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Association of after school sedentary behaviour in adolescence with mental wellbeing in adulthood

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Short title: Screen time and wellbeing

Abbreviations: **BCS70** = 1970 British Cohort Study; **WEMWBS** = Warwick-Edinburgh Mental Well-being Scale ; **TV** = Television

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Author Contributors' statement

Hamer performed the analysis with full access to the data, and takes responsibility for the integrity and accuracy of the results. All authors conceptualized and designed the study, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Abstract

Objective: Sedentary behaviour is associated with poorer mental health in adolescence but no studies have followed participants into mid-life. We investigated the association between after-school sedentary behaviours (screen time and homework) in adolescence with mental wellbeing in adulthood when participants were aged 42.

Methods: Participants (n=2038, 59.2% female) were drawn from The 1970 British Cohort Study (BCS70). At age 16 respondents were asked separate questions about how long they spent in three types of screen based activities (TV, video films, computer games) and homework 'after school yesterday'. Mental well-being and psychological distress were assessed at the age 42 sweep in 2012 using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS) and Malaise Inventory, respectively.

Results: After adjustment for all covariates, participants reporting more than 3hrs of after school screen time as an adolescent had -1.74 (95% CI, -2.65, -0.83) points on the WEMWBS compared with adults reporting less than 1 hr screen time as an adolescent. Participants that reported high screen time both at age 16 (≥3hrs/d) and age 42 (≥3hrs/d TV viewing) demonstrated even lower scores (-2.91; -4.12, -1.69). Homework was unrelated to wellbeing after adjustment for covariates. The longitudinal association between adolescent screen time and adult psychological distress was attenuated to the null after adjustment for covariates.

Conclusions: Screen time in adolescence was inversely associated with mental wellbeing in adulthood.

Key words: Sedentary; screen time; mental health; birth cohort

Introduction

Adults spend approximately 60 – 70% of their waking hours in sedentary activities (Healy et al., 2011; Stamatakis et al., 2012), which are characterized by energy expenditure below 1.5 metabolic equivalents while in a sitting or reclined posture (Sedentary Behaviour Research Network, 2012). There has been increasing interest in the association between sedentary behavior and mental health, and a recent meta-analysis demonstrated increased risk of depressive symptoms in adults reporting greater amounts of sedentary time (Zhai et al., 2015).

In particular, concerns have been raised about links between excessive screen time and psychological distress in children and adolescents. For example, several studies in 5 – 11 year old children have demonstrated a relationship between media use, such as TV viewing, and psychological adjustment as assessed by the Strengths and Difficulties Questionnaire (Booker et al., 2015; Hamer et al., 2009; Parkes et al., 2013). There are, however, little longitudinal data on how childhood screen time relates to mental health in adulthood. In one study TV and total media exposure in adolescence was associated with increased odds of depressive symptoms in young adulthood over 7 years follow-up (Primack et al., 2009). No studies have followed participants into mid-life. Since sedentary behaviours, such as TV viewing, appear to be established in early life (Smith et al., 2015), we might hypothesize that individuals who report high levels of sedentary behavior in early life, would through such sustained exposure across the life course show poorer outcomes in mid and later life. Some, but not all, longitudinal studies have shown associations between screen time in childhood with cardiovascular risk factors in early adulthood (Grontved et al., 2014; Hancox et al., 2004; Lefevre et al., 2002; van de Laar et al., 2014). Thus, further work is needed to establish direct links between physical activity/sedentary time in childhood/adolescence and adult physical and psychological health.

Since the area of sedentary behavior research has focused largely on negative aspects of mental function, such as depressive symptoms (Zhai et al., 2015), we also aimed to examine positive mental wellbeing. Indeed, wellbeing is not simply the absence of negative states but also the presence of positive affective states. Subjective well-being is being increasingly seen as an indicator of societal progress (Stiglitz, 2009) and research has demonstrated the importance of positive wellbeing in predicting various health outcomes, including survival independently of negative states such as depression (Pressman & Cohen, 2005). There is limited evidence in relation to sedentary behavior, although recent data has suggested an association between greater work place sitting and lower mental wellbeing in office employees (Puig-Ribera et al., 2015). These analyses were not adjusted for measures of negative affect, such as depressive symptoms, thus results might simply reflect the absence of negative states.

