wave.
- Some recent studies have looked at the component of BMI or height influenced by genes. But these explain only a small proportion (c. 2%) of the variation in these characteristics, and do not say anything about the effects of the other components of BMI/height.
- This study focuses on association for the population of interest.
- Of course the relationship between BMI/height and health and income may be different at different stages in life.

16-18 Years Old in Wave 1 of Understanding Society

All Records

Age	Male	Female	Total
16	462	475	937
17	411	453	864
18	361	426	787
Total	1234	1354	2588

With Height and BMI Data

Age	Male	Female	Total
16	325	358	683
17	303	335	638
18	255	312	567
Total	883	1005	1888

Very substantial attrition. Only 30% of the sample remains seven years later.

Age	Male	Female	Total
21	3	11	14
22	92	112	204
23	97	104	201
24	68	78	146
25	10	12	22
Total	270	317	587

The survey as a whole includes 1785 people aged 22-24.

The Distribution of Relative Height
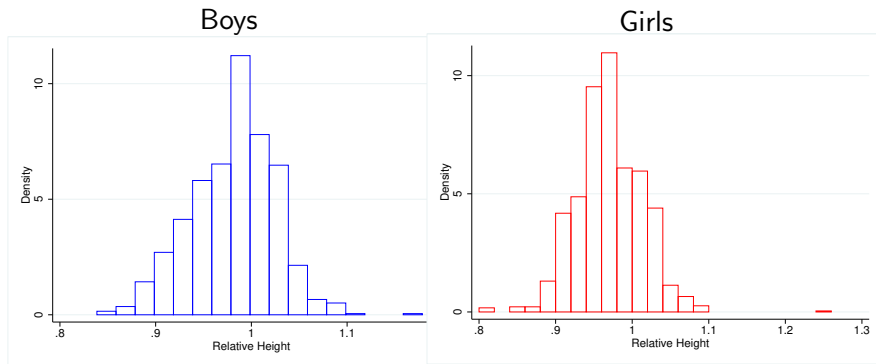
Source: ONS data.

Height is measured relative to average height as a function of age as reported on *onaverage.co.uk*

The Distribution of Body Mass Index

Source: ONS data winsorized at BMI of 15 and 35
Mean: 22 for boys and 21.8 for girls
For people aged 45-54 the mean is 27.2 for men and 26.3 for women
(2010 data)

Determinants of Children's Height

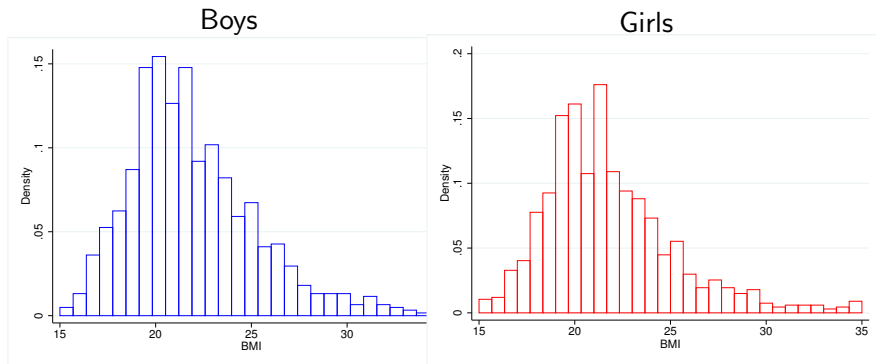|	Men	Women	Men	Women
Average Parents' Relative Height	0.478***	0.514***	0.475***	0.512***
	(13.60)	(14.48)	(13.40)	(14.27)
Log Household Income	0.004**	0.001	0.003	-0.000
	(2.02)	(0.32)	(1.06)	(-0.17)
Professional			0.005	0.009
			(0.67)	(1.24)
Managerial and Technical			0.005	0.001
			(0.94)	(0.14)
Skilled Non-Manual			0.006	-0.001
			(1.21)	(-0.17)
Partly Skilled			0.004	-0.013**
			(0.65)	(-2.13)
Other			0.001	0.000
			(0.21)	(0.01)
Constant	0.474***	0.452***	0.484***	0.462***
	(12.96)	(12.45)	(12.32)	(11.83)
Observations	784	876	784	876
Adjusted R^2	0.202	0.197	0.198	0.202

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Galton (1886, *Journal of the Anthropological Institute*) reported 2/3

