Determination of Physical Activity, Sedentary Time and Mental Wellbeing in 1st Year Postgraduate Research Students at the University of Glasgow: A Mixed Methods Approach.

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Contents

Abstract

University is a time associated with several life changes and represents a key time for development and maintenance of healthy lifestyle behaviours (Trost et al., 2002). Current research shows university students are highly inactive, sedentary and have poor mental health (El Ansari et al., 2011; Moulin and Irwin, 2017; Hunt and Eisenberg, 2010). However, most of this research has been conducted on undergraduate student samples. Therefore, there is a lack of research on physical activity (PA), sedentary time (ST) and mental wellbeing (MWB) in postgraduate students, particularly postgraduate research (PGR) student samples who have distinct needs and challenges.

A systematic review on graduate students' PA, ST, mental health (MH)/MWB, perceptions of PA, exercise and sport, perceived barriers to PA, benefits of PA and motivations for PA was conducted. From 187 papers identified, 25 studies were included for review. Currently, there is a distinct lack of research for PA, ST and MWB in United Kingdom (UK) graduate students. Therefore, the aims of this study were to examine PA, ST and MWB in UK PGR students, the relationship between these variables and to understand underlying perceptions of PA, exercise and sport; perceived barriers to PA; perceived benefits of PA and motivations for PA in UK PGR students.

This study utilised a mixed methods approach. First year PGR students (n=100) registered at the University of Glasgow (UofG) completed an online questionnaire which assessed demographic characteristics, subjectively assessed PA and ST (International Physical Activity Questionnaire (IPAQ)) and MWB (Warwick Edinburgh Mental Wellbeing Scale (WEMWBS)). A sub-cohort (n=20) had PA and ST objectively assessed over 7 days via a hip-worn ActiGraph GT3X accelerometer. From this sub-cohort, PGR students (n=6) volunteered to participate in qualitative focus groups to assess 1st year PGR students' perceptions of PA, exercise and sport; perceived barriers to PA; perceived benefits of PA and motivations for PA.

First year PGR students self-reported being physically active (median moderate vigorous physical activity (MVPA) 195 ± 225 minutes/week, 62.9% meeting PA guidelines (PAG)) yet highly sedentary (median 8 ± 4 hours/day sitting time). In terms of MWB, PGR students reported moderate levels of MWB (48 ± 13 WEMWBS score). The randomised sub-cohort of PGR students who had PA and ST objectively assessed were also physically active yet sedentary (highly active: ActiGraph GT3X estimated MVPA 554.3 ± 187.1 minutes/week, 100% meeting PAG; highly sedentary: 9.6 ± 1.4 hours/day sedentary). No significant correlations between PA, ST and MWB or PA, ST and PGR study time were found. However, a significant weak inverse correlation was found between MWB and PGR study time (r_s= -0.242, p=0.015). Qualitative research identified PGR students' perceptions of PA, sports and exercise. The top perceived barriers to PA were a lack of information and/or awareness of opportunities, undergraduate focused PA opportunities, PGR studies and barriers specific to UofG Sport gym facilities. Whilst the most common perceived benefits of PA were the positive impact of PA on mental and physical health and PGR students' study/work life. Balancing out unhealthy eating habits, health benefits, PGR study/work benefits and image were identified as the most commonly cited motivations for PA.

This PGR student cohort (n=100) were active (met PAG), had a high ST with no significant associations between PA, ST and MWB. On the basis of existing literature, it is likely that despite being physically active, PGR students' high ST is associated with an increased risk of negative physical and mental health outcomes and non-communicable diseases (Biswas et al., 2015; Owen et al., 2010; Owen, 2012; Atkin et al., 2012; Gibson et al., 2017). Therefore, there should be an integrated approach across the UofG to address this high ST and consider ways to reduce ST. This could be through identification of determinants of ST in the PGR population, changes to the built environment and dissemination of information on the benefits of MVPA, risks of ST, relevant opportunities and strategies to increase PA and decrease ST. An interesting finding was the weak yet significant inverse correlation between MWB and PGR study time with steps needing to be taken to address this.

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Abbreviations

ACHA-NCHA – American College Health Association-National College Health Assessment

BAME – Black, Asian and Minority Ethnic

CAPS – Counselling and Psychological Services

CHBs – Compensatory Health Beliefs

CSA – Computer Science Applications

df/DF – Degrees of Freedom

IPAQ – International Physical Activity Questionnaire

GHQ-12 – General Health Questionnaire

GUSA – Glasgow University Sports Association

HIIT – High Intensity Interval Training

LIPA – Light Intensity Physical Activity

METs – Metabolic Equivalents

MH – Mental Health

MVLS – Medicine, Veterinary and Life Sciences

MVPA – Moderate Vigorous Physical Activity

MWB – Mental Wellbeing

NHS – National Health Service

PA – Physical Activity

PAG – Physical Activity Guidelines

PGR – Postgraduate Research

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SHS – Scottish Health Survey

SB – Sedentary Behaviour

ST – Sedentary Time

TV - Television

UofG – University of Glasgow

UG – Undergraduate

UK – United Kingdom

WEMWBS – Warwick Edinburgh Mental Wellbeing Scale

WHO – World Health Organization

95% CI – 95% Confidence Intervals

Presentations Arising from this Research

- **'Mental Wellbeing and Physical Activity in 1st Year PGR Students at the University of Glasgow: Findings and Implications.'** Presented to Deans of Graduate Schools, Heads of Student Support Services, PGR Strategy Manager and Representatives from the Students' Representative Council.

- **'Perceptions of Physical Activity, Perceived Benefits and Barriers to Physical Activity in 1st Year PGR Students at the University of Glasgow.'** Presented to University of Glasgow Research Strategy and Innovation Services Staff, University of Glasgow Sport Staff and President of Glasgow University Sports Association.

- **'Mental Wellbeing and Physical Activity of 1st Year PGR Students at the University of Glasgow: Quantitative Findings.'** Presented to University of Glasgow Research Strategy and Innovation Services Staff and University of Glasgow Sport Staff.

- **'Mental Wellbeing and Physical Activity of 1st Year PGR Students at the University of Glasgow.'** Presented to MSc(R) and PhD Sports Science Students and Academic Staff from the School of Life Sciences.

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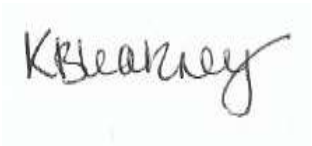
Author's Declaration

I declare, except where explicit reference is made to the contributions of others, that this thesis is the result of my own work and has not been submitted for any other degree to the University of Glasgow or at any other institution.

Signature: 

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1. Introduction

1.1 Definitions

The definitions presented are the ones most widely cited and used for physical activity, sedentary behaviour, mental health and mental wellbeing.

Physical activity (PA) is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen et al., 1985). PA can be further categorised, for example, according to context (i.e. leisure, occupational or household tasks), intensity (i.e. light, moderate or vigorous) or nature of PA (aerobic or resistance) (Shephard, 2003).

Sedentary behaviour (SB) is defined as any waking activity which involves sitting, reclining or lying that expends less than 1.5 metabolic equivalents (METs) (Owen et al., 2010). Typical sedentary behaviours include television (TV) viewing, computer use, reading and sitting on public transport (Tremblay et al., 2017). Conceptually it is important to note that physical inactivity and SB are distinct. This is important as SB is a unique behaviour with unique physiological responses (Owen et al., 2010).

Mental health (MH) is defined as a state in which an individual realizes their potential, can deal with daily life stresses, work productively and can contribute to their community (World Health Organization (WHO), 2018). Importantly, MH is not just the absence of mental illness but also requires a positive dimension in the individual (WHO, 2018).

Currently there is no universal definition for mental wellbeing (MWB). Mental wellbeing is a multi-dimensional construct which includes both hedonic (happiness, positive psychology) and eudaimonic wellbeing (positive functioning) (Dodge et al., 2012). More specifically, mental wellbeing consists of a series of dimensions some of which include; feeling good about ourselves (self-acceptance), a sense of purpose and value in life, personal growth and development, positive relationships, ability to manage personal life and surrounding environment (environmental mastery), a sense of control and freedom over our lives (autonomy), social integration and social acceptance (Ryff and Singer, 2008; Royal Society for Public Health, 2013).

1.2 Physical Activity and Sedentary Behaviour Guidelines

Current physical activity guidelines (PAG) recommend that adults engage in at least 150 minutes of MVPA per week to gain health-enhancing benefits of PA (UK Department of Health, 2011). These guidelines are currently being reviewed by expert working groups, appointed by Chief Medical Officers, who are considering recent evidence and literature. It is anticipated that updated PAG will be published in June 2019 and will include advice on the contribution of high intensity interval training (HIIT) towards PAG. These PAG are consistent with those in the United States which state that adults should engage in at least 150 minutes to 300 minutes of moderate intensity PA per week to gain substantial health benefits. The US guidelines recognise that HIIT may contribute towards these PA guidelines however there is no consensus on duration of maximal effort or recovery periods, number of cycles per HIIT session or duration of HIIT session (US Department of Health and Human Services, 2018).

There are no official quantitative guidelines for ST. The guidelines simply recommend minimising the amount of time spent being sedentary for extended periods (UK Department of Health, 2011). There have been calls to introduce public health guidelines on ST for many years, however currently the evidence base for SB remains underdeveloped and therefore the development of quantitative ST guidelines would be untimely (Stamatakis et al., 2019).

1.3 Physical Activity and Health

Professor J Morris, one of the pioneers in PA and health research described PA as today's "best buy in public health" (Morris, 1994). The benefits of PA on physical health are widely known. Evidence has consistently shown that PA is important in the prevention and treatment of a range of non-communicable diseases such as cardiovascular disease, obesity, type 2 diabetes, and some types of cancers (Penedo and Dahn, 2005; Warburton et al., 2006).

The benefits of PA are not only physical in nature but also encompass benefits for MH and MWB. The New Economics Foundation, on behalf of the UK Government, developed the '5 Steps to Mental Wellbeing' – one of these 5 key steps is to 'Be Active' (Government Office for Science, 2008). Regular PA improves mood both acutely and in the longer term. Research by Bray and Born (2004) found that active students had more positive mood profiles (significantly lower levels of tension, fatigue and higher levels of vigour) compared to inactive students. Regular PA significantly lowers the risk of depression and anxiety disorders (Goodwin, 2003). Physical activity is not only important for prevention of MH issues but is also effective in the treatment of MH issues (Martinsen, 2008). Research by Blumenthal et al., (2007) found that remission rates of individuals with major depressive disorder randomised to exercise or antidepressant medication treatment were significantly higher than a placebo control. There was no significant difference in remission rates between exercise and antidepressant medication (45% supervised exercise; 40% home-based exercise; 47% medication). These findings suggest that exercise is as effective as antidepressant medication in the treatment of major depressive disorder.

In terms of stress, evidence shows that high leisure-time PA is associated with decreased stress levels and increased life satisfaction. The greatest benefit in terms of stress reduction and increased life satisfaction was seen between the sedentary group and the low PA group (Schnohr et al., 2005). This highlights the need to get sedentary individuals to become more active.

In addition, research by Rimmele et al., (2009) examined stress responses in athletes and untrained individuals. These authors found that elite athletes had a significantly lower psychosocial stress response (lower cortisol, lower heart rate and lower state anxiety) compared to untrained individuals. These findings suggest that physical activity level is associated with stress response with more active individuals having a significantly lower response to psychosocial stressors.

Regular PA can also improve cognition (Cirillo et al., 2017), working memory capacity (Martins et al., 2013) and academic performance (Kwak et al., 2009), which are essential for students in terms of personal performance, skill development and career progression. Felez-Nobrega et al., (2017) found that Spanish undergraduate students engaging in more than 3 hours of moderate PA per week had significantly greater working memory capacity. However, this was not correlated with academic performance. It is important to note that 3 hours (equivalent to 180 minutes per week) is greater than current PAG.

1.4 Sedentary Behaviour and Health

SB has become an integral part of daily life. This is primarily due to technological advances, changes in occupational roles, increased car ownership and modern environments promoting SB (e.g. drive-through facilities, seats on public transport, escalators, lifts and seating in conference rooms) (Hallal et al., 2012; Levine, 2015).

Excessive ST is associated with negative physical health outcomes including increased risk of cardiovascular disease, type 2 diabetes, obesity, certain types of cancers and premature mortality (Healy et al., 2011; Wilmot et al., 2012; Schmid and Leitzmann, 2014; Biswas et al., 2015). Most evidence shows that sedentary behaviour is an independent risk factor to MVPA for these conditions (Biswas et al., 2015; Owen et al., 2010; Owen, 2012). Therefore, even if you are an active individual, a high ST will increase an individual's risk of these conditions. For example, Healy et al., 2008 found that individuals who met the weekly PAG yet were highly sedentary (i.e. "active couch potatoes") had significantly impaired glucose metabolism, increased blood pressure and increased waist circumference compared to active less sedentary counterparts. This is important as it highlights the need for individuals to be both active and less sedentary.

A recent meta-analysis by Ekelund et al., 2016 found that only a high level of daily MVPA (60-75 minutes/day) attenuated the risk of all-cause mortality associated with high ST. This would equate to a weekly MVPA of 420 to 525 minutes which is well above current PAG.

Research shows that sitting for less than four hours per day may attenuate the risk of sedentary related non-communicable diseases (van der Ploeg et al., 2012). More recently, researchers have focused on breaking up prolonged ST with short bouts of activity as this may be more effective than replacing ST with light intensity physical activity (LIPA) or MVPA. Research by Peddie et al., (2013) found that breaking up 9 hours of prolonged ST with a short walking bout every 30 minutes significantly reduced postprandial glucose and insulin responses in healthy, normal weight adults. These regular walking bouts were more effective than a single continuous 30-minute walking bout. Similarly, Healy et al., (2015) found that replacing ST with standing and stepping significantly reduced cardio-metabolic risk biomarkers. However, only stepping attenuated body mass index and waist circumference.

In terms of MH, research shows ST is associated with a higher risk of psychological distress (Kilpatrick et al., 2013; Hamer et al., 2014) and negative MWB (Atkin et al., 2012). A meta-analysis by Zhai et al., (2015) found that SB was associated with a significantly increased risk of depression. More recently, Gibson et al., (2017) found that Scottish adults who spent less than 8 hours/day sedentary had significantly lower levels of anxiety and depression compared to those who were sedentary for more than 8 hours/day. Currently, it remains unclear whether it is sedentary time that is directly associated with negative mental health and wellbeing or whether behaviours associated with sedentary time such as screen use, TV viewing, social media use and social isolation are responsible for negative mental health and wellbeing.

