Body-weight and psychological well-being in the UK general population

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Abstract

Background: While the consequences of body weight for physical health are well explored, the evidence for psychological well-being is less straightforward. An instrumental variable approach is used to address the endogenous relationship between body weight and well-being in the UK general population.

Methods: Data from the Health Survey for England (2003, 2004 and 2006) are used to fit linear and ordered probit IV models for a sample of 13862 individuals, with frequent white meat consumption instrumenting for body-weight. Non-linearities in the relationship, robustness to weak instruments and relaxation of strict exogeneity assumption are further examined.

Results: Accounting for endogeneity and conditional on health, a protective effect on well-being is observed. A unit increase in BMI improves GHQ by 0.17 (95% CI: 0.02-0.31) points and reduces the probability of reporting very low GHQ by 2.5% (95% CI: 0.01 - 0.05). Empirical testing showed that the instrument performs well, with increased meat consumption adding 0.58 points (95% CI: 0.42-0.74) to ones' BMI.

Conclusions: We present support for the jolly-fat hypothesis, however caution is recommended in drawing inferences. Further research needs to resolve the mixed findings in the literature.

Keywords: body weight; psychological well-being; body mass index; instrumental variables

Introduction

Over the last decades, the detrimental impacts of overconsumption have become apparent and obesity has grown to epidemic proportions. According to the Organisation for Economic Co-operation and Development (OECD), obesity is a major contributor to the global burden of disease.[1] The growing literature on psychological well-being and its acceptance as an important indicator in public policy (in monitoring societal progress, informing policy design and policy appraisal), render examination of its links with anthropometric indicators, a natural extension.[2]

While the negative consequences of adiposity for physical health are well explored, the evidence for psychological well-being is less straightforward. Various studies show negative associations of psychological well-being with obesity or BMI, [3] an inverse U relationship,[4] lack of association for women[5] or men,[6] or a weakened link once controlling for the effects of obesity on physical capacity and health.[7,8] In addition, a positive association has also been found, often termed the Jolly Fat hypothesis, implying a protective effect of increased body weight on psychological well-being.[9] Others have explored the relative nature of obesity concluding that its influence on life satisfaction is a result of relative comparisons [10] with higher well-being attributed to those “relatively” thin. [4] Mixed findings are also reported in the medical literature of obesity and clinical manifestations of mental health with detrimental, [11,12] weak/insignificant [9,13] and protective [9,14,15] effects identified.

However, the endogenous nature of body weight impedes identification of causal effects. A bi-directional link between body weight and depression is confirmed [16] potentially explaining some of the diverse conclusions reached when looking at associations. Nevertheless, studies exploiting genetic variation as instrument variables (IV) to estimate the effect of body weight on mental disorders also result in mixed findings.[17,18] Higher BMIs predict depressive symptoms [17], with the effect less clear for women [18], while elsewhere a protective effect of higher BMIs and waist-to-hip ratios is observed [19].

Considering well-being a proxy for subjective utility, from a behavioural economics perspective and conditional on health, a priori expectations of the direction of the link are limited. Individuals often engage in risky behaviours and can be assumed to act in their own best interest, with obesity often placed in a rational choice context [20].

Focusing on psychological well-being this paper addresses the endogeneity of body weight through an IV approach, where frequency of white meat consumption is used as instrument while controlling for a large number of individual and environmental confounding factors.

Methods and materials

Data and study sample

Data are taken from the Health Survey for England (HSE), an annual repeated cross-sectional nationally representative survey for England carried out by the National Centre of Social Research and the Department of Epidemiology and Public Health at University College London. Information on the required variables is available for three years (2003, 2004 and 2006). To avoid issues related to growth and idiosyncratic preferences individuals <22 years old (N = 1284) and vegetarians (N=323) are excluded. To mitigate measurement errors we exclude those classified (by the official data collectors) as unreliable for use (N=363), while we also curtail the BMI distribution by dropping those with BMI<13 and BMI>43 (N=97). Accounting for missing items responses analysis is based on complete cases for a sample of 13862 individuals.