Determinants of Children's Body Mass Index

	(1) Men	(2) Women	(3) Men	(4) Women
Average Parents' Relative Height	3.990	2.026	4.369	2.601
	(1.28)	(0.64)	(1.39)	(0.81)
Average Parents' BMI	0.253***	0.192***	0.250***	0.193***
	(8.30)	(6.63)	(8.15)	(6.60)
Log Household Income	-0.426**	-0.325*	-0.321	-0.255
	(-2.43)	(-1.93)	(-1.44)	(-1.25)
Professional			0.134	-0.178
			(0.21)	(-0.27)
Managerial and Technical			-0.191	-0.238
			(-0.42)	(-0.56)
Skilled Non-Manual			0.184	-0.505
			(0.41)	(-1.15)
Partly Skilled			0.439	-0.272
			(0.86)	(-0.51)
Other			0.185	0.070
			(0.39)	(0.15)
Constant	14.614***	17.236***	13.411***	16.301***
	(4.30)	(5.17)	(3.72)	(4.54)
Observations	759	848	759	848
Adjusted R^2	0.089	0.049	0.086	0.046

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Likelihood of Staying on in Education age 16-18 (1=Very Likely, ...4=Not At All Likely)

	(1) Male	(2) Female	(3) Both
Body Mass Index	0.065**	-0.012	0.029
	(2.04)	(-0.34)	(1.25)
Relative Height	-2.982	-5.085*	-3.603**
	(-1.22)	(-1.91)	(-2.04)
Log Household Income	-0.486**	0.105	-0.163
	(-2.47)	(0.60)	(-1.29)
Professional	-0.127	-1.288*	-0.584
	(-0.24)	(-1.83)	(-1.46)
Managerial and Technical	-0.295	-0.754*	-0.525*
	(-0.75)	(-1.89)	(-1.91)
Skilled Non-Manual	-0.534	-0.626	-0.574*
	(-1.27)	(-1.44)	(-1.92)
Partly Skilled	-0.408	0.205	-0.055
	(-0.88)	(0.46)	(-0.17)
Other	-1.011**	0.204	-0.411
	(-2.45)	(0.49)	(-1.42)
Sex: Men=1, Women=2			-0.620**
			(-4.00)
Observations	404	466	870

t statistics in parentheses

$*$ $p < 0.10$, $**$ $p < 0.05$

Data on Self-reported Health: Age 21-25

Table: Mean BMI and Cell Counts

	Male	Female	Male	Female
Excellent	21.20	21.14	72	58
	(0.31)	(0.31)		
Very good	21.73	22.11	113	156
	(0.29)	(0.28)		
Good	22.93	22.17	68	73
	(0.50)	(0.42)		
Fair	22.81	20.33	16	20
	(1.40)	(0.66)		
Poor	26.60	22.32	1	10
		(1.68)		

Physical Characteristics and Health: Aged 21-25 (1=Excellent..5=Poor)

	Men	Women	Both
Body Mass Index	0.096***	0.028	0.061***
	(2.88)	(0.91)	(2.69)
Relative Height	0.998	1.349	2.108
	(0.37)	(0.56)	(1.20)
Log Household Income	0.070	0.051	0.052
	(0.35)	(0.30)	(0.41)
Age	0.056	-0.207*	0.019
	(1.10)	(-1.81)	(0.42)
Professional	-1.768***	-0.957	-1.423***
	(-2.87)	(-1.54)	(-3.33)
Managerial and Technical	-0.826**	-0.621	-0.765**
	(-2.02)	(-1.37)	(-2.54)
Skilled Non-Manual	-0.354	-0.269	-0.328
	(-0.85)	(-0.58)	(-1.06)
Partly Skilled	-0.368	-0.180	-0.285
	(-0.76)	(-0.34)	(-0.80)
Other	-0.273	0.080	-0.136
	(-0.63)	(0.17)	(-0.43)
Sex: Men=1, Female=2			0.312**
			(2.00)
Observations	271	319	590

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Indicators of Mental State at age 21-25

1. Feeling Optimistic about the Future
2. Feeling Useful
3. Feeling Relaxed
4. Dealing with Problems Well
5. Thinking Clearly
6. Feeling Close to Others
7. Able to Make Up Own Mind
8. Caseness

These are quite strongly correlated but have differing relationships with BMI and average height. Here two examples with 5% significance and one with no significance are presented. Then there is a summary of the findings for all eight items.

