**Supplementary Methods** for

Disentangling potential causal effects of educational duration on well-being, and mental and physical health outcomes

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# **Details on phenotype data**

## *Outcome variables*

1. **General happiness** was based on the UKB variables happiness (4526), collected on three instances (2006-2010, 2012-13, and 2014+) in the baseline questionnaire, and general happiness (20459), collected in a follow-up questionnaire (2016-2017).

*Question*: “In general how happy are you?”.

*Original response coding*: 1=extremely happy, 2=very happy, 3=moderately happy, 4=moderately unhappy, 5=very unhappy, 6=extremely unhappy, [-1/-121]=do not know, [-3 /-818]=prefer not to answer.

*Cleaning:* Both variables were first reverse-coded so that a higher score indicates a higher level of well-being. Individuals who indicated “do not know” or “prefer not to answer” were coded as missing. In case individuals had data available for more than one time-point in the baseline questionnaire, we selected the first time-point available. If participants filled out both the baseline and the follow-up questionnaire, we used data from the baseline questionnaire.

1. We used satisfactionitems: **family relationship satisfaction** (4559)**, financial situation satisfaction** (4559)**, friendship satisfaction** (4570)and **work/job satisfaction** (4537) collected on three instances (2006-2010, 2012-13, and 2014+).

*Question*: “In general, how satisfied are you with your […]?

*Original response coding*: 1=extremely happy, 2=very happy, 3=moderately happy, 4=moderately unhappy, 5=very unhappy, 6=extremely unhappy, -1=do not know, -3=prefer not to answer.

*Cleaning:* We reverse-coded the items so that a higher score indicates a higher satisfaction. In case individuals provided data on multiple time-points, we selected the first available time-point.

1. **Health satisfaction** was based on health satisfaction (4548), collected on three instances (2006-2010, 2012-13, and 2014+) in the baseline questionnaire, and general happiness with own health (20459), collected in a follow-up questionnaire (2016-2017).

*Question*: “In general how [happy/satisfied] are you with your health?”.

*Original response coding*: 1=extremely happy, 2=very happy, 3=moderately happy, 4=moderately unhappy, 5=very unhappy, 6=extremely unhappy, [-121/-1]=do not know, [-818/ -3]=prefer not to answer.

*Cleaning*: Both variables were first reverse-coded so that a higher score indicates a higher level of well-being. Individuals who indicated “do not know” or “prefer not to answer” were coded as missing. In case individuals had data available for more than one time-point in the baseline questionnaire, we selected the first time-point available. If participants filled out both the baseline and the follow-up questionnaire, we used data from the baseline questionnaire.

1. **Belief that own life is meaningful** (20460) was collected in the follow-up questionnaire (2016-2017).

*Question*: “To what extent do you feel your life to be meaningful?”.

*Original response coding*: 1=not at all, 2=a little, 3=a moderate amount, 4=very much, 5=an extreme amount, -818=prefer not to answer, -121=do not know.

*Cleaning*: Responses “prefer not to answer” and “do not know” were set to missing.

1. A **Neuroticism** summary score (20127) was derived based on 12 neurotic behaviour domains from fields 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, 2000, 2010, 2020, and 2030 by prof. Jill Pell (Smith et al., 2013). The score summarizes the number of yes answers across the twelve questions.

*Domain questions*:

* Does your mood often go up and down?
* Do you ever feel ‘just miserable’ for no reason?
* Are you an irritable person?
* Are your feelings easily hurt?
* Do you often feel ‘fed-up’
* Would you call yourself a nervous person?
* Are you a worrier?
* Would you call yourself tense or ‘highly-strung’?
* Do you worry too long after an embarrassing experience?
* Do you suffer from ‘nerves’?
* Do you often feel lonely?
* Are you often troubled by feelings of guilt?

 *Domain response coding*: 0=no, 1=yes, -1=do not know, -3=prefer not to answer.

1. A binary **depression** variable was based on medical record data of hospital inpatient records in either the primary or secondary position (41270) and self-reported non-cancer illness data (20002).

*Item construction:* For the medical record data, individuals were coded as 1(=depression ever, present) if they, on any occasion, were diagnosed with any of the following ICD-10 diagnoses: Mild depressive episode (F32.0), moderate depressive episode (F32.1), severe depressive episode without psychotic symptoms (F32.2), severe depressive episode with psychotic symptoms (F32.3), other depressive episodes (F32.8), depressive episode unspecified (F32.9), recurrent depressive disorder current episode mild (F33.0), recurrent depressive disorder current episode moderate (F33.1), recurrent depressive disorder current episode severe without psychotic symptoms (F33.2), recurrent depressive disorder current episode severe with psychotic symptoms (F33.3), recurrent depressive disorder currently in remission (F33.4), other recurrent depressive disorders (F33.8), recurrent depressive disorder unspecified (F33.9). For the self-report data, individuals were coded as 1(=depression ever, present) if they selected the option “depression”. Individuals who were not coded as 1(= depression ever, present) based on the items above, were coded as 0(=depression ever, absent).

1. A binary **anxiety** variable was based on medical record data of hospital inpatient records in either the primary or secondary position (41270) and self-reported non-cancer illness data (20002).

