Associations between Changes in Screen-time and Mental Health Outcomes in Adolescents.

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Abstract:

Introduction

The primary objective of this study was to examine longitudinal associations between changes in recreational screen-time and mental health outcomes during the first year of secondary school in a sample of Australian adolescents.

Methods

Adolescents (N = 322; 65.5% females) reported total and device specific screen-time (television, DVD, computer, and tablet/mobile phone) and mental health (physical self-concept, psychological well-being and psychological difficulties) over a school year. Multi-level linear regression analyses were conducted and adjusted for relevant covariates.

Results

Changes in total recreational screen-time (B = -.003, p = .048) and tablet/mobile phone use (B = -.015, p < .001) were negatively associated with physical self-concept. Changes in total recreational screen-time (B = -.008, p = .001) and computer use (B = -.025, p = .003) were negatively associated with psychological well-being. A positive association was found with television/DVD use and psychological difficulties (B = .007, p = .015). No associations were found for non-recreational screen-time.

Conclusion

Changes in recreational screen-time were associated with changes in a range of mental health outcomes during the first year of secondary school, with no clear device-specific trends emerging. These findings suggest that reducing recreational screen-time among adolescents may have utility as a strategy for promoting mental health in this population.

Key words: Screen-time, Mental Health, Adolescents, Longitudinal

Introduction

Mental health has been defined by the World Health Organization as state of well-being and effective functioning in which an individual realizes their abilities, is resilient to the stresses of life and is able to make a positive contribution to their community. Mental health problems (ill-being) represent a significant global public health issue (Erskine et al., 2015; Gore et al., 2011; Herrman, Saxena, & Moodie, 2005) affecting an estimated 20% of adolescents (Asare, 2015). Despite contributing approximately 45% of the global burden of disease among adolescents (Gore et al., 2011), the underlying factors contributing to mental health problems among this population have received little attention (Erskine et al., 2015). Given that symptoms of mental health problems often appear during adolescence (Erskine et al., 2015) and incidence rates are increasing (Allen & Vella, 2015), there is an urgent need to identify the modifiable determinants.

Excessive screen-time has emerged as a behaviour that may contribute to mental health (both ill-being and well-being) during adolescence (Hamer, Yates, Sherar, Clemes, & Shankar, 2016). While the use of screens is often necessary for educational purposes, and some recreational screen-time (i.e., using television, DVD, computer, and tablet/mobile phone for recreational purposes) may support young people's wll-being by enhancing social connectedness (Houghton et al., 2015), time spent using screens for leisure has dramatically increased in recent decades (Houghton et al., 2015). In response to the secular increases in recreational screen-time observed in many western countries, international guidelines recommending young people limit their recreational screen-time to less than two hours per day have emerged (Mark & Janssen, 2008; Pediatrics, 2001). Yet the majority of adolescents exceed these recommendations (L. Hardy, 2013; Mark & Janssen, 2008; Owens, Crone, Croix, Gidlow, & James, 2013).

Recent systematic reviews have concluded that excessive screen-time is positively associated with ill-being and negatively associated with well-being in young people (Costigan, Barnett, Plotnikoff, & Lubans, 2013; Hamer et al., 2016; Hinkley et al., 2014; Tremblay et al., 2011). Cross-sectional studies (Brunborg, Mentzoni, & Frøyland, 2014; Chen & Lu, 2009; Sanchez-Villegas et al., 2008) have demonstrated that exposure to high levels of screen-time is negatively associated with physical self-concept (Suchert, Hanewinkel, & Isensee, 2016; Suchert, Hanewinkel, Isensee, & Group, 2015) and psychological well-being (Busch, Ananda Manders, & Rob Josephus de Leeuw, 2013) in adolescents. Other studies have found that screen use among adolescents is positively associated with psychological distress (Hamer, Stamatakis, & Mishra, 2009; Parkes, Sweeting, Wight, & Henderson, 2013), (Booker, Skew, Kelly, & Sacker, 2015), anxiety and depression (Cao et al., 2011; Kremer et al., 2014). Although the evidence is building to support the negative influence screen-time can have on mental health in adolescents, methodological weaknesses in previous studies have been noted. For example, the majority of studies have been cross-sectional (Allen & Vella, 2015), involved the examination of only one type of screen (usually television)(Hamer et al., 2009), measured a small selection of mental health indicators (typically depression) (Kremer et al., 2014) and failed to control for confounding variables during statistical analysis (e.g., adiposity and physical activity) (Mathers et al., 2009; Rosen et al., 2014). Developing a more comprehensive understanding of the associations between screen-time and mental health outcomes in adolescents is a critical step in curbing the high incidence of mental health problems typical in youth today.

