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RESEARCH ARTICLE

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Sedentary behaviour in Australian university students: The contribution of study-related sedentary behaviour to total sedentary behaviour

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Abstract

Issue Addressed: Seated activities are attributed to increased sedentary behaviour (SB) and adverse health effects, but little is currently known about university students' SB, particularly study-related SB. This study describes the sociodemographic variations of domain-specific SB in regional Australian university students and the contribution of study-related SB to total SB.

Methods: Self-reported daily SBs from a cross-sectional survey of 451 students were used. Domain-specific and total SB were described within sub-groups, and differences examined using independent *t*-tests. Multinomial regression was used to examine the association of tertiles of duration in study-related SB with total and other domain-specific SBs.

Results: Study participants were a median age of 21 (19–25 years), mostly female (76%) and represented different years of study. On average, students spent 882 ± 292 min/day in total SB, with most SB occurring in the study, screen time and 'other activity' domains. No sociodemographic variations were found in total SB, but significantly higher study-related SB were reported by students studying full time ($p < .001$) and who moved from their family home to study ($p < .022$). Study-related SB contributed 36% of total SB, with students most sedentary during study having the highest total SB.

Conclusions: This study suggests university students have high levels of SB, primarily in the domains of study, screen time and other activities. SB reduction strategies in universities and targeting screen time, across various sociodemographic groups (e.g., gender, university enrolment status, and living arrangements), may be important in reducing SB in university students.

So What? University students are highly sedentary and should be included in SB programs especially students studying full time and those who moved from their family home in the study domain.

KEYWORDS
health promotion, public health, sitting

1 | INTRODUCTION

Sedentary behaviour (SB) (i.e., any wakeful activity expending ≤1.5 METs in a sitting, or reclining posture)[1–3] is a recognised public health priority associated with a greater risk of type 2 diabetes, cardiovascular disease,[4,5] and higher all-cause mortality risk.[6] As such, globally, health guidelines recommend reducing time spent in SB. For instance, Australian SB guidelines for adults aged 18–64 years recommend limiting time spent sitting/lying (e.g., using standing desks) and breaking up long periods of sitting (e.g., walking around when on the phone).[7]

Unhealthy levels of SB are estimated to be highly prevalent across the adult population, with levels increasing over the last decade due to environmental (e.g., increasing sedentary occupations) and social/leisure-time (e.g., screen-based devices) changes encouraging individuals to sit for longer periods of time.[8] Workplaces are well recognised as settings for high SB, particularly those that involve office-based activities.[9,10] Much like office workers, university students are also susceptible to high levels of SB, spending a large portion of their waking day in seated settings[11] and activities which promote SB, such as attending/studying for classes,[12,13] seated travel, and 'hanging out' with fellow classmates.[11,14] Furthermore, the transition from high school to university is considered an at risk period,[15] where students are faced with life-changing events such as stepping towards personal independence[11] and unfavourable behaviour changes.[15] During this period it is important to establish healthy behaviours which can be carried on throughout life.

Recent reviews[8,16] and subsequent studies[17–20] of university students' SB have found varying amounts of total SB, with total SB measured over 7 days ranging from 45 to 861 min/day. Some studies have also assessed domain-specific SB using different combinations of domain categories. These have found daily domain-specific SB time ranges of 97–255 min/day[13,21–25] for occupation (e.g., work, studying, or volunteering), 20–482 min/day[8] for screen time (e.g., television, computer use, mobile phones or social media), and 68–151 min/day[26,27] for other activities (e.g., recreational reading). Other studies have also measured SB while eating,[21] travelling,[21,22] and other activities (such as childcare, elder care, or reading)[15,21,22] as additional domains independently but on weekdays and weekends separately.