Psychological well-being outcome

Psychological well-being is measured through the General Health Questionnaire - 12 (GHQ), a screening device for short-term incidence of distressing phenomena. [21] Scores range from 0 to 12 with 0 indicating no psychological problems. In estimations GHQ is treated both as continuous (range, 0-12) and ordinal (i.e. collapsing it to three categories: 0/1=1, 2/5=2 and 6/12=3).

Body-weight

Weight and height are measured by trained staff through standard protocols and are used to calculate Body Mass Index (BMI).

Instrumental variables and instrument

For the implementation of the IV methodology, a new variable (i.e. the instrument) has to be identified which must not be correlated (i.e. exogenous) to well-being but must be correlated to body-weight (i.e. relevant), while any effect of the instrument on well-being can only exist indirectly through body-weight. If such conditions hold, one can use the variation in the exogenous instrument in an auxiliary regression to obtain predicted values for the endogenous variable (i.e. BMI), which are then substituted for the endogenous variable in the main equation of interest (i.e. the effect of body-weight on psychological well-being).

The documented relationship of weight and well-being with various foods sources and physical activity renders them inappropriate instruments. An investigative search of the medical literature suggests that individuals' white meat consumption (i.e. chicken or turkey) can be a valid instrument. A number of large longitudinal/cohort studies and randomized control trials indicate strong correlations of meat consumption with body weight through protein intake [22–25] and simultaneously a lack of correlation with well-being, depression and other mental health disorders.[26–30] Similar characteristics are not possessed by other protein and fat sources (e.g. soy, fish and dairy) or dietary habits (e.g. vegetarianism potentially reflects a more health conscious lifestyle that can be linked to well-being). [22,23,25,31] On the contrary, red meat consumption, albeit working through similar pathways as white meat, can potentially be linked to unhealthy diets and lifestyles[32,33] again raising concerns of validity and as such is excluded from our main analysis in this study.

Confounding factors and covariates

Acknowledging the potential indirect correlation between well-being and meat consumption through lifestyle (i.e. people who engage in risky health behaviours tend to do so in more than one ways) and exercise (i.e. individuals exercising systematically need to consume more meat to cover the dietary needs of their active lifestyle), we control for such confounding factors. Smoking, drinking and “membership to a sports club, gym, exercise or dance group” are included in the estimations (analysis is replicated using “exercised in last four weeks” as the physical activity indicator, but due to missing values, “membership” is preferred for the main analysis). Further indirect links through health comorbidities are possible and are also captured by including a number of health status and disability indicators (i.e. presence of a long-standing illness, mobility problems, problems with usual activities, experiencing pain/discomfort) in the regressions. Finally, all estimations adjust for socio-economic and demographic characteristics (i.e. sex, age, ethnicity, marital status, number of kids, education, employment, household income), neighbourhood quality and cohesion indicators (i.e. teenagers causing trouble in the street, neighbours look after each other) to control for environmental factors and potentially social capital effects.

Statistical Analysis

Exogeneity of our instrument is further empirically examined in the data. A χ^2-statistic and an ordered probit regression test for differences in the GHQ distribution by meat consumption frequency and a logitstic regression test whether GHQ predicts meat consumption.

Given continuous and ordinal representations for GHQ four main models are presented. Two for continuous (OLS and the corresponding linear IV) and two for ordinal GHQ (standard ordered probit and ordered probit IV).[34] The first stage of the IV estimations is common and hence presented once. Formal statistics for the exogeneity and relevance of the instrument are calculated, while robust-to-weak instruments confidence intervals and p-values are additionally computed for linear models [35]. All models use heteroskedasticity robust standard errors and all analysis is performed in Stata® statistical software.

Results

Sample averages and summary statistics are given in (Table 1). On average our sample has moderate psychological problems and is overweight. Meat consumption features heavily in their weekly diets with 32% having white meat at least three times a week. In terms of demographics, average age is about 50 years old, with 47% being males, 91% of white ethnic background, 67% married and 64% employed with equivalized mean annual income of £30K. 21% holds a degree or higher and 46% reports a long-standing illness or disability. Never-smokers are 43% of the sample, whereas 40% face problems with teenagers on their streets but only 3% live in an area with complete lack of personal contact between neighbours.