At present, there is a distinct lack of research examining the relationship between SB and MH issues. Limitations of existing research is that it is primarily focused on children/adolescents. In addition, in terms of SB research, there is a lack of a standardised approach to classify SB and a wide range of measurement tools and surrogate outcomes are used to assess SB (e.g. sitting time, TV viewing/video game time, computer use, occupational sitting time, leisure sitting time) making it difficult to draw comparisons between studies.

1.5 Physical Activity, Sedentary Behaviour and Mental Wellbeing in Scotland

Scotland as a country has a poor health record and higher mortality rates than the rest of Europe which has led to Scotland being commonly referred to as 'the sick man of Europe' (McCartney et al., 2012). Within Scotland, there are large health inequalities between more affluent and less affluent areas. The West of Scotland, particularly the greater Glasgow and Clyde region has high levels of premature mortality and negative health behaviours and outcomes. This excess mortality had been dubbed as 'The Glasgow Effect' (Landy et al., 2010). No single factor explains why Scotland, particularly Glasgow has poorer health and higher mortality rates than other UK cities with comparable levels of deprivation. It is likely that 'The Glasgow Effect' is due to a complex interaction between behavioural, socioeconomic, political, physiological and psycho-emotional factors (Cowley et al., 2016). It would be inaccurate to infer that these factors would be the same or related to student populations, as student populations are much more diverse with students coming from a range of backgrounds and locations.

In terms of MH and MWB, research carried out by Landy et al., (2010) on behalf of the Scottish Government found that residents of Greater Glasgow and Clyde had significantly higher levels of anxiety, mental distress and psychological ill-health (assessed by the General Health Questionnaire (GHQ-12)), higher prevalence of myocardial infarction and higher levels of obesity. These differences persisted despite adjustment for age, sex, deprivation and socio-economic factors.

Similarly, results from the 2017 Scottish Health Survey (SHS) show that the mean Warwick Edinburgh Mental Wellbeing Scale (WEMWBS) score for adults was 49.8. Furthermore, 17% of Scottish adults had a GHQ-12 score of 4 or more which is indicative of a possible psychiatric disorder with young adults aged 16-24 years most likely to report signs of a possible disorder (Scottish Government, 2018).

In terms of PA, SHS statistics show that 36% of the Scottish adults (aged 19-64 years) failed to meet the UK Department of Health's minimum recommended weekly PAG of 150 minutes of moderate intensity physical activity per week. Significantly less women met the guidelines compared to their male counterparts (59% of women versus 69% of men met the PA guidelines) (Scottish Government, 2016). This high level of inactivity is responsible for approximately 2500 deaths per year in Scotland and directly costs the National Health Service (NHS) £91 million annually (Scottish Government, 2016).

In terms of ST, Scottish adults spent an average of 5.2 hours/day sedentary on weekdays and 5.9 hours/day on weekend days with men significantly more sedentary than women for both weekdays and weekend days (Scottish Government, 2016). One major limitation of these figures is that they are for leisure sedentary time and exclude occupational sedentary time. Therefore, it is highly likely that these values are a gross underestimation of total sedentary time as evidence shows that 65-75% of work time is spent sedentary (Buckley et al., 2015).

1.6 Physical Activity, Sedentary Time and Mental Wellbeing in Student Populations

The proportion of the young adult population in university-level education has risen steadily with over 2.3 million students studying at UK higher education providers (Universities UK, 2018). The transition from secondary to tertiary education (college and university) is a time associated with multiple life changes. For example, gaining independence from parents and development of individual lifestyle beliefs and behaviours.

This transition is also associated with a series of challenges/potential stressors for students. These include: relocation away from home; financial concerns of tuition fee and living costs; pressure to fit in and form new friendships; lack of social support; academic pressures and adapting to the more independent self-motivated style of university education (Gibson et al., 2018).

University is also an important time for development of healthy lifestyle behaviours as evidence shows behaviours adopted in emerging adulthood can track through to later life (Trost et al., 2002). Evidence shows that students who were regularly active during university were as active or more active as alumni whilst those who were inactive during university remained as inactive or more inactive as alumni (Sparling and Snow, 2002). Therefore, there is a huge potential for universities to influence PA, SB and physical and MH related outcomes. Particularly as these students will potentially be future policy makers, educators or "world changers" and may establish norms for the entire population (Moulin and Irwin, 2017).

There is consistent evidence in the literature that student populations tend to have a high prevalence of negative health behaviours such as poor dietary habits, use of recreational drugs, binge drinking, low PA and high SB levels (El Ansari et al., 2011). In terms of Scottish students, Scottish Student Sport conducted a survey in 2016 assessing physical activity, sports participation and mental wellbeing in Scottish students. Results from this survey found that only 46% of Scottish students were meeting current PAG (Scottish Student Sport, 2017). This value was an alarmingly 17% lower than the national Scottish adult population average (Scottish Government, 2016).

One major limitation with the evidence base on PA is that data is primarily from subjective self-report measures. Previous research has shown that self-report measures may not be necessarily reflective of true PA levels with evidence showing systematic overestimation (Celis-Morales et al., 2012) and underestimation of PA levels (Yates et al., 2015).

Research from Downs et al., 2014 specifically compared students' self-reported physical activity (IPAQ short form) to ActiGraph GT3X objectively assessed physical activity. Findings showed that students significantly overestimated self-report physical activity levels by ~46 mins per day which equated to ~5 hours 23 minutes per week. Therefore, there is a need for objective assessment of PA and SB to accurately understand PA and SB patterns in student populations, which will help guide and inform future PA and SB interventions.

According to the Health Belief Model (Janz and Becker, 1984), the likelihood of an individual engaging in a health-promoting behaviour (in this case PA) is a function of the perceived benefits of that behaviour minus the perceived barriers to the behaviour. Other components of this model that influence the likelihood of an individual engaging in a health-promoting behaviour include perceived threat, self-efficacy and cues to action. This model is relevant as it was based and developed within health psychology and is one of the most widely utilised in health behaviour research. Some researchers argue that the ratio of perceived benefits to barriers component of this model is important in determining health-promoting behaviours. Evidence shows that exercisers perceive significantly more benefits of exercise than barriers. On the other hand, non-exercisers perceive significantly more barriers to exercise than benefits (Grubbs and Carter, 2002). However, other research has found that inactive females, reported significantly higher perceived benefits of exercise than barriers (a ratio of 1.33). This finding suggests that perceived barriers are the main predictor of engaging in health-promoting behaviour (Lovell et al., 2010). Therefore, there is a real need to identify and understand perceived barriers to PA, in a population, in order to design and implement effective and successful PA promotion campaigns.

In the student population, commonly cited barriers to PA include lack of time (often due to a busy academic schedule and deadlines); physical exertion; lack of energy; location of exercise facilities; social and family responsibilities and in some cases students' parents gave academic success priority over exercise (Daskapan et al., 2006; Grubbs and Carter, 2002; Lovell et al., 2010; Martínez-Lemos et al., 2014; Muzindutsi et al., 2014).

In comparison to the general adult population, students report less barriers associated with health issues, lack of social support, confidence, interest and/or enjoyment (Justine et al., 2013; Hoare et al., 2017). This is likely to be due to the fact that students are younger and are therefore less likely to have significant health issues or worries; are more likely to have less familial/extra-curricular responsibilities and may have greater social support in comparison to older adults.

Most of the research examining PA barriers has been carried out on undergraduate university/college students. A recent study examined barriers to PA in postgraduate taught (Master of Physical Therapy) students in Canada. These students reported similar barriers: academic pressure to perform, limited time and fatigue. Other barriers reported included: inconsistent and interrupted class scheduling due to clinical placements, classroom design and weather (Smetaniuk et al., 2017). For postgraduate students, it seems that academic pressures, time pressures and fatigue are the main barriers to PA. This is hardly surprising given the fact that postgraduate programmes are often challenging and postgraduate students tend to be older and have greater responsibilities. For example, many postgraduate students work part-time to fund their studies or to pay for living and accommodation costs whilst others may have families or other responsibilities outside of their studies.

In terms of the benefits of PA, students perceive the greatest benefits of PA to be improvements to physical performance (improved fitness, flexibility, stamina); psychological outlook and preventative health as well as enjoyment in engaging in PA (Grubbs and Carter, 2002; Lovell et al., 2010; Muzindutsi et al., 2014).

The benefits of PA often relate to the underlying factors which motivate students to be active. According to the Self-Determination Theory (Deci and Ryan, 1985), motivation occurs on a continuum from extrinsic to intrinsic motivation. Extrinsic motivation refers to behaviour driven by a potential for reward, for example, wealth, grades, praise, status, appearance or avoidance of ill-health. In contrast, intrinsic motivation refers to behaviour carried out for an individual's own personal satisfaction, enjoyment, growth and task mastery rather than for an external reward (Deci and Ryan, 1985).

The Self Determination Theory is relevant as it has been widely applied in PA and health psychology domains. A key strength is that it not only addresses the underlying reasons which motivate individuals to perform behaviours but also recognises the role of social regulation in motivation.

Commonly reported motivations for PA in student populations include both extrinsic and intrinsic factors. Some of these motivational factors include body image; social interaction; fun; fitness; life balance; health-related factors (ill health avoidance, health pressure and positive health); challenge; social recognition; competition and affiliation (Diehl et al., 2018; Egli et al., 2011; Eichorn et al., 2018; Kilpatrick et al., 2005; Kulavic et al., 2013). The majority of these cited motivational factors are extrinsic in nature. This may be an issue for long-term adherence to PA. Research shows that extrinsic factors may be effective for initial PA uptake and engagement however over the longer term, intrinsic factors are more effective for PA adherence (Kilpatrick et al., 2005).

Importantly, motivational factors are specific to specific populations. Evidence has found motivational factors vary between genders (Egli et al., 2011; Lauderdale et al., 2015; Kilpatrick et al., 2005), age groups (Egli et al., 2011), between those who have exercised less than 6 months and those who have exercised more than 6 months (Maltby and Day, 2001) and between traditional and non-traditional students (Kulavic et al., 2013). Therefore, there is a need to investigate motivational factors of PA specifically in PGR student populations.

University responsibilities may promote SB in students as they must dedicate time to attending classes and studying (Cotten and Prapavessis, 2016). For postgraduate research students, these responsibilities may differ slightly. For example, searching for and reading literature, analysing results, writing up theses and attending conferences.

There is limited research on SB in undergraduate students. However, the research that exists suggests that students are highly sedentary. Research by Moulin and Irwin, (2017) identified that students spent an average of 11.88 hours/day sedentary. Similarly, Prapavessis et al., (2015) report that Canadian university students spend 11.65 hours/weekday sedentary with 53% of that time (6.18 hours/weekday) dedicated to university-related sedentary behaviours. In terms of SB associated to MWB, evidence shows that a high screen time in university students was significantly positively associated with anxiety, depression, psychopathological symptoms and poor sleep quality (Wu et al., 2015).

There has been a rise in prevalence and severity of MH issues amongst students (Hunt and Eisenberg, 2010). Statistics show that over 11,700 Scottish students asked for support for MH issues in 2016-2017 with the University of Glasgow reporting a 75% rise in the number of students asking for help between 2012-13 and 2016-17 (Hashemi, 2018). This rise in number of students asking for help may be due to both an increase in MH issues and therefore demand on MH services and/or a decrease in stigmatisation, increased awareness of the need to access help and availability of help. This rise in students asking for support for MH issues is reflective of the general underlying trend of increasing prevalence of mental health issues within young adults. Pitchforth et al., (2018) examined prevalence of mental health conditions in Scottish 16 to 24-year olds between 2003 and 2014. These authors found that between 2003 and 2014, the odds of Scottish 16 to 24-year olds having a mental health condition significantly increased by ~8% per year.

Research by Stallman (2010) found that university students reported significantly higher levels of distress compared to the general population. Of this student sample, 19.2% reported high levels of distress suggestive of a serious mental illness with a further 64.7% reporting symptoms suggestive of a mild-moderate mental illness. Similarly, research from Cooke et al., (2006) found that beginning university coincides with greater psychological distress, with levels of anxiety significantly increased. This psychological distress reduced as the first year progressed however importantly it did not return to pre-university baseline levels.

The Scottish Student Sport Survey identified that active students had higher MWB scores, higher personal wellbeing scores and lower social isolation scores than their inactive counterparts. However, it is important to note that this data is mainly reflective of an undergraduate student population as only 17% of respondents were postgraduate students (Scottish Student Sport, 2017).

Previous research examining PA, SB and MWB in student populations has predominately focused on undergraduate students or students in specific disciplines and therefore there is a paucity of research in this area for postgraduate students.

1.7 Postgraduate Research Students' Needs and Challenges

The number of individuals undertaking PGR training programmes has dramatically risen in the past decade. This is partially due to the widening participation agenda for higher education (Connell-Smith and Hubble, 2018) and employers wanting graduates with a greater level of additional skills (Barry et al., 2018).

PGR training programmes by nature are challenging hence why programme spaces are often only offered to high achieving students. The challenging nature of these programmes has contributed to the high dropout rate of postgraduate research students in comparison to undergraduate students (Pearson, 2012). This drop-out rate can range from 30% to as high as 50% depending on the research area (McAlpine and Norton, 2006).

Compared to undergraduate study, PGR is even more independent and self-directed. Therefore, PGR students as a population have unique needs and challenges. These include pressure to secure research funding, to develop their expertise, skills and identity as a researcher (Pyhältö et al., 2012; Levecque et al., 2017). Another issue that PGR students may face are difficulties with their supervisor whether this be the supervisory relationship or changes in supervisor. For example, findings from Levecque et al., (2017) showed that doctoral students with supervisors who had a passive leadership style had significantly greater psychological distress than those with an 'inspirational' leadership style.

There has also been a shift from the traditional thesis via dissertation to a greater emphasis on thesis via publication of work in academic journals. This has led to a pressure to get published, often referred to as 'Publish or Perish' (Rawat and Meena, 2014).

Other challenges for PGR students include financial pressures, loneliness, social isolation, maintaining a healthy work-life balance, responsibilities outside university and external/personal life events (Noguiera-Martins et al., 2004; Hyun et al., 2006; Janta et al., 2014; Levecque et al., 2017; Barry et al., 2018). The Higher Education Authority conducted a PGR Experience Survey (PRES) in 2017 and found that only 59% of PGR students at the University of Glasgow were satisfied with their work-life balance (University of Glasgow Research and Innovation Services, 2017).

Another issue for many high achieving PGR students and academics is the Imposter Syndrome. The Imposter Syndrome was first coined by Clance and Imes (1978) and refers to the psychological process whereby individuals cannot internalize success and accomplishments and instead attribute success due to external factors such as luck or deceiving others. This can lead to feelings of guilt and that they have bluffed their way through and are not as competent as perceived to be by fellow peers and academics (Craddock et al., 2011).

It is clear that compared to their undergraduate counterparts, PGR students are a unique population with their own specific needs and challenges. Therefore, there is a need for research specifically examining PGR students.