The primary aim of the present study was to examine longitudinal associations between changes in screen-time (total and device specific) with multiple indicators of mental health (well-being and ill-being) among Australian adolescents in the first year of secondary school. We hypothesized that changes in recreational screen-time would be: 1) negatively

associated with changes in physical self-concept and psychological well-being; and 2) positively associated with changes in psychological difficulties, after controlling for potential confounders. A secondary aim was to examine the association between non-recreational screen-time and mental health outcomes. We hypothesized that there would be no significant associations between non-recreational screen-time and mental health outcomes.

Methods:

Participants

Data from the Switch-off 4 Healthy Minds study was used for the current study. A detailed description of the original study protocol and outcomes have been published previously (Babic et al., 2015). Ethics approval for the study was obtained from the Human Research Ethics Committees of the University of Newcastle, Newcastle-Maitland Catholic Schools Office and the Diocese of Broken Bay. Schools, parents and participants provided informed consent. Catholic secondary schools (N = 20) located in the Hunter region of New South Wales, Australia were invited to participate and the first eight schools to provide written consent were accepted. Students in Grade 7 at each of the study schools completed an eligibility questionnaire, asking them to report their total time spent using screen devices on a typical school day. Students failing to meet national screen-time guidelines (i.e., > 2hours/day) were considered eligible and invited to participate. The first 40 students from each school to return signed consent letters were included. Time 1 (T1) data was collected at each school between April and June, 2014 and Time 2 (T2) data (96% of the original) between October and December, 2014.

Measures:

All assessments were conducted at schools by trained research assistants. Basic demographic information including: sex, country of birth, socio-economic status (SES) based on household

postcode, and the number of children who speak English at home were collected (Table 1). Self-report measures were collected in exam-like conditions using an online survey and Apple iPads and physical measures were conducted discretely by a same-sex assessor.

Recreational screen-time

Screen-time was measured using the Adolescent Sedentary Activity Questionnaire (ASAQ) (L. L. Hardy, Booth, & Okely, 2007). The ASAQ required participants to self-report the time they spent using a variety of screen devices on each day of the week, including weekends. Specifically, participants were asked to report time spent using recreational screen-time which included: television, DVD, computer, and tablet/mobile phone for entertainment purposes on a usual school week. The final item (i.e., tablet/mobile phone) was not included in the original ASAQ instrument but was added to reflect current trends in adolescents' use of screen media. Non-recreational screen-time consisted of computer use for homework. Mean daily screen-time was calculated by adding the time spent using each screen device on each day of the week and dividing by the number of reported days (i.e., 7). The ASAQ has previously reported acceptable test–retest reliability in girls (ICC = 0.70, 95% CI: 0.40, 0.85), and boys (ICC = 0.84, 95% CI: 0.69, 0.91) (L. L. Hardy et al., 2007).

Mental health

The physical self-concept subscale from Marsh's Physical Self-Description Questionnaire (Marsh, 1996) was used to provide a measure of self-concept in the physical domain. Students responded to six items on a 6-point scale (1 = '*False*', to 6 = '*True*') to how true each statement was for them (e.g., '*I am a physically strong person'*). The internal consistency of the physical self-concept subscale among the present sample was high (Cronbach's $\alpha = 0.95$). Higher scores on this measure indicate better physical self-concept.