Instrument exogeneity and relevance

Table 2 presents the GHQ distribution by frequency of meat consumption. The null hypothesis of no correlation between GHQ and meat consumption (i.e. exogeneity of instrument) is accepted in all the three tests: χ^2= 13.7 (p = 0.32), ordered probit coefficient -0.02 (95% CI: -0.06, 0.03), logit coefficient -0.01 (95% CI: -0.01, 0.01). Looking at the correlation of meat consumption with BMI (i.e. relevance of instrument), the first stage IV results show a strong effect (Table 3). Being a frequent meat-eater adds 0.58 points (95% CI: 0.42-0.74) to ones BMI (i.e. about 2Kgs for an individual with a BMI of 27 and of 180cms), which is close to the estimate obtained by Schulze et al. [22]. Formal statistics (middle of last column, Table 3) verify this strong correlation with values well-above the critical values suggested in the literature.

BMI and well-being

Columns 2 and 4 of Table 3 present the OLS and ordered probit results ignoring potential endogeneity with coefficients -0.002 (95% CI: -0.004, 0.002) and -0.005 (95% CI: -0.01, 0.001) suggesting negligible effects of body weight on well-being. Turning to columns 3 and 5 the IV coefficients of BMI are now negative and highly significant implying that individuals with higher BMI report better well-being scores (note that lower GHQ scores indicate better well-being). For the linear IV, a unitary increase in BMI for those frequently consuming meat leads to a 0.17 units drop (95% CI: 0.02-0.31) in their GHQ, while from the average marginal effects of the ordinal model a unitary increase in BMI increases chances of reporting very low GHQ by 2.5% (95% CI: 0.01 - 0.05). Estimating robust-to-weak instruments confidence interval (bottom of column 3) conclusions remain unchanged.

Sensitivity analysis

Following a recent methodology[36] we further relax the no-correlation assumption between well-being and meat consumption and calculate a range of correlations that can exist but still allow for robust causal inference. Figure 1 shows the 95% CI for the effect of BMI on well-being when the direct correlation between meat consumption and well-being is in the range γ = [-0.082, +0.082]. Results confirm our previous findings.

Non-linearity in the relationship between well-being and BMI is also examined. As only one instrument is available, power or multilevel categorical transformations of BMI are impossible. We repeat analysis after collapsing BMI into three binary indicators - BMI25 (= 1 if BMI > 25, 0 otherwise), BMI30 (= 1 if BMI > 30, 0 otherwise) and BMI35 (= 1 if BMI > 35, 0 otherwise) - and run separate IV models for each. Findings remain, with strong negative coefficients for all three thresholds (Table 4). Finally, performing the analysis using "exercised in last four weeks" as the exercise indicator or adding red meat consumption in the list of instruments, leaves results unchanged.

Discussion

Main findings of this study

In a general sample of the UK population, using an IV approach to account for endogeneity we find that those with increased BMIs report improved psychological well-being. While the IV analysis supports the jolly-fat hypothesis [15] conventional analysis suggest weak links potentially raising questions about the validity of our instrument. However, the various empirical tests conducted and the number of past studies confirming not only the positive relationship between meat consumption and body weight [37] (i.e. through protein [24] and fat [25] with frequent meat eaters are systematically found to be heavier compared to vegetarian, fish or non-meat diets [25,31], as well as compared to other sources of protein sources [22,23]), but also the exogenous relationship between mental health and meat consumption [26,38] (i.e. randomized controlled trials and systematic reviews have consistently found no association between amino acids intake, tryptophan, fatty acids and changes in mental health [27–30]) mitigate such concerns.

Our results add to a growing literature on the protective effects of higher BMI on well-being. Conditioning on health status, there are limited reasons as to why a detrimental influence of BMI on well-being should be expected [7,8], while preferences heterogeneity, time-inconsistency and price differentials might even explain obesity as rational.[20] Our findings confirm studies using genetic information [19] and recent reviews [39] where the protective effect of obesity has been found. Common underlying biological mechanisms between obesity and well-being can explain such findings [40,41], although recent studies using different genetic information and studying the obesity/well-being relation find contradicting effects [17,18].

