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Association between intelligence quotient and obesity in England

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Abstract

Introduction: In the past years, there has been a controversy regarding the potential association between intelligence quotient (IQ) and obesity. Therefore, the present study aimed to analyze the relationship between IQ and obesity in England using nationally representative community-based data.

Methods: This study used data from people who participated in the 2007 Adult Psychiatric Morbidity Survey. Verbal IQ was estimated using the National Adult Reading Test. Obesity was based on self-reported weight and height and defined as a body mass index higher or equal to 30 kg/m^2. Multivariable logistic regression analyses were conducted to assess the association between IQ and obesity, while adjusting for sex, age, ethnicity, marital status, qualification, employment, income, chronic physical conditions, loneliness, social support, stressful life events, smoking status, alcohol dependence, drug use, and common mental disorders.

Results: There were 6798 individuals aged ≥16 years included in the present study. After adjustment for potential confounders, compared to IQ scores of 120-129, IQ scores of 110-119 (odds ratio [OR] = 1.16), 100-109 (OR = 1.35), 90-99 (OR = 1.26), 80-89 (OR = 1.68), and 70-79 (OR = 1.72) were associated with increased odds for obesity. Furthermore, a 10-point decrease in IQ was associated with a 1.10-fold increase in the odds for obesity.

Conclusions: There was a negative association between IQ and obesity in the UK population. Further research is needed to provide a better understanding of the mechanisms involved in this relationship.

KEYWORDS
England, intelligence quotient, nationally representative study, obesity, regression analyses

1 | INTRODUCTION

In recent decades, there has been an escalating global epidemic of obesity. In 2016, 650 million adults were obese, and this figure accounted for 13% of the worldwide population.[1] There is a strong relationship between obesity and low quality of life,[2] multimorbidity,[3] and mortality,[4] while the economic burden of obesity is substantial in both developed and developing countries.[5] Therefore, identifying risk factors for obesity is of particular importance for the implementation of effective preventive strategies.

In the past years, there has been a controversy regarding the potential association between intelligence quotient (IQ) and obesity.[6–10] For example, one study conducted in the United Kingdom showed that childhood general intelligence was negatively associated with adult obesity at age 51 years after adjusting for education, earnings, mother's body mass index (BMI), father's BMI, childhood social class, sex, and BMI at 16.[10] In contrast, it was found in another UK prospective study of more than 17 400 individuals followed from birth that adjusting for education attenuated the inverse association between childhood IQ and adult obesity at age 42 years to the null.[7] This finding was later corroborated in a meta-analysis of 26 studies, which found no significant relationship between intelligence and obesity after adjusting for education.[8] Although these studies have advanced the field, there are two important limitations that should be mentioned. First, to the best of our knowledge, all of them failed to conduct simultaneous adjustment for a variety of potential confounders. Specifically, none of the studies have taken into account smoking status,[11,12] alcohol dependence,[13,14] drug use,[15,16] and common mental disorders,[17,18] despite the fact that these factors have been reported to be associated with both obesity and IQ. Second, the previous studies were not nationally representative,[6–10] and it is thus difficult to extrapolate their findings.

Therefore, the present study aimed to analyze the association between IQ and obesity in England using nationally representative community-based data while adjusting for key confounders including sex, age, ethnicity, marital status, qualification, employment, income, chronic physical conditions, loneliness, social support, stressful life events, smoking status, alcohol dependence, drug use, and common mental disorders.

2 | SUBJECTS, MATERIALS, AND METHODS

2.1 | Study participants

This study used data from 7403 people who participated in the 2007 Adult Psychiatric Morbidity Survey (APMS). Full details of the survey have been published elsewhere.[19,20] Briefly, this was a nationally representative survey of the English adult population (aged ≥16 years) living in private households. The National Center for Social Research and Leicester University undertook the survey fieldwork in October 2006 to December 2007 using a multistage stratified probability sampling design where the sampling frame consisted of the small user postcode address file, whereas the primary sampling units were postcode sectors. Participant information was obtained through face-to-face interviews where some of the questionnaire items were self-completed (with the use of a computer). Sampling weights were constructed to account for nonresponse and the probability of being selected so that the sample was representative of the English adult household population. The survey response rate was 57%. Ethical permission for the study was obtained from the Royal Free Hospital and Medical School Research Ethics Committee. All participants provided informed consent before their inclusion.