The aim of this study was to investigate the association of after-school sedentary behaviours (screen time and homework) in adolescence (16 years) with both mental wellbeing and psychological distress in mid-adulthood at 42 years of age. We hypothesized that greater screen time in adolescence would be related to worse mental wellbeing in mid-adulthood, independently of negative affect (here, psychological distress). In addition, we hypothesized an association between higher screen time and greater psychological distress.

Method

Design and participants

The 1970 British Cohort Study (BCS70) follows the lives of 17,284 people born in England, Scotland and Wales in a single week of 1970 (Elliott & Shepherd, 2006). Since birth,

participants have been followed up on eight occasions across their life (at ages 5, 10, 16, 26, 30, 34, 38, 42). The present analyses incorporated data from the age 16 and age 42 surveys. The age 16 survey (1986) contained a participant self-completion section on health-related behaviours. The age 42 survey was conducted in 2012/13 and comprised a 60 minute face-to-face computer-assisted-personal-interview, which included a vocabulary task and a self-completion section. At the age 16 survey 6898 participants completed the self-completion module, while 9,842 (56.9% of original sample) took part in the age 42 survey. The lower response at age 16 arose because of a teachers' strike that resulted in many participants not receiving the questionnaires. Participants provided informed consent and all data collection on BCS70 received full ethical approval from London Central Research Ethics Committee.

Sedentary measures

The main measures of sedentary exposure were assessed at age 16: Respondents were asked separate questions about time spent in three types of screen based, sedentary activities (TV, video films, computer games) '*after school yesterday'* (not at all; less than 1hr; > 1 hr; >2 hr; >3hr; >4hr; >5hr). Responses were substituted with dummy variables (ranging from 0 – 6) and then summed across the 3 questions in order to estimate total screen time. Nevertheless, TV time accounted for the majority of total screen time at age 16, (91.1% of the sample reported "not at all" playing computer games after school). In addition participants were asked how much time they spent doing homework (none; up to 2 hr; ≥2 hr). At age 42 respondents reported how many hours they spent watching TV per day (none; 0≤1; 1 <3; 3 <5; ≥5).

Mental health measures

The Warwick-Edinburgh Mental Well-being Scale (WEMWBS) was used to measure positive mental wellbeing at age 42 only, and was not assessed at any other time point. This

is a 14 item scale comprising positively worded items assessing positive affect, satisfying interpersonal relationships and positive functioning (Tennant et al., 2007), summed to provide a single score ranging from 14 – 70 with higher scores reflecting greater wellbeing. Confirmatory factor analysis supported the single factor hypothesis, and reliability was high in the present sample (Cronbach alpha= 0.92). The WEMWBS has displayed content and criterion validity, and acceptable test-retest reliability over one week (Tennant et al., 2007).

Psychological distress was measured by the 24-item (age 16) and 9-item (age 42) Malaise Inventory (Rutter, 1970) consisting of items on depressive mood and anxiety, which has demonstrated acceptable psychometric properties (McGee et al., 1986). A total symptom score, (ranging from 0 to 24 for the 24 item and 0 – 9 for the 9 item inventory), was derived from a count of the number of items eliciting a positive response.

Covariates

At age 16 respondents were provided with a list of 34 sports and physical activities and asked which of them they played (in school and during leisure time) when they were in season during the past year (at least once a week; once a month; not at all). Participants were also asked question on smoking (never; rarely; ≥ 1 cigarette/wk) and frequency of alcohol intake (daily; 4 -5 /wk; 2-3/wk; once a week; once a month; rarely; never). At age 16 parents also provided information on their occupation, which was categorised using the 1970 and 1980 Office of Population Censuses and Surveys Classification of Occupations (managerial/ professional/ intermediate/ routine and manual). At age 42 the participant's highest educational attainment was recorded (none; GCSE/O-level; A-level; Higher education).