2. Systematic Literature Review

2.1 Rationale

Within the existing literature there has been extensive research examining PA, ST and MWB in undergraduate (UG) students or students in specific disciplines (for example, medical students) and there is a paucity of research in this area for postgraduate students. As highlighted earlier, postgraduate students, particularly PGR students face separate unique and specific challenges. Therefore, there is a need for research specifically examining only PGR students.

By reviewing the literature, the author aims to examine the current literature and gain a greater insight in to the PA, ST and MH needs/MWB of postgraduate students and if any studies have examined the association between these variables. In addition, perceptions of PA, barriers to PA, benefits of PA and motivations for postgraduate students to be active were reviewed.

2.2 Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement protocol (Moher et al., 2009) was followed for conducting this systematic literature review.

As there is limited research in graduate students, the eligibility criteria included both postgraduate taught and PGR students.

The search was conducted between 13th and 29th November 2017 through online databases of Web of Science, MEDLINE (Ovid), PsycINFO and PubMed. The search strategy involved the same combination of key words entered into each database.

The key words and combinations were as follows:

1. “graduate student” OR “graduate education” OR “post-graduate student” OR “postgraduate student” OR “doctoral” OR “PhD student” OR “Master* student”
2. “physical activ*” OR “physical fitness” OR “exercise”
3. 1 AND 2
4. “sedentary time” OR “sedentary behaviour” OR “sedentary behavior” OR “sitting time” OR “screen time” OR “TV viewing”
5. 1 AND 4
6. “mental health” OR “mental well*” OR “psychological health” OR “psychological well*”
7. 1 AND 6
8. 3 AND 6
9. 5 AND 6
10. “attitude*” OR “belief*” OR “perception*” OR “determinant*” OR “barrier*” OR “facilitator” OR “benefit*” OR “motivat*”
11. 3 AND 10

Note: * represents truncations allowing for a greater search capacity.

Inclusion Criteria

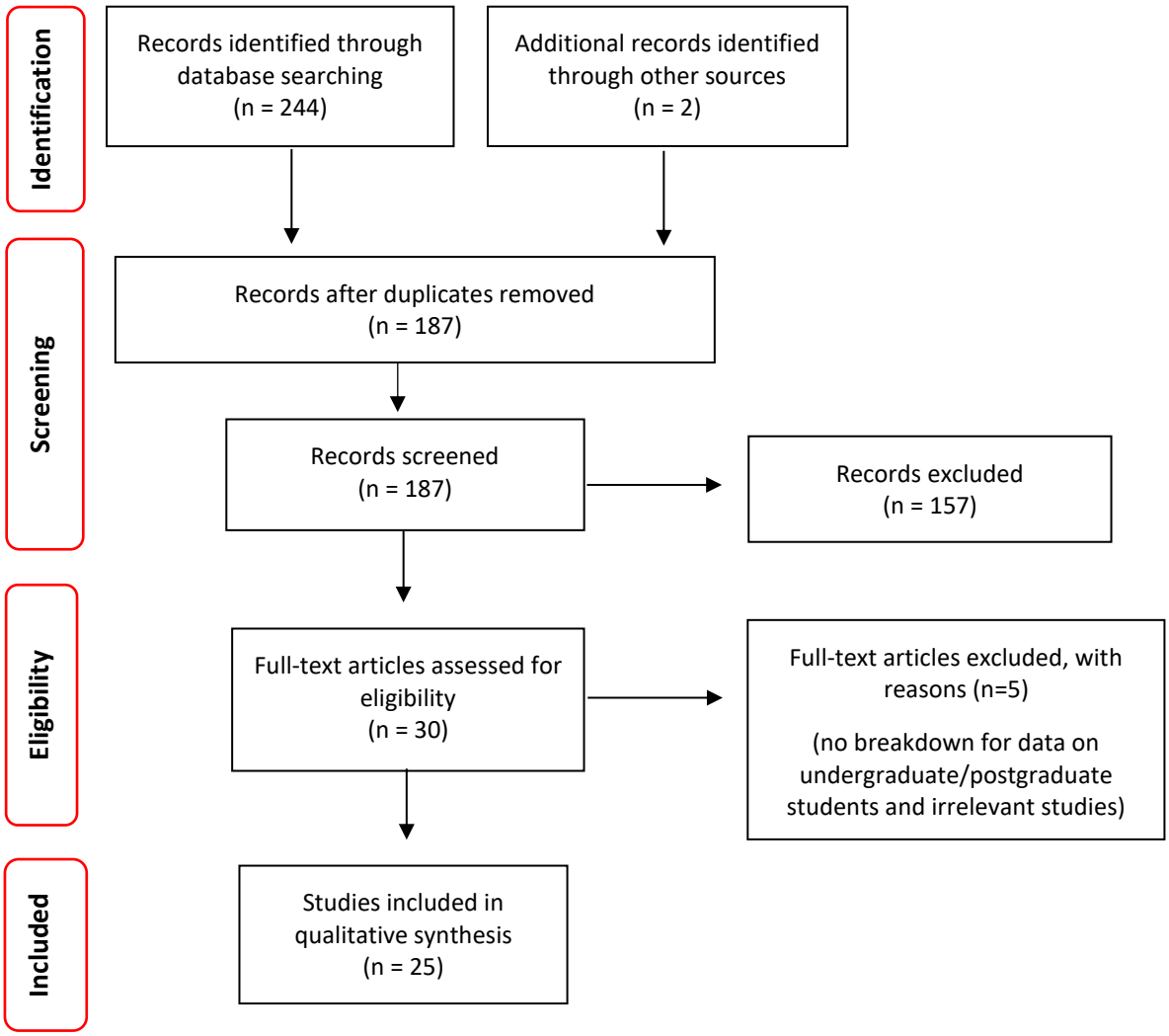
To ensure relevant studies were selected, article titles and abstracts were read by the author to ensure they were appropriate for inclusion. The inclusion criteria were;

- Studies with a sample of either postgraduate taught students, PGR students or a mixed undergraduate and postgraduate student sample where results for the graduate students were presented separately.
- Studies which examined at least one of the following; PA, ST, MH, MWB, perceptions/attitudes of PA; barriers to PA; benefits of PA and motivations for PA.
- Studies published in the English language.
- Studies published from 2000-2017.

2.3 Results from Database Search

The database search resulted in the identification of 244 studies with 2 papers identified from external sources. Screening removed duplicates and irrelevant studies. A final 25 papers were included in the systematic review. This process of identification, screening, eligibility and inclusion is illustrated in Figure 1

Figure 1: Systematic review protocol flow chart.



2.3.1 Search Summary

A total of 25 papers were included: 17 examined MWB/MH, 2 examined PA, 1 examined both PA and ST, 2 examined both MH and PA and 3 examined perceptions of PA, facilitators for PA and barriers to PA. Across all studies there were 109,978 participants, the mean age ranged from 22-39 years old. Systematic review study summary tables can be found in Appendix 8.1.

2.3.2 Graduate Students' Mental Health Study Summary

A detailed summary of the MH/MWB studies can be found in Appendix 8.1.1. Firstly, there is a distinct lack of research on UK graduate students' MH as most papers were from the United States of America (9 papers), with others from countries including Brazil, Belgium, Finland, India, South Africa, Australia, China and one multi-country paper.

Within these studies a wide range of both quantitative and qualitative measures were used to assess MH and MWB. Some studies quantitatively examined specific MH issues such as stress, anxiety, depression and suicide whilst others assessed overall MH and MWB. Other quantitative measures assessed coping skills, self-reported need for MH services, intention to seek help and utilization of MH services. There were no consistently utilised measures, however the Depression Anxiety Stress Scale, General Anxiety Disorder-7, Patient Health Questionnaire-9 and GHQ-12 were used in more than one study. In terms of qualitative measures, only one study utilised solely qualitative research methods in the form of focus groups (Cilliers and Flotman, 2016) whilst other studies (Stubb et al., 2011; Barry et al., 2018) included open-ended questions as an add-on to quantitative measures.

2.3.3 Graduate Students' Physical Activity and Sedentary Time Study Summary

A detailed summary of the PA and ST studies can be found in Appendix 8.1.2. A total of three papers were identified (two conducted in the USA and one in Canada). Participants for all three of these studies were graduate students in health-related fields (health science and physical therapy students) with an average age of 24-25 years (one paper did not provide age data).

Subjective and objective measures were used: two papers used subjective self-report measures to assess PA (IPAQ and self-report PA questions from American College Health Association-National College Health Assessment (ACHA-NCHA)) whilst the third paper objectively assessed PA and ST using ActiGraph GT3X accelerometers.

2.3.4 Graduate Students' Mental Health and Physical Activity Study Summary

To the authors knowledge, only two studies have specifically examined both PA and MH in graduate students. Once again both studies employed different measures to assess these variables, a summary of these studies can be found in Appendix 8.1.3.

2.3.5 Graduate Students' Attitudes, Perceptions, Facilitators and Barriers to Physical Activity Study Summary

Three studies were identified (Appendix 8.1.4); one examined how graduate school affected participation in PA (Longfield et al., 2006) whilst the other two examined facilitators and barriers to PA for graduate students (Yan and Cardinal, 2013; Smetaniuk et al., 2017). All three studies employed qualitative research methods in the form of focus groups (Longfield et al., 2006), semi-structured interviews (Yan and Cardinal, 2013), photovoice and focus groups (Smetaniuk et al., 2017).

2.4 Systematic Review Findings

2.4.1 Mental Health/Wellbeing

In terms of MH and MWB, most of the existing literature suggests that graduate students have poor MH. A high proportion of graduate students reported MH issues such as depression, anxiety and stress (Noguiera-Martins et al., 2004; Stecker, 2004; Hyun et al., 2006; Madhan et al., 2012; Garcia-Williams et al., 2014; Lipson et al., 2016; Levecque et al., 2017; Evans et al., 2018) whilst a smaller proportion reported experiencing suicidal thoughts (Noguiera-Martins et al., 2004; Garcia-Williams et al., 2014).

More specifically, Levecque et al., (2017) found that 51% of Flemish PhD students reported at least two symptoms of psychological distress. This PhD population had significantly greater psychological distress than the highly educated general population, highly educated employees and higher education students. This is supported by recent evidence by Evans et al., (2018) who found that graduate students were six times more likely to experience depression and anxiety compared to the general population.
In contrast, Barry et al., (2018) found that despite graduate students reporting higher levels of stress, anxiety and depression than the general population, these scores were all within normal levels.

In terms of MH service use, a high proportion of graduate students reported utilization of MH services. For example, Garcia-Williams et al., (2014) found that 41% of their sample were currently utilizing MH services. However, concerningly several studies (Stecker, 2004; Hyun et al., 2006; Lipson et al., 2016) found a gap between MH need and mental health service use. This may suggest there are underlying barriers and stigma to MH service utilization and/or an imbalance between demand for MH services and provision of these services.

Interestingly, one study found graduate students had lower rates of negative feelings and behaviours in the previous year compared to undergraduate students but higher rates of negative feelings and behaviours in the period before the last year (Wyatt and Oswalt, 2013). One suggested reason for this was that graduate students may have better developed coping skills.

Furthermore, a recent study found that male graduate students had greater mental health literacy (greater mental health knowledge, more positive attitudes and beliefs, lower self-stigma and greater intentions to seek help) compared to their undergraduate male counterparts (Rafal et al., 2018).

In terms of demographic factors, research shows gender (Noguiera-Martins et al., 2004; Hyun et al., 2006; Evans et al., 2018), race (Wilkinson et al., 2014), academic programme (Lipson et al., 2016) and student status (i.e. domestic vs. international) (Hyun et al., 2007) are all associated with graduate students' mental health and/or mental health service utilization.

A range of factors emerged as common stressors for graduate students: academic work, the academic community, relationships with supervisors and other academic staff, finance and family demands (Nelson et al., 2001; Noguiera-Martins et al., 2004; Stubb et al., 2011; Cilliers and Flotman, 2016; Levecque et al., 2017; Barry et al., 2018).

2.4.2 Physical Activity and Sedentary Time

In terms of graduate students' PA, it is clear there is a distinct lack of research. From the current research, two out of three studies identified graduate students were physically active. Gonzalez et al., (2014) measured PA in US health science graduate students subjectively via the IPAQ. These authors found that health science graduate students' mean total PA was 3038 MET-mins/week with 76% of the sample classified as either moderate or high PA. Similarly, Racette et al., (2014) found that US graduate Doctor of Physical Therapy students were very fit with most students classified as in the outstanding fitness range. In addition, at the beginning of their studies, 70% reported engaging in MVPA on more than 3 days per week and 81% reported doing strength training once a week. Interestingly, these authors found that as their studies progressed, students engaged in significantly less MVPA and strength training. This decrease in MVPA was significantly associated with adverse cardiometabolic markers (increased percentage fat mass and decreased HDL cholesterol).

The findings of Smetaniuk et al., (2017) are in direct contrast with those presented above. Unlike the previous two studies, these authors measured both PA and ST objectively using ActiGraph GT3X accelerometers. They found that Canadian Master of Physical Therapy students were highly inactive (only 26% met current PA guidelines (150 minutes MVPA/week)) and highly sedentary with students spending on average 11.2 hours per day sedentary.

An important point to note is that all three studies' student samples consisted of students studying in health-related fields therefore it is questionable how representative these results are to the general graduate student population.

2.4.3 Mental Health and Physical Activity

There is limited research (only two papers) investigating both PA and MH/MWB in the same sample of graduate students. Unfortunately, both studies failed to examine the association between PA and MH. Melnyk et al., (2016) assessed health lifestyle beliefs and behaviours, MH and PA of 1st year US graduate health science students. Their findings are consistent with other MH and PA literature, a high proportion of graduate students were physically inactive and reported symptoms of depression and anxiety. Anxiety and depression were both significantly negatively correlated to healthy lifestyle beliefs and behaviours. Similarly, Wan (2017) found that Chinese graduate students had poor self-reported MH and low PA levels with a large gap between desire to participate in sports and exercise (95.9%) and actual regular activity (29% regular exercisers).

2.4.4 Attitudes, Perceptions, Facilitators and Barriers to Physical Activity

Only three papers were found that qualitatively assessed graduate students' PA and reported facilitators and barriers to PA. In one of these studies, graduate students identified that PA gave them an opportunity for a break from work, time to be alone and a feeling of accomplishment (Yan and Cardinal, 2013). Longfield et al., (2006) reported on how graduate students' PA patterns have changed since starting graduate school. They identified that PA has become increasingly structured with prior planning and mixing physical activities with social activities to be more time efficient and maximise students' free time. Furthermore, graduate students reported feelings of guilt associated with PA, some individuals felt guilty for spending time away from their studies on PA whilst others reported feeling guilty if they did not engage in PA (Longfield et al., 2006).