2.2 | Measures

2.2.1 | Intelligence quotient (independent variable)

Verbal IQ was estimated using the National Adult Reading Test (NART). The NART, a brief measure administered only to native English speakers and widely used in the world, consists of a list of 50 words and is scored by counting the number of errors made in reading out the words.[21] The reliability of the NART has been assessed by a split-half technique (Cronbach α), which gave a reliability coefficient of .93 compared with the Wechsler Adult Intelligence Scale (WAIS). Previous research has also shown that NART scores are largely unaffected by psychiatric and neurological disorders, underlying the interest of this test in the context of the 2007 APMS.[21] There were 531 participants who were not administered the test (eg, English not their first language, eyesight problems, dyslexia, and refusal). Thus, these participants were excluded from the analysis. The scores ranged from 70 to 130 and this variable was analyzed as a continuous variable or as a categorical variable (ie, 70-79, 80-89, 90-99, 100-109, 110-119, and 120-129) in line with a previous publication using the same dataset.[21] Verbal IQ is referred to as IQ in this manuscript for the sake of brevity.

2.2.2 | Obesity (dependent variable)

BMI was calculated as weight in kilograms divided by height in meters squared based on self-reported weight and height. Using the standard World Health Organization (WHO) definition, obesity was defined as $\geq$30 kg/m^2.

2.3 | Control variables

The control variables were selected based on past literature.[6–10]

2.3.1 | Sociodemographic variables

These included sex, age, British white (yes or no), marital status (single/widowed/divorced/separated or married/cohabiting), qualification (having a qualification, ie, degree, nondegree, A-level, GCSE, other: yes or no), employment (yes or no), and income (high ≥ £29 826, middle £14 057 to < £29 826, or low < £14 057; equivalized income tertiles).

2.3.2 | Chronic physical conditions

The following disorders were included: cancer, diabetes, epilepsy/fits, migraine or frequent headaches, cataracts/eyesight problems, ear/hearing problems, stroke, heart attack/angina, high blood pressure, bronchitis/emphysema, asthma, allergies, stomach ulcer or other digestive problems, liver problems, bowel/colon problems, bladder problems/incontinence, arthritis, bone/back joint/muscle problems, infectious disease, and skin problem.[21] These conditions had to be diagnosed by a doctor or other health professional and be present in the previous 12 months. The total number of chronic physical conditions was further calculated for each individual.

2.3.3 | Loneliness

This was assessed with an item from the Social Functioning Questionnaire (SFQ). Respondents were asked to assess to what extent they had felt "lonely and isolated from other people" in the past 2 weeks with response options, "very much," "sometimes," "not often," and "not at all." In the analyses that follow, these response options were dichotomized with those who responded "sometimes" and "very much" being categorized as lonely.[21]

2.3.4 | Social support

This was assessed with a 7-item measure. Using answer options "not true" (score = 0), "partly true" (score = 1), and "certainly true" (score = 2), participants responded to statements that inquired if family and friends did things to make them happy, made them feel loved, could be relied on no matter what, would see that they were taken care of no matter what, accepted them just the way they are, made them feel an important part of their lives, and gave them support and encouragement. Responses were added to create a scale score that could range from 0 to 14. The internal consistency of the scale was good: Cronbach's $\alpha = .89$.

2.3.5 | Stressful life events

Eighteen items were used to assess different stressful life events (eg, serious illness, death of an immediate family member, and major financial crises).[21] The number of stressful life events was further calculated for each participant and ranged from 0 to 18.

