An ecological momentary assessment of the physical activity and sedentary behaviour patterns of university students

Peter C Rouse
Stuart J H Biddle

Address where work was carried out: Loughborough University, Loughborough, UK

Corresponding author:

Peter Rouse
School of Sport & Exercise Sciences
University of Birmingham
Edgbaston
Birmingham
B15 2TT
P: + 44 (0) 1214 148737
F: + 44 (0) 1214 144121
E: pxr717@bham.ac.uk

Abstract *Objective*. We used ecological momentary assessment to understand the physical activity and sedentary behaviour patterns of university students.

Study Design. Cross sectional, opportunistic sample from a university in the English midlands.

Methods. Ecological momentary assessment diaries were completed every fifteen minutes across two days. The sample comprised 46 males (mean age 20.2 years) and 38 females (mean age 19.5 years). The majority of participants were undergraduates (96.5%) and white European (85%).

Results. Although 'studying' was the predominant behaviour (280 minutes), students spent time conducting a range of behaviours including 'watching television' (79.9 minutes), 'sitting and talking' (72.1 minutes) and 'hanging out' (64.0 minutes). Repeated measure ANOVAs revealed a significant gender effect for some behaviours with 'studying' [$F(1,82) = 10.50$, $p<.006$] and 'computer game playing' [$F(1,82) = 7.97$, $p<.006$] being higher in males, and 'sitting and talking' [$F(1,82) = 24.49$, $p<.006$] higher in females. Pearson correlations suggested that sedentary behaviours compete with each other for students' time. A significant small negative relationship existed between sedentary technology behaviours and physical activity for males ($r=-.217$) but not for females ($r=-.182$).

Conclusions. Students participate in a range of sedentary behaviours that differ by gender. Results question public perception that selected sedentary behaviours, such as 'viewing television', are responsible for declining levels of sport and exercise participation in this age group. Implications for interventions are considered.

Key words: Physical activity, sedentary behaviour, students, ecological momentary assessment

Introduction

Physical activity (PA) is important for establishing and maintaining quality of life. Evidence reveals that beneficial outcomes of PA lie in long term physical health(1) and short term psychological health through enhanced positive affect and mental well being(2). Recently, population increases in chronic disease have led to growing concern over the effect that sedentary lifestyles and apparent declining levels of PA are having on our health(3). Despite the public health importance of studying physical inactivity, little is known about the levels of, and trends in, habitual inactivity(4). Moreover, we have argued that it is important not just to study low levels of physical activity ('inactivity') by distinguishing those not meeting a specified criterion level of physical activity, but also to investigate different behaviours that might be construed as 'sedentary'. Hence we adopt the term 'sedentary behaviour'(5).

Many adult behaviours are established during late adolescence and early adulthood (6) and evidence shows a decline in PA as adolescents progress into adulthood(7;8). The present study aims to bridge a gap in the literature concerning physical activity and sedentary behaviour patterns of students in the U.K. by gathering behaviour-rich data.

Research on sedentary and active lifestyles has focussed a great deal on youth and adolescents(9). Attempts to instil positive health behaviours early in life is thought to be critical for future health. However, this focus has meant that other sub-populations have been studied less frequently. Buckworth and Nigg(6) comment that "few studies have examined the relationship between students' exercise and physical activity and their sedentary behaviours" (p.28). One of the major transition periods for behaviour is from adolescence to young adulthood and is characterised by major life event changes associated with the move from parental home to full residential

independence(10). Understanding behavioural changes at this period is particularly important for achieving optimal adult health. Moreover, university students are not merely a population of convenience but represent a major segment of the young adult population(11). In 2004/2005, there were approximately 2.3 million students in the UK higher education system(12). Furthermore, these students adopt future positions (e.g. teachers, doctors, managers and other leadership roles) that can influence the health behaviour of other populations. Combined with the transition characteristic of increased control over their lifestyle, it is important to facilitate the development of good health behaviours, such as regular PA. However, before it is possible to implement interventions or advance theoretical development, it is critical to understand and increase knowledge of current behavioural trends.

