What psychosocial factors determine the physical activity patterns of university students?

What Psychosocial Factors Determine the Physical Activity Patterns of University Students?

Joseph J. Murphy., Ciaran MacDonncha ., Marie H. Murphy., Niamh Murphy., Alan M. Nevill., Catherine B. Woods

Abstract

Background: Although levels of physical activity (PA) have been researched, no information on how university students organise their PA across different life domains is available. The purpose of this study was to explore if, and how, students organise their PA across transport and recreational domains and identify the psychosocial factors related to these patterns.

Methods: Students from 31 Irish universities completed a supervised online survey measuring participant characteristics, psychosocial factors, and PA. Two-step cluster analysis was used to identify specific PA patterns in students. Binary logistic regressions identified factors associated with cluster membership while controlling for age, sex, household income, and perceived travel time to university.

Results: Analysis was performed on 6,951 students (50.7% male; 21.51 ± 5.55 years). One Low Active cluster emerged. Four clusters containing a form of PA emerged including Active Commuters, Active in University, Active outside University, and High Active. Increases in motivation and planning improved the likelihood of students being categorised in a cluster containing PA.

Conclusions: One size does not fit all when it comes to students PA engagement, with five patterns identified. Health professionals are advised to incorporate strategies for increasing students' motivation, action-, and coping planning into future PA promotion efforts.

Introduction

The recommendation to increase physical activity (PA) is a key element of health promotion strategies in many countries[1,2]. Research suggests that late adolescence and early adulthood may be a critical period of transition, for PA engagement[1]. Increasing numbers of individuals now spend this period in a university setting, with the number of full-time students increasing from 138,362 in 2007 to 181,039 in 2017 in Ireland[3]. Although university students appear to have the opportunity to be involved in regular PA[4], university settings are often associated with low levels of PA engagement[5, 6], which are an important risk factor for cardiovascular disease, certain cancers and type-2 diabetes[7]. Additionally, the benefits of regular health enhancing PA on students' mental health [8, 9], happiness [10], and social interaction [11] are also documented. Young adulthood may be a period when people are especially receptive to advice on adopting regular PA[12], with university contexts providing "pivotal settings" of unrealized opportunities to influence the PA of young adults[13].

PA levels of students have been investigated[1,6,14-17] but no research, to the authors knowledge, has explored how students organise their PA across multiple life domains. PA occurs across at least four life domains: recreational, transport, occupation, and domestic[17-19], with need for a more precise understanding of how students engage in specific PA domains. Research has investigated the relationship between domain-specific PA and health related quality of life in university students [17] and the general population[20]. Pedišić and colleagues (2014) found that recreational, transport and domestic PA were positively associated with improved health related quality of life, suggesting they have potential for improving students' overall health. Exploring the ways which activities are grouped together across different PA life domains has already been investigated in a general adult population[21]. Rovniak and colleagues (2010) identified three clusters based on adults' (n = 1,689; 54.6% male; 44.6 years) PA patterns, which included Low Active, Active Leisure, and Active Job clusters. The clusters identified differed based on socio-economic status, accelerometer measured PA, psychosocial and environmental supports. It was suggested that more extensive transport infrastructure for walking and cycling might be needed to detect an Active Commuter cluster[21]. Recreational, transport and domestic PA have shown the greatest potential for improving students'

health related quality of life[17]. Additionally, universities tend to offer multiple opportunities for students to partake in recreational (i.e. for enjoyment during discretionary time) and transport PA (i.e. walking and cycling to and from university) through the infrastructures, resources and supports[22], suggesting that these two domains hold the greatest potential for increasing students PA engagement and subsequently health. Identification of how students cluster based on their recreational and transport activities can inform health professionals of how students engage in PA while attending university. Additionally, identification of such patterns in students can have implications for intervention design, as strategies targeting specific PA life domains have been shown to be more effective[19].

Once PA patterns are identified, understanding the factors that are associated with these patterns are important[6], and mapping this information into intervention design is a key step for developing effective evidence-based programs. These can be categorised as internal to the person (i.e. biological and psychosocial) or external to the person (i.e. environmental), with research examining their relationship with overall PA in general and student populations[6]. In the general adult population, attitudes towards exercise, intention to exercise, stress, knowledge of health, action planning, and goal conflicts have been identified as correlates of PA[23,24]. Psychosocial factors relating to the PA levels in university populations are also reported[5,6,12,25], with factors such as self-efficacy, perceived social support, and intrinsic motivation noted as influencing PA levels. However, knowledge of such factors relating to the PA patterns of students across multiple life domains are unknown. It may be useful to examine multiple psychosocial factors at once and note how they relate to the PA patterns of students. For this, a practical tool, such as the determinants of PA questionnaire (DPAQ)[25] could be used. Taylor and colleagues (2013) tested the DPAQ in UK university students (N = 465; 30% male; 20.1 ± 3.5 years), finding that "high exercisers" showed increased positive emotions and action planning towards PA when compared to "low exercisers". Knowledge about the benefits of PA and the beliefs about the consequences of PA both scored highly but were found to be similar in both high and low exercisers[25]. Exploring these relationships will indicate important factors that can be utilised by PA promotion strategies. Thus, the purpose of this study was to explore: i) if and how Irish university

79 students' cluster based on their PA patterns; and ii) what psychosocial factors relate to students' PA
80 patterns while at university.