2.3.6 | Smoking status

Participants were asked about their smoking status and were classified as never smokers (never) and past or current smokers (quit/current).[21]

2.3.7 | Alcohol dependence

Excessive alcohol consumption was screened using the Alcohol Use Disorders Identification Test (AUDIT). Alcohol dependence was assessed with the Severity of Alcohol Dependence Questionnaire (SADQ-C) in participants with an AUDIT score of 10 or above. Scores of four or above indicated alcohol dependence in the past 6 months.[21]

2.3.8 | Drug use

Each individual was asked if he/she had used in the past year one of the following drugs: cannabis, amphetamines, cocaine, crack, ecstasy, heroin, acid or LSD, magic mushrooms, methadone or physeptone, tranquilizers, amyl nitrate, anabolic steroids, and glues. Those who claimed to have used at least one of these drugs were considered to be drug users.

2.3.9 | Common mental disorders

Common mental disorders were assessed using the Clinical Interview Schedule Revised (CIS-R), and referred to depressive episode and/or anxiety disorders (ie, generalized anxiety disorder, panic disorder, phobia, and obsessive-compulsive disorder) in the prior week.[21]

2.4 | Statistical analyses

Differences in the sample characteristics between those with and without obesity were tested with Chi-squared tests for categorical variables and Student's *t*-tests for continuous variables. We conducted logistic regression analyses to assess the association between IQ (independent variable: continuous and six-category variable) and obesity (dependent variable). In order to assess the influence of various factors in the association between IQ and obesity, using the continuous IQ variable (per each 10-point decrease in IQ) as the exposure variable, we included all potential confounders (ie, sex, age, ethnicity, marital status, qualification, employment, income, chronic physical conditions, loneliness, social support, stressful life events, smoking status, alcohol dependence, drug use, and common mental disorders) individually in the unadjusted model. We also illustrate the association between IQ (continuous and six-category variable) and obesity while adjusting for all the potential confounders mentioned above simultaneously. To avoid the omission of a large number of individuals from the analysis, we included a missing category only for income as 23.8% of the values were missing in the overall sample. Because BMI can increase during pregnancy,[22] pregnant women (N = 77) were excluded from all analyses. All covariates were included as categorical variables in the model with the exception of age, number of chronic physical conditions, social support, and number of stressful life events. The sample weighting and the complex study design were taken into account in all analyses. The level of statistical significance was set at *P*-value < .05. All analyses were performed with Stata version 13.1 (Stata Corp LP, College Station, TX, USA).

TABLE 1 Sample characteristics (overall and by obesity status)

Characteristics	Category	Overall	Obesity Absent	Obesity Present	*P*-value*
Sex	Male	49.7	50.1	47.9	.201
	Female	50.3	49.9	52.1	
Age (years)	Mean (SD)	46.6 (18.6)	46.0 (18.9)	49.6 (16.4)	<.001
British White	No	14.8	15.0	13.9	.449
	Yes	85.2	85.0	86.1	
Marital status	Single/widowed/divorced/separated	37.0	38.2	31.6	<.001
	Married/cohabiting	63.0	61.8	68.4	
Qualification	No	23.7	22.3	30.1	<.001
	Yes	76.3	77.7	69.9	
Employment	No	39.0	38.4	41.6	.061
	Yes	61.0	61.6	58.4	
Income	High	35.9	37.5	29.0	<.001
	Middle	32.8	32.4	34.3	
	Low	31.3	30.0	36.8	
Number of chronic physical conditions	Mean (SD)	1.4 (1.5)	1.2 (1.4)	1.9 (1.8)	<.001
Loneliness	No	79.7	80.0	77.9	.127
	Yes	20.3	20.0	22.1	
Social support	Mean (SD)	13.2 (1.9)	13.2 (1.8)	13.1 (2.0)	.139
Number of stressful life events	Mean (SD)	3.5 (2.4)	3.3 (2.4)	4.1 (2.7)	<.001
Smoking status	Never	34.8	34.3	37.0	.093
	Quit/Current	65.2	65.7	63.0	
Alcohol dependence	No	92.1	91.8	93.5	.072
	Yes	7.9	8.2	6.5	
Drug use	No	90.6	89.8	94.6	<.001
	Yes	9.4	10.2	5.4	
Common mental disorders	No	92.2	92.9	88.7	<.001
	Yes	7.8	7.1	11.3	

Note. Obesity was defined as a body mass index (BMI) of ≥30 kg/m^2.
**P*-values were based on Chi-squared tests except for age, the number of chronic physical conditions, social support, and the number of stressful life events (Student's *t*-tests).

