Associations between mentally-passive and mentally-active sedentary behaviours during adolescence and psychological distress during adulthood

André O. Werneck \textsuperscript{a,b}, Erin Hoare \textsuperscript{a,c,e}, Brendon Stubbs \textsuperscript{d,f}, Esther M.F. van Sluijs \textsuperscript{a,*}, Kirsten Corder \textsuperscript{b}

\textsuperscript{a} MRC Epidemiology Unit and Centre for Diet and Activity Research (CEDAR), University of Cambridge, Cambridge, UK
\textsuperscript{b} Food & Mood Centre, Centre for Innovation in Mental and Physical Health and Clinical Treatment, School of Medicine, Faculty of Health, Deakin University, Melbourne, Victoria 3004, Australia
\textsuperscript{c} MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Institute of Metabolic Science, Cambridge Biomedical Campus, Box 285, Cambridge CB2 0QQ, UK
\textsuperscript{d} Department of Psychological Medicine, Institute of Psychiatry, Psychology and Neuroscience, King’s College London, De Crespigny Park, Box SE5 8AF, London, UK
\textsuperscript{e} Deakin University, IMPACT Strategic Research Centre, School of Medicine, Barwon Health, Geelong, Australia
\textsuperscript{f} South London and Maudsley NHS Foundation Trust, London, UK

\textbf{A B S T R A C T}

It is unclear if different types of sedentary behaviour during the adolescence are differentially associated with psychological distress during adolescence and adulthood. It is also unknown what may mediate this potential proposed association. The current study aimed to analyse the association of mentally-active and mentally-passive sedentary behaviours during adolescence (16y) with subsequent psychological distress during adulthood (42y), and to examine the role of potential mediators (42y). Data from the 1970 British Cohort Study was used (N = 1787). At age 16y participants reported time and frequency in mentally-passive (TV-viewing and watching movies) and mentally-active (reading books, doing homework and playing computer games) sedentary behaviours, psychological distress and organized sports participation. At 42y, participants reported cognition (vocabulary test), TV-viewing, psychological distress, self-rated health, body mass index and employment status. Education was collected throughout the follow-up years. Logistic regression and mediation models assessed associations. Multiple imputation using chained equations was used to assess the impact of missing data. Mentally-passive sedentary behaviour in adolescence was a risk factor for psychological distress in adulthood in complete-cases analysis \([\text{OR}:1.44(95\%\text{CI}:1.09–1.90)]\), which was confirmed by the model with multiple imputation. Mentally-active sedentary behaviour at 16y was not associated with psychological distress at 42y. Adult TV-viewing during weekends (24.7\%), and self-rated health (19.0\%) mediated the association between mentally-passive sedentary behaviour during adolescence and psychological distress during adulthood. However, the mediation was not clear in the models with multiple imputation. Mentally-passive sedentary behaviour during adolescence was associated with elevated psychological distress during adulthood and this association was mediated TV-viewing and self-rated health in adulthood.

1. Introduction

Depression is highly prevalent and is estimated to affect 4.4% of global population (Ferrari et al., 2013). Moreover, depressive symptoms are associated with a reduced life expectancy (Chang et al., 2011), including the development of cardiovascular disease among patients with depression (Correll et al., 2017). There is large variation in the underlying risk and protective factors for depression, and there has been increased attention on lifestyle behaviours as potential modifiable factors for prevention, management and treatment of common mental disorders (Köhler et al., 2018). Psychological distress is related to depressive symptoms and therefore is of interest in mental health research for the prevention of depression (Bell et al., 2015; Rutter et al., 1970). Low physical activity is associated with increased incidence of depression, especially among adults (Schuch et al., 2018).