Optimistic: Aged 21-25 (1=None of the Time..5=All the Time)

	Men	Women	Both
Feeling optimistic about the future			
Body Mass Index	-0.058*	0.010	-0.019
	(-1.75)	(0.32)	(-0.85)
Sex: Male=1, Female=2			-0.193
			(-1.24)
Relative Height	6.964**	2.437	4.295**
	(2.55)	(1.01)	(2.47)
Log Household Income	0.074	-0.118	-0.025
	(0.37)	(-0.70)	(-0.20)
Age	-0.046	0.158	0.050
	(-0.37)	(1.39)	(0.60)
Professional	0.677	0.686	0.704*
	(1.19)	(1.16)	(1.74)
Managerial and Technical	-0.033	0.349	0.170
	(-0.08)	(0.97)	(0.63)
Skilled Non-Manual	-0.056	0.257	0.058
	(-0.14)	(0.73)	(0.22)
Partly Skilled	0.177	-0.995**	-0.377
	(0.39)	(-2.34)	(-1.21)
Unskilled	-0.146	0.028	-0.103
	(-0.34)	(0.06)	(-0.33)
Observations	271	318	589

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Relaxed: Aged 21-25 (1=None of the Time..5=All the Time)

	Men	Women	Both
Body Mass Index	-0.089**	-0.033	-0.061***
	(-2.56)	(-1.04)	(-2.66)
Sex: Men=1, Women=2	0.000	0.000	-0.499***
	(.)	(.)	(-3.19)
Relative Height	1.344	3.978	2.389
	(0.50)	(1.61)	(1.35)
Log Household Income	0.103	0.129	0.103
	(0.51)	(0.77)	(0.81)
Age	0.100	0.254**	0.133**
	(1.63)	(2.25)	(2.19)
Professional	0.880	0.417	0.701*
	(1.53)	(0.70)	(1.70)
Managerial and Technical	0.204	-0.237	-0.039
	(0.50)	(-0.65)	(-0.14)
Skilled Non-Manual	-0.353	-0.440	-0.425
	(-0.87)	(-1.22)	(-1.59)
Partly Skilled	0.375	-0.115	0.089
	(0.81)	(-0.26)	(0.28)
Unskilled	-0.204	-0.019	-0.179
	(-0.46)	(-0.04)	(-0.57)
Observations	271	318	589

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

General Wellbeing (Caseness): Aged 21-25 (0 High ..12 Low)

	Men	Women	Both
Body Mass Index	0.020	0.001	0.013
	(0.57)	(0.04)	(0.56)
Sex: Men=1, Women=2			0.250
			(1.58)
Relative Height	-1.712	-3.563	-2.666
	(-0.61)	(-1.43)	(-1.48)
Log Household Income	-0.263	-0.048	-0.126
	(-1.27)	(-0.28)	(-0.96)
Age	-0.166	-0.245**	-0.193**
	(-1.29)	(-2.12)	(-2.24)
Professional	0.251	0.123	0.155
	(0.43)	(0.21)	(0.38)
Managerial and Technical	0.070	0.187	0.159
	(0.16)	(0.49)	(0.56)
Skilled Non-Manual	0.344	0.049	0.200
	(0.83)	(0.13)	(0.74)
Partly Skilled	0.132	-0.028	0.077
	(0.27)	(-0.06)	(0.24)
Unskilled	0.780*	-0.182	0.410
	(1.74)	(-0.38)	(1.28)
Observations	270	317	587

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Indicators of Mental State

- For items 1 to 4 BMI is significant for men at 5% or 10% level. For items 5-7 P-values are much lower.
- For women significance levels are always higher than 5%. Height is significant at 10% for 2, 4, 5. BMI is not significant even at 10%.
- Neither BMI nor relative height is significantly related to caseness

Qualification: Aged 21-25 (Higher Degree=1,.. Other Certificate=13)

	Men	Women	Both
Body Mass Index	0.050*	0.072**	0.061***
	(1.65)	(2.34)	(2.86)
Sex: Men=1, Women=2			-0.142
			(-0.94)
Relative Height	-1.131	-3.776	-2.423
	(-0.45)	(-1.59)	(-1.44)
Log Household Income	-0.397**	-0.239	-0.304**
	(-2.03)	(-1.33)	(-2.33)
Age	-0.112	-0.261**	-0.164**
	(-1.57)	(-2.32)	(-2.21)
Professional	-0.805	-0.690	-0.806**
	(-1.54)	(-1.19)	(-2.09)
Managerial and Technical	-0.239	-0.848**	-0.550**
	(-0.63)	(-2.36)	(-2.14)
Skilled Non-Manual	0.054	-0.264	-0.105
	(0.14)	(-0.76)	(-0.42)
Partly Skilled	-0.209	0.296	0.056
	(-0.49)	(0.70)	(0.19)
Unskilled	0.401	0.480	0.432
	(0.97)	(1.04)	(1.43)
Observations	271	318	589

