# Is there an association between psychological distress during early adulthood and later trajectories of physical activity during adulthood? Longitudinal data from two cohort studies

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## ABSTRACT

**Background** Our aim was to analyse the prospective association between psychological distress during early adulthood and physical activity trajectories between early and middle adulthood.

**Methods** We used data from the 1958 National Child Development Study (NCDS) (n=8994, 4388 women) and the 1970 British Cohort Study (BCS) (n=7014, 4388 women). Psychological distress was assessed using the Malaise inventory at 23 years in the 1958 NCDS and at 26 years at the 1970 BCS. Self-report leisure-time physical activity (LTPA) was assessed at 33 years, 42 years, 46 years, 50 years and 55 years in the 1958 NCDS as well as at 30 years, 34 years, 42 years and 46 years in the 1970 BCS. We created physical activity trajectories, using latent class growth analysis. Poisson regression analysis was used for association.

**Results** We identified three trajectories of physical activity during adulthood in both cohorts. Participants with psychological distress at 23 years were less likely to be in the persistently high trajectory ($RR_{adjusted}$: 0.79; 95% CI 0.64 to 0.98) in the 1958 NCDS. In addition, participants with psychological distress at 26 years were less likely to be in the increased LTPA (0.73; 0.59 to 0.89) and persistently high (0.59; 0.50 to 0.69) trajectories, comparing with participants without psychological distress.

**Conclusion** Elevated psychological distress during early adulthood is associated with a lower probability of adopting positive trajectories of LTPA during adulthood.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ People with psychological distress engage in lower physical activity cross-sectionally.

### WHAT THIS STUDY ADDS

⇒ Adults with psychological distress during early adulthood were less likely to be at the persistently high physical activity trajectory in the 1958 National Child Development Study.
⇒ Higher psychological distress during early adulthood was associated with lower likelihood of being at the increased and persistently high PA trajectories in the 1970 British Cohort Study.
⇒ Early detection and treatment of common mental disorders are crucial for the adoption of healthy lifestyles throughout the adulthood.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Early detection and treatment of psychological distress are necessary to prevent the development of risk factors for physical health, such as physical inactivity.

## INTRODUCTION

Physical activity is a recognised protective factor for the development of different diseases, including mental disorders, cardiovascular diseases and different types of cancer.[1 2] However, physical activity engagement tends to decline throughout adulthood.[3] The identification of risk and protective factors for active trajectories throughout middle adulthood is important to identify and support groups vulnerable to decreasing physical activity, helping to promote physical activity and maintain optimal health.

Physical activity can be practised across the different life domains, including leisure time, transportation, occupational and household. However, studies have shown that leisure time and partly transportation physical activity are associated with health benefits, while occupational physical activity may be harmful for different health outcomes.[4 5] Therefore, the leisure-time domain is focused on specific guidelines such as from the World Health Organization.[6]

Among the determinants of leisure-time physical activity (LTPA), depressive and anxiety symptoms are cross-sectionally and prospectively associated with a lower physical activity practice during adulthood.[7–9] Psychological distress, including a mix of depressive and anxiety symptoms, is prevalent in the UK population.[10] Previous research showed that persistently high or increasing trajectories of depressive symptoms between adolescence and early adulthood are associated with lower LTPA later in life.[11 12] However, even LTPA has moderate maintenance during adulthood, there are different trajectory groups throughout early and middle adulthood,[13–15] and how psychological distress during early adulthood is associated with later trajectories of LTPA is still unclear.

Therefore, we aimed to analyse the association between psychological distress during early adulthood and physical activity trajectories between early and middle adulthood. For this purpose, we used two comparable British cohorts, with a temporal difference of 12 years to also estimate potential cohort effects.