Also, sedentary behaviour during adolescence has been associated...
with later depressive symptoms (Hamer et al., 2016; Kandola et al., 2020). Inflammation has been suggested as a biological mechanisms linking sedentary behaviour and depressive symptoms among adults (Endrighi et al., 2016). However, it is plausible that mentally active sedentary behaviours may provide stimulation and other protective benefits that may not be achieved through mentally passive sedentary behaviours. Thus the type of sedentary behaviour, as opposed to duration of time spent sedentary, which is of primary interest for physical chronic diseases, is of particular interest for mental health outcomes (Hallgren et al., 2020; Hallgren et al., 2018; Kikuchi et al., 2014).

Indeed, previous studies found that the association between sedentary behaviour and depressive symptoms is possibly domain-dependent. Specifically, mentally-passive (e.g. watching TV) sedentary behaviours were associated with depressive symptoms, while mentally-active (e.g. reading, working) sedentary behaviours had no association or were protective of depressive symptoms (Hallgren et al., 2019; Hallgren et al., 2018). However, previous studies have primarily emerged from adult samples and the association between different types of sedentary behaviour during adolescence and mental health in adulthood is still unclear. This is highlighted due to the importance of adolescence for the long-term adoption of health behaviours (Hayes et al., 2019), and a longer period presenting higher sedentary behaviour can be differently associated with the outcome, considering the higher latency period. Also, the onset of mental disorders as depression occurs during adolescence, which can be a critical period for the development of health behaviours (Kessler et al., 2007).

Considering that sedentary behaviour, especially in mentally-passive activities, is independently associated with depressive symptoms (Hallgren et al., 2018), previous research also has identified several potential physical, psychological and behavioural mediators of the association between overall sedentary behaviour and depressive symptoms (Stubbs et al., 2018). However, mediators of mentally-active and mentally-passive sedentary behaviours have not been examined and may differ because mentally-active and mentally-passive sedentary behaviours have potential distinct associations with health indicators (Hallgren et al., 2018).

Considering tracking of sedentary behaviour (Russchaert et al., 2015), it is possible that higher levels of sedentary behaviour during adolescence may be associated with higher levels of sedentary behaviour during adulthood, and consequently associated with adult depressive symptoms (Hamer et al., 2016; Vancampfort et al., 2017). Similarly, sedentary behaviour can also be associated with other risk behaviours such as physical inactivity (Koyanagi et al., 2018), which is also associated with depressive symptoms and could be potential mediators of the association between in the association between sedentary behaviours and psychological distress (Stubbs et al., 2018; Werneck et al., 2019).

Considering that mentally-passive sedentary behaviour is associated with minimal cognitive demands, cognition can also be a potential mediator of the association between mentally-passive sedentary behaviour and psychological distress (Horowitz-Kraus and Hutton, 2018; Kaser et al., 2017). In addition, sedentary behaviour is associated with self-rated health (Rosenkranz et al., 2013), which is a general perception of health and is closely associated with several indicators of physical health as chronic diseases and mobility that can also be influenced by higher sedentary behaviour (Gyasi and Phillips, 2018; Mansyelka et al., 2003) and self-rated health can be associated with depressive symptoms, acting as a potential mediator (Uchino et al., 2019).

Therefore, we aimed to examine the association between mentally-passive and mentally-active sedentary behaviours during adolescence with psychological distress during adulthood and investigate the role of potential mediators in the association between adolescent sedentary behaviours and adult psychological distress.

2. Methods

2.1. Cohort design and sample

The 1970 British Birth Cohort (BCS70) is a multidisciplinary longitudinal study (Elliott and Shepherd, 2006). Initially, BCS70 was designed as the British Births Survey and included all individuals from England, Scotland, Wales and Northern Ireland who were born in a specific week of 1970 (Elliott and Shepherd, 2006). The sample was followed-up in 1975 (5y), 1980 (10y), 1986 (16y), 1996 (26y), 2000 (30y), 2004 (34y), 2008 (38y), 2012 (42y) and 2016 (46y). The present study analysed data from 1986 and 2012 waves. All questionnaire data were collected through face-to-face interviews, including self-reported questions. 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. All procedures involving human subjects/patients were approved by a internal committee for the 1986 wave and London-Central MREC (11/LO/1560) for the 2012 wave. Participants provided informed consent and all procedures.