Deiner and colleagues' Flourishing Scale (Diener et al., 2010) was used to measure participants' psychological well-being. The Flourishing Scale is a brief 8-item summary measure of a person's self-perceived success in key areas such as, engagement relationships, self-esteem, meaning, purpose and optimism (Diener et al., 2010). Participants were asked to respond using a 1–7 scale (1 = strongly disagree, to 7 = strongly agree) on each item (e.g., '*I lead a purposeful and meaningful life'*). The possible range of scores is from 8 (lowest possible) to 56**.** A high score represents a person with many psychological resources and strengths (Diener et al., 2010)**.** The Flourishing Scale has shown acceptable validity and reliability among adolescents (Silva & Caetano, 2013).

To measure mental ill-being, participants completed the Strength and Difficulties Questionnaire (Goodman, 1997), which is a behavioral screening questionnaire divided into five subscales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behavior (Truman et al., 2003). Four of these are potential problems, and one is strength-related (prosocial). Participants were asked to indicate whether a specific attribute is "not true", "somewhat true", or "certainly true" (e.g., '*I worry a lot'*). Each subscale comprises of five items that can be scored zero, one, or two. Therefore, each total subscale score can range from zero to 10 with the Strength and Difficulties Questionnaire total difficulties score (range 0 – 40) calculated by summing the scores of the four difficulties subscales (i.e. all subscales excluding pro-social). Each one-point increase in the total difficulty score corresponds to an increase in the risk of mental health disorders (Goodman, 1997). The Strength and Difficulties Questionnaire have been validated in youth of 11 years or over (Goodman, Meltzer, & Bailey, 1998).

Adiposity

Weight was measured without shoes, in light clothing using a portable digital scale (Model no. UC-321PC, A&D Company Ltd, Tokyo Japan) and height was recorded using a portable

stadiometer (Model no. PE087, Mentone Educational Centre, Australia). Body mass index (BMI) was calculated using the standard equation (weight [kg] / height $[m]^2$) and BMI z-scores were calculated using the 'LMS' method (Onis et al., 2007). All assessments were conducted by same sex and trained research assistants in a sensitive manner.

Physical activity

Physical activity was assessed over seven days using GENEActiv (Model GAT04, Activinsights Ltd, Cambridgeshire England) wrist worn accelerometers, and activity intensity was determined using existing cut-points (Phillips, Parfitt, & Rowlands, 2013a). Valid wear time was defined as a minimum of ten hours per day on at least three days. GENEActiv wrist worn accelerometers have displayed acceptable intra-and inter-instrumental reliability and provide a valid and reliable estimate of physical activity in young people (Phillips, Parfitt, & Rowlands, 2013b). Students providing valid accelerometer wear time are reported in Table 3.

Statistical analysis

All analyses were performed using MPlus, version 7.11 for Windows (Muthén & Muthén, Los Angeles, CA) and statistical significance were set at $p < 0.05$. Multi-level linear regression analyses were used to assess associations between screen-time (total and device specific) at T2 and the presence of mental health at T2. Analyses were adjusted for: T1 measures, group allocation, school clustering, sex, SES, BMI and physical activity. Previous studies have demonstrated that all of these outcomes are associated with indicators of mental in adolescent populations (Pulsford, Griew, Page, Cooper, & Hillsdon, 2013)(Marshall, Biddle, Gorely, Cameron, & Murdey, 2004). Ninety-six percent of individuals were retained across the study (308/322). A sensitivity analysis was performed to assess the possibility of selection bias due to missing data and loss of data at T2 by comparing estimates of the

associations in the sample with complete data. Participants with missing data were not included in the analyses, results were not affected due to high retention at T2.

Results

Eligibility screening was completed by 1154 students, of whom 935 (81%) were considered eligible. Characteristics of the study sample are presented in Table 1. Descriptive statistics of screen-time and mental health (at both time points) by sex, including means and standard deviations are reported in Table 2. Table 3 reports the associations between screen-time and mental health indicators.