Few studies have explored 'studying' as an independent domain to occupation. A recent review[8] and subsequent studies[18,21] have found study-related SB ranging from 97 to 339 min/day. However, these studies incorporated different study-related SB activities such as, study time (e.g., writing, reading, or computer use), time in class, studying at home or university, and study time/time in class, making comparisons difficult. Further, three studies explored sociodemographic differences in study-related SB. One study found males to have higher SB levels[28] and the other two[24,29] found females to sit longer in study-related activities (e.g., study time or homework).

Although SB research on university students is emerging, evidence is still somewhat in its infancy, particularly in understanding students' SB across domains and studying as its own separate domain and the sociodemographic differentials in students' SB. Understanding the nature of students' SB, including the environments in which it is occurring and who are most at risk of high SB, can help inform the development of setting-specific public health strategies and policies.

Therefore, the purpose of this study is to describe sociodemographic variations of domain-specific SB in regional Australian university students and the contribution of studying on total SB.

2 | METHODS

2.1 | Participants

All first and third year (equivalent) university students over the age of 18 years were invited to participate in the cross-sectional study from two regional universities in Australia via a range of promotional activities providing a link to the online questionnaire. First year students were recruited specifically to assess them as a sub-group in understanding potential differentials in SB that come with transitioning to tertiary study. Third year students were used for comparison. Exclusion criteria included students under the age of 17 years and who were not in their first or third year equivalent of study.

2.2 | Procedures

An online self-completed questionnaire administered via QuestionPro, over a four-week period during the start of semester one in 2017, was used to collect data. The questionnaire was promoted using poster displays (e.g., mounted in faculty common areas), social media groups (e.g., advertised weekly through university Facebook), student associations communication mediums (e.g., student guild notice board), university research participation systems (e.g., online portal for recruiting participants for university research projects), and student email systems. A random prize draw of a chance to win one of five $50 vouchers to a major department store was used as an incentive to participate in the study. Ethics (approval number S/16/969) and gatekeeper ethical approval by the second university was granted. Informed consent was obtained from all participants in the study.

2.3 | Measures

2.3.1 | Outcome measures

Total and six domain-specific measures of SB over the last 7 days were used in the study: (1) sitting while eating; (2) sitting while travelling; (3) sitting while studying; (4) sitting while working/volunteering; and (5) screen time (excluding study-related), and (6) other activities (e.g., hobbies, caring or socialising). Questions on each measure were taken from the validated 'last 7-day sedentary time questionnaire' (SIT-Q-7d)[30] that has shown fair to excellent test–retest reliability (ICC = .45–.76) across domain and total SB.[31] Adaptations were made to work, and screen time domain questions. Studying questions were removed from the work domain question set and asked as a separate

set of questions to enable the independent measurement of study-related SB. Snacking while watching television questions, as specific sub-activities of watching television, were excluded from the screen time and other activities section as the study was not interested in eating behaviour as a specific activity.

The complete list of these revised questions is available in the Supporting Information. The modified questionnaire was reviewed by research team members for content validity[32] and piloted with a sample of 18 university students for content, composition, relevance, clarity, language, length, layout, format, understandability, and appropriateness.[33] Changes to the questionnaire were made accordingly.

Domain-specific SB was calculated by summing the total time across measures in the domain, and total SB was calculated by summing total time across domains.

2.3.2 | Exposure measures

Sociodemographic measures included: age, gender, study mode (full time, part time), year level, international student (no, yes), living arrangements (single and living by yourself, single and living with friends, single and living with family, single parent living with one or more children, couple (married or partner) living with no children, and couple (married or partner) living with one or more children), and moving from family home to study (no, yes). For analyses, living arrangement was categorised into two groups: 'living in a household with no children' and 'living in a household with children'. Some students indicated they were in their second year ($n = 26$) and fourth year ($n = 25$) of study. These students were retained in the study and grouped into a category 'greater than first year' with third year students as a comparison for first-year students who were considered possibly still in the process of transitioning to university life and establishing behavioural habits.