81 Methods

82 Procedure

83 Participants (N = 8122; 50.9% male; 21.51 ± 5.65 years) were recruited from 31 tertiary level
84 institutes in Ireland using quota based sampling, and considering institution size and field of study.
85 Information on the quota-based sampling procedures can be found in the Student Activity and Sport
86 Study Ireland (SASSI) report[22]. Participants were recruited through direct contact, as they completed a
87 supervised online questionnaire during class time. This protocol was based on previous research
88 where participation rates in excess of 90% were achieved[1,26]. The University of Ulster Research
89 Governance approved ethics, with informed consent sought at the beginning of the online
90 questionnaire after a short description of the project.

91 Measures

92 Participant Characteristics

93 Age, sex, socio-economic status, and perceived distance to university were assessed in participants.
94 Socio-economic status was assessed by asking students to 'Please estimate the gross (before tax)
95 annual income of your family household'[27], with the seven options ranging from less than 20,000
96 (£/€) to more than 90,000 (£/€). Perceived distance to university was assessed by asking the students
97 'How long does your journey to university usually take?' with participant responses given in hours
98 and minutes.

99 Physical Activity

100 Overall PA was measured using the International Physical Activity Questionnaire – Short Form
101 (IPAQ-SF)[28], which has been found to be a valid (77.4% agreement against accelerometry) and
102 reliable (ICC = 0.52 over 9 days) tool for measuring attainment of the PA guidelines (PAGL; ≥150
103 mins.MVPA.week) in students[29]. As mentioned earlier, PA can occur across four life domains but the

research team decided to investigate students' behaviours across the recreational and transport domains. This is due to the potential for engaging in recreational and/or transport PA while at university[22] and the documented benefits of each for students health related quality of life[17]. Transport related PA was measured using a single item measure adapted from the Census of the Irish Population survey[30], that asked "How do you usually travel to university (i.e. what is the longest part of your journey)". Responses included six options, including car, bus, train, motorcycle, scooter, bicycle or by foot. Recreational PA was measured using a single item measure adapted from the Higher Education Sport Participation and Satisfaction Survey[31], which asked students the following; "Thinking about the last 4 weeks, did you do any sporting or recreational PA?" The responses included 1) I have not participated in any sport or PA either within or outside of my university, 2) My participation was only through my university, 3) My participation was only through organisations and facilities not connected to my university, and 4) My participation was both through university and non-university provision.

Psychosocial Factors

Psychosocial factors of PA were measured using an adapted determinants of PA questionnaire (DPAQ)[25]. The DPAQ is based on the theoretical domains framework[32], which identifies factors and constructs related to PA, and can subsequently signal opportunities for intervention[25]. The DPAQ was shortened from three (four for action planning) to one statement asked for each of the 11 factors (Suppl. Table 1), with the most appropriate statement selected based on highest loadings shown in confirmatory factor analysis[25]. These factors include knowledge of the PAGL, perceptions of the environment, motivation, beliefs about capabilities, skills, emotions, social influences, beliefs about consequences, action planning, coping planning and goal conflict regarding PA. Taylor and colleagues (2013) factor analysis was conducted in a UK university staff and students (n = 832; 325.8% male; 33.6 ± 11.52), a population similar to the students in Ireland and Northern Ireland. Thus, the results of the factor analysis were seen to apply in some way to the student population of this study. Students selected the most appropriate response using 7-point Likert scales ranging from 1 = strongly disagree to 7 = strongly agree.

131 ***Statistical Analysis***

132 SPSS Inc., Chicago IL, version 23 was used for all analyses. The responses from a number of
133 measures were analysed or dichotomised before any further statistical analysis. Responses for
134 household income (>£35,000/ €50,000 and <£35,000/ €50,000) and travel activities (active and
135 motorised) were dichotomised. Students distance to university was organised into ten-minute intervals
136 aiding interpretation in further analysis. Student's answers to the IPAQ-SF were analysed as advised
137 by similar research[33], and dichotomised into meeting and not meeting the PAGL[34]. Negatively phrased
138 questions in the DPAQ were reverse coded so an increase in the score was seen as a positive response
139 to the statement.

140 Descriptive statistics (e.g. means, medians, standard deviations etc.) were calculated for
141 sociodemographic data and for both transport and recreational PA. Pearson's chi-square test for
142 independence was performed to note any significant differences in the transport and recreational
143 physical activities between sexes. A two-step cluster analysis was used as an explanatory tool to
144 identify the PA patterns of university students. This method was designed to handle large data sets
145 and enables the input of categorical variables. The number of clusters was based on the on the log-
146 likelihood distance and Schwarz Bayesian criterion[35]. The cluster analysis procedures were repeated
147 with five internal random samples (50%) of the total study sample and kappa statistics were used to
148 assess reliability of the cluster solutions[36]. Participants who did not complete all of the items needed
149 for the cluster analysis were removed from the study. Once a valid and reliable cluster structure had
150 been identified, ANOVA with Bonferroni post hoc (or Welch with Games-Howell post hoc when tests
151 of homogeneity were failed) was used to examine cluster profiles for differences in age and perceived
152 distance to university. Differences between cluster outputs for sex and proportion meeting the PAGL
153 were assessed using chi-square analysis with the adjusted residual (AR) observed[37]. Binary logistic
154 regressions, with enter method, were used to identify which participant DPAQ item scores predict the
155 cluster membership, whilst controlling for age, sex and household income. Logistic regression allows
156 categorically and continuously scaled variables to predict any categorically scaled criterion[38]. The
157 binary logistic regression was performed for each cluster output versus the Low Active cluster, with