## METHODS

### Sample

The 1958 National Child Development Study (NCDS) is a cohort study that included all individuals from England, Scotland, Wales and Northern Ireland who were born in a specific week of 1958.[16] We included data from the 23 (1981), 33 (1991), 42 (2000), 46 (2004), 50 (2008) and 55 (2013) years. All the procedures were approved by an internal committee in the 23-year, 33-years and 46-year waves, by the London MREC ethics committee for the 42 years and 50 years (08/H0718/29) waves, and by the London—Central (12/LO/2010) for the 55-year wave. Participants provided informed consent. The initial study sample with complete data at 23 years was 12 478. However, 3484 (27.9%–1857 women) participants presented missing data in at least one variable from the present study and were excluded from the sample. Therefore, the final sample was composed of 8994 participants (4388 women). More details of the 1958 NCDS were previously described.[17]

The 1970 British Cohort Study (BCS) is a multidisciplinary longitudinal study 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.[18 19] The present study analysed data from 26 (1996), 30 (2000), 34 (2004), 42 (2012) and 46 (2016) years. All procedures involving human subjects/patients were approved by an internal committee for the 26-year and 34-year waves, by the London MREC (98/2/120) for the 30-year wave, by the London-Central MREC (11/LO/1560) for the 42-year wave, and by the South-east Coast—Brighton and Sussex (15/LO/1446) for the 46-year wave. Participants provided informed consent. The initial study sample with complete data at 26 years was 8263. However, 1249 (15.1%—617 women) participants presented missing data in at least one variable from the present study and were excluded from the sample. Therefore, the final sample was composed of 7014 participants (3911 women). The methods and sample characteristics of the 1970 BCS have been described fully elsewhere.[18]

### Psychological distress

Psychological distress was evaluated using the Malaise Inventory in both cohorts (at 23 years in the 1958 NCDS, and at 26 years in the 1970 BCS). The Malaise Inventory includes questions regarding depressive mood, lack of energy, anxiety and stress. The Malaise Inventory of 24 items presented good reliability (Cronbach alpha=0.80) in a previous study among the UK population.[20]

### LTPA practice

We estimated LTPA practice (at least once a week) using different questions throughout the waves of both cohorts that have been previously used.[21] LTPA was assessed at 30 years, 34 years, 42 years and 46 years of the 1970 BCS as well as in the 33-year, 42-year, 46-year, 50-year and 55-year waves of the 1958 NCDS through the question about frequency of LTPA. Participants were shown a list of LTPA (take part in competitive sports of any kind; go to 'keep fit' or aerobics classes; go running or jogging; go swimming; go cycling; go for walks; take part in water sports; take part in outdoor sports; go dancing; take part in any other sport or LTPA which involves physical exercise), and asked: 'Do you regularly take part in any of the activities? By regularly I mean at least once a month, for most of the year'. Possible answers were 'yes' or 'no'. Participants who answered 'yes' were also asked a further question: 'How often do you take part in any activity of this type?'. Possible answers were rated on a Likert scale: 'every day', '4 to 5 days a week', '2 to 3 days a week', 'once a week', '2 to 3 times a month' or 'less often'. In the 55-year wave of the 1958 NCDS, the participants were asked: 'Whether you take part in the following activities and frequently: (1) play sports or go walking or swimming; (2) attend leisure activity groups such as evening classes, keep fit, yoga, etc'. Possible answers were 'never', 'several times a year', '1× month' or '1× week'. For the 42-year and 46-year waves of the 1970 BCS, the participants were asked: 'On how many days in a typical week do you do 30 min or more of exercise where you are working hard enough to raise your heart rate and break into a sweat?'. Possible answers were 0 to 7 days. These questionnaires have been used extensively to measure LTPA and more information on these and the estimation of LTPA is reported in further detail elsewhere.[21]

### Covariates

Gender (male or female), employment status (yes or not), living status (with partner or not) and gross family income (for the 1958 NCDS) or education (up to high school or college/more—for the 1970 BCS) were used as covariates. The adjustments were made considering the variables assessed at the first included wave of each cohort study (23 years for the 1958 NCDS and 26 years for the 1970 BCS).

### Statistics

We used absolute and relative frequencies as well as mean and SD to the characterisation of the sample. To compare the included with the excluded sample, we used the $\chi^2$ test for categorical variables and the Mann-Whitney test for gross domestic income. We also used the Kruskal-Wallis test and $\chi^2$ for trend to identify trends of the covariates according to the trajectories of LTPA practice.