Recreational screen-time and mental health outcomes

Changes in total recreational screen-time (B = -.003, p = .048) and tablet/mobile phone use (B = -.015, p < .001) were negatively associated with physical self-concept. Changes in total recreational screen-time (B = -.008, p = .001) and computer use (B = -.025, p = .003) were negatively associated with psychological well-being. Whereas, a positive association was found with television/DVD use and psychological difficulties (B = .007, p = .015). All results were adjusted for multiple covariates (baseline values, group allocation, clustering, sex, SES, T1 measurements, BMI and physical activity).

Non-recreational screen-time and mental health outcomes

No associations were found with indicators of mental health in any of the models examining changes in screen use for homework.

Discussion

The primary aim of this study was to examine associations between changes in recreational screen-time and changes in mental health outcomes among a sample of adolescents in the first year of secondary school. Significant associations were found between changes in total

and device-specific recreational screen-time and a range of mental health outcomes, with no clear device specific trends emerging. In regards to our secondary aim, no evidence of an association between non-recreational screen-time and mental health outcomes was found.

Changes in both total recreational screen-time and tablet/mobile phone use were negatively associated with changes in physical self-concept. Previous cross-sectional studies among adolescents have found negative associations between screen-time (television/DVD and video games use) and physical self-concept (Suchert et al., 2016) as well as physical attractiveness (Suchert et al., 2015). Alternatively, no significant associations were found in a cross-sectional study examining the relationship between screen-time (across multiple devices) and physical self-concept in a sample of adolescent girls from schools located in low income communities. It is possible that the evolving influence of social media technology predominantly used by adolescents (such as Facebook, Instagram, Snapchat and DailyBooth) is an important mechanism responsible for the adverse changes in physical-self-concept observed in the current study. Social media today predominantly relies on visual representations and often promotes adolescents comparing themselves with peers (Zwier, Araujo, Boukes, & Willemsen, 2011). As a consequence of engaging with these social media platforms, the discrepancies between broadcasted ideals and self-perceptions of adolescents may have negative mental health consequences due to inflated social pressure to conform, feelings of body inadequacy (Eyal & Te'eni-Harari, 2013), and unhealthy changes in behaviour adopted in an attempt to adhere to social expectations (e.g., image-based trends like "fitspiration" which encourages the perseverance in, or even "suffering" through, exercise to achieve aesthetic changes in one's physical appearance) (Mabe, Forney, & Keel, 2014; Meier & Gray, 2014).

Changes in total recreational screen-time and computer use were negatively associated with psychological well-being in this study. In current study, eudemonic well-

being was measured using the Flourishing Scale developed by Diener and colleagues. This questionnaire is considered to be an appropriate measure of well-being in samples where pathology is absent. Our findings are consistent with the recent ATLAS school-based obesity prevention program for adolescent boys, which found that reductions in recreational screen-time mediated the effect of the intervention on well-being (assessed using the Flourishing Scale). We suggest that computer use may negatively impact adolescents' psychological well-being through cyberbullying (i.e., harassment through technology via posts, chat forums or online gaming) and peer victimization, with previous studies reporting increased rates of negative feelings, fear and helplessness (Spears, Slee, Owens, & Johnson, 2009); increased levels of depression, social dissatisfaction and withdrawal (Perren, Dooley, Shaw, & Cross, 2010); and lower levels of self-esteem (Jackson et al., 2010). Our findings, although important, now present the unique challenge of determining how different devices impact on well-being, relative to their multiple purposes (i.e., gaming, communication, education).

Associations between changes in screen-time and psychological difficulties were inconclusive and television/DVD use was the only significant association found. Previous research examining the relationship between screen-time and psychological difficulties has also produced inconsistent findings in cross-sectional (Booker et al., 2015; Busch et al., 2013; Liu, Ming, Yi, Wang, & Yao, 2016) and longitudinal studies (Booker et al., 2015; Chen & Lu, 2009; Parkes et al., 2013)(O'Connor et al., 2016; Parkes et al., 2013) in young people. It is possible the varying outcomes may be due to differences in the measurement of screen-time (in addition to the combining of time engaged in television and DVD viewing) and or the duration of follow-up periods. Although such examinations were beyond the scope of this study, previous findings suggest that elevated levels of psychological distress can lead to changes in behavior in adolescence. Studies have shown that television use (especially if the content is violent) may increase conduct problems (Parkes et al., 2013)(Liu et al., 2016), and

