



## Research paper

# Association of mentally-active and mentally-passive sedentary behaviour with depressive symptoms among adolescents

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## ABSTRACT

**Background:** The evidence on the association between sedentary behaviour and depression in adolescence is mixed. We aimed to investigate the association between mentally-active and mentally-passive sedentary behaviours at 11 years (11y) and depressive symptoms at 14y, and to examine potential mediators.

**Methods:** UK Millennium Cohort Study data were used ( $n=7,124$ ; 49% boys). At 11y, participants self-reported frequency of mentally-passive (listening to music, internet use) and mentally-active sedentary behaviours (reading, playing electronic games). Additional parental-reported behaviours (mentally-passive: TV viewing; mentally-active: homework) were summed with self-reported behaviours to represent continuous indicators of mentally-active and mentally-passive sedentary behaviour. Depressive symptoms were assessed (at 11y and 14y) using the short-version of Mood and Feelings Questionnaire. Body mass index (BMI), mentally-passive sedentary behaviour and cognition at 14y were examined as potential mediators. Linear regression models were adjusted for confounders and stratified by sex. Subsequent mediation analyses reporting e-values were used to assess unmeasured confounding.

**Results:** Among girls, mentally-passive sedentary behaviour at 11y was associated with later depressive symptoms (14y) [ $\beta:0.089$  (95%CI:0.055–0.122), e-value:1.32]. This association was mediated by BMI [5.6% (95%CI:4.1%–8.6%)] and mentally-passive sedentary behaviour [105.6% (95%CI:79.6%–156.7%)]. No associations were observed in boys or between mentally-active sedentary behaviour and later depressive symptoms.

**Limitations:** The parental report of behaviours and the assessment of mediators and outcome in the same wave are the main limitations.

**Conclusion:** Future interventions aiming to improve mental health among girls could aim to reduce mentally-passive sedentary behaviour in early teens and could target potential mediators including BMI.

## 1. Introduction

Major depressive disorder is a leading cause of disability worldwide (Kyu et al., 2018). The onset of depression commonly occurs during middle-adolescence, especially after puberty, and is more common among girls (Kessler et al., 2007). Previous studies have found a considerable prevalence of depressive symptoms among adolescents, at approximately 30% across different middle-income countries (Van-campfort et al., 2018). Specifically, previous findings from the UK

Millennium Birth Cohort Study showed a prevalence of depressive symptoms at the 15 years wave of 9.2% for boys and 24.0% for girls (Patalay and Gage, 2019). Depressive symptoms are not only a precursor to subsequent clinical depression, but are a major factor for suicide ideation (Consoli et al., 2013) as well as early development of negative cardiovascular outcomes (Correll et al., 2017; Gross et al., 2018).

Both higher physical activity and lower sedentary behaviour are associated as protective factors with mental health indicators (Hoare et al., 2016; Rodriguez-Ayllon et al., 2019; Schuch et al., 2018;

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Vancampfort et al., 2018). However, a previous systematic review investigating adolescents, found that different types of sedentary behaviours can be differently associated with depressive symptoms (Hoare et al., 2016). The authors suggested that screen-based behaviours are the most consistently associated with depressive symptoms.

For studying associations with mental health outcomes, the division of different types of sedentary behaviours into mentally-active (behaviours that increase mental demands as reading and during work) and mentally-passive (behaviours that require minimal demands as TV-viewing and listening to music) has been proposed (Hallgren et al., 2018; Kikuchi et al., 2014). Recent evidence has suggested that mentally-passive, but not mentally-active sedentary behaviour is associated with a higher risk for depression among adults (Hallgren et al., 2019, 2018; Hamer et al., 2016). However, the association between type of sedentary behaviours and depressive symptoms among adolescents is unclear.