Graduate students identified several key facilitators for PA: social support, availability of resources, changing perceptions of femininity, motivation to improve health, accountability to someone/something, financial investment (for example, pre-paid classes) and weather (Longfield et al., 2006; Yan and Cardinal, 2013; Smetaniuk et al., 2017). In terms of barriers to PA, a lack of time, high academic workload, lack of social support, lack of information on PA and available resources, weather, seasonality and built environment were all consistently cited as barriers to PA (Longfield et al., 2006; Yan and Cardinal, 2013; Smetaniuk et al., 2017).

2.4.5 Summary of Systematic Review Findings

From the studies reviewed it is clear there are several key points in terms of MH, MWB, PA, ST and attitudes and perceptions of PA, facilitators of PA and barriers to PA in the graduate student population. These are:

- Graduate students tend to have poor MH and a high prevalence of MH issues such as depression, anxiety and stress.
- Many graduate students are utilizing MH services, yet there still remains a gap between MH need and service use.
- There is limited research on PA and ST in graduate students. The findings of existing research are mixed in terms of levels of PA and ST in graduate students.
- No research has been found to examine the relationship between PA/ST and MH/MWB in graduate students.
- There is limited qualitative research examining graduate students' perceptions and attitudes of PA, facilitators for PA and barriers to PA. From the research reviewed, there is consistency in the facilitators and barriers cited.

2.5 Aim

Although there has been some research into the MH, MWB, PA, ST, facilitators and barriers of PA in graduate students, there is a distinct lack of research specifically examining these variables and their association with each other in graduate students. In addition, research is predominately on subjects based in the USA therefore it is difficult to draw comparisons to UK graduate students as there are a range of cultural differences and differences in university systems. For example, university fees in USA are substantially higher than the UK and university programmes tend be longer in duration. The average length of a PhD in the USA is 5-7 years whereas in the UK PhD programmes usually last 3 years (Nerad, 2004; Park, 2005).

Therefore, this further reinforces the importance of this study to assess PA, ST and MWB in UK graduate students. Based on this literature review, the aims of this study were to examine PA, ST and MWB in UK PGR students, the relationship between these variables and to understand underlying perceptions of PA, sport and exercise; perceived barriers to PA; perceived benefits of PA and motivations for PA in UK PGR students.

The objectives of this study were to:

- measure levels of PA, ST and MWB in 1st year PGR students.
- assess if there is any association between PA, ST and MWB in 1st year PGR students.
- assess if there are differences in outcome measures (PA/ST/MWB) based on participants' demographic characteristics (e.g. home/international students, degree type, dependents etc.)
- identify perceptions of PA, sport and exercise; perceived barriers to PA; perceived benefits of PA and motivations for PA in 1st year PGR students.

3. Methods

3.1 Ethics

Ethical approval was granted for this study by the College of Medical, Veterinary and Life Sciences Research Ethics Committee at the University of Glasgow. All subjects gave informed consent for their data to be included in this study by completion of the online questionnaire. Those who participated in focus groups were given a briefing by the researcher and an information sheet (Appendix 8.2) prior to providing written consent (Appendix 8.3) for participation in focus groups.

3.2 Recruitment to Study

All 1st year PGR students were sent an email explaining the study, its importance and a link to an online questionnaire. Questionnaires were developed by authors using an online survey tool (Google Documents). A reminder email was sent out two weeks after the initial email. A third email containing a brief explanation of the study and the link to the online questionnaire were included in an email detailing resources available for PGR wellbeing which was sent out to all PGR students during the springtime (Spring 2018).

In addition to email advertisement, the study and online questionnaire link were advertised on relevant UofG and UofG related social media platforms (Facebook and Twitter; UofG, UofG Sport, Gilchrist Postgraduate Club, PGR Service, Glasgow University Sports Association (GUSA), UofG specific college social media channels) and on MyGlasgow (the UofG online student portal system). Posters advertising the study were displayed at multiple locations across the UofG campus and on all digital UofG campus screens.

3.3 Participants

An opportunistic sample of first year PGR students (enrolled in MRes, PhD or MD programmes) at the UofG during the second semester of the 2017-2018 academic term were recruited. Inclusion criterion was that the participant must be in their first year of a postgraduate research programme at the UofG. Participants were excluded if they were later year (2nd or 3rd year) PGR students or if they were postgraduate taught students.

The final sample of PGR students recruited was n=100 (n=9 excluded from the study (1 taught, 8 later year students)). This corresponded to a response rate of 12.5%. As seen overleaf (Table 1), recruited participants were 25.5 ± 7.0 years old, 3.0 ± 5.8 years since undergraduate degree completion and spending 35.0 ± 10.0 hours per week on PGR study. A higher proportion of females (74%), single individuals (59%), those with no dependents (90%), those of White/Caucasian background (80%), UK students (52%), Medicine, Veterinary and Life Sciences (MVLS) students (36%) and those who had never used UofG Counselling and Psychological Services (CAPS) (80%) responded to the online questionnaire.

Table 1: Study sample descriptive statistics for 1st Year University of Glasgow postgraduate research students (n=100) who responded to the online questionnaire. Data are presented as median ± interquartile range for continuous variables and as percentages for categorical variables. (*BAME: Black, Asian and Minority Ethnic)

Variable		
Age (years)		25.5 ± 7.0
Time since Undergraduate Degree completion (years)		3.0 ± 5.8
PGR Study Time (hours/week)		35.0 ± 10.0
Gender	Female	74%
	Male	23%
	Prefer Not to Say	2%
	Non-Binary	1%
Relationship Status	*Single*	59%
	Cohabiting	27%
	Married	8%
	Civil Partnership	2%
	Prefer Not to Say	2%
	Separated	1%
	Widowed or Surviving Partner of a Civil Partnership	1%
Dependents	*No*	90%
	Yes – dependent children	5%
	Yes – dependent adult(s)	2%
	Yes – dependent children and adults	2%
	Prefer Not to Say	1%
Number of Dependents	*None*	90%
	1 dependent	5%
	2 dependents	2%
	3 dependents	1%
	4 dependents	1%
	Prefer Not to Say	1%
Ethnicity	*White/Caucasian*	80%
	Asian	12%
	Hispanic/Latino	4%
	Mixed	2%
	Prefer Not to Say	1%
	Other: BAME	1%
Student Status	*UK*	52%
	EU	24%
	International	24%
University College	*Medicine, Veterinary and Life Sciences (MVLS)*	36%
	Social Sciences	28%
	Science & Engineering	23%
	Arts	13%
UofG Counselling and Psychological Service Use	*No*	80%
	Yes	19%
	Prefer Not to Say	1%

3.4 Online Questionnaire

The online questionnaire assessed a range of demographic variables (age, gender, ethnicity, relationship status, dependents, student status, years since undergraduate degree completion, university college and weekly PGR study time). In addition, the questionnaire subjectively assessed PA, ST and MWB.

Subjective Assessment of Physical Activity and Sedentary Time

The questionnaire assessed self-reported PA and ST through the IPAQ short form (Appendix 8.4) which requires the subject to recall frequency and duration of vigorous PA, moderate PA, walking and daily duration of sitting time in the previous 7 days. Weekly duration of vigorous PA, moderate PA and walking was calculated by multiplying reported frequency of activity by reported duration of activity. Weekly MVPA was calculated by combining weekly moderate PA and weekly vigorous PA.

Validity and Reliability of IPAQ Short Form in Assessing Physical Activity and Sedentary Time

The IPAQ short form is a widely used measurement tool. It is predominately used for public health surveillance purposes, assessing PA and SB patterns across a range of countries and socio-economic contexts (Craig et al., 2003; Cleland et al., 2018). Research from Craig et al., (2003) examined test-retest reliability and criterion validity of the IPAQ short form across 12 countries. The authors found an acceptable level of test-retest reliability ($r_s = 0.75$). For criterion validity, the IPAQ short form was compared against Computer Science Application (CSA) accelerometers. Criterion validity was found to be acceptable for both the 12-country pooled sample ($r_s = 0.30$) and the UK specific sample ($r_s = 0.40$). From these results, the authors concluded that the IPAQ short form had an acceptable level of reliability and validity to be utilised as a population level tool to measure PA in adults aged 18 to 65 years old.

In the case of this research, the IPAQ short form was chosen for practical reasons. It was agreed that the IPAQ long form was too long and time intensive to complete given the fact that participants were already completing several demographic questions and questions to assess MWB. Therefore, to secure higher response rates the IPAQ short form was deemed more feasible. In addition, despite the fact that many potential participants did not speak English as a first language, an English language version of the IPAQ short form was utilised. This was justified as all participants should have passed English language qualifications to study at the UofG and it was not considered feasible to provide a copy of the IPAQ to every participant in their first spoken language.

Mental Wellbeing

The questionnaire assessed self-reported MWB through the WEMWBS (Appendix 8.5). Students rated their experience of 14 different statements over the past 2 weeks on a 5-point scale from 'None of the time' (1 point) to 'All of the time' (5 points). Scores were summed to give an overall WEMWBS score. The minimum possible score is 14 with a maximum score of 70. The higher the WEMWBS score the higher the level of MWB. Previous research has shown the WEMWBS to be reliable and valid in both student samples and population samples (Cronbach's alpha scores of 0.89 and 0.91 respectively) (Tennant et al., 2007). The online questionnaire also included a question which asked students if they had ever used the UofG Counselling and Psychological Services.

3.5 Objective Assessment of Physical Activity and Sedentary Time

One of the questions in the online questionnaire asked subjects to indicate if they were interested in objective assessment of PA. A random sample (n=22) was generated from interested participants (n=62). Subjects wore a tri-axial accelerometer (ActiGraph GT3X+, Pensacola, FL, USA) initialized at a sampling rate of 100Hz on their right hip for seven consecutive days. The accelerometer was worn at all times except for during water-based activities (swimming) and when sleeping. To assess compliance, subjects completed a PA monitor diary (Appendix 8.6) to record device removal and reason for removal. Table 2 details participants' characteristics for those randomised to objective assessment of PA.

Table 2: Descriptive statistics for PGR students (n=20) randomly selected for ActiGraph GT3X objective assessment of physical activity. Data are presented as median ± interquartile range for continuous variables and as frequency (percentages) for categorical variables.

Variable		
Age (years)		24.0 ± 5.8
Time since Undergraduate Degree completion (years)		1.0 ± 2.8
PGR Study Time (hours/week)		35.0 ± 18.0
IPAQ MVPA (minutes/week)		285.0 ± 307.5
IPAQ Sitting Time (hours/day)		6.0 ± 3.8
Total WEMWBS Score		47.5 ± 11.3
Gender	Female	15 (75%)
	Male	4 (20%)
	Non-Binary	1 (5%)
Relationship Status	*Single*	11 (55%)
	Cohabiting	6 (30%)
	Civil Partnership	1 (5%)
	Separated	1 (5%)
	Widowed or Surviving Partner of a Civil Partnership	1 (5%)
Dependents	*No*	17 (85%)
	Yes – dependent adult(s)	2 (10%)
	Yes – dependent children	1 (5%)
Number of Dependents	*None*	17 (85%)
	1 dependent	2 (10%)
	4 dependents	1 (5%)
Ethnicity	*White/Caucasian*	18 (90%)
	Asian	2 (10%)
Student Status	*UK*	11 (55%)
	EU	5 (25%)
	International	4 (20%)
University College	*Medicine, Veterinary and Life Sciences (MVLS)*	7 (35%)
	Social Sciences	3 (15%)
	Science & Engineering	7 (35%)
	Arts	3 (15%)
UofG Counselling and Psychological Service Use	*No*	16 (80%)
	Yes	4 (20%)

Accelerometry

There has been a rise in the use of accelerometers in the past decade due to the need for accurate and objective measures of PA (Troiano et al., 2014). Furthermore, declining costs and the development of smaller, more lightweight devices has made accelerometer use more feasible.

Accelerometers measure acceleration along an axis of motion via a range of mechanisms including piezoelectric sensors, micro-electrical mechanical springs and changes in capacitance. Raw acceleration is detected by the accelerometer sensor, which then converts motion into counts using proprietary algorithms. These counts are summed over a set time period (epoch) and stored in the device. Some devices also provide raw unfiltered data output (John and Freedson, 2012; Migueles et al., 2017).

Modern accelerometer devices are able to measure acceleration across multiple axis, allowing multiple axis of motion to be assessed. For example, the ActiGraph GT3X accelerometer (used in this study) contains a triaxial capacitive micro electrical mechanical system sensor which assesses acceleration in three different axes (vertical, mediolateral and anterior-posterior) (John and Freedson, 2012).

Validity and Reliability of ActiGraph GT3X in Assessing Physical Activity

The ActiGraph GT3X has been recognised as a valid and reliable measure of PA. Kelly et al., (2013) examined the validity of ActiGraph GT3X in assessing PA compared to criterion indirect calorimetry. Results showed that the GT3X accelerometer count/minute was significantly correlated to the rate of oxygen consumption ($r = 0.81$, $p<0.001$) and therefore has a high concurrent validity. In addition, evidence shows high inter-instrument reliability ($r = 0.93 – 0.99$ for 7-day measurement period) and test-retest reliability (MVPA $r = 0.88$, ST $r = 0.91$) under free-living conditions (Aadland and Ylvisåker, 2015; Pfister et al., 2017).

Rationale for ActiGraph GT3X Positioning and Initialization Properties

Device Location

The ActiGraph GT3X can be worn either on the wrist or on the hip. In this study, the hip was selected as the measurement site as research shows that hip-based measurement is more accurate for assessing PA type, PA intensity and steps (Ellis et al., 2016; Hildebrand et al., 2014; Tudor-Locke et al., 2014). Despite research showing there is no significant difference between the left and right hips as measurements sites (Aadland and Ylvisåker, 2015), the ActiGraph GT3X was positioned on the right hip for consistency in approach.

Measurement Duration

Migueles et al., (2017) state that in order for data to be valid accelerometers must be worn for a minimum of 10 hours per day over 4 or more days. This was set as the wear time validation criteria for this study. A measurement duration of 7 days was selected to allow for potential data attrition due to participants forgetting to wear the device. Also, this 7-day duration allows for comparison with the subjective PA measure (IPAQ short form) which is based upon 7-day recall.

Epoch Length

Despite epoch length being less of an issue for PA and SB measurement in adults. This study utilised 15 second epochs to allow for sensitivity to detect any potential sporadic activity.

Sampling Frequency

There is limited research on sampling frequency. Migueles et al., (2017) suggest that for adults a sampling frequency of 90-100Hz is appropriate. Therefore, 100Hz was selected as sampling frequency.