In reconciling such discrepancies, it is possible that, given the small (in magnitude) effect of genetic information and of meat consumption on mean BMIs, body-weight has beneficial effects on well-being through biological pathways but detrimental effects through stigmatization and social marginalisation.[42] Alternatively, non-linear effects of body-weight on well-being could explain the mixed findings with protective effects up to a certain threshold (potentially varying across study populations) and detrimental impact from then on,[4] although our explicit test of non-linearities did not confirm this. Further, the local average treatment interpretation of IV estimates of this study implies that protective effects work their way through increased meat intake but are not necessarily generalized to other pathways. Note that our control for exercising regimes and lifestyle choices should control for the correlation between the beneficial effects of exercising and the lean/healthy diets that such individuals usually follow. At the same time, the fact that past studies with different instruments have also resulted in similar protective effects suggests that they are present in more than one causal pathways.

What is already known on this topic

Increased weight has traditionally been considered to reduce psychological well-being. Yet, the endogenous nature of body weight is ignored in observational studies identifying associations, whereas causal studies have so far focused predominantly on biomarkers to identify pathways.

What this study adds

The causal effect of weight on well-being is investigated through an instrumental variable approach that uses nutritional information (white meat consumption) to correct for the endogeneity of body weight. We provide evidence of a protective causal effect of weight on well-being, with increased reported BMI improving psychological well-being. Our results confirm studies using genetic information and evidence from reviews where a protective effect of obesity on mental health has been identified. Our findings offer an alternative complementary pathway (to the common underlying biological mechanisms) for the link between obesity and mental health outcomes.

Limitations of this study

A few limitations are acknowledged within the present study. While our instrument is shown to be exogenous, residual variation could still bias our results. Yet, controlling for a large array of confounding factors should alleviated such problems. Lack of longitudinal data prohibits controlling for adaptation effects, unobserved heterogeneity and time-invariant omitted factors (i.e. individuals' genes, perpetual habits etc.). Alternative adaptation behaviours (i.e. individuals who have changed their diet to combat obesity) are also ignored although this should not bias our results as it would only weaken the link between BMI and meat consumption. Finally, the self-reported nature of well-being and its social desirability and reporting heterogeneity extensions could again influence our results, although such biases would be similar across all observational studies with self-reported constructs.

Conclusions

We present further support for the jolly-fat hypothesis with a cross-sectional representative dataset from the UK. Nevertheless, the fact that individual psychological well-being might not be lower for heavier populations does not imply that negative externalities of obesity are not borne by the society as a whole and that body-weight interventions are unjustified. Overall, our results should be interpreted with caution as further research is necessary to resolve the mixed findings reported in the literature.

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Conflicts of interest:

The authors declare that they have no conflict of interest.

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Table 1 Baseline descriptive statistics (HSE, 2003, 2004 and 2006)[a]

	Mean	SD / % [b]
Age	49.7	15.1
Male	6,549	(47.2)
Ethnicity		
Black	490	(3.53)
Asian (non-Chinese)	377	(2.72)
Other	2.81	(2.03)
# of kids	0.52	0.91
Marital status		
Married	9,331	(67.3)
Single	2,049	(14.7)
Equivalized household income (£1000s)	30.1	25.9
Employed	8,877	(64.0)
Education		
Degree	2,936	(21.2)
A levels	3,401	(24.5)
GCSE A-G	4,217	(30.4)
FT student	367	(2.65)
Health status		
Long-standing illness/disability	6,394	(46.1)
Mobility problems	2,043	(14.7)
Usual activities problems	1,870	(13.5)
Pain/discomfort	4,341	(31.3)
Regularly join sports club, gym, exercise or dance group	3,802	(27.4)
Smoking status		
Ex-smoker	4,683	(33.8)
Current smoker	3,135	(22.6)
Drink > 3 times a week	5,554	(40.1)
Fairly/Very big problem with teens hanging around on the street	4,012	(28.9)
The neighbours do not look after each other at all	438	(3.16)
GHQ score (0 to 12)	1.21	2.42
BMI	27.2	4.55
Consume meat >3 times a week	4,404	(31.7)

[a] Reference categories for the following variables in parentheses: ethnicity (white), marital status (divorced/separated/widowed), education (no qualification) and smoking status (never smoker).