There are a number of potential mechanisms that may explain the association between different types of sedentary behaviour and depressive symptoms. The main theoretical difference between mentally-passive and mentally-active sedentary behaviour is the higher cognitive demands of mentally-active sedentary behaviour, making it plausible that cognition may mediate this association (Aggio et al., 2016; Dunning et al., 2018). Obesity is associated with depressive symptoms (Köhler et al., 2018; Mannan et al., 2016) and has been suggested to mediate the association between types of sedentary behaviour and depressive symptoms (de Jong et al., 2013). Lastly, sedentary behaviour has a moderate tracking during adolescence, thus, higher sedentary behaviour during early adolescence is associated with a higher sedentary behaviour during mid-adolescence (Biddle et al., 2010; Busschaert et al., 2015). This can be a pathway linking sedentary behaviour during early adolescence to later depressive symptoms. Therefore, current levels of behaviour are relevant to examine as potential mediators of the prospective association between sedentary behaviour and depressive symptoms. To the best of our knowledge, no population representative cohort study has investigated the relationship between the different types of sedentary behaviour and depressive symptoms during adolescence.

Therefore, our aims were two-fold. First, we analysed the association between mentally-active and mentally-passive sedentary behaviours at 11 years and depressive symptoms at 14 years, and second we analysed the roles of later mentally-passive sedentary behaviour, body mass index (BMI) and cognition as potential mediators of the association.

## 2. Methods

### 2.1. Cohort design and sample

We used data from the UK Millennium Cohort Study (MCS), a nationally representative longitudinal study of children born in the UK between September 2000 and January 2002. Children were over-sampled from disadvantaged wards across the UK, ethnic minority areas in England, and from Scotland, Wales and Northern Ireland (Connelly and Platt, 2014). The Millennium cohort has seven waves so far: 9 months (2001), 3 years (2004), 5 years (2006), 7 years (2008), 11 years (2012), 14 years (2015) and 17 years (2018). For the present study, we used data from the 11-year and 14-year follow-ups. The initial sample consisted of 18,827 children assessed in 2001. From this, adolescents (63% from the initial) completed the questionnaires at 14 years. A total of 7,124 participants (38% of the original sample) (3,494 boys – 49%) provided full data for the current analyses and were included in the final sample. Ethics approval for all procedures was obtained from the Northern and Yorkshire Multi-Centre Research Ethics Committee of the NHS. Informed consent was secured from all participating families.

### 2.2. Sedentary behaviour type at 11 years

We used two sources of information to characterise sedentary behaviour at 11 years. We used parentally reported data of how much time per day their child spent watching television and doing homework, in which parents reported the exact amount of time (open answers). Additionally, we used data from the adolescent self-reported questionnaire, which included questions regarding the frequency of listening to music, reading for enjoyment, playing electronic games and internet use for leisure (not for school) (five response categories corresponding with 1=never, 2=less often than once a month, 3=at least once a month, 4=at least once a week and 5=most days). Parental report of adolescents' sedentary behaviours was also transformed into five categories (1=less than 60 min, 2=60–119 min, 3=120–179 min, 4=180–299 min and 5=300 min or more). Activities were divided into mentally-active (doing homework, reading for enjoyment and playing electronic games) and mentally-passive (TV-viewing, listen to music and internet use) according to previous studies (Hallgren et al., 2018) and summed (including both parental report and adolescent report), creating two continuous indicators with a potential range of 2 to 10 (mentally-active and mentally-passive sedentary behaviour).

### 2.3. Depressive symptoms

The short-version of the Mood and Feelings Questionnaire (MFQ) was used to completed by adolescents to assess depressive symptoms at 14 years (Angold et al., 1995). The short MFQ comprises 13 items and aims to assess how true a set of statements are, in relation to the completer's recent experiences (considering previous two weeks). It asks about depressive and anxiety symptoms with a 3-point Likert response (not true, sometimes or true). The items were scored and added to give a final overall score ranging from 0 to 26, with higher scores reflecting higher presence of depressive symptoms. The short MFQ has been validated previously (Angold et al., 1995; Turner et al., 2014) and deemed reliable due to a good Cronbach's alpha (0.928) (Tavakol and Dennick, 2011).

### 2.4. Mediators

We considered the following indicators at age 14 years as mediators: BMI, mentally-passive sedentary behaviour and cognition. All have been previously demonstrated to be associated with both types of sedentary behaviour and depressive symptoms (Aggio et al., 2016; de Jong et al., 2013; Dunning et al., 2018; Faragher et al., 2005; Mannan et al., 2016).