Statistical analysis

We examined associations between screen time at age 16 with mental wellbeing at age 42 using general linear models. The exposure (i.e. screen time) was analysed as a categorical variable from which coefficients were generated. The p-trend value was generated by entering the exposure as a continuous variable. We tested for sex interactions although as none were observed we analysed the whole sample together adjusting for sex (model 1). We then further adjusted the models (model 2) for smoking at age 16, alcohol intake at age 16, leisure sports participation at age 16, psychological distress (malaise score) at age 16, parental socio-occupational group, and participants' highest educational attainment. Lastly, we examined the combined influence of screen time in adolescence and adulthood on mental wellbeing in adulthood using the same models described above. We created binary variables for screen time at age 16 and 42 using a cut point of three hours per day and subsequently generated a variable consisting of four categories reflecting combinations of high/low screen time, i.e. high screen time in adolescence and low screen-time in adulthood, low screen time in adolescence and high screen time in adulthood, low screen time at both ages and high screen time at both ages. Pre specified covariates were chosen because they were hypothesised to be associated with both the exposure and outcome (e.g. mental wellbeing) in the main analyses (Booker et al., 2015; Hamer et al., 2009; Parkes et al., 2013). All analyses were conducted using SPSS version 22.

Results

At age 16 the sedentary behaviour questions were completed by 4,091 (59.3%) participants. After exclusion of data because of missing covariates and loss of information on outcome variables at follow-up the final analytic sample comprised 2,038 participants. Excluded participants did not differ markedly on the exposure variable when compared with those

included (% reporting screen time >3hrs= 39.0 vs. 35.3% respectively, p=0.06). Also there were no differences in psychological distress at age 16 (p=0.68) or alcohol intake (p=0.37) in those excluded and included. However, those excluded were more likely to be smokers at age 16 (19.2 vs. 15.8%, p=0.007).

At 16 years 35.3% of the sample reported over 3 hrs of screen time after school. Participants reporting higher screen time were more likely to be male, non-smokers, rarely drank alcohol, did not participate in sports, and had lower educational attainment (Table 1).

After school screen time at age 16 was inversely associated with positive mental wellbeing at 42 years, and these associations persisted after adjustment for psychological distress at age 16 (Table 2). After adjustment for all covariates, adolescents reporting more than 3hrs of after school screen time had -1.74 (95% CI, -2.65, -0.83) WEMWBS points at 42 years compared with adolescents reporting less than 1 hr screen time. In further analyses we explored other forms of after school sedentary activities, namely homework. In these analyses students reporting more than 2hrs homework had 1.62 (95% CI, 0.65, 2.59) higher WEMWBS points at follow up compared with participants reporting none (Table 2). However, these associations did not persist after adjustment for all covariates including screen time and educational attainment (p-trend = 0.23).

We also explored longitudinal associations between after-school sedentary behaviours and psychological distress using the Malaise Inventory. There was a longitudinal positive association between screen time age 16 and psychological distress age 42 (p-trend= 0.004) that was attenuated after adjustment for covariates (Table 3). Homework at age 16 was inversely associated with psychological distress in adulthood, independently of covariates.

Lastly, we examined the combined influence of screen time in adolescence and adulthood on mental health at age 42 (Table 4). Participants that reported high screen time both at age 16

(≥3hrs/d) and age 42 (≥3hrs/d TV viewing) demonstrated the lowest wellbeing scores at age 42. However, this additive effect was not observed in relation to psychological distress at age 42.

Discussion

The aim of this study was to investigate the association between after school sedentary behaviours in adolescence with mental wellbeing in adulthood when participants were aged 42. To our knowledge this is the first paper to take a life course approach using a birth cohort study to examine associations between sedentary behaviour and mental wellbeing. The key findings demonstrate that screen time in adolescence was associated with different aspects of mental wellbeing in adulthood. In particular, we demonstrated the novel finding of a relationship between screen time at age 16 and poorer positive mental wellbeing at age 42. Subjective well-being is being increasingly seen as an indicator of societal progress (Stiglitz, 2009) and recent research has demonstrated the importance of positive wellbeing in predicting various health outcomes independently of negative states such as depression (Pressman & Cohen, 2005). The link between sedentary behavior and subjective wellbeing may be explained by a variety of pathways including overall lifestyle, health, social and economic circumstances.