The initial study sample included 17,284 people (at 1970). However, there are substantial missing data in the adolescence wave (1986–16 years), due to a teacher’s strike; 6350 participants did not complete the self-completion module during adolescence, with 4393 adolescents with valid data for the main exposures. When also considering the 2012 wave, our final sample was composed of 1787 participants with complete data (706 men).

2.2. Exposures: sedentary behaviour during adolescence

Mentally-active and mentally-passive sedentary behaviours were used as our main exposures. Sedentary behaviour during adolescence was assessed using questions covering several domains. Questions about time spent in sedentary behaviour during the previous day were asked regarding reading books, doing homework, watching films, playing computer games and TV-viewing. For all these questions, possible answers were: a) not at all, b) less than 1 h, c) more than 1 h, d) more than 2 h, e) more than 3 h or f) more than 4 h.

Sedentary behaviours were divided into two sub-groups, mentally-passive sedentary behaviour (TV-viewing and watching movies) and mentally-active sedentary behaviours (reading books, doing homework and playing computer games) as per previous research (Hallgren et al., 2019; Hallgren et al., 2018) (Supplementary Fig. A). We then summed the number of hours reported watching TV and movies (for mentally-passive sedentary behaviour) and the number of hours reported reading books, doing homework and playing computer games (for mentally-active sedentary behaviour) and dichotomised using the cut-off point of more than 3 h was used as in previous studies (high: ≥3 h/day and low: <3 h/day) (Rezende et al., 2016). Magazine and newspaper reading were also assessed, but we were unable to include in our indicators as they were on a different scale.

2.3. Outcome: adult psychological distress

Psychological distress was evaluated using the Malaise Inventory at both time-points, which asks questions regarding depressive moods, lack of energy, anxiety and stress (Kutter et al., 1970). During adolescence, the 24-item scale was used, excluding the “rheumatism and fibrosis” and “nervous breakdown” questions. A score of 15 or higher was considered as elevated. During adulthood, the 9-item version was applied. A score of 4 or more was considered as elevated, as adopted in previous analyses (Ploubidis et al., 2017). Aiming to improve the comparability between the measures, we also considered the same 9 items of the adolescent scale in the adolescent measurement, with a score of 4 or more considered as elevated. The Malaise inventory of 24 items presented good reliability (Cronbach alpha = 0.80) in a previous study among the UK adult
population (Rodgers et al., 1999) and the 9-item version have a high correlation with the 24-item questionnaire (Ploubidis et al., 2017). However, the reliability among adolescents is unknown.

2.4. Potential mediators

Potential mediators were identified from the existing evidence base (Hamer et al., 2016; Kaser et al., 2017; Koyanagi et al., 2018; Stubbs et al., 2018; Vancampfort et al., 2017; Werneck et al., 2019). Cognition was estimated using the vocabulary test, which used 20 words and cohort members were asked to select which of the five words next to it had a similar meaning to the original word. Vocabulary test was categorized according the mean (below mean and equal or superior to mean). Self-rated health was also assessed using a 5-item Likert scale; responses “good”, “very good” and “excellent” were considered as “good” self-rated health. During adulthood, participants were asked about the time spent watching television during weekdays and weekends. Possible answers were a) none, b) less than an hour, c) between 1 and 3 h, d) between 3 and 5 h and e) 5 h or more. More than 3 h of TV-viewing, considering the weighted average of TV-viewing during weekdays and weekends, was considered as elevated as used in previous studies (Rezende et al., 2016). For physical activity assessment during adulthood, participants were asked about the frequency of physical exercise participation; participants who reported at least 5 days/week were considered as active, based on proposed threshold from the World Health Organization (World Health Organization, 2010). We used self-rated health and physical activity at 34 years as mediators for a post-hoc analysis, aiming to explore the temporal sequence in the association. The question for self-rated health at 34y was similar to the question at 42y, while physical activity at 34y was assessed through a question regarding the frequency of physical exercise practice and we adopted the cut-off point of 5 days/week.