3 | RESULTS

There were 6798 individuals aged ≥16 years included in the present study (Table 1). Women constituted 50.3% of the sample and the mean age was 46.6 (standard deviation = 18.6) years. Individuals with obesity were more likely to be older, married/cohabiting, have lower levels of education and wealth, have common mental disorders, have more chronic physical conditions, have stressful life events, and were less likely to be drug users. The prevalence of obesity decreased from 21.3% in the IQ 70-79 group to 14.6% in the IQ 120-129 group (Figure 1). The results of the regression analyses, which used the six-category IQ variable, are displayed in Figure 2. After adjusting for all potential cofounders, compared to those with IQ scores of 120-129, people with IQ scores of 110-119 (odds ratio [OR] = 1.16; 95% confidence interval [CI], 0.90-1.51), 100-109 (OR = 1.35; 95% CI, 1.03-1.77), 90-99 (OR = 1.26; 95% CI, 0.95-1.65), 80-89 (OR = 1.68; 95% CI, 1.22-2.29), and 70-79 (OR = 1.72; 95% CI, 1.21-2.41) were at an increased odds for obesity. All potential confounders had very little influence in the association between IQ and obesity (Table 2). After adjustment for all potential confounders, a 10-point decrease in IQ was associated with a 1.10 times higher odds for obesity.

TABLE 2 The association of intelligence quotient (independent variable) with obesity (dependent variable) estimated by logistic regression

Model	Odds ratio	95% confidence interval	*P*-value
Unadjusted	1.08	1.03-1.13	.001
Adjusted for sex	1.08	1.03-1.13	.001
Adjusted for age	1.10	1.06-1.16	<.001
Adjusted for ethnicity	1.08	1.03-1.13	.001
Adjusted for marital status	1.10	1.05-1.15	<.001
Adjusted for qualification	1.06	1.01-1.11	.025
Adjusted for employment	1.08	1.03-1.13	.001
Adjusted for income	1.07	1.01-1.12	.011
Adjusted for chronic physical conditions	1.09	1.04-1.14	<.001
Adjusted for loneliness	1.08	1.03-1.13	.001
Adjusted for social support	1.08	1.03-1.13	.002
Adjusted for stressful life events	1.10	1.05-1.15	<.001
Adjusted for smoking status	1.08	1.03-1.13	.001
Adjusted for alcohol dependence	1.08	1.03-13	.001
Adjusted for drug use	1.09	1.04-1.14	<.001
Adjusted for common mental disorders	1.07	1.03-1.12	.002
Adjusted for all variables*	1.10	1.05-1.16	<.001

Note. IQ was assessed using the National Adult Reading Test (NART). In this analysis, the continuous IQ variable was used, and the estimates represent the change in odds associated with a 10-point decrease in IQ. Obesity was defined as a body mass index (BMI) of ≥30 kg/m^2.
*Adjusted for sex, age, ethnicity, marital status, qualification, employment, income, chronic physical conditions, loneliness, social support, stressful life events, smoking status, alcohol dependence, drug use, and common mental disorders.

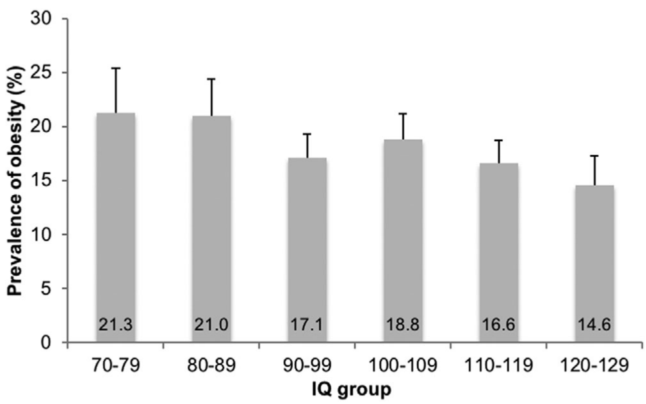

FIGURE 1 Prevalence of obesity by intelligence quotient (IQ) score
Note. IQ was assessed using the National Adult Reading Test (NART). Obesity was defined as a body mass index (BMI) of ≥30 kg/m^2.
Bar denotes upper end of 95% confidence interval.