2.4 | Data clearance

Of the 520 study participants, 69 were excluded from analysis due to: (i) not answering SB questions ($n = 8$), (ii) not answering any questions ($n = 15$), (iii) having more than 40% of unanswered questions ($n = 46$). Removing participants with more than 40% missing data is consistent approach with previous research when using the technique of multiple imputation.[34] In addition, participants who reported erroneous values exceeding 24 h/day were excluded from the analysis; within the other activities ($n = 4$) and total SB ($n = 112$). Previous researchers also reported issues with erroneous values exceeding 24 h/day with these types of questionnaires[13,22] and excluded a similar number of participants ($n = 122$).[22]

Given the variability in completeness of the data across participants and questions and to enable the appropriate inclusion of participants in data analyses, multiple imputation was used.[34,35] Item scores were modelled to gain the most accurate regression estimates.[36] All SB variables were imputed and used as predictors except the demographic characteristics; gender, living arrangements, and study year were used as predictors only. Minimum and maximum values were indicated in the regression model to not exceed the item score options.[35] Missing values were imputed using chained equations (m [number of imputations] = 5) and 50 iterations.[35] Results of the model were combined into a single estimate by applying Rubin's rules.[35] After imputation was completed, convergence of the imputations were checked before analysing the imputed data. Standard deviations are not automatically pooled in SPSS, therefore, these were calculated by computing the average over the five imputed standard deviations.[35]

2.5 | Statistical analysis

The dataset was cleaned and SB measures assessed in accordance with the SIT-Q-7d protocol.[37] Descriptive statistics were used to summarise average domain-specific and total SB across student sub-groups and the contribution of study activity to total SB. Differences within bivariate characteristics were analysed using independent t-tests and effect sizes (Hedges' g and Cohen's d) used to describe differences. Cohens d is recommended for calculating effect sizes where variances are equal and Hedges' g is recommended for calculating effect sizes where variances are not equal,[38] however they can be interpreted in the same way as Cohen's d: .2 small, .5 medium, .8 large.

A data driven approach replicated from a previous study[9] was used to examine whether the study-related SB levels differed in SB reported across other domains, where participants were grouped into 'low' (<224.5 min/day), 'medium' (224.6–365 min/day) and 'high' (>365.1 min/day) tertiles based on the amount of time reported sedentary during studying activities. Multinomial regression was used to examine the association of study-related SB groups with domain-specific and total SB, while adjusting for gender, age, study mode, moving from family home to study, and domain-specific SB as covariates.

All statistical analyses were performed using IBM SPSS version 26 and statistical significance set at $p < .05$.

3 | RESULTS

3.1 | Participant characteristics

Participants' sociodemographic characteristics ($n = 451$) are presented in Table 1. Participants were predominantly female (76%), studying full time (91%), and domestic (86%), with a median age of 21 (19–25) years, and were relatively evenly split between being in their first year (51%) and greater than first year (49%) of study.

3.2 | Total SB time

There were no significant differences between the two universities in students' total and domain-specific SB, therefore, data were combined.

TABLE 1 Mean (±SD) total and domain-specific daily sitting times (min/day) for the sample as a whole, and according to sociodemographic characteristics.