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Degree: Aged 21-25 (HE Qualification)

	Men	Women	Both
Body Mass Index	-0.057	-0.061*	-0.060**
	(-1.43)	(-1.68)	(-2.26)
Sex: Men=1, Female=2			0.282
			(1.60)
Relative Height	3.230	3.987	3.366*
	(1.02)	(1.46)	(1.67)
Log Household Income	0.279	0.166	0.207
	(1.18)	(0.83)	(1.37)
Age	0.100	0.262**	0.145*
	(1.38)	(2.03)	(1.81)
Professional	1.121*	0.247	0.685
	(1.70)	(0.38)	(1.50)
Managerial and Technical	0.700	0.673	0.657**
	(1.50)	(1.63)	(2.15)
Skilled Non-Manual	0.458	0.166	0.267
	(0.98)	(0.41)	(0.88)
Partly Skilled	0.129	-0.173	-0.070
	(0.23)	(-0.34)	(-0.19)
Unskilled	-0.135	-0.280	-0.256
	(-0.25)	(-0.52)	(-0.68)
Constant	-7.456*	-10.432**	-8.125***
	(-1.88)	(-2.25)	(-2.60)
Observations	271	318	589
χ^2_2	2.8	5.6	7.9

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Qualifications: Teenage Health or Teenage BMI?

	(1) Highest educational qualification	(2) Highest educational qualification	(3) Highest educational qualification
Body Mass Index	0.060*	0.049	0.052**
	(1.85)	(1.56)	(2.33)
Relative Height	-0.639	-3.385	-2.590
	(-0.25)	(-1.41)	(-1.52)
Age	-0.550***	-0.274**	-0.380***
	(-4.19)	(-2.43)	(-4.52)
Log Household Income	-0.346*	-0.300	-0.295**
	(-1.76)	(-1.62)	(-2.24)
Hlth age 16-18: Excellent	-0.452	-1.718***	-0.781
	(-0.31)	(-4.00)	(-0.54)
Hlth age 16-18: Very Good	-0.345	-1.123***	-0.464
	(-0.24)	(-2.85)	(-0.32)
Hlth age 16-18: Good	0.091	-0.594	-0.014
	(0.06)	(-1.48)	(-0.01)
Hlth age 16-18: Fair	-0.186	0.000	0.266
	(-0.12)	(.)	(0.18)
Sex: Male=1, Female=2			-0.201
			(-1.31)
Observations	270	317	587

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Social Class Dummies are also included.

Working at least 20 Hours a Week

	Male	Female	Both
Body Mass Index	0.017	-0.030	-0.001
	(0.72)	(-1.37)	(-0.09)
Sex: Male=1, Female=2			-0.127
			(-1.18)
Relative Height	3.996**	-2.304	0.628
	(2.14)	(-1.43)	(0.52)
Log Household Income	-0.098	0.202*	0.115
	(-0.73)	(1.68)	(1.29)
Professional	0.553	-0.140	0.138
	(1.40)	(-0.35)	(0.50)
Managerial and Technical	0.377	0.210	0.245
	(1.39)	(0.84)	(1.35)
Skilled Non-Manual	0.785***	0.443*	0.612***
	(2.85)	(1.79)	(3.34)
Partly Skilled	0.452	-0.050	0.288
	(1.46)	(-0.17)	(1.35)
Unskilled	0.256	0.167	0.216
	(0.89)	(0.53)	(1.02)
Observations	270	318	588
ρ	-0.855***	0.005	0.016

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Log Weekly Income (Working at least 20 Hours/week)

	Male	Female	Both
Body Mass Index	-0.008	-0.016	-0.008
	(-0.77)	(-1.52)	(-1.16)
Sex: Male=1, Female=2			-0.079
			(-1.62)
Relative Height	0.477	0.010	0.858*
	(0.50)	(0.01)	(1.66)
Log Household Income	0.064	0.057	0.069*
	(0.95)	(0.96)	(1.69)
Professional	-0.041	0.283	0.155
	(-0.21)	(1.45)	(1.20)
Managerial and Technical	0.163	0.209*	0.208**
	(1.14)	(1.78)	(2.32)
Skilled Non-Manual	-0.028	0.167	0.168
	(-0.20)	(1.36)	(1.58)
Partly Skilled	0.010	-0.051	0.078
	(0.06)	(-0.37)	(0.75)
Unskilled	0.023	0.061	0.078
	(0.14)	(0.41)	(0.75)
Observations	270	318	588