may predict aggression and attention problems (Strasburger, Jordan, & Donnerstein, 2010; Zimmerman & Christakis, 2007). The nature of screen viewing (how adolescents watch, what they watch, and with whom) may have also been important implications for their mental health. Television/DVD use involves viewing rapidly changing images which may impact on excitement, concentration and attention levels (Parkes et al., 2013); contribute to feelings of loneliness, anxiety and unhappiness elicited by excessive screen-time often viewed in solitude (Bohnert & Garber, 2007; Gentile et al., 2011; Sund, Larsson, & Wichstrøm, 2011); and reduce prosocial behavior (associated with reduced levels of empathy through exposure to violent content) (Anderson & Bushman, 2001). Alternatively, the negative effect of screen-time on mental may be due to the reduced opportunities to participate in activities that promote improved mental health (Pea et al., 2012; Primack, Swanier, Georgiopoulos, Land, & Fine, 2009), such as sleep (Kaneita et al., 2009), physical activity (Sanchez-Villegas et al., 2008) or social activities (Primack et al., 2009)).

The current study builds on previous research by examining the association between changes in screen-time and mental health outcomes over the first year of school. In addition, all analyses were adjusted for SES, BMI and physical activity. Additional strengths of this study include the high participant retention, robust multi-level modeling which adjusted for multiple covariates, and the use of objectively measured physical activity. However, there are some limitations that should be noted. First, participants were predominantly female and ethnically homogeneous. As a result, findings may not be generalizable to other groups or the population as a whole. Second, recreational screen-time was measured using a questionnaire. Self-report measures remain a significant challenge to the accurate assessment of sedentary behavior such as screen-time due to the possibility of recall and social desirability biases (Atkin et al., 2012). The current study only assessed raw daily screen-time and was unable to measure the content of devices being used. It also remains unknown if the content of screen

use enhances or is detrimental to mental health rather than the duration of exposure, and findings do not provide evidence of causality. Further research is also needed to determine if screen-time and media multitasking are influencing mental health, or if adolescents with challenged social competencies and poor mental health are drawn towards spending more time into multiple technologies as a means of escapism. It is also not possible to conclusively attribute all of the negative mental health effects reported in this study to screen-time since lack of physical activity, disturbed sleeping patterns and social influences were not assessed.

Conclusion

This study makes a unique contribution by examining how changes in total and device-specific screen-time relate to changes in a variety of mental health indicators in adolescents. Although significant associations were found between changes in total and device-specific recreational screen-time and mental health outcomes, no clear device specific trends emerged. Further longitudinal and experimental studies are needed to improve our understanding of the casual mechanisms that explain why and how screen-time impacts upon mental health outcomes.

Competing interests

The authors have no competing interests to declare.

Author contributions

All authors contributed to developing, editing, and approving the final version of the paper.

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Table 1: Characteristics of the study sample

Characteristics	Total (N = 322)
Age, y, mean, SD [a]	14.40 ± 0.6
Born in Australia, n	322 (100%)
Sex, n	
Female	211 (66%)
Male	111 (34%)
English language spoken at home, n	316 (98%)
Cultural background, n	
Australian	316 (98%)
European	4 (2%)
African	0 (0%)
Asian	2 (0%)
Middle eastern	0 (0%)
Other	0 (0%)
Socioeconomic position, n [b]	
1-2	13 (4%)
3-4	84 (26%)
5-6	188 (58%)
7-8	25 (8%)
9-10	12 (4%)
Weight, kg, mean, SD [c]	51.49 ± 12.9
Height, cm, mean, SD [c]	156.98 ± 7.3
BMI, $kg.m^{-2}$ [d]	20.73 ± 4.2
Weight status, n	
Underweight	37 (12%)
Healthy weight	167 (52%)
Overweight	75 (23%)
Obese	43 (13%)

[a] Abbreviations: y = years, SD = standard deviation

[b] Socioeconomic position determined by population decile using Socio-Economic Indexes For Areas of relative socioeconomic disadvantage based on residential postcode (1 = lowest, 10 = highest).