2.5. Covariates

Education and employment status were inserted as covariates given their well-known associations with depressive symptoms (Bjelland et al., 2008; Perreault et al., 2017). Education (highest qualification achieved) was categorized into three groups: None (no formal education or incomplete secondary education), at least high school and more than high school. Employment status was assessed during adulthood (having a full-time job versus not having a full time job). Physical activity during adolescence was evaluated through two questions asking about the frequency of sports participation on the street/park or in a club/sports centre. Possible answers were a) Rarely/never, b) Less than once a week, c) once a week or d) More than once a week. Participants that answered “More than once a week” were considered as active. Also, body mass index during adulthood was estimated through self-reported stature and body mass and classified using the cut-off points of 25 kg/m² for overweight and 30 kg/m² for obesity.

2.6. Statistics

Frequencies and logistic estimated 95% confidence intervals were used to describe the sample. Chi-square test and Cramer’s V were used for the comparison between included and excluded sample in the attrition analysis. Logistic regression models, reporting odds ratio (OR) were used to analyse the association between different types of sedentary behaviour during adolescence and psychological distress.

Dependent on finding an association between types of sedentary behaviour (16y) and psychological distress (42y), the potential mediation of cognition, physical activity, sedentary behaviour and self-rated health in adulthood (42y) was tested using the methods proposed by Valeri and Vanderweele (Valeri and VanderWeele, 2013). For this, the total effect was decomposed into total effect (i.e. the effect of types of sedentary behaviour on psychological distress that was not explained by the mediators), reference interaction (i.e. the effect of types of sedentary behaviour due to the interaction with the mediators), mediated interaction (i.e. the effect of types of sedentary behaviour due to both mediation and interaction with the mediators), and pure indirect effects (i.e. mediation effect). We created separate models for each mediator and we used command “med4way” on Stata 15.1 to undertake these analyses. All models were adjusted for the other type of sedentary behaviour (e.g. mentally-active sedentary behaviour for mentally-passive sedentary behaviour analysis), organized sports practice and psychological distress symptoms (Malaise Inventory with 9 items) at 16y, education, body mass index and employment status at 42y. As post-hoc analysis, we created models with self-rated health and physical activity at 34y, aiming to explore the temporal sequence in the association. The bias of potential unobserved/unmeasured confounders in the main analyses was estimated through the “E-value” (VanderWeele and Ding, 2017), which is 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. The proposed theoretical model of mediation in the association between type of sedentary behaviour and psychological distress is presented on Fig. 1.

2.7. Missing data

There was a high number of missing observations for all variables along the follow-up of the BCS70. Specifically for the present analyses, the wave of 16y was problematic due to a teacher’s strike, which affected the collection of data independently of sociodemographic factors as gender, social class and region of residency. For example, considering the participants with valid data for mentally-passive and mentally-active sedentary behaviour at 16y and participants with missing data, the basics sociodemographic data from the initial wave were similar: Age of mother at birth: Included: 26.1 ± 5.3 vs. excluded: 25.9 ± 5.6; Father’s social class (manual work): Included: 42.2% vs. excluded: 45.0%; Country of residency (England): Included: 83.1% vs. Excluded: 81.5%; Region of residency (Southeast): Included: 27.6% vs. Excluded: 29.7%. However, in the posterior waves (34y and 42y), there was a classical pattern of missing data, with a collected sample composed of participants with higher education, women and from other regions than Southeast (Mostafa and Wiggins, 2014). To handle missing data, we conducted sensitivity analysis with multiple imputation. Considering that there was no clear pattern of missing at 16y, and the lack of strong predictors of mentally-active and mentally-passive
mentally-active and mentally-passive sedentary behaviours and psychological distress during adolescence and adulthood (prospective). Association between sedentary behaviour at adolescence and elevated psychological distress symptoms (Malaise Inventory) at adolescence (cross-sectional) and adulthood (prospective).