Domain	N	%	Eating	Travel	Study	Work	Screen time[c]	Other activities[a,d]	Total sitting[a]
Total sample	451		52 ± 28	77 ± 93	320 ± 167	30 ± 68	318 ± 263	314 ± 258	882 ± 292
University									
Uni 1	349	77	51 ± 28	79 ± 95	316 ± 166	31 ± 70	307 ± 255	312 ± 266	870 ± 295
Uni 2	102	23	54 ± 28	68 ± 87	334 ± 169	28 ± 66	354 ± 288	322 ± 226	924 ± 274
Gender									
Male	106	23	45 ± 22	64 ± 56	310 ± 154	27 ± 57	372 ± 305	380 ± 303[b]	861 ± 281
Female	343	76	53 ± 29[b]	81 ± 102	323 ± 171	31 ± 72	302 ± 247	294 ± 240	888 ± 295
Unspecified	2	.4	51 ± 9	24 ± 13	195 ± 22	11 ± 16	220 ± 92	288 ± 64	790 ± 172
Study mode									
Full time	411	91	52 ± 28	75 ± 93	329 ± 167[b]	25 ± 59	324 ± 269	321 ± 262	886 ± 289
Part time	40	9	51 ± 29	94 ± 99	229 ± 178	81 ± 124[b]	257 ± 186	239 ± 196	846 ± 317
Year level									
First year	229	51	50 ± 26	72 ± 82	334 ± 172	26 ± 60	296 ± 261	310 ± 263	864 ± 285
>First year	222	49	53 ± 30	82 ± 103	305 ± 160	35 ± 71	340 ± 265	318 ± 252	900 ± 298
International student									
No	387	86	51 ± 27	78 ± 94	311 ± 157	34 ± 72	318 ± 261	312 ± 257	885 ± 292
Yes	64	14	54 ± 30	69 ± 90	370 ± 211	11 ± 32	314 ± 281	328 ± 264	858 ± 289
Living arrangement									
Living with no children	407	90	52 ± 28	75 ± 86	319 ± 170	29 ± 63	324 ± 267	317 ± 257	887 ± 291
Living with children	44	10	44 ± 25	92 ± 147	326 ± 139	38 ± 110	258 ± 218	289 ± 266	835 ± 296
Moved from family home									
No	246	54.5	50 ± 27	89 ± 101[b]	303 ± 158	35 ± 75	305 ± 260	295 ± 264	853 ± 295
Yes	205	45.5	54 ± 29	61 ± 81	340 ± 175[b]	25 ± 60	333 ± 267	336 ± 248	918 ± 283

[a]Missing values present in this category.
[b]Statistically significant ($p < .05$), highlighting the category with the highest sitting time.
[c]Recreational screen time, not including work or study related activities; television viewing and playing on computers (e.g., computer games, social media etc).
[d]Other activities include: household tasks, caring (elder or child care) hobbies (reading, playing a musical instrument), and socialising.

Participants reported spending an average of 882 min/day (SD = 292) in total SB (Table 1). Across SB domains, participants reported most SB in the study domain ($M = 320$, SD = 167 min/day), followed by screen time ($M = 318$, SD = 263 min/day), other activities ($M = 314$, SD = 258 min/day), travel ($M = 77$, SD = 93 min/day), eating ($M = 52$, SD = 28 min/day), and working ($M = 30$, SD = 68 min/day). Table S1 presents the SB of individual activities within each domain.

3.3 | Domain-specific SB

Significant differences were found in domain-specific SB within student sub-groups. These included: (1) eating domain: female students ($M = 53$, SD = 29) sitting longer than males ($M = 45$, SD = 22 min/day, Hedges' $g = .29$, $p < .003$); (2) travel domain: students residing in their family home ($M = 89$, SD = 101) sitting longer than students who relocated to study ($M = 61$, SD = 81 min/day, Cohens $d = .30$, $p < .002$); (3) studying domain: full time students ($M = 329$, SD = 167) sitting longer than part time students ($M = 229$, SD = 178 min/day, Cohens $d = .59$, $p < .001$) and students who relocated to study ($M = 340$, SD = 175) sitting longer than those who resided in their family home ($M = 303$, SD = 158 min/day, Cohens $d = .22$, $p < .022$), and (4) working: part time students ($M = 81$, SD = 124) sitting longer than full time students ($M = 25$, SD = 59 min/day, Hedges' $g = .83$, $p < .009$); and (5) other sedentary activities: males ($M = 380$, SD = 303) sitting longer than female students ($M = 294$, SD = 240, Hedges' $g = .33$, $p < .014$).

3.4 | Contribution of study-related SB activities to total SB

Study-related SB activities contributed 39% to total SB of first year students and 35% of students enrolled beyond their first year.

TABLE 2 Mean (±SD) total and domain-specific daily sitting times (min/day) for students grouped into tertiles according to reported time spent sitting during study-related activities.