4 | DISCUSSION

4.1 | Main findings

To the best of our knowledge, this is the first nationally representative study investigating the association between IQ and obesity, while it is also the first study that adjusted for a variety of potential confounders. In this sample of almost 6800 individuals, we found that the prevalence of obesity decreased from approximately 21% in the IQ 70-79 group to 15% in the IQ 120-129 group. In addition, after adjusting for potential confounders (ie, sociodemographic, physical, psychological, behavioral, and psychiatric), we found that IQ was negatively associated with obesity with the OR (95% CI) for IQ 70-79 (vs 120-129) being 1.72 (1.21-2.41). All potential confounders had little influence in the association between IQ and obesity in our study.

4.2 | Interpretation of the findings

Recently, there has been some controversy on the association between IQ and obesity, and several studies have suggested that education may play a major confounding role in this association.[7,8] Specifically, one large prospective study from the United Kingdom found that lower childhood IQ scores increased the risk of adulthood obesity but that this association was no longer significant after adjustment for education.[7] Based on these findings, the authors emphasized the fact that education is likely to be a strong confounding factor in the association between childhood IQ and adulthood obesity. Although these results are of particular interest, other authors have reported a significant relationship among IQ, BMI changes,[9] and obesity[10] even after adjusting for education levels. Of particular interest is the Kanazawa study that used data from a birth cohort of 17 419 individuals in the United Kingdom and reported an independent effect of childhood