the model containing 11 factor variables and controlling for age, sex and annual household income. The numbers used in the regression analysis were lower due to missing data from a combination of the participant characteristic and DPAQ questions (N = 3,089). Results are presented as Odds Ratios (OR) and 95% Confidence Intervals (CI).

Results

After data cleaning, the analytical sample comprised of 6,951 participants (50.7 % male; 21.51 ± 5.55 years). Participants included for analyses were not significantly different from those excluded for age (t (7619) = 0.21, p=0.83) or sex (X^2 (1) = 0.45, p=0.50). Most participants were undergraduate students (95.2%), studying full-time (95.9%) coming from a household income of less than £35,000 or €50,000 (60.9%). Table 1 shows that 66.7% of students reported meeting the PAGL, where significantly more males than females reportedly met the PAGL (X^2(1) = 121.11, p<0.01). Most travelled to university using motorised (58.3%) rather than active transport, with no significant difference for sex. Students participated in recreational PA; 1) through their university (15.0%), 2) through organisations and facilities outside their university (31.8%), 3) through organisations and facilities in and outside their university (18.3%), or 4) not at all (32.9%). Participation in recreational related PA was different based on sex (X^2(3) = 158.21, p<0.01), with a higher proportion of females reporting no participation and a higher proportion of males reporting participation outside their university or both inside and outside their university.

-----Insert Table 1 about here-----

Using PA participation data from the two identified relevant PA life domains -transport and recreational – a two-step cluster analysis was performed to establish if any distinct PA patterns existed for the student population. Results revealed five distinct clusters based on self-reported PA. A very good agreement between the cluster solution derived from the full sample and the five random subsamples was obtained (kappa = 0.86, p<0.01). The clusters were given the descriptive titles, based on self-reported PA: Low Active, Active Commuters, Active in University, Active Outside

University, and High Active. The next section and Table 2 present the characteristics of each cluster based on the PA domains engaged in, cluster members sex, age, household income, perceived distance to university, proportion meeting the PAGL and the mean scores for each of the DPAQ items. The differences between cluster members for participant characteristics (i.e. sex, age and household income, perceived distance to university), self-reported attainment of the PAGL, and DPAQ item scores are also presented in (Table 2). The results from binary logistic regressions, showing the relationship between the psychosocial factors and clusters, are presented in the following section and Table 3.

Cluster Characteristics and Related Psychosocial Factors

Cluster 1: Low Active – Students in this cluster travelled to university using motorised forms of transport (100%) and did not engage in recreational PA (68.7%). This cluster contained a lower proportion of male students (48.5%), with a mean age of 22.35 ± 6.94, household incomes of more than €50,000 or £35,000 (34.7%), and living 27.09 ± 14.49 minutes from the university. Over half of students placed in this cluster reported meeting the PAGL (57.1%). The Low Active cluster was used as a reference category for the Chi-square, ANOVA (Table 2) and regression (Table 3) analyses.

Cluster 2: Active Commuters – This cluster contained students who travelled to university using active forms of transport (100%) and did not engage in recreational PA (100%). When compared to the reference category, this cluster contained younger students (21.06 ± 4.35, $p<0.01$) living closer to their university (17.28 ± 10.79, $p<0.01$), with fewer achieving the PAGL (51.7%). The regression model was significant ($X^2(15)=504.19$, $p<0.01$; $R^2 = 37.1\%$). A one year increase in age (OR=0.95, $p<0.01$) and a ten minute increase in travel time to university (OR=0.59, $p<0.01$) decrease the likelihood of being in the Active Commuters cluster when compared to the reference. A one-unit increase in a student's perceived skills (OR=0.89, $p<0.05$) and beliefs about consequences (OR=0.85, $p<0.01$) both provide a decreased likelihood of being in this cluster when compared to the Low Active.

Cluster 3: Active in University – Students in this cluster travelled to university using active transport (61.1%) and participated in recreational PA though their university (100%). Students in this cluster were significantly younger (20.43 ± 3.06, $p<0.01$), lived closer to the university (19.07 ± 13.46, $p<0.01$), and were more likely to report attainment of the PAGL (67.2%) when compared to the reference category. The regression model was significant ($X^2(15) = 267.26$, $p<0.01$; $R^2 = 20.2\%$). A one year increase in age (OR=0.92, $p<0.01$) and a ten minute increase in the time to university (OR=0.80, $p<0.01$) reduced the likelihood of being in this cluster compared to the Low Active. A one-unit increase in a student's motivation (OR=1.13, $p<0.01$) and action planning (OR=1.22, $p<0.01$) both provide an increased likelihood of being in the cluster. A one-unit improvement in a student's goal conflict (OR=0.91, $p<0.05$) provides a decreased likelihood of being placed in the cluster as opposed to Low Active.