In previous research using longitudinal BCS70 data from ages 16 to 34 years, sports participation was inversely associated with psychological distress using the Malaise Inventory (Sacker & Cable, 2006). In the present analysis, however, the associations between more adolescent screen time and greater adult psychological distress were independent of adolescent sports participation. This might suggest that the link between screen time and mental health is not simply explained by displacement of physical activities. Nevertheless,

screen time might displace other activities beneficial for mental and cognitive development such as sleep, reading and socialising with family/friends. Indeed, another common form of after school activity, homework, was inversely associated with adult psychological distress. Thus, context (ie screen time or reading) appears to be relevant when examining associations between sedentary behaviour and mental health.

The main limitation of many previous studies in this field has been the use of a cross-sectional design, which precludes making any inferences about direction. Indeed, negative mental states may not only be an outcome but may also act as an exposure in promoting sedentary behaviour. Sedentary behavior has been longitudinally associated with risk of future depression in some (Sanchez-Villegas et al., 2010; Lucas et al., 2011), but not all (Hamer et al., 2014; van Uffelen et al., 2013) studies. However, previous longitudinal studies have been limited by relatively short follow up periods and have not studied associations across the life course.

Limitations of the present study include the self-reported nature of the variables and observational study design. The sedentary exposure variables have not been validated. Participants were only asked to recall sedentary behaviour *after school yesterday*. Although immediate recall has been shown to display acceptable validity (Ekelund et al., 2006), it is possible that unmeasured confounding biased the association between screen time and mental well-being. For example, increased consumption of fast food and calorie-dense snacks has been associated with TV and screen based entertainment (Pearson & Biddle, 2011), although the analysis did somewhat address this issue by controlling for behaviours known to be associated with mental health such as alcohol and smoking at age 16. These same lifestyle behaviours at age 42 were not incorporated into our models for several reasons. Firstly, lifestyle behaviours at age 16 track into adulthood and are correlated, thus would have resulted in collinearity if all variables were included. Secondly, in the context of the present

analysis it is unclear if lifestyle behaviors at age 42 act as confounders, intermediate pathways, or indeed outcomes. For example, poor mental health at age 42 could partly drive lifestyle factors in adulthood. The age 16 data were collected in 1986, thus screen time exposure may not be reflective of contemporary society where media such as smart phones and tablets are common place. Arguably the present generation of youth may be exposed to greater screen time across their lifecourse. Nevertheless, only 45% of the present sample met the screen time viewing (<2 hr/d) recommendation, which is comparable to contemporary data (Fakhouri et al., 2013; Atkin et al., 2014). Despite these limitations, strengths of the present study include the relatively large sample and longitudinal design spanning 26 years.

In conclusion, greater screen time in adolescence was associated with poorer mental wellbeing in adulthood. Future experimental studies are needed to further tease apart the association between screen time and mental health.

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Table 1. Descriptive characteristics of the sample at baseline (age 16) relative to after school screen time.

Variable	**After school screen time at age 16**			
	0 < 1 hr (n=500)	≥1 < 2 hr (n=413)	≥2 < 3 hr (n=404)	≥3hr (n=721)
Gender				
Boys	179 (35.8)	152 (36.8)	164 (40.6)	337 (46.7)
Girls	321 (64.2)	261 (63.2)	240 (59.4)	384 (53.3)
Smoking				
Never	276 (55.2)	230 (55.6)	249 (61.6)	428 (59.4)
Rarely	119 (23.8)	123 (29.8)	100 (24.8)	191 (26.5)
Smoke ≥ 1 cig/wk	105 (21.0)	60 (14.6)	55 (13.6)	102 (14.1)
Alcohol intake				
≥ 2 /wk	102 (20.4)	73 (17.7)	65 (16.1)	127 (17.6)
Once a week	153 (30.6)	123 (29.8)	117 (28.9)	185 (25.7)
Once a month	83 (16.6)	60 (14.5)	63 (15.6)	126 (17.5)
Rarely/never	162 (32.4)	157 (38.0)	159 (39.4)	283 (39.2)
Leisure time sports participation				
At least 1/wk	400 (80.0)	324 (78.5)	304 (75.2)	550 (76.3)
Highest educational attainment (at age 42)				
None	80 (16.0)	65 (15.7)	64 (15.8)	148 (20.6)
GCSE/O-level	104 (20.8)	103 (24.9)	108 (26.7)	247 (34.2)
A-level	92 (18.4)	63 (15.3)	56 (13.9)	132 (18.3)
Higher education	224 (44.8)	182 (44.1)	176 (43.6)	194 (26.9)