We used latent class growth analysis, through a semiparametric group-based modelling to identify trajectories of LTPA practice along middle adulthood. The models were estimated using the 'traj' function in Stata V.15.1 software. A logistic model was used to fit the data, using the indicators of LTPA practice as dichotomic (1—LTPA practice at least 1 day/week or 0—less frequently). The number of trajectory groups was based on Bayesian Information Criterion and on the interpretability of the trajectories (online supplemental table 1).[22] The selection of appropriate models (linear, quadratic or cubic) was guided by posterior probability scores for each trajectory group and an average posterior probability (APP) higher than 0.70[22] as well as by the odds of correct classification (OCC). We used full-information maximum likelihood to treat missing data.

To analyse the association between psychological distress and later LTPA practice trajectories, we used multinomial logistic regression, adjusting for gender, employment status, living status and gross family income (for the 1958 NCDS) or education (for the 1970 BCS) and reporting risk ratio. All the analyses were conducted using the Stata V.15.1 software.

**Table 1** Characteristics of the sample and attrition analysis of both cohort studies during the first wave (23 years for the 1958 NCDS, and 26 years for the 1970 BCS)

| | 1958 NCDS | | | 1970 BCS | | |
|---|---|---|---|---|---|---|
| | Included (n=8994) | Excluded (n=3484) | P | Included (n=7014) | Excluded (n=1249) | P |
| Gender | | | <0.001 | | | <0.001 |
| Male | 4606 (51.2%) | 1627 (46.7%) | | 3103 (44.3%) | 632 (50.6%) | |
| Female | 4388 (48.8%) | 1857 (53.3%) | | 3911 (55.8%) | 617 (49.4%) | |
| Living status | | | <0.001 | | | <0.001 |
| Single | 4575 (50.9%) | 1649 (47.3%) | | 2941 (41.9%) | 629 (50.4%) | |
| Cohabitating | 4419 (49.1%) | 1835 (52.7%) | | 4073 (58.1%) | 620 (49.6%) | |
| Employment status | | | <0.001 | | | <0.001 |
| No | 2081 (23.1%) | 1205 (34.6%) | | 1133 (16.2%) | 309 (24.7%) | |
| Yes | 6913 (76.9%) | 2279 (65.4%) | | 5881 (83.9%) | 940 (75.3%) | |
| Education | | | | | | 0.095 |
| Up to high school | --- | --- | | 5218 (74.4%) | 957 (76.6%) | |
| College or more | --- | --- | | 1796 (25.6%) | 292 (23.4%) | |
| Gross family income* | 107.6 (63.9) | 94.2 (61.9) | <0.001 | --- | --- | |
| Psychological distress | | | <0.001 | | | <0.001 |
| No | 8448 (93.9%) | 3082 (88.5%) | | 6150 (87.7%) | 1032 (82.6%) | |
| Yes | 546 (6.1%) | 402 (11.5%) | | 864 (12.3%) | 217 (17.4%) | |

*Gross family income is presented as mean and standard deviation, with GBD/wk as unit.
BCS, British Cohort Study; NCDS, National Child and Development Study.

## RESULTS

The final sample included 8994 adults from the 1958 NCDS and 7014 from the 1970 BCS. The characteristics of the sample are presented in table 1. The sample from the 1958 NCDS was predominantly composed by men, single and employed adults. Also, the prevalence of psychological distress at 23 years was 6.1%. On the other hand, the sample from the 1970 BCS was mainly composed by women, cohabitating and employed participants. The prevalence of psychological distress at 26 years was 12.3%. There were differences in the included and excluded samples, especially regarding gender, employment status and psychological distress.

Figure 1 presents the trajectories of LTPA practice in both cohorts. We identified three trajectories of physical activity during adulthood in both cohorts (1958 NCDS: 8.3% (APP: 0.69; OCC: 14.7) increased PA, 38.8% (APP: 0.87; OCC: 32.6) decreased PA and 53.0% (APP: 0.62; OCC: 8.5) persistently high PA; 1970 BCS: 18.9% (APP: 0.58; OCC: 17.9) increased PA, 28.9% (APP: 0.85; OCC: 11.4) persistently low and 52.2% (APP: 0.73; OCC: 6.0) persistently high), using the latent class growth analysis.