Cluster 4: Active outside University – These students travelled to university using a motorised form of transport (100%) and participated in recreational PA through organisations external to their university (100%). A significantly higher proportion of students in this cluster were male (54.8%), reported a higher household income (41.6%), and reported meeting the PAGL (71.7%). The regression model was significant ($X^2(15) = 146.86$, $p<0.01$; $R^2 = 9.3\%$). A one-unit increase in a student's perception of the environment (OR=1.13, $p<0.01$), motivation (OR=1.15, $p<0.01$), action planning (OR=1.12, $p<0.01$), and coping planning (OR=1.10, $p<0.01$) each provide an increased chance of being in the cluster as opposed to the reference cluster.

Cluster 5: High Active – This cluster contained students who actively travelled to university (100%) and participated in recreational PA through both their university and organisations external to their university (53.6%). Students in this cluster were younger (20.55 ± 3.90, $p<0.01$), more likely to be male (55.7%), reported a higher household income (46.7%), and reported a smaller travel time to university (16.52 ± 10.82, $p<0.01$), when compared to the Low Active cluster. A significantly higher proportion of these students reported attainment of the PAGL (81.5%). The regression model was significant ($X^2(15) = 851.05$, $p<0.01$; $R^2 = 46.5\%$). A one year increase in students' age (OR=0.94, $p<0.01$) and a ten minute increase in a travel time to university (OR=0.58, $p<0.01$) decrease the

likelihood of being placed in this cluster as opposed to the Low Active. A one-unit increase in a student's perceptions of their environment (OR=1.11, $p<0.05$), motivation (OR=1.27, $p<0.01$), action planning (OR=1.09, $p<0.05$), and coping planning (OR=1.15, $p<0.01$) each provide an increased chance of being in the High Active cluster.

-----Insert Table 2 about here-----

-----Insert Table 3 about here-----

Discussion

The purpose of this study was to explore if and how Irish university students' cluster based on their PA patterns and what psychosocial factors relate to these patterns. An increased understanding of PA engagement can be gained through the examination of different domains[17], while the identification of influential psychosocial factors for promoting PA are important for effective intervention design[6]. Engagement in PA was not the same for all students with five clusters of students containing specific PA patterns identified. Each cluster had somewhat distinct properties including different participant characteristics and behaviours, but some similarities observed for the related psychosocial factors. As research suggests, females, older students and those reporting a lower household income were less likely to be members of certain clusters containing PA[1,39,40,45].

The Active Commuters cluster had a lower proportion of members meeting the PAGL, which may show a potential problem of the IPAQ-SF for capturing PA through the transport domain[41] even with this found to be the instrument of choice for assessing attainment of the PAGL in students[29]. A higher proportion of students classified as Active Commuters reported a lower household income (>€50,000/£35,000), which leads to the assumption that students with a low socio-economic status may not see walking to and from university as PA but a necessity since they may not have access to a

personal vehicle[15]. Additionally, it appears that students lack an understanding of the contribution active transport has for overall PA[42,43]. Education regarding the role of active commuting for overall PA, in addition to its promotion around university campuses is warranted. The results also show that students in clusters containing transport and/or recreational physical activities in relation to their university perceive their travel time to university as shorter than those in the Low Active cluster do. A 10-minute increase in travel time to the university decreased the likelihood of being classified in a cluster containing active commuting and recreational PA at university. Where feasible, universities are advised to provide or inform students of PA opportunities close to their residencies. Additionally, the provision of adequate walk- and cycle paths around university campuses are endorsed to increase the safety for active commuting and to enhance the accessibility of on campus PA facilities. The provision of opportunities close to university housing and adequate transport infrastructure has the potential to increase both transport and recreational PA among students[44].

Certain psychosocial factors were stronger for predicting membership in clusters containing a form of PA. Increased motivation and planning were factors seen to increase the likelihood of students being Active in University, Active Outside University, and High Active. The motives of university students to be physically active are frequently studied with intrinsic reasons such as enjoyment and interest, and extrinsic reasons such as social norms and physical appearance being mentioned[6,45]. Self-Determination Theory proposes that humans are motivated by their fundamental psychological needs for competence (i.e. ability to interact with the environment), autonomy (i.e. having control over your life) and relatedness (i.e. feeling part of a social group)[46]. University campuses and services external to universities could provide activities for all levels of ability (competence), listen to the students' needs and support their PA choices (autonomy), and overall create a positive environment promoting social inclusion (relatedness), instead of providing PA programs that are only relevant for those who are already active[47,48].

Action planning is the process of deciding what steps are needed in order to achieve particular goals[49]. It has been noted that university students tend to have unstructured days, making it hard for them to plan their PA[6], but each student is given a class timetable when beginning each semester that could be

used as an aid for such planning. Coping planning, which was seen to enhance the likelihood of being in the Active outside University and High Active clusters, should be used in addition to action planning to create strategies that increase PA engagement in students. Coping planning is a barrier-focussed, self-regulation strategy where a person anticipates the risk situations and develops suitable coping responses[49]. Strategies could include prompting students to recognise times in the semester when engagement in PA may be difficult (e.g. examination periods) and identifying other ways to stay physically active during these times. Research has noted that forming action plans in addition to coping plans increases the likelihood of longer-term behaviour change[49].