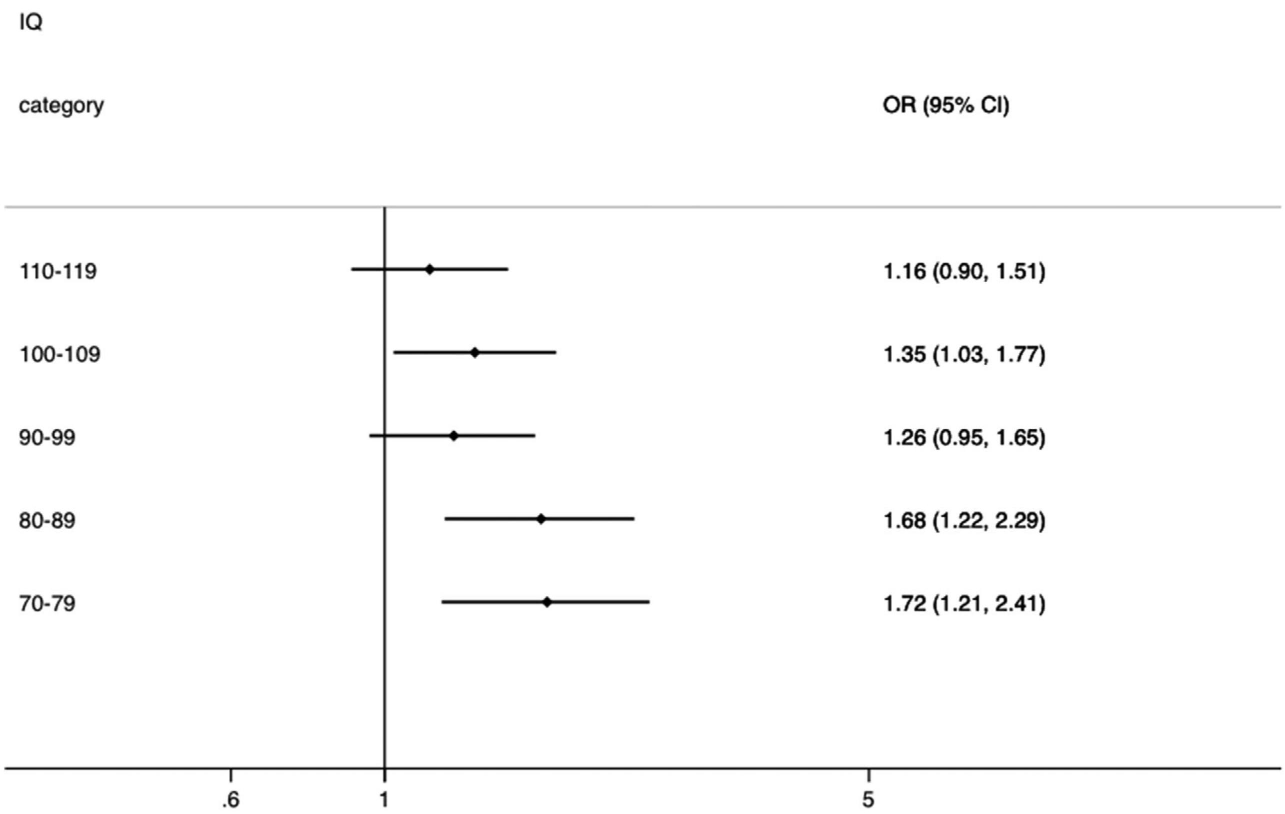

FIGURE 2 Association between intelligence quotient (IQ) and obesity estimated by multivariate logistic regression
Note. IQ was assessed using the National Adult Reading Test (NART). Obesity was defined as a body mass index (BMI) of ≥30 kg/m^2. Reference category is IQ 120-129. The model was adjusted for sex, age, ethnicity, marital status, qualification, employment, income, the number of chronic physical conditions, loneliness, social support, the number of stressful life events, smoking status, alcohol dependence, drug use, and common mental disorders.
Abbreviations: CI, confidence interval; OR, odds ratio.

intelligence on adult obesity, regardless of education or earnings.[10] Our study results concur with the latter studies that found that education is unlikely to be a confounder in the association between IQ and obesity.

There are several hypotheses to explain the IQ-obesity relationship. The fact that the potential confounders assessed in this study had little influence in the association between IQ and obesity points to the possibility that other factors that were not investigated in this current study may be important. For example, people with high IQ may be more likely to engage in healthy behaviors than those with low IQ. One study found that adulthood consumption of fruits and vegetables was more frequent and adulthood consumption of chips and cakes/biscuits was less frequent in those with high childhood mental ability.[23] That same study further highlighted the fact that there was a positive association between high mental ability and exercise habit. These results were corroborated in a recent study that found that high IQ in youth increased the odds of moderate cardiovascular activity and strength training in middle age, whereas it decreased the odds of having a sugary drink in the previous week and heavy alcohol consumption.[24] It is also possible that obesity may be a risk factor for low IQ. It has been observed that BMI is negatively associated with both cognitive function and word-list learning,[25] while there is some evidence that high BMI may alter gray matter volume.[26]

4.3 | Clinical implications and directions for future research

Although the present findings provide valuable information on the link between low IQ and obesity, it is important to understand that IQ is a nonmodifiable risk factor that is rarely assessed in the general population. Therefore, the development of obesity prevention programs focusing on intelligence is difficult to implement. Nevertheless, IQ may be regularly assessed in specific situations such as the follow-up of children with developmental difficulties or the follow-up of adults with psychiatric disorders. Our findings suggest that low IQ is an independent risk factor for obesity even after adjusting for several potential confounding factors. Thus, we believe that individuals with low cognitive abilities should be screened for obesity on a regular basis. Furthermore, the management of individuals with low IQ should be transdisciplinary, and should involve several health professionals (eg, dietitian, physiotherapist, and general practitioner) in order to evaluate their health behaviors (eg, diet and physical activity) that may lead to obesity.

4.4 | Strengths and limitations

The strengths of this study include the large sample size and the use of nationally representative data. However, our findings should be considered in the light of several limitations. First, IQ was estimated with the NART, a test requiring good understanding of English, and this may have biased the present results. Second, BMI was based on self-reported weight and height, and it is thus possible that the prevalence of obesity was underestimated in this sample as people tend to underreport their weight.[27] Third, this was a cross-sectional study and thus no conclusions about causality or temporality of the association between IQ and obesity can be drawn.