Physical Activity and Sedentary Time Classification

In order to classify PA intensity and ST, cut points are applied to accelerometer data. These cut points are based on the number of activity counts per minute. Most of these cut points have been developed and validated using accelerometer data from vertical and/or antero-posterior planes rather than vector magnitude data from all three planes (vertical, antero-posterior and medio-lateral). Sasaki et al., (2011) were one of the first to develop cut points based on ActiGraph GT3X vector magnitude data, these cut points were applied to accelerometer data in this study to classify PA intensity and ST.

Sleep Data

Sleep data was not assessed as currently there are no algorithms to estimate sleep related behaviours for hip-based devices (Migueles et al., 2017). Participants removed the ActiGraph GT3X device when they went to bed and this removal time was corroborated by participants completing PA monitor diaries.

3.6 Focus Groups

Upon completion of objective PA and ST assessment, subjects were contacted by email to register their interest in participating in focus groups. Recruited participants (n=10, final sample n=6 (n=4 drop out)) attended a focus group session on campus during working hours. Focus groups were conducted in a semi-structured format led by the author with the discussion guided by open-ended questions (Appendix 8.7) on participant's perceptions of PA, sport and exercise; perceived barriers to PA; perceived benefits of PA; motivations for PA and experiences and opportunities for an active lifestyle at the UofG.

Prior to focus group sessions, the author was trained by a researcher from the University of Strathclyde who specialises in qualitative focus group research of physical activity. This researcher guided the author in structure and set up of focus groups; appropriateness of questions developed for focus groups and how to conduct thematic qualitative analysis. A pilot focus group was conducted with MSc Sports Science students and questions were revised or reworded accordingly to ensure questions were clear.

Prior to commencement of the focus group, participants were given information sheets (Appendix 8.2) and consent forms (Appendix 8.3) to obtain written informed consent and permission for audio recording.

Focus groups were audiotaped and transcribed verbatim. Transcripts were sent to participants to confirm they reflected what was discussed during the session. Participants were offered university branded items and free access passes to the UofG Sport gym as a token of appreciation for focus group participation. Table 3 shows summary characteristics of the final focus group sample (n=6). Note this sample had one part-time PGR student hence mean PGR study time (22 hours/week) was lower than that of the full PGR sample (35 hours/week).

Table 3: Descriptive statistics for sub-cohort of PGR students (n=6) who participated in qualitative focus groups. Data are presented as median ± interquartile range for continuous variables and as frequency (percentages) for categorical variables.

Variable		
Age (years)		25.0 ± 15.0
Time since Undergraduate Degree completion (years)		3.0 ± 14.3
PGR Study Time (hours/week)		22.0 ± 41.0
IPAQ MVPA (minutes/week)		330.0 ± 405.0
IPAQ Sitting Time (hours/day)		6.5 ± 3.5
Total WEMWBS Score		47.5 ± 14.3
Gender	Female	5 (83.3%)
	Male	1 (16.7%)
Relationship Status	*Single*	4 (66.7%)
	Cohabiting	1
	Widowed or Surviving Partner of a Civil Partnership	1
Dependents	*No*	5
	Yes – dependent adult(s)	1
Number of Dependents	*1 dependent*	1
Ethnicity	*White/Caucasian*	5
	Asian	1
Student Status	*UK*	4
	International	2
University College	*Medicine, Veterinary and Life Sciences (MVLS)*	3
	Social Sciences	1
	Science & Engineering	1
	Arts	1
UofG Counselling and Psychological Service Use	*No*	5
	Yes	1

3.7 Data Analysis

Accelerometer Data Analysis and Reduction

Accelerometer data were downloaded, and raw accelerometer counts were summarised in 15 second epochs using the ActiLife® Software (ActiGraph, Pensacola, Florida, USA). Data were saved as raw GT3X files and converted to AGD files. Accelerometer data were screened for non-wear visually and using the participant PA monitor diary. Wear time validation criteria (a minimum accelerometer wear time of 10 hours per day for a minimum of 4 days) was applied to accelerometer data. All subjects (n=20) met wear time validation criteria (Table 4). Physical activity intensity was defined by application of validated cut points (Sasaki et al., 2011) to vector magnitude data (Table 5).

Table 4: Number of ActiGraph GT3X monitoring days and hours of monitoring per day for PGR students randomised to ActiGraph GT3X assessment (n=20). All subjects met wear time validation criteria of 10 hours per day for a minimum of 4 days.

Recruited Sample Size	22					
Final Sample Size	20 (-2: non-compliant, device malfunction)					
Number of Monitoring Days	7	6	5			
N	4	15	1			
Mean Number of Monitoring Hours (hours/monitoring day)	17	16	15	14	13	12
N	1	2	7	8	1	1

Table 5: ActiGraph GT3X vector magnitude cut points for each physical activity intensity (Sasaki et al., 2011).

Physical Activity Intensity	**Cut Points**	
	Minimum (counts/minute)	**Maximum (counts/minute)**
Sedentary	0	500
Light Physical Activity	501	2689
Moderate Vigorous Physical Activity	2690	∞

Quantitative Statistical Analysis

Data were analysed to ensure all data included in statistical analysis were relevant. Relevant data were statistically analysed using MINITAB (Version 18.1, Minitab Inc, Pennsylvania, USA) software package. Data were checked for normality using the Anderson-Darling normality test. Descriptive statistics were produced for the data set. Normally distributed data are reported as mean ± standard deviation whilst non-normally distributed data are reported as median ± interquartile range. Categorical variables are reported as frequencies and/or percentages. Data were analysed subjectively through boxplots and scattergraphs.

Differences within categorical variables for each outcome of interest were investigated via one-way ANOVAs (normally distributed data) or Kruskal Wallis tests (non-normally distributed data). Data for one-way ANOVAs are presented as (F statistic (degrees of freedom $(df)_{factor}$, df_{error}) = F ratio, p value) whilst data for Kruskal Wallis tests are presented as (x^2 (df) = H value, p value). Results that were statistically significant were subjected to post hoc tests (Tukey test for ANOVA and Dunn's pairwise comparison test for Kruskal Wallis) to identify where the significant differences lay. In the case where sample sizes were too small to run a Tukey test (i.e. Gender: Non-Binary n=1) a two-sample t test was performed. To assess effect sizes for one-way ANOVAs, omega squared (ω^2) values were calculated. Effect sizes were considered small if $\omega^2 = 0.01$, medium if $\omega^2 = 0.06$ or large if $\omega^2 = 0.14$.

To assess the association(s) between PA, ST, PGR study time and MWB, Pearson's correlation analysis (normally distributed data), regression analysis (normally distributed data) and Spearman's rank correlation analysis (non-normally distributed data) was carried out. A paired t test was performed to assess the difference in IPAQ and ActiGraph measured MVPA and ST. To ensure consistency in measurement units, ActiGraph MVPA data was manipulated by dividing MVPA by monitoring period and multiplying by 7 to give MVPA in minutes per week (ActiGraph estimated MVPA). Statistical significance was set at $p<0.05$.

Qualitative Analysis of Focus Groups

Following focus group transcription verbatim, transcripts were analysed deductively using Braun and Clarke's (2006) protocol for thematic analysis (Table 6 below).

Table 6: Thematic Analysis Protocol (Braun and Clarke, 2006)

Phase of Thematic Analysis	Description
1. Familiarization with data	Transcription of data, reading and re-reading data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of data in a systematic fashion across entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each theme.
4. Reviewing themes	Checking if the themes work in relation to coded extracts and entire data set, generating a thematic 'map' of the analysis.
5. Defining and naming themes	Ongoing analysis to refined specifics of each theme and overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	Final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature producing a scholarly report of the analysis.

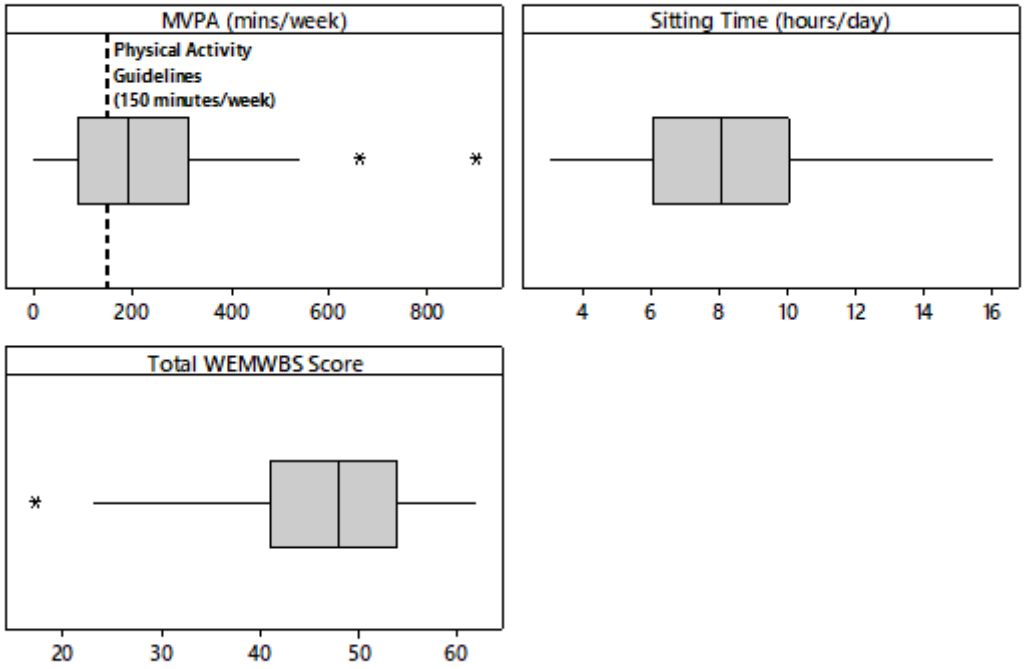
4. Results

4.1 Online Questionnaire

Table 7: Physical activity and mental wellbeing data for 1st Year University of Glasgow postgraduate research students (n=100) who responded to the online questionnaire. Physical activity and mental wellbeing were assessed via the IPAQ and WEMWBS respectively. Data are presented as median ± interquartile range for continuous data and frequency (percentage) for categorical data.

Variable	N		Median ± Interquartile Range
Moderate PA (mins/week)	97		60 ± 170
Vigorous PA (mins/week)	99		90 ± 180
MVPA (mins/week)	97		195 ± 225
Meeting PA Recommendations (150 minutes/week MVPA)	97	Yes	61 (62.9%)
		No	36 (37.1%)
Walking (mins/week)	98		210 ± 280
Sitting Time (hours/day)	97		8 ± 4
Total PA (MET-mins/week)	95		2036 ± 1386
Total WEMWBS	100		48 ± 13

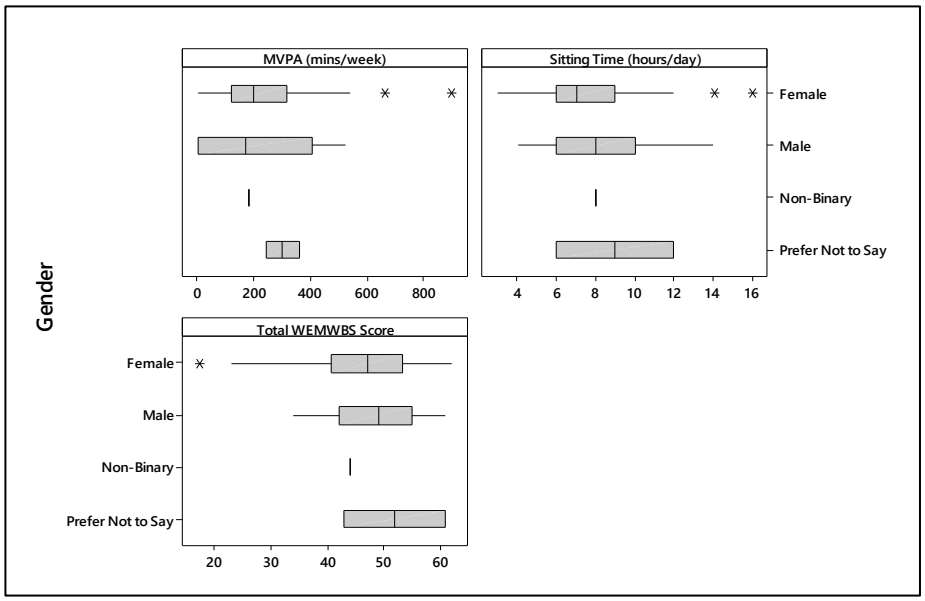
Figure 2: Boxplots showing self-reported moderate vigorous physical activity (MVPA)(minutes/week) (n=97), sitting time (hours/day) (n=97) and mental wellbeing (WEMWBS score) (n=100) of 1st Year PGR students who completed the online questionnaire. Dashed line in MVPA plot represents current PA guidelines (150 minutes/week MVPA).



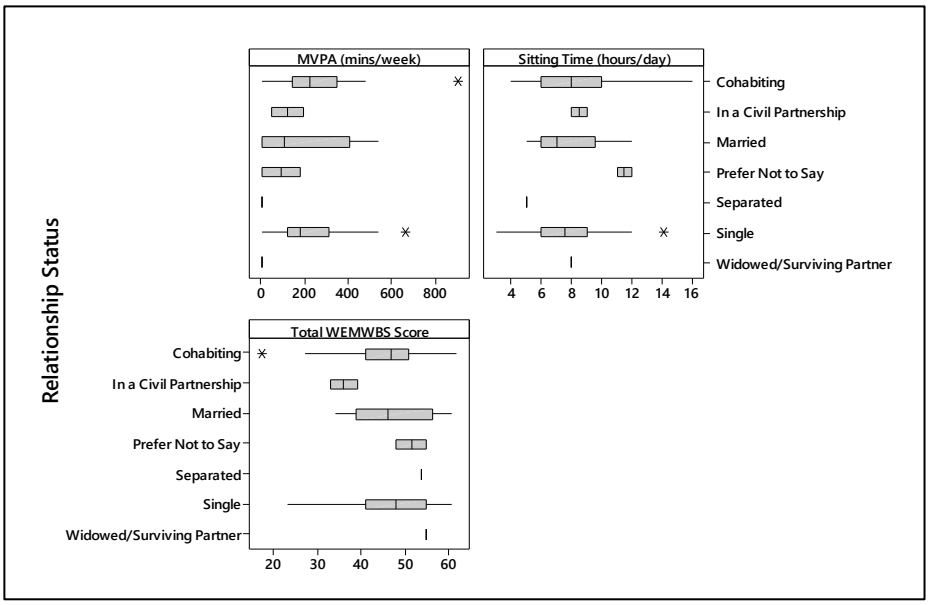
As seen in Table 7 and Figure 2, self-reported MVPA was 195 ± 225 minutes/week (45 minutes/week above current physical activity guidelines). Importantly, as seen in Figure 2, there is a large range in MVPA with some PGR students reporting as low as 0 minutes/week to as high as 900 minutes/week. In terms of self-report sitting time, the PGR student population are highly sedentary (8 ± 4 hours/day sitting time). Again, there is a large range in self-report sitting time with some PGR students reporting as little as 3 hours/day sitting time to as high as 16 hours/day. For MWB, PGR students reported a total WEMWBS score of 48 ± 13. Similarly, there is a large range in total WEMWBS scores with some PGR students reporting total WEMWBS scores as low as 17 to as high as 62.