Curiously, increased beliefs about the consequences of not being physically active and perceived skill levels were factors found to reduce the likelihood of being an Active Commuter. Again, this questions their knowledge of the benefits and contribution of active commuting for overall PA and health[42,43,50] and suggests a need for awareness raising in such students. Finally, these findings suggest that knowledge of the recommended PAGL, beliefs about capabilities, emotions towards PA, and social influences for PA had no effect on cluster membership. Taylor and colleagues (2013) found knowledge of PA to have no effect on students' exercise levels, which may suggest that possessing such knowledge alone may be insufficient to induce PA participation. Alternatively, knowledge of the PAGL was the lowest scored item of the DPAQ, warranting the promotion of these recommendations due to the positive association between knowledge and increased PA[51,52].

This study addresses an important topic identifying the patterns of PA in a large sample of students from the whole island of Ireland, which could be considered its greatest strength. A second strength were the clustering patterns, which have emerged from the data-driven approach and used empirical measures to minimise subjectivity in deciding the number of clusters. A number of limitations also need to be noted in the present study, with the most evident being the student survey, which was self-reported and thus liable to social desirability and recall bias[39]. The DPAQ was adapted from its original, with one question selected for each of the eleven areas, as opposed to multiple. This was done for practical purposes, with the process for selecting the most appropriate questions for each section found in the methods section. Another limitation of the DPAQ is that we cannot confirm

whether students were motivated to engage in PA for external or internal reasons. Recreational and transport PA were measured using single item tools which allow for quick and easy measurement, but do not allow us to investigate the frequency or intensity of the activities. In addition, the unknown psychometric properties of the shortened and adapted measures used should be acknowledged, suggesting a need to test the validity and reliability of them in future research. Finally, the use of another PA domain (e.g. occupational PA) in the analysis may have led to different cluster outputs. The use of the occupational and domestic life domains would also help understand how the Low Active students are engaging in PA, if at all, and should be considered in the future.

Conclusion

Research suggests that PA can be better understood through its examination across multiple life domains[17] and these results provide this deepened understanding of students PA engagement. Identification of these patterns can help target students not engaging in any PA (i.e. Low Active), while creating the opportunity for research to investigate their relationship with psychosocial factors, the university environment, and health outcomes. Psychosocial factors that have a positive influence on PA engagement have been identified in this study and need to be mapped into effective intervention design helping create active student populations. Health professionals are advised to incorporate strategies for increasing students' motivation, action-, and coping planning into their future PA promotion efforts.

Acknowledgements and Funding

The authors would like to thank all researchers and participants involved in SASSI. This study was funded by Student Sport Ireland.

340 References

341 1. Haase A, Steptoe A, Sallis JF, Wardle J. Leisure-time physical activity in university students
342 from 23 countries: associations with health beliefs, risk awareness, and national economic
343 development. *Prev Med (Baltim)*. 2004;39(1):182-190

344 2. World Health Organization, *A European Framework to Promote Physical Activity for Health.*
345 Copenhagen, Denmark; 2007.
346 http://www.euro.who.int/__data/assets/pdf_file/0020/101684/E90191.pdf

347 3. Central Statistics Office. Students enrolled in and entrants to third level courses. 2018.
348 http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/saveselections.asp

349 4. Roberts S, Reeves MJ, Ryrie A. The influence of physical activity, sport and exercise motives
350 among UK-based university students. *J Furth High Educ*. 2014;39(4):598-607.

351 5. Deliens T, Deforche B, Bourdeaudhuij I De, Clarys P. Determinants of physical activity and
352 sedentary behaviour in university students : a qualitative study using focus group discussions.
353 *BMC Public Health*. 2015;15(1):201.

354 6. Keating XD, Guan J, Piñero JC, Bridges DM. A meta-analysis of college students' physical
355 activity behaviors. *J Am Coll Heal*. 2005;54(2):116-126.

356 7. Pengpid S, Peltzer K, Kassean HK, Tsala Tsala JP, Sychareun V, Müller-Riemenschneider F.
357 Physical inactivity and associated factors among university students in 23 low-, middle- and
358 high-income countries. *Int J Public Health*. 2015;60(5):539-549.

359 8. Conry, M. C., Morgan, K., Curry, P., McGee, H., Harrington, J., Ward, M., & Shelley, E. The
360 clustering of health behaviours in Ireland and their relationship with mental health, self-rated
361 health and quality of life. *BMC Public Health.* 2011;11(1), 692.

362 9. Ye, Y. L., Wang, P. G., Qu, G. C., Yuan, S., Phongsavan, P., & He, Q. Q. Associations
363 between multiple health risk behaviors and mental health among Chinese college students.
364 *Psychology, Health & Medicine*. 2016;21(3), 377-385.