| 16 years | 42 years |
|----------------|----------------|
| Psychological distress (malaise inventory) | Psychological distress (malaise inventory) |
| 22 items | 9 items | 9 items |

Note. Base model: adjusted for sex, other sedentary behaviour pattern (e.g. mentally-active SB adjusting the model of mentally-passive SB) for 16 years analysis) plus employment status, education, weight status and psychological distress symptoms at 16 years (with 9 items) for 42 years analysis. Cognition model: Base model + vocabulary test (below average vocabulary). Lifestyle potential mediators: Base model + physical activity and TV-viewing during weekdays and weekends. Physical and psychological potential mediators: Base model + self-rated health. OR, odds ratio. 95%CI, 95% confidence interval. SB, sedentary behaviour.

Table 4 shows the cross-sectional and longitudinal associations between adolescent mentally-active and mentally-passive sedentary behaviours and psychological distress during adolescence and adulthood with multiple imputation for missing values at 34y and 42y. Similar to the complete-cases analysis, mentally-passive was prospectively associated with higher psychological distress at 42y in all models. However, differently from the complete-cases analysis, cognition, lifestyle behaviours or self-rated health did not change the association between mentally-passive sedentary behaviour and psychological distress, highlighting a direct association.
Table 4

| Psychological distress (malaise inventory) | 16 years | 42 years |
|------------------------------------------|----------|----------|
|                                          | 22 items | 9 items  |
|                                          | OR (95%CI) | OR (95%CI) | OR (95%CI) |

Base model

Mentally-active SB  | 0.90 (0.62 to 1.32) | 0.90 (0.59 to 1.37) | 1.01 (0.76 to 1.35) |
Mentally-passive SB | 1.26 (0.96 to 1.67) | 1.01 (0.73 to 1.39) | 1.25 (1.02 to 1.53) |

Potential mediators at 42 years

Cognition

Mentally-active SB | – | – | 1.04 (0.77 to 1.40) |
Mentally-passive SB | – | – | 1.24 (1.01 to 1.51) |

Lifestyle potential mediators

Mentally-active SB | – | – | 1.08 (0.81 to 1.45) |
Mentally-passive SB | – | – | 1.39 (1.11 to 1.74) |

Self-rated health

Mentally-active SB | – | – | 1.04 (0.77 to 1.39) |
Mentally-passive SB | – | – | 1.30 (1.04 to 1.63) |

Potential mediators at 34 years

Physical activity

Mentally-active SB | – | – | 1.01 (0.76 to 1.35) |
Mentally-passive SB | – | – | 1.25 (1.02 to 1.53) |

Self-rated health

Mentally-active SB | – | – | 1.02 (0.76 to 1.37) |
Mentally-passive SB | – | – | 1.24 (1.01 to 1.52) |

Note. Base model: adjusted for sex, other sedentary behaviour pattern (e.g. mentally-active SB adjusting the model of mentally-passive SB) for 42 years analysis) plus employment status, education, weight status and psychological distress symptoms at 16 years (with 9 items) for 42 years analysis. Cognition model: Base model + vocabulary test (below average vocabulary). Lifestyle potential mediators: Base model + physical activity and TV-viewing during weekdays and weekends. Physical and psychological potential mediators: Base model + self-rated health. OR, odds ratio. 95%CI, 95% confidence interval. SB, sedentary behaviour.