Sedentary Relationships

Although there is growing concern over the effects of sedentary lifestyles, mixed evidence exists to support this public perception. Marshall et al.'s (4;13) systematic review found limited evidence to support claims that television viewing and other screen based media are the cause of decreases in PA and increased obesity in young people. Only small correlations between selected sedentary behaviours (television viewing) and physical activity in youth have been found(13), suggesting that there is time for both(14). This evidence supports Owen et al's(15) contention that sedentary behaviour can sometimes compete with and sometimes coexist with PA. These findings contradict the displacement hypothesis which proposes that sedentary pursuits, such as television viewing, will displace more active pursuits. While this will be true for a given moment, it has not been supported when behaviours are studied over a period of time.

Ecological Momentary Assessment

Mixed evidence exists concerning the validity and reliability of self-reported PA(16-19) and much has been written about the challenge of collecting accurate and detailed self-reports. Of the various difficulties, the most vexing is the extensive memory distortion that pervades retrospective self-reports(20). The present study aims to overcome these challenges by employing an Ecological Momentary Assessment (EMA) methodology. EMA is a strategy that reduces distortion caused by recall bias by simultaneously capturing a behaviour, and the factors that may influence it, by allowing the participant to instantaneously report their current activity, location, and social surroundings(21). Momentary data collection methods are increasingly appearing in the literature(20). Health behaviours assessed through EMA include physical and sedentary behaviours in children(9). The present study aims to understand the most prevalent sedentary behaviours that students participate in. Furthermore, we aim to further understand how associations between different types of sedentary behaviour contribute to patterns of overall sedentariness. How do categories of sedentary behaviour correlate with themselves and physical activity?

Method

Participants

Data were collected from 46 males (mean age 20.2 years, SD= 2.03) and 38 females (mean age 19.5 years, SD= 1.15), with 96.5% being undergraduates and 66% in their first year of university. The majority of the sample (85%) identified themselves as white European. An opportunistic sample of participants was taken from a university in the English Midlands. All participants lived in catered halls of residence on campus. Sampling occurred at 8 different halls of residence over a three week period. Diaries (n=147) were distributed with 84 being returned by the closing date (57% response rate). From the 84 diaries collected, small amounts of

data were missing: 0.3% of behaviour data, 1% of location data and 1.7% of social context data. No diaries were dropped from the data analysis process. Ethical approval was obtained by the Ethical Advisory Committee of the host university.

Ecological Momentary Assessment Tool

The EMA data collection instrument was an adapted version of a diary used in prior research with young people and a thorough description of the tool is provided by Gorely et al.(22) and has also been used in other contemporary research(23). Essentially, the diary requests participants to write down their main behaviour that they are currently undertaking every 15 minutes, as specified in the diary. At the same time, they respond to two other questions concerning where they are and who they are with, with both questions having a selection of possible responses that can be chosen.

Procedure

Students were asked to complete an EMA diary. Participants were instructed to carefully read the information sheet and standardised instructions before completing the diary. Any questions that participants had at this time were answered. Each diary was randomly assigned two days (one week day and one weekend day). Participants were made aware of the instantaneous self-reporting nature of the diary and completed an informed consent sheet. Diaries were returned to boxes allocated in each of the 8 halls. A cut-off date was implemented and, therefore, the sample consisted of all those who returned their diary by this date.

Data Analysis

Behaviours were coded into categories based on an adapted form of previous research data coding, derived inductively from research about how English youth spend their time(22). For example, a participant that reported watching television was

coded as TV. Twenty four different behaviour codes existed including a code for other behaviours (those that cannot be classified) and one for missing behaviour data.

To estimate the time spent in each behaviour category, the number of times a behaviour was recorded each day was multiplied by 15. This makes an assumption that each episode of behaviour occurred for the entire 15 minutes of the sampling period. The mean time per behaviour was calculated and used for analysis (minutes per day). All statistical analyses were conducted using SPSS (Version 13). Descriptive statistics for 8 key sedentary and physically active behaviours were obtained (television viewing, computer game use, computer use, sitting and talking, shopping and hanging out, studying, sport and exercise, and active transport). A series of repeated measures analyses of variance were performed, with day (within) and gender (between) as the independent variables. A Bonferroni procedure was implemented to control familywise error due to repeated tests. A series of Pearson correlation coefficients were computed to establish the relationships between the different sedentary behaviour groups and physical activity. Three sedentary behaviour categories were created to identify interrelationships. These were studying, sedentary technology, and sedentary social behaviours.