10. Piqueras, J. A., Kuhne, W., Vera-Villarroel, P., Van Straten, A., & Cuijpers, P. Happiness and health behaviours in Chilean college students: a cross-sectional survey. *BMC Public Health*. 2011;11(1), 443.

11. Lovell GP, Ansari W El, Parker JK. Perceived exercise benefits and barriers of non-exercising female university students in the United Kingdom. *Int J Environ Res Public Health*. 2010;7(3):784-798.

12. Rovniak LS, Anderson ES, Winett RA, Stephens RS. Social cognitive determinants of physical activity in young adults: a prospective structural equation analysis. *Ann Behav Med*. 2002;24(2):149-156.

13. Leslie, E., Sparling, P. B., & Owen, N. University campus settings and the promotion of physical activity in young adults: lessons from research in Australia and the USA. *Health Education*. 2001;101(3), 116-125.

14. Clemente FM, Nikolaidis PT, Martins FML, Mendes RS. Physical activity patterns in university students: Do they follow the public health guidelines? *PLoS One*. 2016;11(3):1-11.

15. Molina-García J, Sallis JF, Castillo I. Active commuting and sociodemographic factors among university students in Spain. *J Phys Act Health*. 2014;11(2):359-363.

16. Fagaras S, Radu L, Vanvu G. The level of physical activity of university students. *Procedia - Soc Behav Sci*. 2015;197:1454-1457.

17. Pedišić Ž, Rakovac M, Titze S, Jurakić D, Oja P. Domain-specific physical activity and health-related quality of life in university students. *Eur J Sport Sci*. 2014;14(5):492-499.

18. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health*. 2006;27(1):297-322.

19. Bélanger M, Townsend N, Foster C. Age-related differences in physical activity profiles of English adults. *Prev Med (Baltim)*. 2011;52(3):247-249.

20. Jurakić, D., Pedišić, Ž., & Greblo, Z. Physical activity in different domains and health-related quality of life: a population-based study. *Quality of Life Research*. 2010;19(9), 1303-1309.

21. Rovniak LS, Sallis JF, Saelens BE, et al. Adults' physical activity patterns across life domains: cluster analysis with replication. *Heal Psychol*. 2010;29(5):496-505.

22. Murphy M, Murphy N, MacDonncha C, et al. *Student Activity and Sports Study Ireland (SASSI)*. 2015. http://www.studentsport.ie/wp-content/uploads/2016/02/SASSI-Full-Report-Without-Appendices..pdf

23. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW. Correlates of physical activity: why are some people physically active and others not? *Lancet*. 2012;380(9838):258-271.

24. Choi J, Lee M, Lee J, Kang D, Choi J-Y. Correlates associated with participation in physical activity among adults: a systematic review of reviews and update. *BMC Public Health*. 2017;17(1):356.

25. Taylor N, Lawton R, Conner M. Development and initial validation of the determinants of physical activity questionnaire. *Int J Behav Nutr Phys Act*. 2013;10(1):1-11.

26. Patterson E, McGeough D, Cannon E, et al. Self-efficacy, stages of change and physical activity in Irish college students. *J Public Health (Bangkok)*. 2006;14(2):81.

27. Delaney L, Bernard A, Harmon C, Ryan M. *Eurostudent Survey: Report on the Social and Living Conditions of Higer Education Students in Ireland*. 2010. https://www.ucd.ie/t4cms/Eurostudent%20Survey%20IV%20Report.pdf

28. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003;35(8):1381-1395.

29. Murphy JJ, Murphy MH, Macdonncha C, Murphy N, Nevill AM, Woods CB. Validity and reliability of three self-report instruments for assessing attainment of physical activity guidelines in university students. *Meas Phys Educ Exerc Sci*. 2017;21(3):1-8.

30. Central Statistics Office. *Census of Populaion of Ireland*.; 2011. http://www.cso.ie/en/census/census2011reports/

31. Sport England. *Higher Education Sport Participation and Satisfaction Survey*.; 2012. https://bucs.org.uk/page.asp?section=17017&sectionTitle=HE+Sport+Participation+and+Satisfaction+Survey&preview=1

32. Michie S, Johnston M, Francis J, Hardeman W, Eccles M. From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques. *Appl Psychol*. 2008;57(4):660-680.

33. Healthy Ireland. *Healthy Ireland Survey 2015: Summary of Findings*. 2015. http://health.gov.ie/wp-content/uploads/2015/10/Healthy-Ireland-Survey-2015-Summary-of-Findings.pdf

34. World Health Organization. *Global Recommendations on Physical Activity for Health*. Geneva, Switzerland; 2010. http://apps.who.int/iris/bitstream/handle/10665/44399/9789241599979_eng.pdf;jsessionid=2DED51EB81A7D9477C56AA8331A9D724?sequence=1

35. Everitt B. Cluster analysis. *Qual Quant*. 1980;14(1):75-100.

36. Landsberg B, Plachta-Danielzik S, Lange D, Johannsen M, Seiberl J, Müller MJ. Clustering of lifestyle factors and association with overweight in adolescents of the Kiel Obesity Prevention Study. *Public Health Nutr*. 2010;13(10A):1708-1715..