[c] Abbreviations: SD = standard deviation

[d] Abbreviations: BMI = body mass index, SD = standard deviation

Table 2: Levels of screen-time and mental health across time points in the total sample and by sex.

Outcome	**T1**			**T2**		
Recreational screen-time	**All mean (SD)**	**Females mean (SD)**	**Males mean (SD)**	**All mean (SD)**	**Females mean (SD)**	**Males mean (SD)**
Total screen-time	302.60 (194.80)	290.09 (194.84)	326.37 (193.38)	266.55 (195.10)	258.57 (209.35)	281.54 (164.95)
Television/DVD	141.83 (95.20)	139.84 (94.92)	145.60 (96.06)	124.52 (102.97)	121.86 (107.49)	129.53 (94.17)
Personal computer use	38.69 (70.10)	26.32 (46.72)	62.20 (96.55)	33.56 (66.94)	23.56 (57.11)	52.35 (79.24)
Tablet/mobile phone use	122.08 (101.30)	123.92 (107.18)	118.57 (89.40)	108.46 (92.08)	113.16 (97.86)	99.65 (79.80)
Non-recreational screen-time						
Homework	42.43 (36.09)	43.34 (36.42)	40.69 (35.56)	37.75 (37.35)	37.12 (32.65)	38.93 (45.00)
Mental health outcomes						
Physical self-concept	27.63 (7.41)	27.44 (7.66)	27.97 (6.94)	27.34 (8.23)	26.72 (8.68)	28.50 (7.20)
Psychological well-being	46.61 (7.78)	47.33 (7.55)	45.24 (8.07)	46.57 (8.15)	47.20 (7.97)	45.39 (8.40)
Psychological difficulties	15.46 (4.05)	15.64 (3.88)	15.11 (4.34)	14.98 (4.64)	15.01 (4.36)	14.92 (5.15)

Note. SD = Standard deviation. T1 = Time 1 and T2 = Time 2. All screen-time measured in minutes/da

Table 3: Associations of screen-time (T2) and mental health (T2) for the total sample over 1 school year.

Screen-time at (T2)	Mental health (T2)	Model 1 B (SE), *p* value
Total recreational screen-time	Physical self-concept	-0.003 (0.002), $p = .048$
	Psychological well-being	-0.008 (0.002), $p = .001$
	Psychological difficulties	0.004 (0.002), $p = .087$
Television/DVD	Physical self-concept	0.002 (0.003), $p = .471$
	Psychological well-being	-0.007 (0.007), $p = .257$
	Psychological difficulties	0.007 (0.003), $p = .015$
Personal computer use	Physical self-concept	-0.004 (0.007), $p = .565$
	Psychological well-being	-0.025 (0.008), $p = .003$
	Psychological difficulties	0.009 (0.005), $p = .054$
Tablet/mobile phone use	Physical self-concept	-0.015 (0.003), $p < .001$
	Psychological well-being	-0.008 (0.005), $p = .078$
	Psychological difficulties	0.001 (0.004), $p = .799$
Homework	Physical self-concept	0.019 (0.012), $p = .124$
	Psychological well-being	-0.002 (0.015), $p = .874$
	Psychological difficulties	-0.001 (0.023), $p = .968$

Note. T2 = Time 2, B = unstandardized regression coefficient; SE = standard error. Results are adjusted for: baseline values, group allocation, clustering, sex, SES, T1 measurements, BMI and physical activity. 245 and 264 students recorded valid accelerometer wear time at Time 1 on weekend days and weekdays, respectively. 180 and 175 students recorded valid accelerometer wear time at Time 2 on weekend days and weekdays, respectively.

Figure 1: Mean screen-time usage across time points in the total sample and by sex.