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Current Financial Sitn 1=Comfortable.. 5=V. Difficult

	Men	Women	Both
Body Mass Index	0.010	0.009	0.004
	(0.29)	(0.29)	(0.18)
Sex: Male=1, Female=2	0.000	0.000	0.074
	(.)	(.)	(0.48)
Relative Height	-8.504***	2.459	-1.777
	(-3.01)	(1.05)	(-1.02)
Log Household Income	-0.181	-0.439**	-0.323**
	(-0.92)	(-2.42)	(-2.45)
Age	0.110	-0.073	-0.025
	(0.85)	(-0.65)	(-0.30)
Professional	-1.449**	-0.130	-0.720*
	(-2.45)	(-0.22)	(-1.74)
Managerial and Technical	-1.135***	-0.303	-0.686**
	(-2.86)	(-0.82)	(-2.55)
Skilled Non-Manual	-1.215***	-0.387	-0.717***
	(-3.02)	(-1.07)	(-2.70)
Partly Skilled	0.158	0.583	0.317
	(0.36)	(1.38)	(1.05)
Unskilled	0.310	0.430	0.435
	(0.69)	(0.86)	(1.33)
Observations	270	317	587

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Feeling Unsafe (14/270 Men; 35/317 Women

	Men	Women	Both
Body Mass Index	0.083	-0.122*	-0.049
	(1.16)	(-1.86)	(-1.02)
Sex: Male=1, Female=2	0.000	0.000	0.767**
	(.)	(.)	(2.30)
Relative Height	-7.690	-0.043	-1.472
	(-1.18)	(-0.01)	(-0.43)
Log Household Income	-0.259	-0.176	-0.197
	(-0.58)	(-0.60)	(-0.82)
Age	-0.220	-0.125	-0.152
	(-0.66)	(-0.63)	(-0.90)
Professional	0.000	-0.829	-1.365
	(.)	(-0.72)	(-1.25)
Managerial and Technical	-0.664	-0.722	-0.770
	(-0.79)	(-1.17)	(-1.55)
Skilled Non-Manual	-0.959	-0.149	-0.366
	(-1.04)	(-0.27)	(-0.80)
Partly Skilled	-1.102	-0.923	-1.022
	(-0.95)	(-1.11)	(-1.52)
Unskilled	-0.522	-0.264	-0.401
	(-0.58)	(-0.36)	(-0.71)
Observations	254	317	587

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Summary of Findings (D=Declining, I=Increasing)

| | Men | | Women | | Both | |
	BMI	Height	BMI	Height	BMI	Height
Staying on in Ed	D					
Health 21-25	D				D	
Caseness						
Optimistic 21-25	D	I				I
Relaxed 21-25	D				D	
Qualification	D		D		D	
Degree			D		D	I
Working 20hrs		I				
Income						I
Financial Situation		I				
Feeling Unsafe			D			

Conclusions I

- For young men a clear link between BMI at 16-18 and subsequent health and mental state. A number of studies have suggested that stress may lead to higher BMI (Pyko *et al.*, 2015 *Occupational and Environmental Medicine*.

- Huang *et al.*, 2018 *International Journal of Obesity* find a relationship between high No_2 in childhood and higher BMI among teenage boys. But high SO_2 is associated with lower BMI. Frondelius *et al.*, 2018, *Environemntal Research and Public Health* found no connection between childhood obesity and prenatal exposure to NO and NO_2.

- Also a connection with qualification. Further work is needed to establish whether this is intermediated through health.

- Tall men are more likely to be working and also to see their financial situation more favourably. But this does not show up in their income conditional on working at least twenty hours/week

Conclusions II

- For women no obvious link with health as a young adult.
- A connection with qualifications and specifically the probability of having a degree
- And women with a high BMI are more likely to feel unsafe.

Conclusions III

- When the sexes are pooled a connection between BMI and health and qualifications shows through.
- Taller people are more likely to be optimistic, and to have a degree
- In the pooled data set there is a connection with income conditional on working at least twenty hours.