Figure 3(a-g): Boxplots showing self-reported MVPA (minutes/week), sitting time (hours/day) and mental wellbeing (total WEMWBS score) split by questionnaire assessed categorical variables. ((a) gender, (b) relationship status, (c) dependents, (d) ethnicity, (e) university college, (f) student status and (g) use of University of Glasgow counselling and psychological services) for 1st Year PGR students (n=100) who completed the online questionnaire.

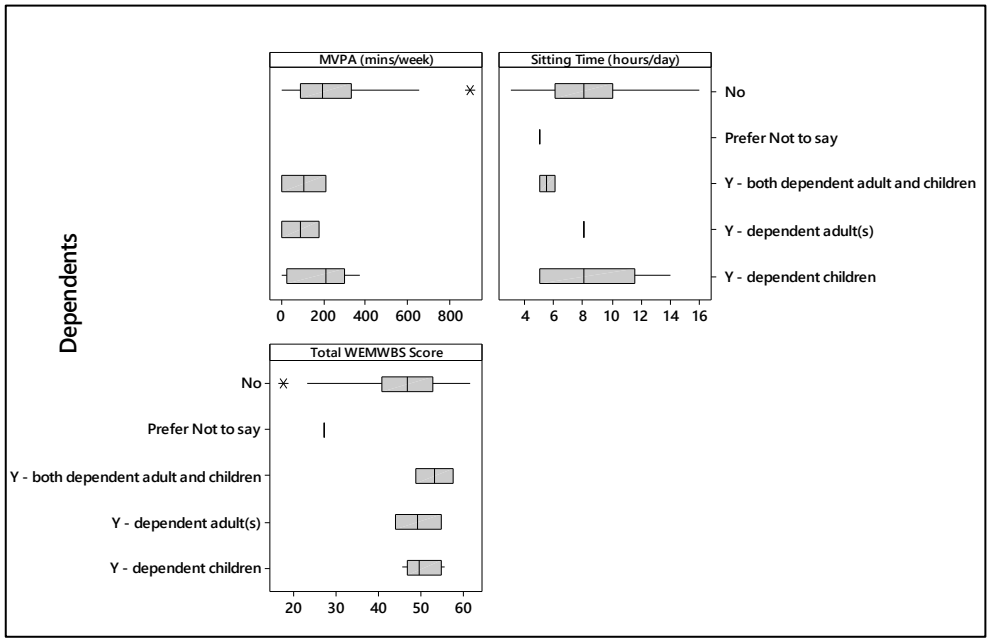
(a)



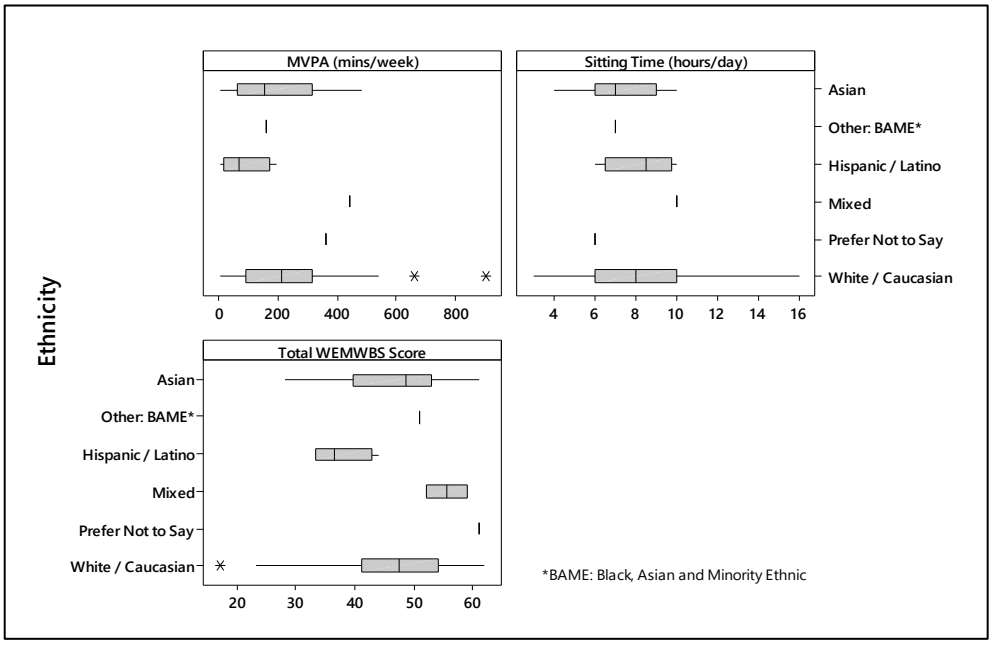
(b)



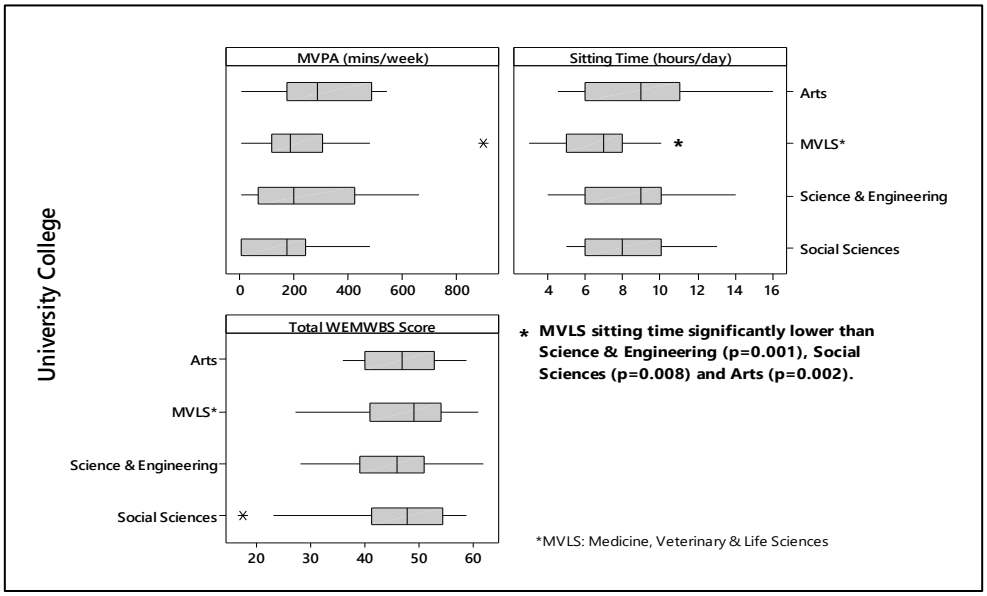
(c)


Dependents
MVPA (mins/week)
Sitting Time (hours/day)
No
Prefer Not to say
Y - both dependent adult and children
Y - dependent adult(s)
Y - dependent children
0 200 400 600 800
4 6 8 10 12 14 16
Total WEMWBS Score
No
Prefer Not to say
Y - both dependent adult and children
Y - dependent adult(s)
Y - dependent children
20 30 40 50 60

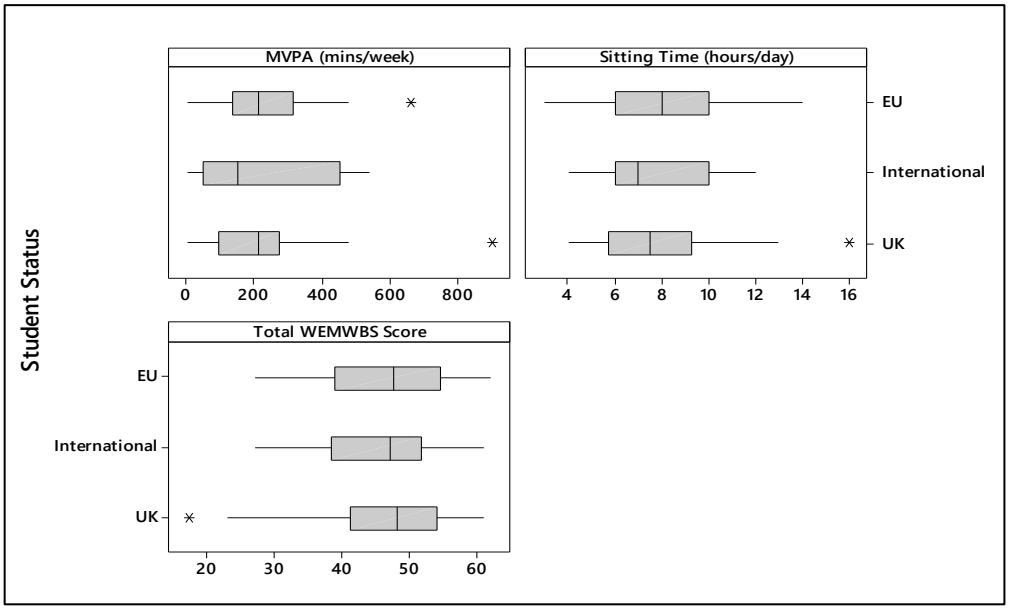
(d)


Ethnicity
MVPA (mins/week)
Sitting Time (hours/day)
Asian
Other: BAME*
Hispanic / Latino
Mixed
Prefer Not to Say
White / Caucasian
0 200 400 600 800
4 6 8 10 12 14 16
Total WEMWBS Score
Asian
Other: BAME*
Hispanic / Latino
Mixed
Prefer Not to Say
White / Caucasian
20 30 40 50 60
*BAME: Black, Asian and Minority Ethnic

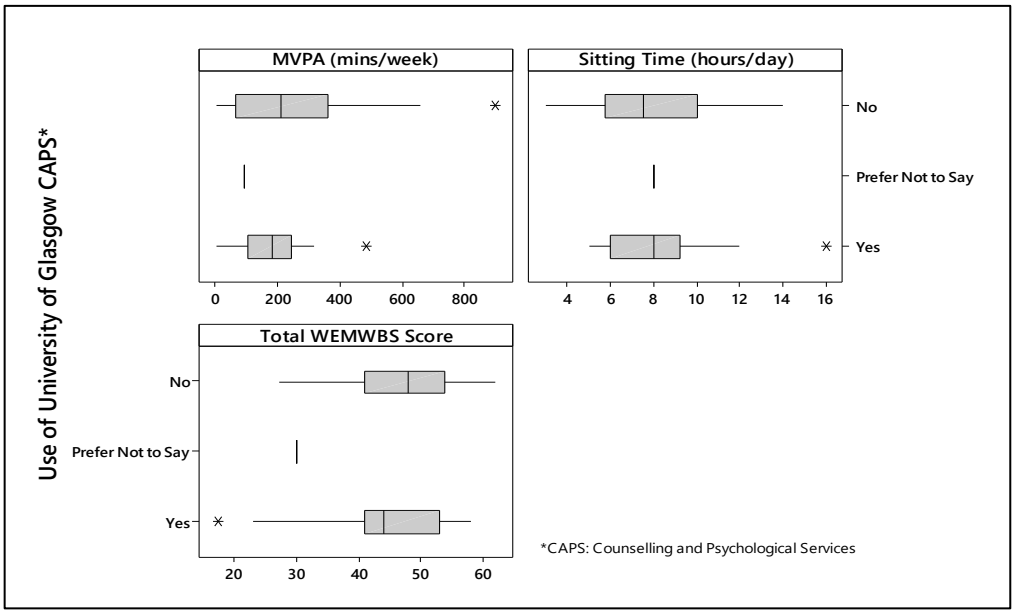
(e)


University College
MVPA (mins/week)
Sitting Time (hours/day)
Arts
MVLS*
Science & Engineering
Social Sciences
0 200 400 600 800
4 6 8 10 12 14 16
Total WEMWBS Score
Arts
MVLS*
Science & Engineering
Social Sciences
20 30 40 50 60
* MVLS sitting time significantly lower than Science & Engineering (p=0.001), Social Sciences (p=0.008) and Arts (p=0.002).
*MVLS: Medicine, Veterinary & Life Sciences

(f)


Student Status
MVPA (mins/week)
Sitting Time (hours/day)
EU
International
UK
0
200
400
600
800
4
6
8
10
12
14
16
Total WEMWBS Score
EU
International
UK
20
30
40
50
60

(g)


Use of University of Glasgow CAPS*
MVPA (mins/week)
Sitting Time (hours/day)
No
Prefer Not to Say
Yes
0
200
400
600
800
4
6
8
10
12
14
16
Total WEMWBS Score
No
Prefer Not to Say
Yes
20
30
40
50
60
*CAPS: Counselling and Psychological Services

4.1.1 Analysis of self-report MVPA split by demographic factors.

Table 8: Self-report IPAQ MVPA (minutes/week) data split by demographic factors for 1st Year PGR students who completed the online questionnaire (n=100). Formal statistical analysis carried out by performing Kruskal-Wallis Tests. (*BAME: Black, Asian and Minority Ethnic; CAPS: Counselling and Psychological Services; DF: Degrees of Freedom; MVLS: Medicine, Veterinary and Life Sciences)

Gender	**N**	**Median**	**DF**	**H Value**	**P Value**
Female	71	195	3	1.56	0.67
Male	23	170			
Non-Binary	1	180			
Prefer Not to Say	2	300			
Overall	97				
Relationship Status	**N**	**Median**	**DF**	**H Value**	**P Value**
Cohabiting	27	220	6	7.35	0.29
In a Civil Partnership	2	120			
Married	8	105			
Prefer Not to Say	2	90			
Separated	1	0			
Single	56	180			
Widowed or a surviving partner	1	0			
Overall	97				
Dependents	**N**	**Median**	**DF**	**H Value**	**P Value**
No	88	195	3	2.60	0.46
Yes – both dependent adult and children	2	105			
Yes – dependent adult(s)	2	90			
Yes – dependent children	5	210			
Overall	97				
Ethnicity	**N**	**Median**	**DF**	**H Value**	**P Value**
Asian	11	150	5	5.54	0.35
Other: BAME	1	160			
Hispanic/Latino	4	67.5			
Mixed	1	440			
Prefer Not to Say	1	360			
White/Caucasian	79	210			
Overall	97				
University College	**N**	**Median**	**DF**	**H Value**	**P Value**
Arts	13	280	3	4.97	0.17
MVLS	34	180			
Science & Engineering	23	195			
Social Sciences	27	170			
Overall	97				
Student Status	**N**	**Median**	**DF**	**H Value**	**P Value**
EU	23	210	2	1.06	0.59
International	23	150			
UK	51	210			
Overall	97				
UofG CAPS Use	**N**	**Median**	**DF**	**H Value**	**P Value**
No	77	210	2	1.50	0.47
Prefer Not to Say	1	90			
Yes	19	180			
Overall	97				

Figures 3(a-g) show boxplots for self-report MVPA, sitting time and MWB split by demographic factors. Trends show lower self-report MVPA for those with dependents (adult and both adult & children) (Figure 3(c)), those who are not single or cohabiting (Figure 3(b)) and individuals of Hispanic/Latino ethnicity (Figure 3(d)). However, as seen in Table 8 no significant differences were found for self-report MVPA across any of the demographic factors (gender $x^2(3)=1.56$, $p=0.67$; relationship status $x^2(6)=7.35$, $p=0.29$; dependents $x^2(3)=2.60$, $p=0.46$; ethnicity $x^2(5)=5.54$, $p=0.35$; university college $x^2(3)=4.97$, $p=0.17$; student status $x^2(2)=1.06$, $p=0.59$; UofG CAPS use $x^2(2)=1.50$, $p=0.47$).