Results of mediation models, considering the complete-cases analysis, for the association between mentally-passive sedentary behaviour during adolescence and psychological distress during adulthood are presented in Table 5. TV-viewing during weekends and self-rated health at 42 years mediated the association between mentally-passive sedentary behaviour during adolescence and psychological distress during adulthood, explaining 24.7% (TV-viewing during weekends) and 19.0% (self-rated health) of the association. In the sensitivity analysis including self-rated health and physical activity at 34y as mediators of the association between mentally-passive sedentary behaviour during adolescence (16y) and psychological distress during adulthood (42y), we found that self-rated health at 34 years mediated 26.0% of the association (Table 6).

4. Discussion

The main findings of the present study were that adolescent mentally-passive sedentary behaviour was associated with elevated psychological distress during adulthood. This association was mediated by adult TV-viewing during weekends and self-rated health during adulthood in complete-cases analysis, but the evidence of mediation was not supported in the analysis with multiple imputation procedures for missing data. Adult cognition, physical activity and TV-viewing during weekdays did not emerge as mediators. Adolescent mentally-active sedentary behaviour was not associated with adult psychological distress. Our findings confirm previous research that different types of sedentary behaviour can have different associations with health outcomes (Hallgren et al., 2018).

Sedentary behaviour has been reported to be consistently negatively associated with depressive symptoms during adolescence (Vancampfort et al., 2018), however, previous studies have adopted single indicators of sedentary behaviour such as total sitting time, screen time or TV-viewing (Hoare et al., 2016; Vancampfort et al., 2018) and have not examined both mentally-active and mentally-passive sedentary...

Table 6

| Potential mediators | Total effect | Controlled direct effect | Reference interaction | Mediated interaction | Pure indirect effect |
|---------------------|-------------|-------------------------|----------------------|---------------------|---------------------|
| Physical activity   | 0.38 (0.18 to 0.58) | 0.42 (–0.05 to 0.89) | –0.27 to 0.00 | 0.01 (–0.03 to 0.01) | –0.02 to 0.01 |
| Self-rated health    | –0.37 (–0.50 to 0.33) | 0.30 (–0.08 to 0.02) | –0.02 to 0.01 | –0.10 to 0.05 | 0.01 to 0.10 |

Note. Values are presented in β (95% confidence interval). Adjusted for mentally-active SB, organized sports practice and psychological distress symptoms (Malaise Inventory with 9 items) at 16 years, education and employment status at 42 years. % of mediation was only estimated for significant indirect effects. % of mediation: Self-rated health: 26.0%.

Table 5

| Potential mediators | Total effect | Controlled direct effect | Reference interaction | Mediated interaction | Pure indirect effect |
|---------------------|-------------|-------------------------|----------------------|---------------------|---------------------|
| Cognition           | 0.44 (0.04 to 0.84) | 0.41 (–0.03 to 0.85) | 0.01 (–0.24 to 0.26) | 0.01 (–0.05 to 0.05) | 0.02 (–0.01 to 0.06) |
| Lifestyle potential mediators | 0.44 (0.04 to 0.84) | 0.36 (–0.06 to 0.78) | 0.08 (–0.09 to 0.26) | –0.01 (–0.05 to 0.02) | 0.01 (–0.01 to 0.03) |
| Physical activity   | 0.44 (0.04 to 0.84) | 0.46 (0.04 to 0.87) | –0.06 (–0.20 to 0.08) | –0.05 (–0.17 to 0.07) | 0.09 (–0.01 to 0.19) |
| TV-viewing during weekends | 0.44 (0.04 to 0.84) | 0.43 (–0.01 to 0.86) | –0.06 (–0.29 to 0.16) | –0.04 (–0.17 to 0.09) | 0.11 (0.01 to 0.20) |
| Self-rated health    | 0.44 (0.04 to 0.84) | 0.38 (0.01 to 0.83) | –0.04 (–0.30 to 0.23) | –0.01 (–0.05 to 0.04) | 0.08 (0.01 to 0.15) |