The characteristics of each trajectory of LTPA practice by cohort are presented in table 2. The proportion of women in the increased LTPA trajectory was higher in the 1958 NCDS, while it was higher in the persistently low trajectory in the 1970 BCS. The prevalence of psychological distress was lower in the persistently high trajectory from the 1958 NCDS. Similarly, the increased LTPA and persistently high trajectories from the 1970 BCS presented the lowest rates of psychological distress.

Table 3 presents the association between psychological distress during early adulthood and later trajectories of LTPA practice throughout adulthood. Participants with psychological distress at 23 years were less likely to be in the persistently high trajectory ($RR_{adjusted}$: 0.79; 95% CI 0.64 to 0.98) in the 1958 NCDS. Similarly, participants with psychological distress during early adulthood (26 years) were less likely to be in the increased LTPA ($RR_{adjusted}$: 0.73; 95% CI 0.59 to 0.89) and persistently

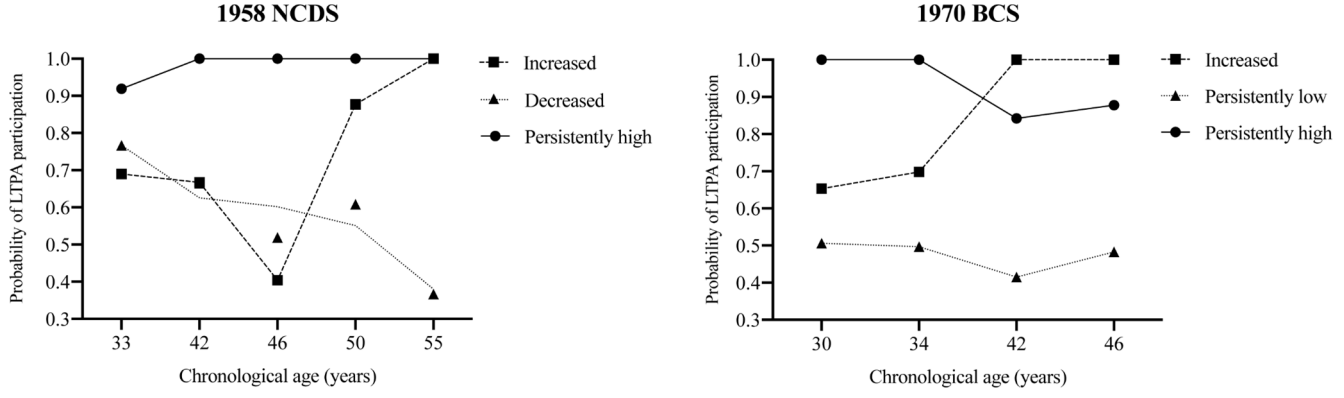


**Figure 1** Trajectories of leisure-time physical activity practice in each cohort. BCS, British Cohort Study; LTPA, leisure-time physical activity; NCDS, National Child Development Study.

**Table 2** Baseline characteristics by the trajectory groups of leisure-time physical activity practice

| 1958 NCDS | Decreased (n=3485) | Increased (n=743) | Persistently high (n=4766) | P |
|---|---|---|---|---|
| Gender (% women) | 46.5 | 52.0 | 49.2 | <0.001 |
| Living status (% cohabitating) | 49.9 | 50.1 | 47.4 | 0.074 |
| Employment status (% yes) | 75.9 | 75.4 | 79.2 | 0.001 |
| Education (% college or more) | --- | --- | --- | |
| Gross family income (GBD/week) | 106.3 (65.0) | 106.4 (61.8) | 110.0 (65.5) | 0.079 |
| Psychological distress (% yes) | 6.6 | 6.3 | 5.3 | 0.043 |
| **1970 BCS** | **Persistently low (n=3661)** | **Increased (n=1327)** | **Persistently high (n=2026)** | **p** |
| Gender (% women) | 61.1 | 50.5 | 54.7 | <0.001 |
| Living status (% cohabitating) | 57.0 | 60.5 | 57.8 | 0.111 |
| Employment status (% yes) | 80.1 | 84.9 | 85.6 | <0.001 |
| Education (% college or more) | 19.2 | 22.1 | 30.4 | <0.001 |
| Gross family income (GBD/week) | --- | --- | --- | |
| Psychological distress (% yes) | 17.1 | 11.9 | 9.8 | <0.001 |

BCS, British Cohort Study; NCDS, National Child Development Study.

high ($RR_{adjusted}$: 0.59; 95% CI 0.50 to 0.69) trajectories in the 1970BCS.