BMI at 14y was calculated using values of research assistant-measured stature (in metres) and body mass (in kilograms) and was used continuously in the analysis. For association analyses, BMI was used as z-score (Must and Anderson, 2006). Sedentary behaviour at 14y was adolescent-reported using questions regarding time spent in sedentary activities (playing electronic games, watching TV/films, using internet and doing homework) during a normal weekday. Categories were re-coded to the midpoint in each category to represent the amount of time in each activity (e.g. for category 1–2 h, was computed 1.5 h). Subsequently, sedentary behaviours were divided into mentally-active (playing electronic games and doing homework) and mentally-passive sedentary behaviour (watching TV/films and using internet) and summed to create continuous indicators of time spent in each type of sedentary behaviour. To estimate cognition at 14y, we used data from the Cambridge Gambling Task, which is taken from the Cambridge Neuropsychological Test Automated Battery (Robbins et al., 1994). It measures decision-making and as a final indicator, we adopted quality of decision making (the total number of rational choices made by the participants).

## 2.5. Confounding variables

Psychological distress at 11 years, parental education, parental psychological distress, sports practice and soft drinks consumption were included in the analyses as potential confounders considering their associations with the exposure and outcome (Hoare et al., 2016; Kandola et al., 2021).

Child mental health at 11y was assessed the parent-reported Strengths and Difficulties Questionnaire, which is commonly used among children and adolescents (Goodman et al., 2000) and asks about difficulties in four domains (emotional symptoms, conduct problems, hyperactivity and peer problems), with five 3-point Likert scale items each. Individual item scores were summed to produce a component score for each domain. The sum of these components produces a total difficulties score.

Parental psychological distress (at the child's 11y wave) was assessed using the Kessler 6-scale, which includes six questions about depressive and anxiety symptoms (5-point Likert answers categories plus "do not know/do not wish to answer") (Kessler et al., 1998).

Parental education was assessed by asking the highest academic qualification achieved by the head of the family.

Child sports practice at 11y was assessed through the question "How often do you play sports or active games inside or outside?", with the possible answers: "1= Never, 2=less often than once a month, 3=At least once a month, 4=At least once a week, 5=Most days."

Child soft drinks consumption at 11y, which is a diet component associated with mental health (Kang et al., 2018; Zhang et al., 2019), was adopted as a healthy-diet proxy and assessed using the self-reported question: "How often does the cohort member drink sweetened drinks?", with possible answers: "1=Hardly ever or never, 2=less than once a month, 3=less often but at least once a month, 4=1-2 days a week, 5=3-6 days a week, 7=once a day and 8=more than once a day".

## 2.6. Statistical analysis

Characteristics of the sample were presented using values of mean or frequency and 95% confidence intervals. Non-crossed confidence intervals were used to detect differences between groups. Associations of mentally-passive and mentally-active sedentary behaviour (at 11y) with depressive symptoms (at 14y) as well as potential mediators (at 14y) were analysed using linear regression models (with square root transformation for the outcome given the non-normality). All models were adjusted for psychological distress at 11y, parental education, parental psychological distress, sports practice and soft drinks consumption. A sensitivity analysis was also conducted exploring the association between different types of sedentary behaviour and depressive symptoms using linear regression models. Preliminary analyses identified a statistically significant interaction between sex and mentally-passive sedentary behaviour in predicting depressive symptoms, but not for mentally-active sedentary behaviour (Mentally-active SB:  $\beta$ : 0.013; 95% CI: -0.017–0.043. Mentally-passive SB:  $\beta$ : 0.027; 95%CI: 0.001–0.055). For consistency we stratified all analyses by sex.