Study SB level	*N*	Eating	Travel	Work	Screen time	*N*	Other activities	*N*	Total SB
Low	153	49 ± 26[a]	83 ± 89	35 ± 70	312 ± 268	152	278 ± 254	131	768 ± 298[ab]
Medium	146	49 ± 26	73 ± 79	27 ± 59	334 ± 256	145	335 ± 256	111	909 ± 278 [ac]
High	152	56 ± 30[a]	74 ± 109	30 ± 75	307 ± 266	150	331 ± 260	97	1004 ± 239[bc]

Note: Daily sitting times were statistically significant ($p < .05$) between groups in the same domain with the same superscript ([a,b,c]).

Students enrolled in their first year ($M = 142$, SD = 13 min/day) sat longer while studying off campus than students who were enrolled in beyond their first year ($M = 121$, SD = 11 min/day, Cohens $d = 1.7$, $p < .042$).

Students in the high study-related SB tertile was sedentary significantly longer while eating than those in the low study-related SB tertile ($p < .024$) and had significantly higher total SB ($p < .001$) (Table 2). Students in the medium study-related SB tertile also reported significantly higher total SB than those in the low study-related SB tertile ($p < .002$), and students in the medium study-related SB tertile had significantly lower total SB than those in the higher study-related SB tertile ($p < .020$).

4 | DISCUSSION

4.1 | Main finding of this study

The purpose of this study was to describe sociodemographic variations of domain-specific SB in regional Australian university students, and the contribution of studying on total SB. Overall, we found students spent on average 882 min/day (or 15 h/day) engaged in sedentary activities, with studying domain (320 min/day or 5 h/day) being the greatest contributor towards total SB, followed closely by the screen time domain (318 min/day or 5 h/day), and other activities domain, which included hobbies, caring or socialising (314 min/day or 5 h/day). Less SB time was spent in travel (77 min/day or 1 h/day), eating (52 min/day or .9 h/day) and work domains (30 min/day or .5 h/day).

Sociodemographic differences were not found in total SB; however, differences were found in domain-specific SB, with females reporting that they sit longer while eating, whereas males reported sitting longer in other sedentary activities. As expected, this study found full time students spent more time sedentary during study-related activities and part time students spent more sedentary time at work. Additionally, students who resided in their family home were sedentary longer while travelling, suggesting that students who relocated from their family home may have moved to residences in closer proximity to frequented destinations (e.g., university). No significant differences were found in sedentary screen time between sociodemographic groups, consistent with other literature.[22]

University study activities contributed substantially to total SB, and more for first year students than students in their later years of study. Activities on campus in and outside of class combined contributed up to almost one-quarter (21%–23%) of total SB, with off campus study-related SB contributing an additional 14%–16%. We also found students who were sedentary more during their study activities also had the highest total SB, suggesting there may be potential to reduce overall SB with strategies targeting breaking up SB during study activities.

4.2 | What is already known on this topic

Research on SB in students is emerging, but findings have varied across studies, with total SB ranging from 45 to 861 min/day.[8,16–20] Some of this variation may be due to measures used in studies, for example, the use of accelerometers versus self-report surveys, and being context specific. Our study found students' total SB was at the upper end of the range using a self-report tool, at 882 min/day. It could be that students' reporting overestimated their SBs.

University students' SB in specific domains is less understood; however, this study found consistency in SB times with those of previous studies. Study SB times have been found to range from 97 to 339 min/day,[8,18,21] with SB study times from this study in the upper limits of this range (320 min/day). SB in the work domain in this study was also consistent with previous findings.[21] Whereas, SB while eating in this study was lower and travelling slightly higher than a previous study by Moulin and Irwin,[21] which measured SB separately during the week and weekend. Higher travelling could be due to this study being undertaken in regional universities.