[b] For categorical variables numbers indicate percentages (%)

Table 2 GHQ score distribution by meat consumption frequency (HSE, 2003, 2004 and 2006)

	Consume meat	
	< 3 times a wk	> 3 times a wk
0	65.14	65.05
1	12.38	13.19
2	6.196	6.403
3	3.637	3.906
4	2.654	2.566
5	2.167	2.248
6	1.681	1.431
7	1.586	1.158
8	1.121	1.226
9	0.867	0.658
10	0.899	0.568
11	0.772	0.749
12	0.899	0.840
Total	100	100
	χ^2 = 13.7 (p = 0.319)	

Note: Lower GHQ scores imply lower psychological disorders and higher well-being.

Table 3 Estimation results for the effect of BMI on linear and ordinal GHQ in standard and IV models (HSE, 2003, 2004 and 2006)

	GHQ Linear[a,b]		GHQ categorical[a,b]		First stage IV[a,b]
	OLS	Linear IV	Ordered probit	IV Ordered probit	
Meat > 3 times a wk	–	–	–	–	0.585***
					(0.0827)
BMI (kg/m^2)	-0.00717	-0.169**	-0.00513*	-0.0929**	–
	(0.00467)	(0.0748)	(0.00271)	(0.0369)	
Observations			13,862		
rk LM [c]					49.72
rk F [c]					49.99
Robust 95% CI [d]		(-0.335, -0.029)			
Robust p-value [d]		0.0180			
Average Marginal Effects					
P(GHQ = 1)			0.00134*	0.0250**	
P(GHQ = 2)			-0.000723*	-0.0114***	
P(GHQ = 3)			-0.000617*	-0.0136*	

[a] Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[b] All models are adjusted for: age, gender, ethnicity (white, black, asian, other), number of kids, marital status (married, single, divorced/separated/widowed), equivalized household income, employment status, education (first degree, A levels, GCSEs, FT student, no education), presence of a long-standing illness, mobility problems, problems with usual activities, experiencing pain/discomfort, gym membership, smoking status (never smoker, ex-smoker, current smoker), alcohol drinking, problems with teenagers in neighbourhood, neighbours do not care.

[c] The LM statistic is an under-identification, i.e. whether instrument is relevant. The F (Wald) statistic tests for weak identification, i.e. whether the instrument is correlated with the endogenous outcome (body-weight) but only weakly. Stock-Yogo critical values = 16.38.

[d] Robust to weak instruments 95% CIs and p-values.

Table 4 Estimation results for the non-linear effect of BMI on linear GHQ in standard and IV models (HSE, 2003, 2004 and 2006)

	BMI25[a,b]		BMI30[a,b]		BMI35[a,b]	
	OLS	Linear IV	OLS	Linear IV	OLS	Linear IV
BMI25 [c]	-0.0429	-2.088**				
	(0.0423)	(0.952)				
BMI30 [c]			-0.0677	-2.554**		
			(0.0459)	(1.190)		
BMI35 [c]					0.0284	-4.581**
					(0.0872)	(2.172)
Observations			13,862			
rk LM [d]		30.90		23.92		21.50
rk F [d]		30.97		23.67		21.50
Robust 95% CI [e]		[-4.402, -0.361]		[-5.598, -0.441]		[-10.16, -0.786]
Robust p-value [e]		0.0180		0.0180		0.0180

[a] Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1

[b] All models are adjusted for: age, gender, ethnicity (white, black, asian, other), number of kids, marital status (married, single, divorced/separated/widowed), equivalized household income, employment status, education (first degree, A levels, GCSEs, FT student, no education), presence of a long-standing illness, mobility problems, problems with usual activities, experiencing pain/discomfort, gym membership, smoking status (never smoker, ex-smoker, current smoker), alcohol drinking, problems with teenagers in neighbourhood, neighbours do not care.

[c] BMI25 = 1 if BMI > 25 and 0 otherwise; BMI30 = 1 if BMI > 30 and 0 otherwise; BMI35 = 1 if BMI > 35 and 0 otherwise.

[d] The LM statistic is an under-identification, i.e. whether instrument is relevant. The F (Wald) statistic tests for weak identification, i.e. whether the instrument is correlated with the endogenous outcome (body-weight) but only weakly. Stock-Yogo critical values = 16.38.

[e] Robust to weak instruments 95% CIs and p-values.

Fig 1. 95% confidence interval estimates for the effect of BMI on well-being when the direct correlation between meat consumption and well-being is in the range γ = [-0.082, +0.082].