Frequency (Percentages)

Table 2. Association between after-school sedentary behaviours at age 16 and positive mental wellbeing (assessed using the WEMWBS) at age 42 (n=2,038).

Screen time	N	Mean WEMWBS	Model 1 B (95% CI)	Model 2 B (95% CI)
<1 hr	500	51.0	Ref	Ref
<2 hr	413	50.5	-0.45 (-1.50, 0.61)	-0.42 (-1.45, 0.60)
<3 hr	404	50.1	-0.89 (-1.95, 0.17)	-0.85 (-1.88, 0.19)
≥ 3 hr	721	48.9	-2.14 (-3.06, -1.21)	-1.74 (-2.65, -0.83)
p-trend			<0.001	0.005
Homework†				
None	1253	49.5	Ref	Ref
Up to 2 hrs	434	50.7	1.25 (0.37, 2.14)	0.45 (-0.43, 1.33)
≥2 hrs	351	51.1	1.62 (0.65, 2.59)	0.53 (-0.47, 1.52)
p-trend			<0.001	0.23

WEMWBS = Warwick-Edinburgh Mental Well-being Scale

Model 1: adjusted for sex

Model 2: adjusted for sex, smoking at 16, alcohol intake at 16, leisure sports participation age 16, psychological distress age 16, parental socio-occupational group, highest educational attainment, †additionally adjusted for total screen time

Table 3. Association between after-school sedentary behaviours at age 16 and psychological distress (Malaise Inventory score) at age 42 (n=2,038).

Screen time	N	Mean malaise score‡	Model 1 B (95% CI)	Model 2 B (95% CI)
<1 hr	500	1.62	Ref	Ref
<2 hr	413	1.55	-0.07 (-0.31, 0.17)	-0.08 (-0.31, 0.15)
<3 hr	404	1.73	0.11 (-0.13, 0.35)	0.08 (-0.15, 0.31)
≥ 3 hr	721	1.89	0.26 (0.05, 0.47)	0.18 (-0.02, 0.39)
p-trend			0.004	0.032
Homework†				
None	1253	1.84	Ref	Ref
Up to 2 hrs	434	1.45	-0.39 (-0.59, -0.19)	-0.26 (-0.46, -0.07)
≥2 hrs	351	1.58	-0.26 (-0.48, -0.04)	-0.14 (-0.37, 0.08)
p-trend			<0.001	0.027

Model 1: adjusted for sex

Model 2: adjusted for sex, smoking at 16, alcohol intake at 16, leisure sports participation age 16, parental socio-occupational group, psychological distress age 16, and highest educational attainment, †additionally adjusted for total screen time

‡Total Malaise score calculated from 24-item and 9-item inventory at age 16 and 42, respectively.

Table 4. Combined association of screen time at age 16 and age 42 on mental wellbeing and psychological distress (Malaise Inventory score) at age 42 (n=2038).

Screen time age 16†	TV viewing age 42†	N	WEMWBS B (95% CI)‡	Malaise score B (95% CI)‡
Low	Low	1103	Ref	Ref
Low	High	214	-1.13 (-2.31, 0.05)	0.30 (0.03, 0.56)
High	Low	512	-0.98 (-1.82, -0.15)	0.23 (0.05, 0.42)
High	High	209	-2.91 (-4.12, -1.69)	0.21 (-0.06, 0.48)

† High screen time at age 16 (≥3hrs/d); High TV viewing age 42 (≥3hrs/d)

‡ adjusted for sex, smoking at 16, alcohol intake at 16, leisure sports participation age 16, parental socio-occupational group, psychological distress age 16, and highest educational attainment.