Results

Descriptive Data

Demographic information revealed that 97.6% had one or more computer(s) in their bedrooms with internet and TV access. Only 15.5% of the sample had a video game console(s) in their bedroom but 54.8% had one or more video game console in their halls of residence. A bicycle was owned and kept on campus by 16.7% and 7.1% owned and kept a car on campus.

Prevalent Behaviours

Table 1 reveals the mean time (minutes) spent in 8 selected behaviours for each gender on weekdays and weekends. 'Studying' was the predominant behaviour for both males (280 minutes) and females (184 minutes) on both days. 'Television viewing' (79.9 minutes, across genders) was most prevalent after 'studying', with females watching slightly more than males. 'Hanging out' was also prominent, with both genders spending at least one hour a day participating in this behaviour.

Insert Table 1 here.

Gender and Day Differences

A series of eight mixed design repeated measures analyses of variance were conducted with the eight specified behaviours as the dependent variables, with day (day of the week; within-participants factor) and gender (between-participants factor) as the independent variables. Results revealed no significant effect of day on any of the behaviours. Furthermore, there were no significant interactions. However, significant differences were found for gender. For 'computer game playing' results revealed a significant difference for gender [$F(1,82) = 7.97$, $p<.006$], with males participating more than females, but there was no difference for day [$F(1,82)<1.0$, $p>.05$], nor a significant interaction [$F(1,82) = 2.07$, $p>.05$].

A significant gender difference was revealed for 'sitting and talking' [$F(1,82) = 24.49$, $p<.006$], with females spending more time in this behaviour than males, but not for day [$F(1,82)= 6.84$, $p>.006$], and there was no significant interaction [$F(1,82)<1.0$, $p>.05$]. Finally, a significant gender difference was found for 'studying' [$F(1,82) = 10.50$, $p<.006$], with higher scores being shown for males. There was no significant difference for day [$F(1,82)=1.05$, $p>.006$], nor was there a significant interaction [$F(1,82)=2.01$, $p>.006$].

Intercorrelations

Table 2 reveals the mean time in minutes that males and females spent in the three different sedentary behaviour groupings and in physical activity (a combination of 'sport and exercise' and 'active transport'). Most time was spent in the 'Sedentary study' category (247.1 minutes), followed by 'Sedentary technology' (132.3 minutes) and 'Sedentary social' (81 minutes) behaviours. Pearson correlations were conducted on five dependent group variables separated by gender due to the differences observed in the ANOVAs.

Insert Table 2 here.

Sedentary Behaviour Groups

Pearson correlations (n=168) revealed significant negative correlations between Sedentary study and Sedentary social times for males (r = -.310, $p<.001$) and females (r = -.465, $p<.001$). A significant negative correlation was also revealed between Sedentary technology and Sedentary study for males (r = -.378, $p<.001$) and females (r = -.242, $p<.001$). No significant relationship was found between Sedentary social and Sedentary technology behaviours for males (r = -.102, $p>.05$) or females (r = -.130, $p>.05$).

Physical Activity

When combining 'sport and exercise' and 'active transport' to form a composite 'Physical activity' variable, a significant negative relationship existed between Physical activity and Sedentary technology for males (r=-.217, $p<.05$), but not for females (r= -.182, $p>.05$). No significant relationship existed between Physical activity and Sedentary social for males (r= .203, p>.05) or females (r=.153, p>.05) and neither was there a significant relationship between Physical activity and Sedentary study for males (r= -.137, $p>.05$) or females (r=-.090, $p>.05$).

Discussion

Despite the public health importance of studying inactivity, little is known about student levels of, and trends in, sedentary behaviour. The purpose of this study, therefore, was to investigate the sedentary and active behaviour trends of students, using an EMA method.