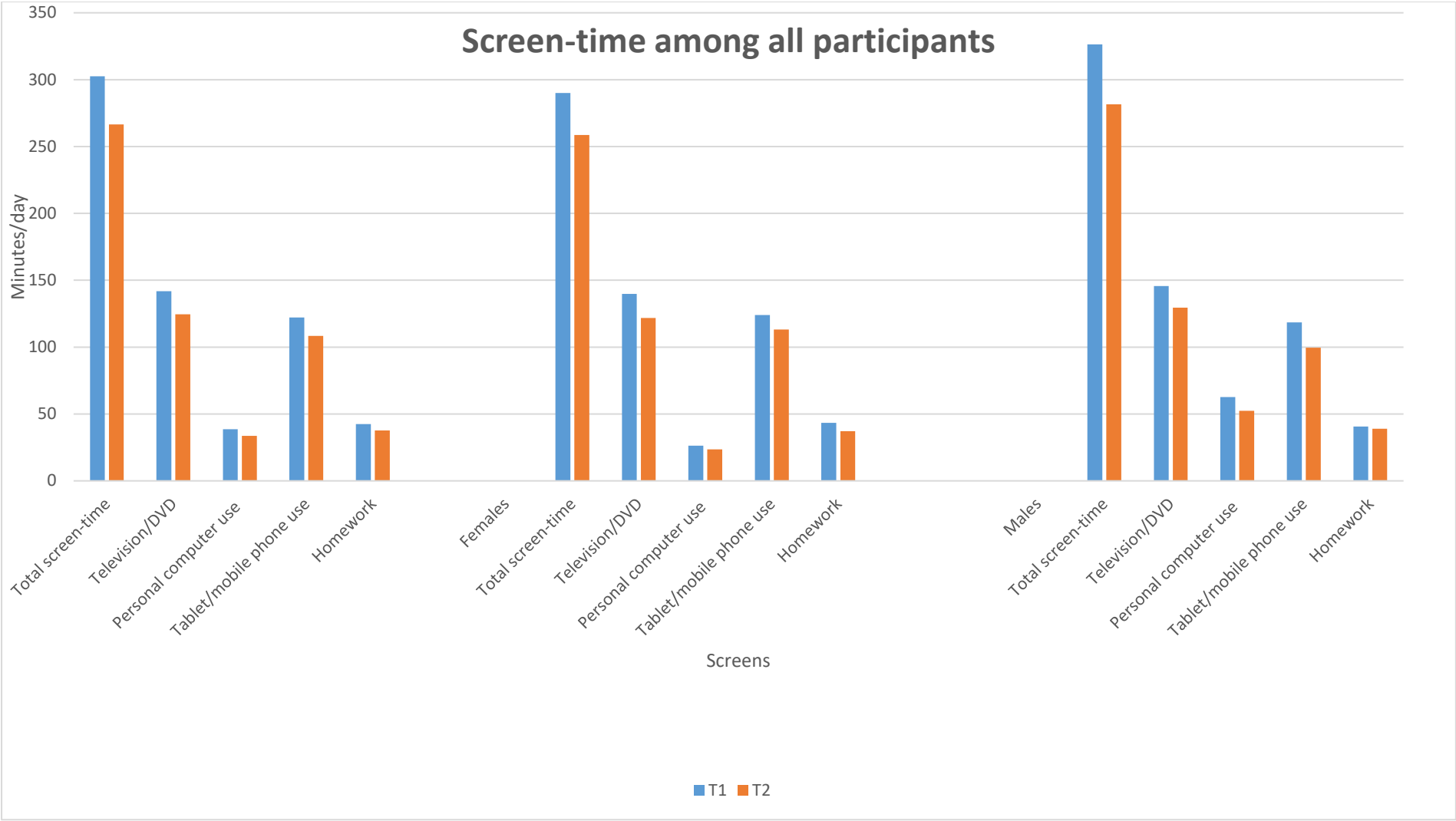

Figure 2: Mean mental health scores across time points in the total sample and by sex.