4.1.2 Analysis of self-report Sitting Time split by demographic factors

Table 9: Self-report IPAQ sitting time (hours/day) data split by demographic factors for 1st Year PGR Students who completed the online questionnaire (n=100). Formal statistical analysis carried out by performing Kruskal-Wallis Tests. (*BAME: Black, Asian and Minority Ethnic, CAPS: Counselling and Psychological Services; DF: Degrees of Freedom; MVLS: Medicine, Veterinary and Life Sciences)

Gender	**N**	**Median**	**DF**	**H Value**	**P Value**
Female	71	7	3	1.36	0.71
Male	23	8			
Non-Binary	1	8			
Prefer Not to Say	2	9			
Overall	97				
Relationship Status	**N**	**Median**	**DF**	**H Value**	**P Value**
Cohabiting	27	8	6	6.16	0.41
In a Civil Partnership	2	8.5			
Married	8	7			
Prefer Not to Say	2	11.5			
Separated	1	5			
Single	56	7.5			
Widowed or a surviving partner	1	8			
Overall	97				
Dependents	**N**	**Median**	**DF**	**H Value**	**P Value**
No	87	8	4	3.71	0.45
Prefer Not to Say	1	5			
Yes – both dependent adult and children	2	5.5			
Yes – dependent adult(s)	2	8			
Yes – dependent children	5	8			
Overall	97				
Ethnicity	**N**	**Median**	**DF**	**H Value**	**P Value**
Asian	11	7	5	2.84	0.73
Other: BAME	1	7			
Hispanic/Latino	4	8.5			
Mixed	1	10			
Prefer Not to Say	1	6			
White/Caucasian	79	8			
Overall	97				
University College	**N**	**Median**	**DF**	**H Value**	**P Value**
Arts	13	9	3	13.88	0.003
MVLS	35	7			
Science & Engineering	23	9			
Social Sciences	26	8			
Overall	97				
Student Status	**N**	**Median**	**DF**	**H Value**	**P Value**
EU	24	8	2	0.88	0.64
International	23	7			
UK	50	7.5			
Overall	97				
UofG CAPS Use	**N**	**Median**	**DF**	**H Value**	**P Value**
No	78	7.5	2	0.50	0.78
Prefer Not to Say	1	8			
Yes	18	8			
Overall	97				

Table 10: Results from post hoc Dunn's pairwise comparison test analysing association between self-report sitting time (hours/day) and university college. (MVLS: Medicine, Veterinary and Life Sciences)

University College	N	Median
Arts	13	9
MVLS	35	7
Science & Engineering	23	9
Social Sciences	26	8
Comparisons	**P Value**	
MVLS vs. Science & Engineering	0.0010	
MVLS vs. Social Sciences	0.0084	
MVLS vs. Arts	0.0015	
Social Sciences vs. Arts	0.75	
Social Sciences vs. Science & Engineering	0.48	
Arts vs. Science & Engineering	0.78	

As seen in Figures 3 (a-d and f-g) subjectively there are no visible differences in sitting time for gender, relationship status, dependents, ethnicity, student status and UofG CAPS use. This is seen through similar median values and a large overlap in the boxplots. However, as seen in Figure 3(e), PGR students in the College of MVLS self-reported a lower sitting time (7 hours/day) than PGR students in all other UofG Colleges (Arts: 9 hours/day; Science & Engineering: 9 hours/day; Social Sciences: 8 hours/day).

Formal analysis (Table 9) confirmed there were no significant differences in self-report sitting time for gender ($x^2(3)=1.36$, $p=0.71$), relationship status ($x^2(6)=6.16$, $p=0.41$), dependents ($x^2(4)=3.71$, $p=0.45$), ethnicity ($x^2(5)=2.84$, $p=0.73$), student status ($x^2(2)=0.88$, $p=0.64$) or UofG CAPS use ($x^2(2)=0.50$, $p=0.78$).

However, formal analysis confirmed that there was a significant difference for self-report sitting time and university college ($x^2(3) =13.88$, $p=0.003$). Post hoc analysis (Table 10) confirmed that MVLS students self-reported significantly less time sitting than their counterparts in Arts ($p=0.0015$), Science & Engineering ($p=0.001$) and Social Sciences ($p=0.0084$).

4.1.3 Analysis of Mental Wellbeing split by demographic factors

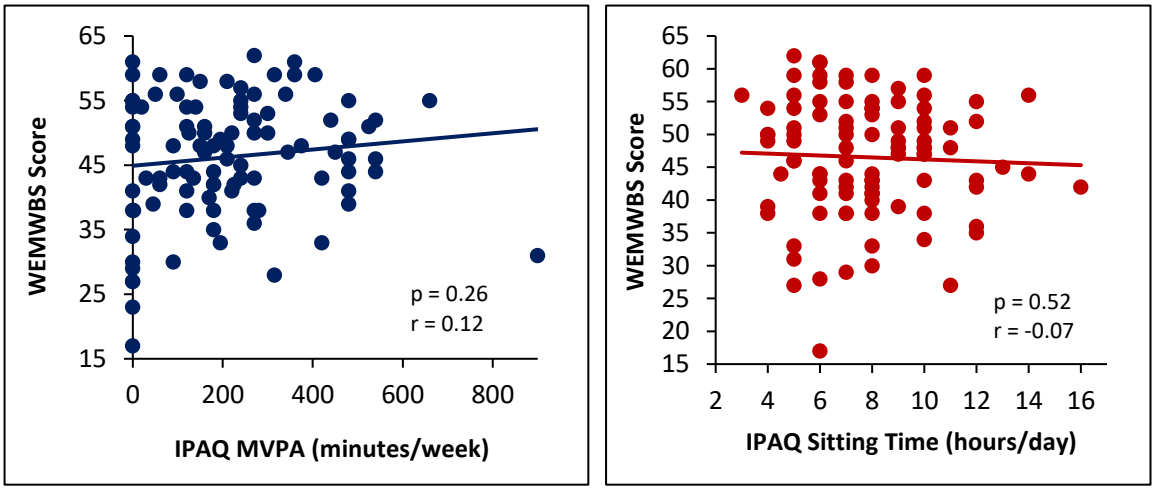
Table 11: Mental wellbeing (WEMWBS score) data split by demographic factors for 1st Year PGR students who completed the online questionnaire (n=100). Formal statistical analysis carried out by performing Kruskal-Wallis Tests. (*BAME: Black, Asian and Minority Ethnic, CAPS: Counselling and Psychological Services; DF: Degrees of Freedom; MVLS: Medicine, Veterinary and Life Sciences)

Gender	**N**	**Median**	**DF**	**H Value**	**P Value**
Female	74	47	3	2.08	0.56
Male	23	49			
Non-Binary	1	44			
Prefer Not to Say	2	52			
Overall	100				
Relationship Status	**N**	**Median**	**DF**	**H Value**	**P Value**
Cohabiting	27	47.0	6	6.50	0.37
In a Civil Partnership	2	36.0			
Married	8	46.0			
Prefer Not to Say	2	51.5			
Separated	1	54.0			
Single	59	48.0			
Widowed or a surviving partner	1	55.0			
Overall	100				
Dependents	**N**	**Median**	**DF**	**H Value**	**P Value**
No	90	47.0	4	5.49	0.24
Prefer Not to Say	1	27.0			
Yes – both dependent adult and children	2	53.5			
Yes – dependent adult(s)	2	49.5			
Yes – dependent children	5	50.0			
Overall	100				
Ethnicity	**N**	**Median**	**DF**	**H Value**	**P Value**
Asian	12	48.5	5	9.69	0.085
Other: BAME	4	36.5			
Hispanic/Latino	2	55.5			
Mixed	1	51.0			
Prefer Not to Say	1	61.0			
White/Caucasian	80	47.5			
Overall	100				
University College	**N**	**Median**	**DF**	**H Value**	**P Value**
Arts	13	47	3	0.18	0.98
MVLS	36	49			
Science & Engineering	23	46			
Social Sciences	28	48			
Overall	100				
Student Status	**N**	**Median**	**DF**	**H Value**	**P Value**
EU	24	47.5	2	0.37	0.83
International	24	47.0			
UK	52	48.0			
Overall	100				
UofG CAPS Use	**N**	**Median**	**DF**	**H Value**	**P Value**
No	80	48	2	3.38	0.19
Prefer Not to Say	1	30			
Yes	19	44			
Overall	100				

For MWB, as seen in Figures 3(b) and 3(d), trends showed lower MWB for those in civil partnerships and those of Hispanic/Latino ethnicity. However, no significant differences were found for MWB across any of the demographic factors (Table 11).

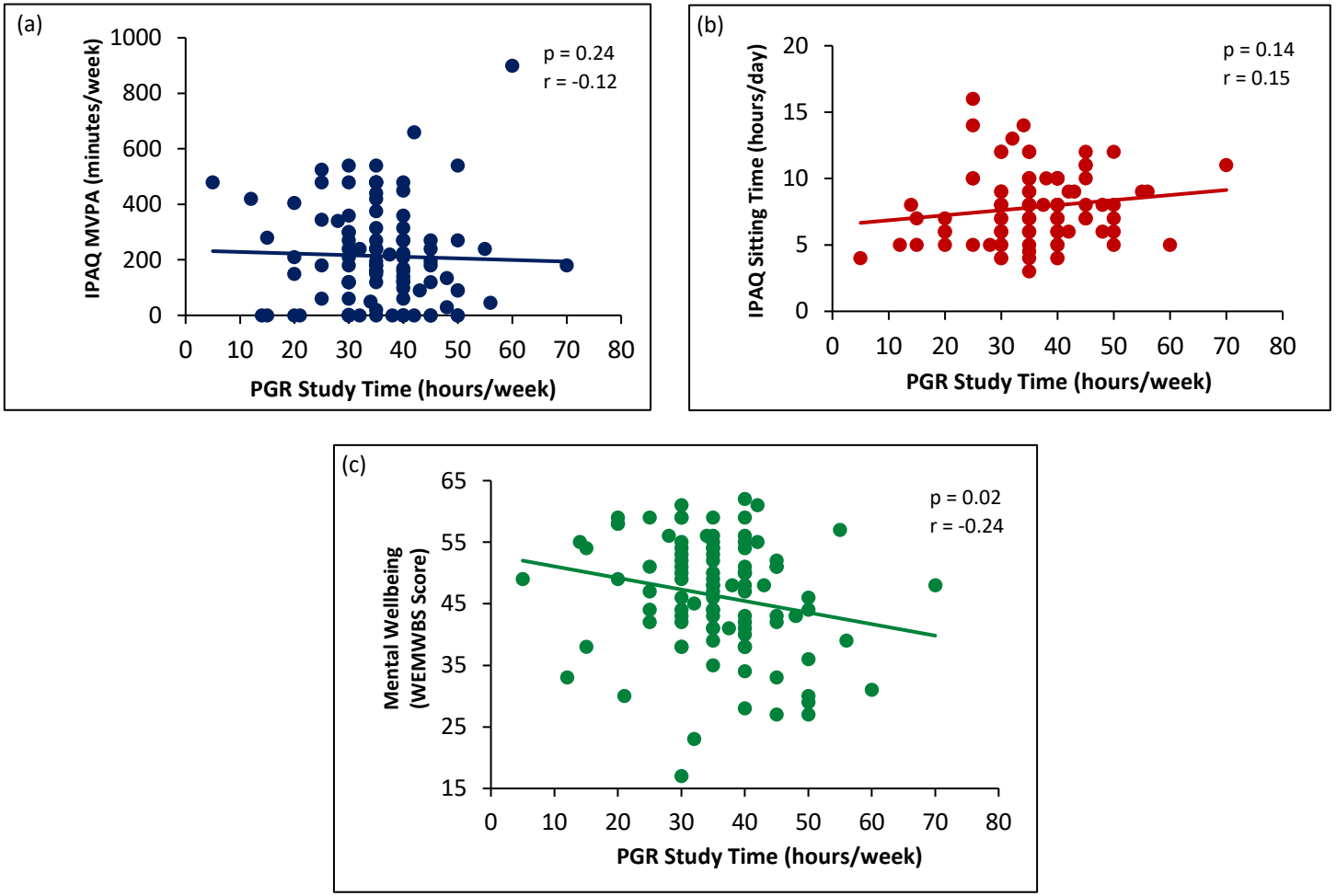
4.1.4 Correlation between self-reported MVPA, Sitting Time, Mental Wellbeing and PGR Study Time

Figure 4: Scatterplots of mental wellbeing (WEMWBS score) against IPAQ self-reported MVPA (minutes/week) and sitting time (hours/day) for 1st Year PGR students (n=100). Line represents a line of best fit.



As seen in Figure 4 above, there was no association between self-reported MVPA and MWB or self-reported sitting time and MWB.

Figures 5(a-c): Scatterplots of (a) IPAQ self-report MVPA (minutes/week), (b) IPAQ self-report sitting time (hours/day) and (c) mental wellbeing (WEMWBS score) against self-report PGR study time (hours/week) for 1st Year PGR students (n=100). Lines represent line of best fit.



As seen in Figures 5(a) and 5(b), there is no association between IPAQ MVPA or IPAQ sitting time and PGR study time. However, there is a negative association between MWB and PGR study time (Figure 5(c)). Further analysis identified that there is a weak yet significant negative correlation between MWB and PGR study time (r_s=-0.24, p=0.02). However, it is important to note that the low r_s value (-0.24) highlights that this is only a weak correlation and therefore other factors are involved in the correlation between MWB and PGR study time.

4.2 Objective ActiGraph GT3X Assessment

Table 12: Descriptive ActiGraph GT3X data for the sample cohort of PGR students (n=20) who were randomly selected for objective assessment of physical activity. Data are presented as mean ± standard deviation.