Student Behaviour

Student's most prevalent behaviour was 'studying', with both male and female students spending an average of just under 4 hours a day conducting this behaviour. A cluster of behaviours followed with participants spending at least one hour a day 'watching television', 'sitting and talking' and 'hanging out'. This highlights the multifaceted nature of sedentary behaviour and supports Marshal et al's(4) call for the need to examine sedentary behaviour beyond a simple analysis of television viewing. The dominance of 'studying' behaviour may be explained by the fact that data were collected between May and June, the exam period for students at the university. Steptoe et al.(24) showed that for participants suffering from exam stress, vigorous PA declines. Nevertheless, knowledge of student's active and sedentary behavioural patterns during this period remains important. Understanding how young people engage in sedentary behaviour provides more leverage for intervention efforts designed to encourage lifestyles that are more active(14).

Gender Differences

Akin to previous research(11) this study found gender differences in the sedentary behaviour patterns of students. Three sedentary behaviours differed significantly by gender: (a) 'sitting and talking', (b) 'computer game playing', and (c) 'studying'. Females spent significantly more time 'sitting and talking' than male students. These results support work conducted by Marshall et al.(13) who found that females clearly enjoy socialising and that this is responsible for an important

proportion of their sedentary behaviour. This claim is supported by evidence that friends' participation in PA within specific social structures mediates activity levels of girls and women(25). Future interventions for females may benefit from integrating social elements when increases in PA or decreases in sedentary behaviour are desired.

Male students spent significantly more time 'studying' than females. This appears contrary to previous research that suggests female students are more conscientious than male students(26). An explanation that could explain these results is sampling bias. This study may have attracted male students who were most hard working. Further evidence is necessary to understand and confirm this gender difference.

Although only three behaviours differed significantly by gender, other behaviours were close to significance, including 'sport and exercise'. Males spent on average 38.9 minutes a day participating in 'sport and exercise' compared to females who spent 21.7 minutes. This highlights a typical trend that has been statistically significant in previous studies(27), although in the present sample, the gender difference, while meaningful, was small (effect size d = 0.33) In contrast, females spent 40.8 minutes a day participating in active forms of transport compared to males who spent an average 23.8 minutes. A Bonferroni test was implemented to control for familywise error due to multiple ANOVAs. By being more conservative in the type I error for each comparison, it increases the chance that a genuine difference in the data will be missed (type II error)(28). Therefore, a genuine difference in these physically active behaviours may exist that the present study has missed due to a loss of statistical power, although the effect size calculation suggests that the difference may still be small due to high variability.

A gender difference was also identified for computer game playing and supports previous research indicating that males spend more time playing computer games than females (29). At a time when games consoles are becoming ever more advanced, this finding has important implications for interventions. Our results support the exploration of interventions that make use of computer games that require physically active participation, particularly for males. An example is Maloney et al. (30) who examined the use of dance mats as a PA intervention for children. The implementation of a dance mat revealed reduced sedentary behaviour and let to a slight increase in vigorous physical activity. Future research will need to test the longevity of such effects.

Sedentary Behaviour Intercorrelations

Categories of sedentary behaviours were created to identify their interrelationships, and also their relationships with PA. However, it is important to note that these results are correlational, therefore causal effects cannot be established. Sedentary study and Sedentary social behaviours demonstrated a significant negative relationship, suggesting these two sedentary categories may somewhat compete with each other for students' time. If more time is spent studying, less time may be spent conducting social sedentary behaviours. A similar but slightly smaller correlation was found between Sedentary study and Sedentary technology. Marshall et al.(4) hypothesised that a "substitution effect" operates in which contemporary forms of screen-based entertainment (e.g. video game and computer use) replaces more traditional media (reading comic books, listening to music etc.). The present data suggest that current forms of sedentary behaviour may carry a substitution effect, where if one is dominant another is reduced.

Physical Activity Correlations

A small significant correlation was identified between Sedentary technology behaviours and PA for males but no relationship for females. Although significant for males these small relationships suggest that technological sedentary behaviours and PA do not compete significantly for time and can largely coexist as part of a student's lifestyle. This finding appears contrary to lay perceptions and supports Marshall et al.(13) in their view that there is time for both behaviours in the lives of young people. Indeed, contemporary research suggests that TV viewing and physical activities are largely uncorrelated(31). Nevertheless, more research is needed on the optimal balance of prolonged sedentary time and health, and whether bouts of physical activity offset the effects of sedentary time.