37. Agresti A. *Categorical Data Analysis*. Springer Berlin Heidelberg; 2003.

38. King JE. Logistic regression in the social sciences. In: Osborne JW, ed. *Best Practices in Quantitative Methods*. Sage Publications Inc.; 2008:358-383.

39. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels : surveillance progress , pitfalls , and prospects. *Lancet*. 2012;380(1):247-257.

40. Sallis JF, Bull F, Guthold R, et al. Physical Activity 2016 : Progress and Challenges Progress in physical activity over the Olympic quadrennium. *Lancet*. 2016;388(10051):1325-1336.

41. Scholes S, Bridges S, Fat LN, Mindell JS. Comparison of the physical activity and sedentary behaviour assessment questionnaire and the short-form international physical activity questionnaire: An analysis of health survey for England data. *PLoS One*. 2016;11(3):1-30.

42. Sahlqvist S, Song Y, Ogilvie D. Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults. *Prev Med (Baltim)*. 2012;55(3):206-211.

43. Sisson SB, Tudor-locke C. Comparison of cyclists' and motorists' utilitarian physical activity at an urban university. *Prev Med (Baltim)*. 2008;46:77-79.

44. Reed J a, Phillips DA. Relationships between physical actvitiy and the proximity of exercise facilities and home exercise equipment used by undergraduate university students. *J Am Coll Heal*. 2005;53(6):285-290.

45. Lerner J, Burns C, De Róiste Á. Correlates of physical activity among college students. *Recreat Sport J*. 2011;35:95-106.

46. Ryan RM, Williams GC, Patrick H, Deci EL. Self-determination theory and physical activity: the dynamics of motivation in development and wellness. *Hell J Psychol*. 2009;6:107-124.

47. Johnson LG. Physical activity behavior of university students: an ecological approach. 2006. http://digitalcommons.lsu.edu/gradschool_dissertations/1556

48. Teixeira PJ, Carraça E V, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. *Int J Behav Nutr Phys Act*. 2012;9(1):78.

49. Sniehotta FF, Schwarzer R, Scholz U, Schuz B. Action planning and coping planning for long-term lifestle change: theory and assessment. *Eur J Soc Psychol*. 2005;35(December 2004):565-576.

462 50. Saunders LE, Green JM, Petticrew MP, Steinbach R, Roberts H. What are the health benefits
463 of active travel? A systematic review of trials and cohort studies. *PLoS One*. 2013;8(8).

464 51. Plotnikoff RC, Costigan SA, Williams RL, et al. Effectiveness of interventions targeting
465 physical activity , nutrition and healthy weight for university and college students : a
466 systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2015;12(1):1-10.

467 52. Abula K, Gröpel P, Chen K, Beckmann J. Does knowledge of physical activity
468 recommendations increase physical activity among Chinese college students? Empirical
469 investigations based on the transtheoretical model. *J Sport Heal Sci*. 2018;7(1):77-82.

470

471

472

473

474

475

476

477

478

479

480

481

482

483

484

485

486

Table 1. Percentage of students meeting the physical activity guidelines and participating in the recreational and transport physical activity.

	Total (n= 6951)	Male (n= 3512)	Female (n= 3409)	X^2 (df)
PAGL				
Meeting	66.7	55.5	44.5	121.11(1)**
Transport related PA				
Active Transport	41.7	49.8	50.2	1.66(1)
Recreational related PA				
No Participation	32.9	41.5	58.5[a]	158.21(3)**
Inside University	15.0	48.5	51.5	
Outside University	31.8	54.5[a]	45.5	
Both Inside & Outside	18.3	61.6[a]	38.4	

X^2: *= $p<0.05$, **= $p<0.01$; the total number is higher due to missing data in the sex question (n= 30);
Adjusted Residuals: [a] = higher proportion than expected.

493 Table 2. Cluster characteristics and differences based on participant characteristics, attainment of the physical activity guidelines, and DPAQ item scores.