After the first set of analyses, we created mediation model, using age 14y data on BMI z-score, physical activity, mentally-passive sedentary behaviour and cognition as mediators, in the association of mentally-passive sedentary behaviour and depressive symptoms among girls (Fig. 1). The mediation models were created using the concepts of Valeri and Vanderweele (2013), including interactions between exposure and mediator when appropriate, with linear regression models, using the command "medeff" (Imai et al., 2010). After this, the level of potential unmeasured confounders was estimated using E-values, which are defined as the minimum strength of association (risk ratio scale) that an unmeasured confounder would need to have with both exposure and the outcome to fully explain the specific exposure-outcome association, conditional on the measured covariates (VanderWeele and Ding, 2017). As a sensitivity analysis, we re-ran the mediation models excluding leisure-time computer use as a mentally-passive sedentary behaviour, as some of the activities during the leisure-time use of the computer may be

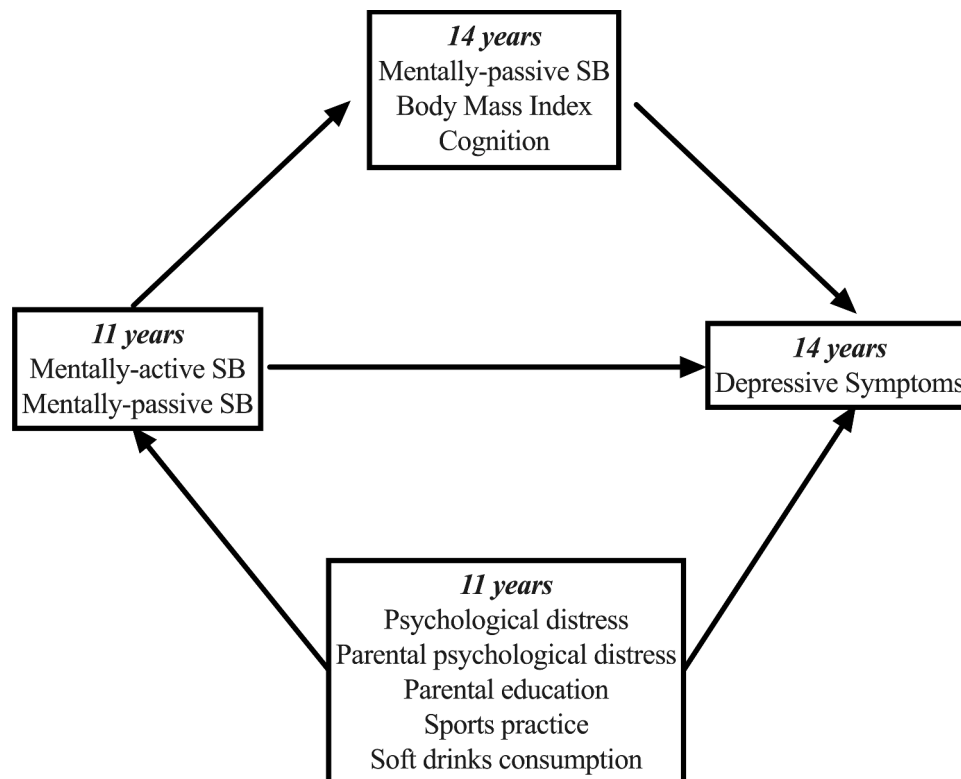


Fig. 1. Theoretical model. Note. SB, sedentary behaviour.

considered mentally-active. All analyses accounted for non-response sampling weights and were conducted in the software Stata 15.1.

### 3. Results

**Table 1** presents the characteristics of analysis sample. Girls reported more time in mentally-passive sedentary behaviour at both time-points and also less time in mentally-active sedentary behaviour at 14y. Also, girls reported lower levels of physical activity and a higher number of depressive symptoms at 14y.

Neither mentally-active nor mentally-passive sedentary behaviours were associated with depressive symptoms among boys (**Table 2**). However, higher mentally-passive sedentary behaviour was associated with subsequent higher levels of depressive symptoms among girls, with an e-value of 1.32. Mediation analyses were pursued for this association. Considering the different types of sedentary behaviour individually (**Supplementary Table A**), there were no associations among boys, while reading for enjoyment, TV-viewing and listen to music were associated with higher depressive symptoms among girls.

The association between different types of sedentary behaviour and potential mediators of the association between the sedentary behaviour and depressive symptoms are presented in **Table 3**. Mentally-passive sedentary behaviour at 11y was consistently associated with higher mentally-passive sedentary behaviour among boys and girls at 14y as well as with lower cognition scores and higher BMI among girls.