SB in other domains such as screen time and other activities are more commonly reported separately in the literature. Previous studies suggest that SB screen time ranges from 20 to 482 min/day,[8] with this study falling within this range (318 min/day). However, the included studies among the Castro et al[8] review rarely reported the purpose of screen time, which may have included study-related and leisure-related screen time, whereas, our study only included leisure-related.

In addition, previous studies have reported SB in other activities over 7 days ranging from 68 to 151 min/day[26,27] and separately on a weekday and weekend (111–135 min/day vs. 172–195 min/day, respectively).[21,22] Averages in our study are higher than that measured over 7 days, but may have explored more SB activities within this domain, for example, previous studies included only recreational reading or books as other activities; we included hobbies, caring, socialising and more.

4.3 | What this study adds

This study further builds evidence to understand the nature and quantity of SB in students, including total levels of SB and domain-specific SB to students at regional universities. The study found that students accumulate most of their SB while studying (at least equally to other leisure time pursuits such as screen time and other activities), and found that students who sat most during study also have the highest total SB, suggesting universities may be appropriate settings and/or have a role in SB intervention. All forms of study activities contributed to SB in students, including those during formal classes, on-campus more generally and also while studying off campus. This level of disaggregation of study SB had not previously been assessed and helps to ascertain where interventions may be best targeted to the authors' knowledge.

Given the relationship found between the contribution of study-related SB to total SB, targeting SB while studying among students who sit the most (e.g., full time and those residing in their family homes), may reduce total SB of university students. Universities provide an ideal setting to implement health promotion interventions which could include modifying university policy to include structured breaks or micro breaks during on campus classes to interrupt SB, and modifying the classroom environment to include standing desks, which have been shown potential to decrease SB within a university environment.[39,40] Other strategies such as standing breaks promoted by lecturers have also been found to be acceptable by students, with added perceived benefits of increases in concentration, receptiveness/retentiveness, motivation, and well-being.[41] There is also potential to influence breaking up SB off campus (e.g., at home) while studying, for example, using technology enabled apps on electronic devices.

Screen time SB was also confirmed as being a substantial contributor to total SB, suggesting interventions such as electronic monitoring devices found to be effective across different population groups (e.g., children and adolescents under 18 years old),[42,43] may be applicable to a university population in breaking up SB. Other such SB activities may also be influenced or initiated through changes in study sitting habits and ideals and could be targeted simultaneously.

Other domains such as travel show less sitting, but still contribute around 60 min/day to total SB and may also be potentially important settings to gain public health benefits through targeted interventions.

There are some limitations to this study. First, although short term recall measures were used, assessing habitual levels of SB are known to be susceptible to random and systematic reporting errors.[44] Second, this study used a modified version of a validated questionnaire given none specific to university students existed at the time, which may have resulted in overestimating study and work domains by breaking them into two. However, we found similar levels of SB across domains to previous studies with university students and the primary focus of the study was in understanding within sample differences across SB domains. Third, the findings may have been affected by recall bias, which could explain the proportion of participants who reported sitting time in excess of 24 h/day. Finally, not all potential confounders such as body mass index and PA were not included in the study. This could be a potential area that would be useful for further research.

5 | CONCLUSIONS

This study contributes to the growing body of evidence on university students' SB. It suggests that this sample of university students are highly sedentary, particularly while studying, in screen time, and other activities such as hobbies, caring or socialising across various sociodemographic groups (e.g., gender, university enrolment status, and living arrangements). The study suggests that interventions at university may be relevant in reducing students' SB which could include modifying university policy (e.g., to include structured class breaks) and classroom environments (e.g., standing desks), as well interventions targeting screen time and other SB activities such when socialising. As a SB target group, university students should be included in the research agenda and the roles of universities in promoting health-enhancing environments explored further.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest and financial support associated with this study.

DATA AVAILABILITY STATEMENT

All data generated or analysed during the current study are included in this published article.

ETHICS STATEMENT

Ethics approval was granted by the University of the Sunshine Coast Human Research Ethics Committee (approval number S/16/969), and gatekeeper ethical approval by the second university.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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