5 | CONCLUSIONS

There was a negative association between IQ and obesity in the UK population even after adjustment for a variety of potential confounders. Further research is needed to gain a better understanding of the mechanisms involved in this relationship.

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ETHICAL APPROVAL

Ethical permission for the study was obtained from the Royal Free Hospital and Medical School Research Ethics Committee. All participants provided informed consent before their inclusion.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Louis Jacob and Ai Koyanagi designed the study, managed the literature searches, undertook the statistical analysis, and wrote the first draft of the manuscript. Josep Maria Haro and Lee Smith contributed to the design of the study and the correction of the manuscript. All authors contributed to and have approved the final manuscript.

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DATA AVAILABILITY STATEMENT

Regarding the data on which the present study was based, the dataset is publically available to all interested researchers but they must make a formal request to the UK data service data repository (https://www.ukdataservice.ac.uk/) where the dataset is stored.

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REFERENCES

1. World Health Organization. Obesity and Overweight. http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed September 1, 2020.
2. Busutil R, Espallardo O, Torres A, Martínez-Galdeano L, Zozaya N, Hidalgo-Vega Á. The impact of obesity on health-related quality of life in Spain. *Health Qual Life Outcomes*. 2017;15(1):197. https://doi.org/10.1186/s12955-017-0773-y.
3. Booth HP, Prevost AT, Gulliford MC. Impact of body mass index on prevalence of multimorbidity in primary care: cohort study. *Fam Pract*. 2014;31(1):38-43. https://doi.org/10.1093/fampra/cmt061.
4. Adams KF, Schatzkin A, Harris TB, et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *N Engl J Med*. 2006;355(8):763-778. https://doi.org/10.1056/NEJMoa055643.
5. Tremmel M, Gerdtham U-G, Nilsson PM, Saha S. Economic burden of obesity: a systematic literature review. *Int J Environ Res Public Health*. 2017;14(4):435. https://doi.org/10.3390/ijerph14040435.
6. Halkjaer J, Holst C, Sørensen TIA. Intelligence test score and educational level in relation to BMI changes and obesity. *Obes Res*. 2003;11(10):1238-1245. https://doi.org/10.1038/oby.2003.170.
7. Chandola T, Deary IJ, Blane D, Batty GD. Childhood IQ in relation to obesity and weight gain in adult life: the National Child Development (1958) Study. *Int J Obes*. 2006;30(9):1422-1432. https://doi.org/10.1038/sj.ijo.0803279.
8. Yu ZB, Han SP, Cao XG, Guo XR. Intelligence in relation to obesity: a systematic review and meta-analysis. *Obes Rev Off J Int Assoc Study Obes*. 2010;11(9):656-670. https://doi.org/10.1111/j.1467-789X.2009.00656.x.
9. Rosenblad A, Nilsson G, Leppert J. Intelligence level in late adolescence is inversely associated with BMI change during 22 years of follow-up: results from the WICTORY study. *Eur J Epidemiol*. 2012;27(8):647-655. https://doi.org/10.1007/s10654-012-9713-7.
10. Kanazawa S. Childhood intelligence and adult obesity. *Obes Silver Spring Md*. 2013;21(3):434-440. https://doi.org/10.1002/oby.20018.
11. Sulander T, Rahkonen O, Nissinen A, Uutela A. Association of smoking status with obesity and diabetes among elderly people. *Arch Gerontol Geriatr*. 2007;45(2):159-167. https://doi.org/10.1016/j.archger.2006.10.007.
12. Wennerstad KM, Silventoinen K, Tynelius P, Bergman L, Kaprio J, Rasmussen F. Associations between IQ and cigarette smoking among Swedish male twins. *Soc Sci Med*. 2010;70(4):575-581. https://doi.org/10.1016/j.socscimed.2009.10.050.
13. Sayon-Orea C, Bes-Rastrollo M, Nuñez-Cordoba JM, Basterra-Gortari FJ, Beunza JJ, Martinez-Gonzalez MA. Type of alcoholic beverage and incidence of overweight/obesity in a Mediterranean cohort: the SUN project. *Nutrition*. 2011;27(7):802-808. https://doi.org/10.1016/j.nut.2010.08.023.