## DISCUSSION

The present study aimed to investigate the prospective association between psychological distress during early adulthood and trajectories of LTPA practice during middle adulthood using two cohorts. Our main findings were that participants with psychological distress were less likely to be in the increased (1970 BCS) and persistently high (1958 NCDS and 1970 BCS) trajectories of LTPA practice.

Our findings are consistent with previous evidence suggesting that trajectories of elevated or increasing psychological distress and depressive symptoms during adolescence are associated with lower physical activity practice later in life,[11 12] advancing previous findings in creating trajectories of LTPA practice during middle adulthood. Elevated psychological distress can affect physical activity through different mechanisms. Some symptoms

**Table 3** Association between psychological distress (at 23 years for the 1958 cohort and 26 years for the 1970 cohort) and the trajectories of leisure-time physical activity practice throughout early and middle adulthood

| 1958 NCDS | | | | | | |
|---|---|---|---|---|---|---|
| | Decreased LTPA | | Increased LTPA | | Persistently high | |
| | % | RRR (95% CI) | % | RRR (95% CI) | % | RRR (95% CI) |
| Crude | | | | | | |
| *Psychological distress* | | | | | | |
| No | 25.7 | Ref | 40.9 | Ref | 33.4 | Ref |
| Yes | 26.9 | Ref | 44.3 | 0.97 (0.78 to 1.19) | 28.8 | 0.79 (0.65 to 0.98) |
| Adjusted | | | | | | |
| *Psychological distress* | | | | | | |
| No | – | Ref | – | Ref | – | Ref |
| Yes | – | Ref | – | 0.91 (0.74 to 1.13) | – | 0.79 (0.64 to 0.98) |
| **1970 BCS** | | | | | | |
| | Persistently low | | Increased LTPA | | Persistently high | |
| | % | RRR (95%confidence interval) | % | RRR (95%confidence interval) | % | RRR (95%confidence interval) |
| Crude | | | | | | |
| *Psychological distress* | | | | | | |
| No | 19.0 | Ref | 27.3 | Ref | 53.7 | Ref |
| Yes | 18.3 | Ref | 40.2 | 0.65 (0.53 to 0.80) | 41.6 | 0.53 (0.45 to 0.62) |
| Adjusted | | | | | | |
| *Psychological distress* | | | | | | |
| No | – | Ref | – | Ref | – | Ref |
| Yes | – | Ref | – | 0.73 (0.59 to 0.89) | – | 0.59 (0.50 to 0.69) |

Adjusted for gender, living status, employment status and education (for the 1970 BCS) or gross family income (for the 1958 NCDS).
BCS, British Cohort Study; NCDS, National Child Development Study; RRR, relative risk ratio.

such as anhedonia, lack of energy and elevated perceived fatigue can be frequently barriers for people with depression to be engaged in physical activity.[23 24] Also, people with elevated psychological distress likely prefer to isolate and have lower social contact, which would also be associated with lower physical activity, especially in group-based activities.[25–27]

We found slight differences across the findings of each cohort study. Initially, we detected different trajectory patterns, in which the 1958 NCDS presented an initially higher LTPA and three trajectories (ie, increased PA, decreased PA and persistently high), while the 1970 BCS presented a lower overall prevalence of LPTA in the first wave and then three trajectories (increased LTPA, persistently low and persistently high trajectories). There were some differences in the characteristics of the cohorts that could partly explain the different trajectories such as the higher proportion of women, cohabitating participants, employed and with higher psychological distress. For instance, although there are mixed findings regarding the associations of cohabitating and employment with physical activity,[28 29] previous findings showed that women and people with higher depressive and anxiety symptoms tend to present lower physical activity.[8 30]