Mediation models revealed that the most consistent mediator of the association between mentally-passive sedentary behaviour and depressive symptoms among girls was mentally-passive sedentary behaviour at 14y [%mediation: 105.6% (95%CI: 79.6%–156.7%)]. In addition, BMI [%mediation: 5.6% (95%CI: 4.1%–8.6%)] presented small mediation effects, while cognition did not demonstrate a consistent mediation effect (**Table 4**). The sensitivity analysis excluding leisure-time computer use of the indicator of mentally-passive sedentary behaviour revealed similar findings (**Supplementary Table B**).

**Table 1**  
Characteristics of sample.

	Boys (n = 3,494)	Girls (n = 3,630)
<b>11 years</b>		
<i>Mentally-passive SB</i>		
Listen music (most days), %	57.3 (55.3–59.2)	64.3 (62.5–66.2)
Internet use (most days), %	55.1 (53.1–57.1)	53.1 (51.0–55.1)
TV-viewing (2h/day), %	39.4 (36.9–41.9)	43.0 (40.6–45.4)
<i>Mentally-active SB</i>		
Playing games (most days), %	67.9 (65.7–70.0)	40.3 (38.4–42.3)
Reading for leisure (most days), %	38.7 (36.4–41.0)	53.2 (51.0–55.3)
Doing homework (2h/day), %	47.8 (45.4–50.2)	56.6 (54.4–58.8)
Mentally-passive SB (score)	11.7 (11.6–11.8)	12.1 (12.0–12.1)
Mentally-active SB (score)	11.0 (10.9–11.1)	11.1 (11.0–11.2)
Total difficulties, score	7.75 (7.45–8.04)	6.75 (6.49–7.01)
Sports practice (most days), %	66.2 (64.2–68.2)	50.6 (48.5–52.7)
<b>14 years</b>		
Depressive symptoms, score	4.16 (3.98–4.34)	7.15 (6.86–7.44)
Mentally-passive SB (h/day)	6.8 (6.7–7.0)	7.4 (7.2–7.5)
Mentally-active SB (h/day)	5.9 (5.8–6.0)	4.3 (4.2–4.4)
Soft drinks ingestion (everyday), %	26.3 (24.5–28.2)	20.7 (19.0–22.5)
Happy with school, %	11.5 (10.2–13.1)	16.3 (15.0–17.8)
MVPA (7 days during previous week), %	23.9 (22.1–25.9)	12.5 (11.0–14.1)
BMI, kg/cm <sup>2</sup>	20.9 (20.7–21.0)	21.9 (21.8–22.1)
Cognition, score	0.81 (0.80–0.82)	0.82 (0.81–0.82)
Parental psychological distress, score	4.25 (4.04–4.45)	4.51 (4.30–4.72)
Parental academic status (college), %	43.3 (40.7–46.0)	43.4 (40.9–46.0)

Note. Values are presented using values of frequency (percentages of sample) / mean and 95% confidence interval). SB, sedentary behaviour.

**Table 2**

Association of mentally-active and mentally-passive SB at 11 years with depressive symptoms at 14 years.

	Boys β (95% CI)	E- value	Girls β (95% CI)	E- Value
Mentally-active SB	0.015 (-0.011–0.040)	1.11	0.025 (-0.006–0.056)	1.15
Mentally-passive SB	0.018 (-0.007–0.043)	1.12	0.089 (0.055–0.122)	1.32

Note. Values of Mood and Feelings Questionnaire were transformed using the square root function Adjusted for psychological distress, parental education, parental psychological distress, sports practice and soft drinks ingestion. Sex-interactions: Mentally-active SB: β: 0.013 (95%CI: -0.017–0.043); Mentally-passive SB: β: 0.027 (95%CI: 0.001–0.055).

**Table 3**

Association between mentally-active and mentally-passive SB and potential mediators.