14. Sjölund S, Hemmingsson T, Allebeck P. IQ and level of alcohol consumption—findings from a national survey of Swedish conscripts. *Alcohol Clin Exp Res*. 2015;39(3):548-555. https://doi.org/10.1111/acer.12656.
15. White J, Mortensen LH, Batty GD. Cognitive ability in early adulthood as a predictor of habitual drug use during later military service and civilian life: the Vietnam Experience Study. *Drug Alcohol Depend*. 2012;125(1-2):164-168. https://doi.org/10.1016/j.drugalcdep.2012.03.024.
16. Huang DYC, Lanza HI, Anglin MD. Association between adolescent substance use and obesity in young adulthood: a group-based dual trajectory analysis. *Addict Behav*. 2013;38(11):2653-2660. https://doi.org/10.1016/j.addbeh.2013.06.024.
17. Kivimäki M, Batty GD, Singh-Manoux A, et al. Association between common mental disorder and obesity over the adult life course. *Br J Psychiatry*. 2009;195(2):149-155. https://doi.org/10.1192/bjp.bp.108.057299.
18. Wraw C, Deary IJ, Der G, Gale CR. Intelligence in youth and mental health at age 50. *Intelligence*. 2016;58:69-79. https://doi.org/10.1016/j.intell.2016.06.005.
19. Jenkins R, Meltzer H, Bebbington P, et al. The British Mental Health Survey Programme: achievements and latest findings. *Soc Psychiatry Psychiatr Epidemiol*. 2009;44(11):899-904. https://doi.org/10.1007/s00127-009-0112-7.
20. McManus S, Meltzer H, Brugha T, Bebbington P, Jenkins R. Adult Psychiatric Morbidity in England, 2007: Results of a Household Survey. Leeds, England: The NHS Information Centre for Health and Social Care; 2009. https://digital.nhs.uk/data-and-information/publications/statistical/adult-psychiatric-morbidity-survey/adult-psychiatric-morbidity-in-england-2007-results-of-a-household-survey. Accessed September 1, 2020.
21. Jacob L, Haro JM, Koyanagi A. Association between intelligence quotient and violence perpetration in the English general population. *Psychol Med*. 2019;49(8):1316-1323. https://doi.org/10.1017/S0033291718001939. Published online July 30.
22. Varma TR. Maternal weight and weight gain in pregnancy and obstetric outcome. *Int J Gynaecol Obstet Off Organ Int Fed Gynaecol Obstet*. 1984;22(2):161-166.
23. Batty GD, Deary IJ, Schoon I, Gale CR. Childhood mental ability in relation to food intake and physical activity in adulthood: the 1970 British Cohort Study. *Pediatrics*. 2007;119(1):e38-e45. https://doi.org/10.1542/peds.2006-1831.
24. Wraw C, Der G, Gale CR, Deary IJ. Intelligence in youth and health behaviours in middle age. *Intelligence*. 2018;69:71-86. https://doi.org/10.1016/j.intell.2018.04.005.
25. Cournot M, Marquié JC, Ansiau D, et al. Relation between body mass index and cognitive function in healthy middle-aged men and women. *Neurology*. 2006;67(7):1208-1214. https://doi.org/10.1212/01.wnl.0000238082.13860.50.
26. Taki Y, Kinomura S, Sato K, et al. Relationship between body mass index and gray matter volume in 1,428 healthy individuals. *Obes Silver Spring Md*. 2008;16(1):119-124. https://doi.org/10.1038/oby.2007.4.
27. Krul AJ, Daanen HAM, Choi H. Self-reported and measured weight, height and body mass index (BMI) in Italy, the Netherlands and North America. *Eur J Public Health*. 2011;21(4):414-419. https://doi.org/10.1093/eurpub/ckp228.

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