	Low Active	Active Commuters	Active in University	Active Outside University	High Active
Cluster Characteristics	N = 2090	N = 850	N = 1046	N = 1554	N = 1411
Recreational PA	None (68.7%)	None (100%)	In University only (100%)	Outside University only (100%)	In and outside University (53.6%)
Transport PA	Motorised (100%)	Active (100%)	Active (61.1%)	Motorised (100%)	Active (100%)
Participant Characteristics					
Sex (% Male)	48.5	43.4	48.5	54.8[a]	55.7[a]
Age (Mean ± SD)	22.35 ± 6.94	21.06 ± 4.35**	20.43 ± 3.06**	22.25 ± 6.29	20.55 ± 3.90**
Household Income (%> €50,000/£35,000)	34.7	30.9	41.0[a]	41.6[a]	46.7[a]
Perceived Distance (Mean minutes ± SD)	27.09 ± 14.49	17.28 ± 10.79**	19.07 ± 13.46**	27.43 ± 14.16	16.52 ± 10.82**
Physical Activity					
% Meeting PAGL	57.1	51.7[b]	67.2[a]	71.7[a]	81.5[a]
DPAQ Item Scores (Mean ± SD)					
Knowledge	3.15 ± 2.02	2.98 ± 2.01	3.17 ± 1.99	3.31 ± 2.02	3.37 ± 2.02*
Environment	5.94 ± 1.44	6.04 ± 1.34	6.16 ± 1.31**	6.23 ± 1.18**	6.41 ± 1.16**
Motivation	4.55 ± 1.80	3.95 ± 1.72**	4.95 ± 1.55**	5.20 ± 1.53**	5.51 ± 1.40**
Beliefs about capabilities	4.58 ± 1.97	3.77 ± 1.90**	4.74 ± 1.76	5.14 ± 1.80**	5.26 ± 1.73**
Skills	4.79 ± 1.87	4.02 ± 1.79**	4.95 ± 1.63	5.34 ± 1.65**	5.53 ± 1.57**
Emotions	5.19 ± 1.84	4.61 ± 1.89**	5.24 ± 1.72	5.67 ± 1.57**	5.75 ± 1.54**
Social Influences	4.60 ± 1.95	4.25 ± 1.83**	4.91 ± 1.76**	5.07 ± 1.87**	5.26 ± 1.79**
Beliefs about consequences	5.93 ± 1.34	5.73 ± 1.37**	6.05 ± 1.21	6.11 ± 1.26**	6.30 ± 1.03**
Action Planning	4.75 ± 1.75	4.49 ± 1.72**	5.28 ± 1.54**	5.26 ± 1.60**	5.52 ± 1.48**
Coping Planning	3.55 ± 1.79	3.01 ± 1.54**	3.77 ± 1.58**	4.18 ± 1.72**	4.45 ± 1.66**
Goal Conflict	4.06 ± 1.86	3.61 ± 1.67**	4.16 ± 1.63	4.51 ± 1.67**	4.90 ± 1.56**

494 Reference category = Low Active Cluster; ANOVA (Bonferroni/ Games-Howell) *= $p<0.05$; **= $p<0.01$; Chi square (Adjusted Residuals) [a] higher
495 proportion than reference category, [b] lower proportion than the reference category.

496

497

498

499 Table 3. Psychosocial factors predicting cluster membership when compared to the Low Active students.

	Likelihood of being in each cluster for every unit increase of each DPAQ item score							
	Active Commuters		Active in University		Active Outside University		High Active	
N	475		524		845		803	
X^2 (df)	504.19 (15)**		267.26 (15)**		146.86 (15)**		851.05 (150**	
Nagelkerke's R^2	37.1		20.2		9.3		46.5	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Participant Characteristics								
Age	0.95**	0.92 - 0.97	0.92**	0.90 - 0.95	1.00	0.99 - 1.02	0.94**	0.92 - 0.96
Sex (female)	0.89	0.68 - 1.15	1.02	0.81 - 1.29	0.96	0.79 - 1.16	0.83	0.66 - 1.06
Income (>50,000 or 35,000)	0.78	0.59 - 1.02	0.95	0.76 - 1.20	1.15	0.95 - 1.40	1.25	1.00 - 1.57
Distance (+ 10 minutes)	0.59**	0.54 - 0.63	0.80**	0.76 - 0.83	1.01	0.98 - 1.04	0.58**	0.54 - 0.61
DPAQ Item Scores								
Knowledge	0.98	0.92 - 1.04	1.00	0.95 - 1.06	1.00	0.96 -1.05	1.01	0.96 - 1.07
Environment	1.08	0.98 - 1.19	1.08	0.99 - 1.19	1.13**	1.05-1.21	1.11*	1.00 - 1.22
Motivation	0.96	0.88 - 1.04	1.13**	1.03 - 1.23	1.15**	1.07-1.23	1.27**	1.16 - 1.38
Beliefs about capabilities	0.92	0.83 - 1.02	1.05	0.95 - 1.15	0.98	0.91 - 1.05	1.01	0.92 - 1.11
Skills	0.89*	0.80 - 0.99	1.01	0.91 - 1.11	1.06	0.98 - 1.13	1.07	0.97 - 1.18
Emotions	1.00	0.92 - 1.09	0.94	0.86 - 1.02	1.05	0.98 - 1.13	0.97	0.89 - 1.06
Social Influences	1.01	0.94 - 1.09	1.04	0.97 - 1.11	1.02	0.97 - 1.08	1.00	0.94 - 1.07
Beliefs about consequences	0.85**	0.76 - 0.95	0.91	0.82 - 1.02	0.97	0.89 - 1.05	1.02	0.90 - 1.15
Action Planning	0.99	0.91 - 1.07	1.22**	1.12 - 1.33	1.12**	1.05 - 1.19	1.09*	1.00 - 1.18
Coping Planning	0.93	0.84 - 1.02	1.00	0.92 - 1.09	1.10**	1.03 - 1.18	1.15**	1.05 - 1.25
Goal Conflict	0.98	0.90 - 1.07	0.91*	0.84 - 0.99	0.95	0.88 - 1.01	1.00	0.91 - 1.08

500 Binary logistic Regression: Reference category = Low Active Cluster (N = 1215); *= $p<0.05$, **= $p<0.01$,[a]= included in the final step but non-significant;
501 NS= not significant; OR = Odds Ratio; 95% C.I. = 95% Confidence Interval.

502

503