The trajectory patterns can also be useful to understand differences in results, such as the lack of protective association for the 'increased LTPA' pattern compared with the 'decreased LTPA' pattern in 1958 NCDS. Although both the prevalence of psychological distress and the 'increased LTPA' membership were relatively low, which probably influenced the statistical power, there are other differences comparing with the 1970 BCS trajectories. In this sense, we noticed that the increased LTPA pattern was similar to the 'decreased LTPA' pattern in three of the five waves in 1958 NCDS, only increasing after age 50, which is different from the 1970 BCS, in which the increased LTPA pattern starts from a higher plateau and is distinctly superior to the 'persistently low' pattern. Therefore, the 'increased LTPA' trajectory from the 1958 NCDS may have a distinct characteristic than the 'increased LTPA' trajectory of the 1970 BCS.

These results also highlight the need to investigate specific periods of life and their own determinants for LTPA and psychological distress, such as the moving to other locations, changes in social relationships, family issues and work transitions. Furthermore, corroborating a previous study,[10] there was a tendency for younger cohorts to have greater symptoms of psychological distress than older cohorts, with the 1970 BCS cohort consistently showing greater depressive symptoms than the 1958 NCDS cohort. Thus, with lower symptoms of psychological distress, there is a tendency for a lower influence of behavioural factors.

Our findings highlight the importance of early detection and treatment of psychological distress to avoid adherence to trajectories of unhealthy behaviours such as physical inactivity. Considering that the age of onset of most anxiety and depressive disorders occurs during late adolescence and early adulthood,[31] this period should be focused on detection and treatment. We also highlight that early detection and treatment would also help in physical health, considering that being in a trajectory of lower LTPA can be associated with different negative health outcomes.[32–34] Although we used the cut-off point of practising LTPA once a week, which is below the WHO recommendations, there are numerous studies showing that there are health benefits even with low doses of physical activity.[35 36] Considering that one of the greatest impacts of mental disorders is on physical health, where people with mental disorders as depressive disorders are more prone to develop cardiovascular diseases,[37] being in physically active trajectories could help in protecting physical health.

Our study has limitations that must be considered in the interpretation of the findings. First, the included sample was slightly different from the excluded sample. While in both cohort studies, the included sample presented higher proportion of employed people, differences were observed concerning gender and living status between the cohorts. Second, both the indicators of psychological distress and physical activity were self-reported, which can be followed by a recall bias. Third, there were different questions of LTPA along the waves of both cohorts. Although we considered any regular LTPA in our outcome, it is possible that the difference among the questions affected our latent class growth analysis. Fourth, there were classes with an APP lower than 0.7; however, these classes also presented an elevated OCC, which led us to assume the solutions of using three classes. However, as the participants are classified to the trajectory that is closely associated with their behaviours, it is possible to exist misclassification. For instance, there is a possibility of an implausible event in the increased trajectory of the 1958 NCDS, in which we observed a decline followed by an increase. On the other hand, we included data from two cohorts, with long follow-up periods, and multiple waves, allowing us to explore trajectories of LTPA throughout middle adulthood. Also, the analysis of the two cohort studies in different periods in time strengthens the consistency of the association between better mental health and persistent active habits during leisure time over adulthood.

Thus, presenting elevated psychological distress during early adulthood is associated with a lower probability of being in the positive trajectories of LTPA. Future studies should investigate how psychological distress would affect other physical activity domains as well as how specific symptoms (eg, anxiety, depression) would be associated with later physical activity trajectories.

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**Patient consent for publication** Not applicable.

**Ethics approval** The 1958 NCDS procedures were approved by an internal committee in the 23-year, 33-year and 46-year waves, by the London MREC ethics committee for the 42-year and 50-year (08/H0718/29) waves, and by the London-Central (12/LO/2010) for the 55-year wave. The 1970BCS procedures were approved by an internal committee for the 26-year and 34-year waves, by the London MREC (98/2/120) for the 30-year wave, by the London-Central MREC (11/LO/1560) for the 42-year wave, and by the Southeast Coast—Brighton and Sussex (15/LO/1446) for the 46-year wave. Participants gave informed consent to participate in the study before taking part.

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**Data availability statement** Data are available in a public, open access repository. Data from both the 1958 National Child Development Study and the 1970 British Cohort Study are available in the UK Data Service System (https://ukdataservice.ac.uk/).

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