Research Critique

Attempts to assess sedentariness often fail to capture the diversity of physically inactive behaviours and tell us nothing about what inactive people are actually doing(32). The strength of the present study lies in measuring a range of behaviours that students participate in.

EMA techniques have been developed to acquire self-reported information with less distortion than is found in traditional recall methodologies. Although the EMA technique is designed to gather instantaneous reports, the pen and paper method implemented makes assessment of compliance difficult.(20) Furthermore, previous studies suggest that problems with poor compliance is an issue in research using paper diaries(33). Therefore, future studies need to pay attention to maximising compliance. More effective and comprehensive training is thought to improve compliance and increase the likelihood that procedures are followed correctly.

Conclusions

In conclusion, the present study suggests that interventions aiming to increase PA in students by only reducing sedentary behaviour may have limited success. This is because sedentary and physically active behaviours appear largely uncorrelated or, at best, weakly associated. More targeted interventions that aim to increase PA while satisfying the need to participate in sedentary behaviour are likely to be more effective. Moreover, decreasing sedentary behaviours may have important health outcomes independent of physical activity(34). This requires further investigation.

Table 1. *Mean time in minutes (and standard deviations) spent participating in eight selected behaviours across gender and time.*

Behaviour	Male			Female			Gender x Time	Gender Effect [a]
	Weekday	Weekend	Total	Weekday	Weekend	Total	**Total**	
Television viewing	52.3 (64.3)	84.0 (67.5)	68.2 (67.5)	83.1 (90.4)	103.8 (87.6)	93.5 (89.1)	79.9 (79.0)	F(1,82)= 3.45, p=.067
Computer games	24.3 (51.9)	15.7 (40.6)	20.0 (46.5)	0.0 (0.0)	5.0 (21.9)	2.5 (15.6)	11.9 (36.3)	F(1,82) = 7.97, p=.006*
Computer	50.0 (67.6)	41.7 (59.1)	45.8 (63.3)	46.9 (70.9)	31.9 (38.8)	39.4 (57.3)	42.9 (60.5)	F(1,82)= 0.336, p=.564
Study	284.0 (136.1)	176.0 (183.1)	280.0 (160.4)	160.0 (154.2)	209.6 (176.3)	184.8 (166.4)	235.8 (169.6)	F(1,82) = 10.50, p=.001*
Sitting Talking	49.3 (60.3)	34.3 (54.6)	41.8 (57.7)	122.7 (89.9)	91.5 (83.5)	107.1 (87.6)	72.1 (79.9)	F(1,82) = 24.49, p=.002*
Shopping hanging	71.0 (118.4)	49.0 (95.7)	60.0 (107.6)	84.6 (75.4)	52.7 (81.4)	68.7 (79.5)	64.0 (95.4)	F(1,82) = 0.345, p=.56
Sport and Exercise	42.0 (75.8)	35.7 (61.0)	38.8 (68.5)	21.5 (40.1	21.9 (34.4)	21.7 (37.1)	30.9 (56.6)	F(1,82)=2.93, p=.091
Active transport	24.3 (51.9)	23.3 (34.8)	23.8 (24.8)	46.9 (44.0)	34.6 (39.1)	40.8 (41.8)	31.7 (39.0)	F(1,82)=6.16, p=.015

* $p < 0.006$ [a]Repeated measures ANOVA with Time (within) and Gender (between) as factor

Table 2. Mean time in minutes (and standard deviations) for three sedentary behaviour groups and sport and exercise behaviour.

	Male	Female	Total
Sedentary technology	134.0 (105.9)	135.4 (102.2)	134.6 (103.9)
Sedentary social	51.0 (64.3)	118.7 (100.4)	82.4 (89.4)
Sedentary study	298.5 (163.3)	197.3 (174.6)	251.5(175.6)
Physical activity	62.7 (75.0)	62.5 (48.6)	62.6 (63.9)
Sport and exercise	38.8 (38.5)	21.7 (37.1)	30.9 (56.6)

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