Note. Values are presented in β (95% confidence interval). Adjusted for mentally-active sedentary behaviour, organized sports practice and psychological distress symptoms (Malaise Inventory with 9 items) at 16 years, education, body mass index and employment status at 42 years. % of mediation: TV-viewing during weekends: 24.7%; Self-rated health: 19.0%.
behaviours could be associated with psychological distress through a
adolescence and psychological distress during adulthood. During adolescence can predict self-rated health in adulthood (Burdette et al., 2019). It is also possible that choosing TV-viewing during weekends may be more detrimental for mental health than weekday TV-viewing as there is usually more discretionary free time at weekends so the absolute exposure to TV-viewing may be higher than on weekdays (Khouja et al., 2019). It is also possible that choosing to watch TV rather than participating in other, potentially more 'active' behaviours could be associated with psychological distress through a lack of motivation and energy (Firth et al., 2016). In addition, this finding indicates a possible association of mentally-passive sedentary behaviour maintenance on psychological distress. Sedentary behaviour during adolescence can predict self-rated health in adulthood (Burde et al., 2017), which can consequently affect mental health (Uchino et al., 2019). Moreover, self-rated health can be influenced by the presence of other chronic diseases such as cardiovascular disease which can also be promoted by highly sedentary lifestyles and can also be associated with depressive symptoms (Correll et al., 2017). However, we highlight that the mediation analysis should be inferred with caution, considering the we did not found that lifestyle behaviours or self-rated health reduced the association between mentally-passive sedentary behaviour and psychological distress in the models with multiple imputation for missing values.

Limitations of the present study should be recognized. Firstly, the number of missing data at 16 years was high; when including data from both 16 years and 42 years, the number of missing data is even more substantial, presenting a potential bias and precluding further stratified analyses. Also, attrition analysis revealed slight differences in the included sample when comparing with the excluded sample, especially concerning education. For this, multiple imputation was used to reduce the bias caused by the differential dropout considering specific socio-demographic factors. All measures were self-reported, which can present potential recall bias as well as limited reliability and validity, although our exposures were based on contexts of sedentary behaviour and our outcome was psychological distress, which we currently still do not have an objective measure. Moreover, the measure of sedentary behaviour was different during adolescence and adulthood, separate domains of mentally-active and mentally-passive behaviour were not available in adulthood. Also, there were no time-points between 16 years and 42 years at which sedentary behaviour data were measured. However, sensitivity analysis using self-rated health and physical activity at 34 years as mediator confirmed our main results (with self-rated health and physical activity at 42 years). It is also plausible that part of the adolescents TV-viewing could be watching educational programs, which can be a mentally-active activity, stimulating cognition. Despite the limitations, to our knowledge, this is the first study to prospectively investigate the association between adolescent mentally-passive and mentally-active sedentary behaviours with sedentary behaviour and mental health in mid-adulthood, and also to explore potential mediators.

Mentally-passive sedentary behaviour during adolescence was associated with psychological distress during adulthood, while mentally-active sedentary sedentary behaviour during adolescence was not associated with psychological distress during adulthood. The association between mentally-passive sedentary behaviour during adolescence and psychological distress during adulthood was mediated by TV-viewing and self-rated health in adulthood. Potential interventions targeting sedentary behaviours could focus on reducing mentally-passive sedentary behaviours instead of total sitting time. Future studies could investigate this association with more time-points and could explore a greater range of potential mediators.

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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).

Ethics approval and consent to participate

Ethical approval was given for all waves, including internal review of London Multi-Centre Research on 1970, 1975, 1980, 1986, 1996 and
2004 waves and approval from London MREC (98/2/120) for the 2000 wave, Southampton & South West Hampshire (08/H0504/144) for the 2008 wave and London-Central (11/LO/1560) for the 2012 wave. Informed consent was obtained for all waves.

Consent for publication
Not applicable.

Conflict of interests
None.

Author contribution
AOW: Analysis, interpretation of data and writing. KC and EH: Interpretation of data and writing. BS and EMFvS: Revision of the draft with substantial improvements.

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