Sedentary behaviour at 11y	Mentally-passive 14yβ (95% CI)	Cognition 14 yearsβ (95% CI)	BMI (z-score)β (95% CI)
<i>Boys</i>			
Mentally-active	-0.003 (-0.019–0.012)	0.000 (-0.001–0.001)	0.005 (-0.015–0.026)
Mentally-passive	0.182 (0.168–0.195)	-0.001 (-0.002–0.001)	0.023 (0.001–0.045)
<i>Girls</i>			
Mentally-active	-0.005 (-0.020–0.010)	-0.000 (-0.002–0.001)	0.007 (-0.016–0.031)
Mentally-passive	0.217 (0.204–0.230)	-0.002 (-0.003 to -0.001)	0.060 (0.036–0.084)

Note. Adjusted for psychological distress at 11y, parental education, parental psychological distress, sports practice and soft drinks ingestion.

### 4. Discussion

In a large representative cohort of UK adolescents, Mentally-active sedentary behaviour at 11y was not associated with depressive symptoms at 14y in either boys or girls. In contrast, mentally-passive sedentary behaviour at 11y was associated with increased depressive symptoms among girls at 14y. This association was mediated by mentally-passive sedentary behaviour, and BMI at 14y.

Previous studies have shown that more time spent sedentary was associated with higher depressive symptoms among adolescents (Hoare et al., 2016; Rodriguez-Ayllon et al., 2019; Vancampfort et al., 2018), but this evidence is large based on screen-based behaviours. We examined mentally-active and mentally-passive sedentary behaviours separately as recommended previously (Hallgren et al., 2018; Kikuchi et al., 2014) and our results align with evidence suggesting a potentially association between mentally-passive sedentary behaviour and depressive symptoms among adults (Hallgren et al., 2019, 2018). To our knowledge, this is the first study to investigate this association among adolescents, and to examine the role of potential mediators. We showed that the association between mentally-passive sedentary behaviour and depressive symptoms was statistically significant only among girls but not boys. These sex differences highlight that risk factors for depressive symptoms may be sex-specific and that other (non-sedentary) behaviours are likely to be more important for boys (Hoare et al., 2016; Kandola et al., 2021). This observation may have important public health implications, as adolescent females experience higher rates of mental health problems than males, but also engage in greater mentally-passive sedentary behaviour. On the other hand, it is encouraging to note that mentally-active sedentary behaviour was not associated with depressive symptoms. Theoretically, mentally-active behaviours should even be associated with lower depressive symptoms due its characteristics and brain activation (Horowitz-Kraus and



**Table 4**

Mediation models of the association between mentally-passive sedentary behaviour at 11y and depressive symptoms at 14y among girls.

	Total effect	Direct effect	Mediation effect	E-value	% of mediation
Body mass index (z-score)	0.089 (0.055–0.122)	0.084 (0.051–0.116)	0.005 (0.002–0.009)	1.05	5.6% (4.1%–8.6%)
Mentally-passive SB	0.089 (0.055–0.122)	-0.005 (-0.047–0.036)	0.094 (0.070–0.118)	1.34	105.6% (79.6%–156.7%)
Cognition	0.089 (0.055–0.122)	0.090 (0.059–0.122)	-0.001 (-0.003–0.001)	1.03	N/A

Note. Adjusted for psychological distress at 11y, parental education, parental psychological distress, sports practice and soft drinks ingestion. % of mediation was only presented for significant indirect effects.

Hutton, 2018). The global response to the COVID-19 pandemic has given rise to concerns about increased screen use amongst young people and this evidence suggests that greater screen use for mentally-active sedentary behaviours (such as home schooling) may not carry the mental health risks feared. However, excessive engagement in mentally-passive sedentary behaviours should be discouraged.

In order to investigate potential mechanisms underlying the proposed association between mentally-passive sedentary behaviour and depressive symptoms, we also analysed the role of potential mediators. This showed that later mentally-passive sedentary behaviour mediated the association in girls. As mentally-active sedentary behaviour at 11y was associated with mentally-passive sedentary behaviour at 14y, this suggests a potential maintenance pathway, as supported by previous studies (Smith et al., 2015; Telama, 2009).