*Item construction*: For the medical record data, individuals were coded as 1(=anxiety ever, present) if they, on any occasion, were diagnosed with any of the following ICD-10 diagnoses: agoraphobia (F40.0), social phobias (F40.1), specific (isolated) phobias (F40.2), other phobic anxiety disorders (F40.8), phobic anxiety disorder unspecified (F40.9), panic disorder (F41.0), generalized anxiety disorder (F41.1), mixed anxiety and depressive disorder (F41.2), other mixed anxiety disorders (F41.3), other specified anxiety disorders (F41.8) anxiety disorder unspecified (F41.9). For the self-report data, individuals were coded as 1(=anxiety ever, present) if they selected the option “anxiety/panic attacks”. Individuals who were not coded as 1(= anxiety ever, present) based on the items above, were coded as 0(=anxiety ever, absent).

1. A binary **manic or bipolar disorder** variable was based on medical record data of hospital inpatient records in either the primary or secondary position (41270) and self-reported non-cancer illness data (20002).

*Item construction:* For the medical record data, individuals were coded as 1(=manic/bipolar ever, present) if they, on any occasion, were diagnosed with the following ICD-10 diagnoses: hypomania (F30.0), mania without psychotic symptoms (F30.1), mania with psychotic symptoms (F30.2), other manic episodes (F30.8), manic episode unspecified (F30.9), bipolar affective disorder (BAD) current episode hypomanic (F31.0), BAD current episode manic without psychotic symptoms (F31.1), BAD current episode with psychotic symptoms (F31.2) BAD current episode mild or moderate depression (F31.3), BAD current episode severe depression without psychotic symptoms (F31.4) BAD current episode severe depression with psychotic symptoms (F31.5), BAD current episode mixed (F31.6), BAD currently in remission (F31.7), other bipolar affective disorders (F31.8), BAD unspecified (F31.9). For the self-report data, individuals were coded as 1=(manic/bipolar ever, present) if they selected the option “mania/bipolar disorder/manic depression”. Individuals who were not coded as 1=(manic/bipolar ever, present), based on the items above, were coded as 0(=manic/bipolar ever, absent).

1. A binary **cardiovascular problems** variable was based on vascular/heart problems diagnosed by a doctor (6150) and self-reported non-cancer illness data (20002).

*Question (6150)*: “Has a doctor ever told you that you have had any of the following conditions? (you can select more than 1 answer)”.

*Original response coding*: 1=heart attack, 2=angina, 3=stroke, 4=high blood pressure, -7=none of the above, -3=prefer not to answer.

*Item construction*: if a participant indicated having any of the conditions stated above, or self-reported any of the following conditions (based on item 20002): hypertension, heart/cardiac problem, peripheral vascular disease, venous thromboembolic disease, other venous/lymphatic disease, stroke, transient ischaemic attack, subdural haemorrhage/ haematoma, or cerebral aneurysm, they were coded as 1(=cardiovascular problems ever, present). If not, they were coded as 0(=cardiovascular problems ever, absent).

# *Control variables*

1. We used standing height (50), measured using a Seca 2020 device at the assessment centres on three occasions (2006-2010, 2012-13, and 2014+) to assess participant **height**.

*Cleaning procedures*: We followed cleaning procedures similar to Lai et al. (2018). If height was measured on more than one occasion and there was a height difference of more than 5cm between two occasions, we set height to missing. For individuals who had height data on more than one occasion but the difference was smaller than 5 cm, we took the mean. Next, we standardized height for males and females separately to assess the presence of potential outliers. Participants with a deviation of more than 4 standard deviations were set to missing.

1. Participants were asked to enter their own **birthweight** (20022) on three instances (2006-2010, 2012-13, and 2014+).

*Cleaning procedures*: We followed cleaning procedures similar to Warrington et al. (2018). If birthweight was entered on more than one occasion, and there was a weight difference of more than 0.5kg, we set birthweight to missing. Additionally, participants with a birthweight lower than 2.5kg or higher than 4.5kg were also set to missing (as these are implausible for live term births before 1970).

1. We used **comparative body size at age 10** (1687) as assessed on three instances (2006-2010, 2012-13, and 2014+).

*Question*: “When you were 10 years old, compared to average would you describe yourself as:”

*Original response coding*: 1=thinner, 2=plumper, 3=about average, -1=do not know, -3=prefer not to answer.

*Cleaning procedures*: Individuals indicating “do not know” or “prefer not to answer” were set to missing. Additionally, when individuals provided a different answer across different occasions, they were also coded as missing. We re-coded the response categories to 1=thinner, 2=about average, and 3=plumper so that a higher score indicated a larger body size.

1. We used **comparative height size at age 10** (1697) as assessed on three instances (2006-2010, 2012-13, and 2014+).

*Question*: “When you were 10 years old, compared to average would you describe yourself as:”.

*Original response coding:* 1=shorter, 2=taller, 3=about average, -1=do not know, -3=prefer not to answer.

*Cleaning procedures*: Individuals indicating “do not know” or “prefer not to answer” were set to missing. Additionally, when individuals provided a different answer across different occasions, they were also coded as missing. We re-coded the response categories to 1=shorter, 2=about average, and 3=taller so that a higher score indicated a larger body height.

1. **Income** was based on average total household income before tax (738) as assessed on three instances (2006-2010, 2012-13, and 2014+).

*Question*: “What is the average total income before tax received by your household?”

*Original response coding*: 1=less than 18,000, 2=18,000 to 30,999, 3=31,000 to 51,999, 4=52,000 to 100,000, 5=greater than 100,000, -1=do not know, -3=prefer not to answer.

*Cleaning procedures:* if individuals indicated “do not know” or “prefer not to answer”, they were set to missing. If individuals provided a response on more than one occasion, we selected the first available time-point.

# **References**

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