BMI demonstrated only a small mediation effect in the association between mentally-passive sedentary behaviour and depressive symptoms. It is plausible to infer that there are also other potential psychological mechanisms linking obesity and depression such as body image perception (Mond et al., 2011) and lower self-esteem (Russell-Mayhew et al., 2012). There may also be other biological mechanisms, such as through changes in inflammatory and immunological profiles (Köhler et al., 2017; Luppino et al., 2010; Schachter et al., 2018), which were not available in the current study but warrant further investigation.

We hypothesized that higher mentally-passive sedentary behaviour could be associated with reduced brain activity (Horowitz-Kraus and Hutton, 2018), particularly in the hippocampus (Firth et al., 2018) and consequently with lower cognitive performance, given that mentally-passive sedentary behaviour requires minimal cognitive efforts (Aggio et al., 2016; Bakrania et al., 2018). However, we found that even though mentally-passive sedentary behaviour was associated with lower cognitive performance, cognition did not mediate the association between mentally-passive sedentary behaviour and depressive symptoms, raising questions about this mechanisms.

Our results consistently show that different types of sedentary behaviour have different associations with depressive symptoms. Our data has identified a range of potentially modifiable factors from which to inform mental health promotion among adolescent girls. Interventions could aim to target mentally-passive sedentary behaviours during early adolescence, which may be especially important considering the potential tracking of sedentary behaviour through mid-adolescence. Mental health promotion could also focus on the reduction of passive screen behaviours such as TV-viewing and computer use for leisure (Wu et al., 2016).

Despite the nationally representative prospective design used in the present study, our results should be interpreted in light of potential limitations. We combined parentally- and adolescent-reported measures of sedentary behaviour which involved translating response categories for the parental items from reported time into frequency. However, despite limited accuracy in estimating time, self-reported data on behaviour is likely to be able to rank time spent in behaviour (Corder et al., 2009), and is still the predominant method for assessing type of sedentary behaviour. This analysis therefore presents a pragmatic use of the data available, which also allows incorporation of a wider range of sedentary behaviours. Moreover, we also created continuous indicators based on Likert scales, which may be susceptible to potential bias, especially considering the merge of different scales of parental and

adolescent report. We were also unable to adjust for depressive symptoms at 11 years due to unavailability of data. However, we adjusted the analyses for the parent-reported psychological distress. We were also unable to adjust the analyses for a broader indicator of physical activity as only data on sports practice was available in the dataset. Although sports participation is a frequent physical activity practice among adolescents there are other frequent activities (e.g. active transport, active play) that are not captured by this indicator (Payne et al., 2013). Further work should consider the mediating role of other physical activity behaviours. Unmeasured confounding, such as anxiety, which can be associated with exposures, mediators and outcome may have also affected the analyses. In addition, we did not have intermediary time-points and consequently, mediators and outcomes were measured in the same wave, limiting our ability to infer causality. Even though we hypothesised a consistent framework as a potential causal model for structuring this analysis, we acknowledge the possibility of potential reverse causality in the associations. For example, it is plausible that depressive symptoms could be associated with increased mentally-passive sedentary behaviours due to depressive symptoms causing a lack of energy and motivation (Firth et al., 2016; Vancampfort et al., 2017).

In conclusion, mentally-passive sedentary behaviour at 11y was associated with depressive symptoms at 14y among girls only, and this association was mediated by BMI, and mentally-passive sedentary behaviour at 14 years. In contrast, mentally-active sedentary behaviour was not associated with depressive symptoms in either boys or girls. Future interventions aiming to improve mental health among girls could consider targeting reductions in mentally-passive sedentary behaviours rather than focussing on overall time spent sedentary.

### Declaration of Competing Interest

The authors declare that they have no competing interests.

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### Availability of data

Cohort data comply with ESRC data sharing policies, readers can access data via the UK Data Archive ([www.data-archive.ac.uk](http://www.data-archive.ac.uk)).

### Ethical standards

The 2011 wave was approved by the Yorkshire and The Humber – Leeds East Ethics Committee (11/YH/0203) and the 2015 wave was approved by the London – Central MREC (13/LO/1786). All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jad.2021.07.004](https://doi.org/10.1016/j.jad.2021.07.004).

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