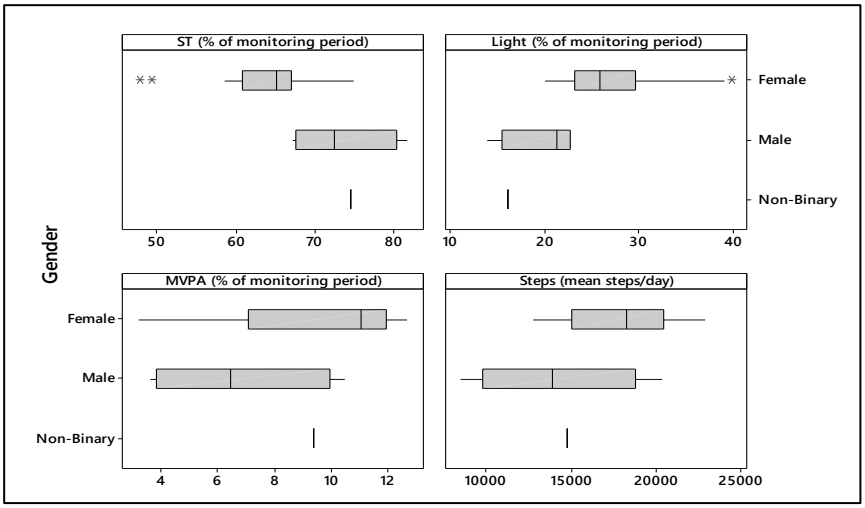
	Absolute	**% of Monitoring Period**
Sedentary Time (hours/day)	9.6 ± 1.4	65.8 ± 8.1
Light Physical Activity (minutes/monitoring period)	1360.3 ± 371.2	25.2 ± 6.4
MVPA (minutes/monitoring period)	485.4 ± 165.2	9.0 ± 3.1
ActiGraph GT3X Estimated MVPA (minutes/week)	554.3 ± 187.1	
Steps (steps/day)	17054.0 ± 3692.0	
Mean wear time (hours/day)	14.6 ± 1.07	
	Yes	**No**
Meeting PA Guidelines	100% (n=20)	

In terms of ActiGraph GT3X objectively assessed PA and ST, all participants (n=20) had valid accelerometer data. As seen in Table 12, this sub-cohort of PGR students were highly sedentary (9.6 ± 1.4 hours sedentary per day, 65.8 ± 8.1% of monitoring period) but also highly active (MVPA; 485.4 ± 165.2 minutes/monitoring period). ActiGraph GT3X estimated MVPA was 554.3 ± 187.1 minutes/week, which is ~404 minutes/week above current PAG (150 minutes/week MVPA) of which 100% of the cohort were meeting. These findings are consistent with the IPAQ self-reported MVPA and sitting time data and suggest that the PGR student population are highly active (meeting guidelines) yet highly sedentary.

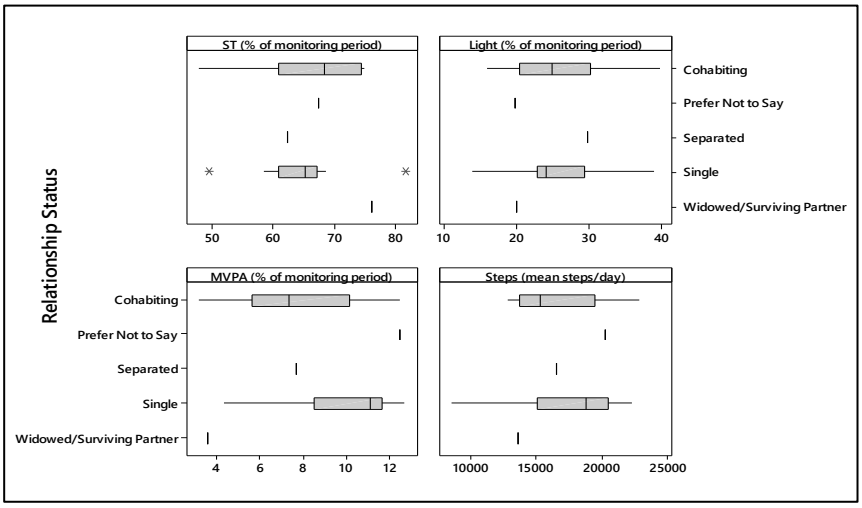
Objective ActiGraph GT3X Assessed MVPA, Light Physical Activity, Sedentary Time and Steps across all Demographic Factors

Figures 6(a-g): Boxplots showing ActiGraph GT3X assessed sedentary time (% of monitoring period), light physical activity (% of monitoring period), MVPA (% of monitoring period) and steps (mean steps/day) split by questionnaire assessed categorical variables ((a) gender, (b) relationship status, (c) dependents, (d) ethnicity, (e) university college, (f) student status and (g) use of University of Glasgow counselling and psychological services) for 1st Year PGR students who were randomly selected for ActiGraph GT3X objective assessment of physical activity (n=20).

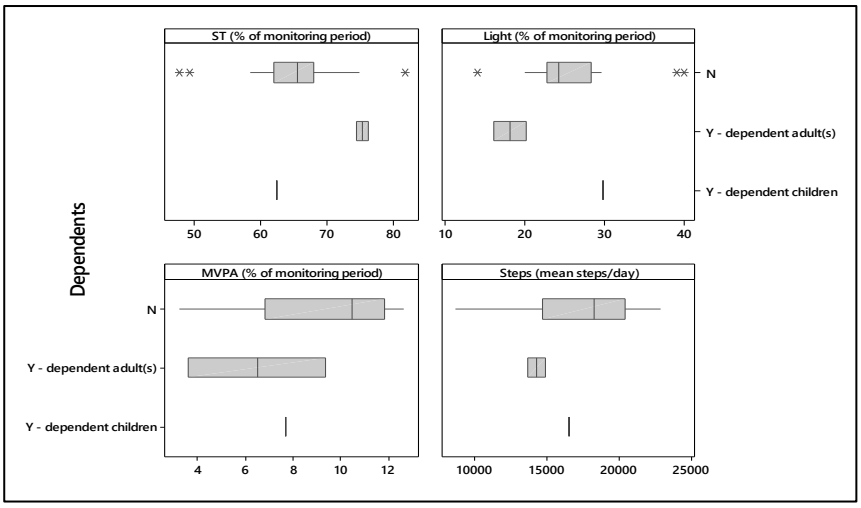
(a)



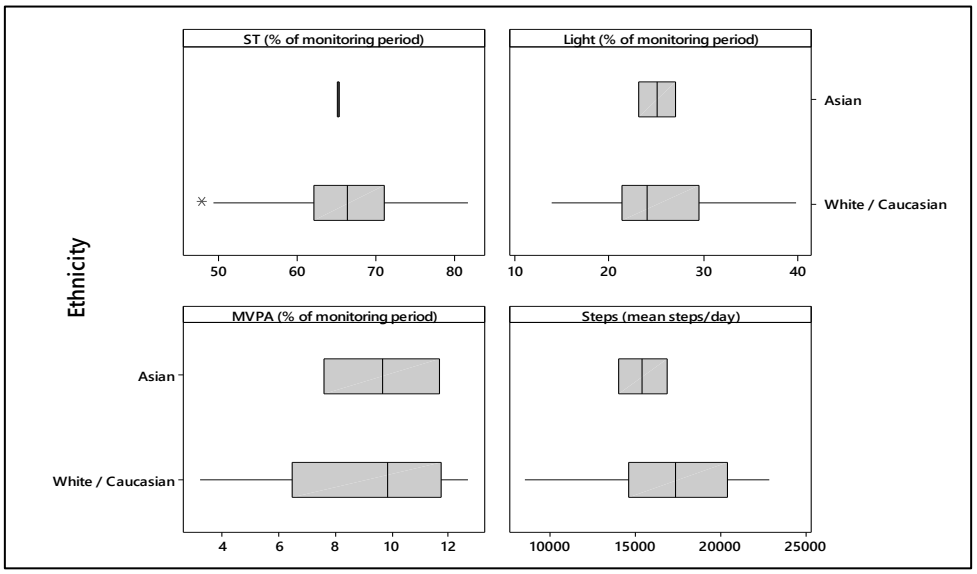
(b)



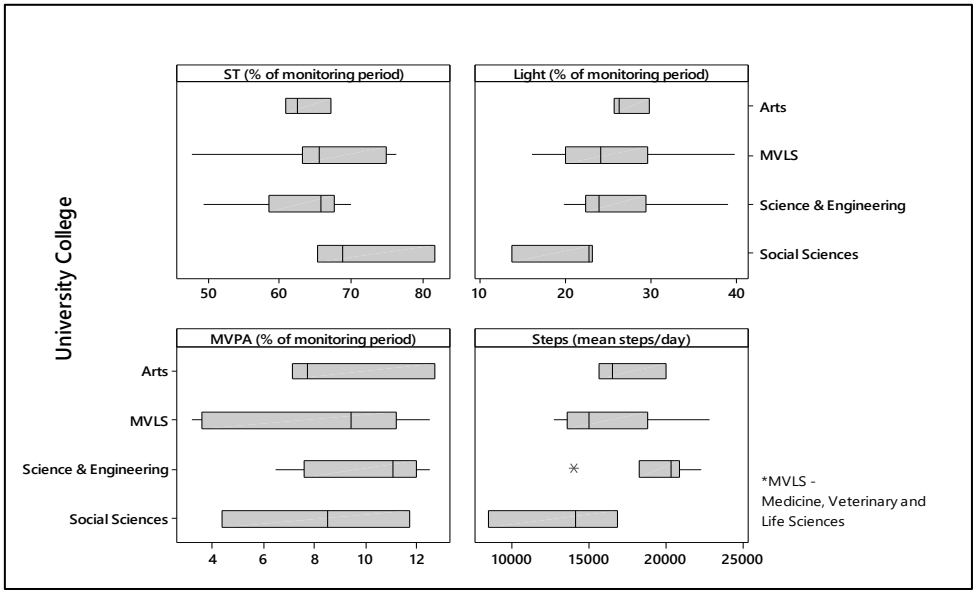
(c)



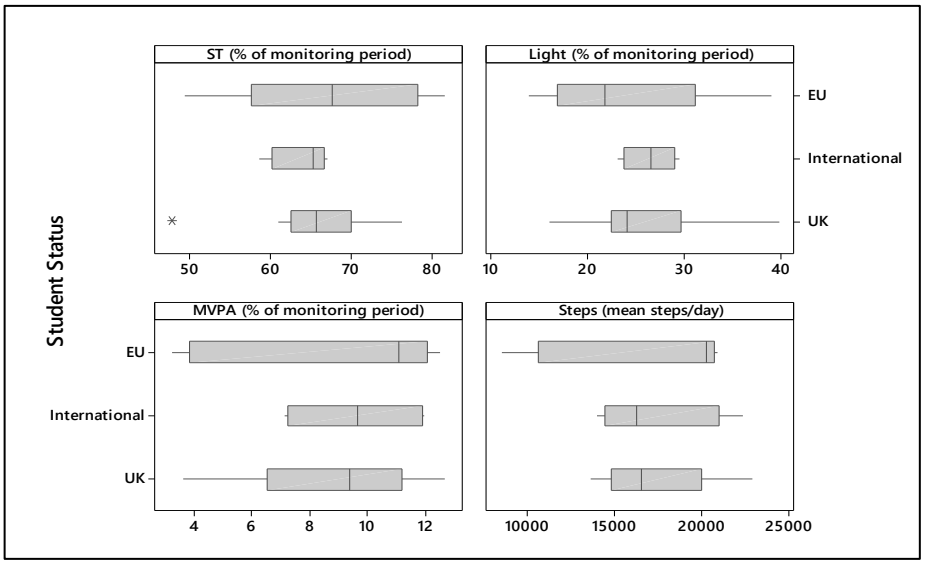
(d)


ST (% of monitoring period)
Light (% of monitoring period)
MVPA (% of monitoring period)
Steps (mean steps/day)
Ethnicity
Asian
White / Caucasian
50
60
70
80
10
20
30
40
4
6
8
10
12
10000
15000
20000
25000

(e)


ST (% of monitoring period)
Light (% of monitoring period)
MVPA (% of monitoring period)
Steps (mean steps/day)
University College
Arts
MVLS
Science & Engineering
Social Sciences
*MVLS - Medicine, Veterinary and Life Sciences
50
60
70
80
10
20
30
40
4
6
8
10
12
10000
15000
20000
25000

(f)


ST (% of monitoring period)
Light (% of monitoring period)
MVPA (% of monitoring period)
Steps (mean steps/day)
Student Status
EU
International
UK
50
60
70
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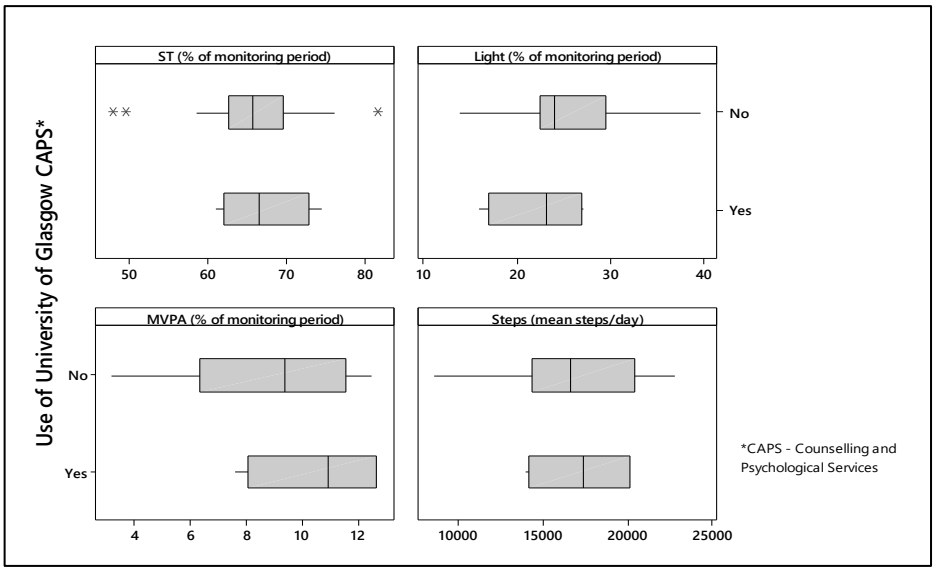
10
20
30
40
4
6
8
10
12
10000
15000
20000
25000

(g)


ST (% of monitoring period)
Light (% of monitoring period)
MVPA (% of monitoring period)
Steps (mean steps/day)
Use of University of Glasgow CAPS*
No
Yes
50
60
70
80
10
20
30
40
4
6
8
10
12
10000
15000
20000
25000
*CAPS - Counselling and Psychological Services

4.2.1 Analysis of ActiGraph GT3X MVPA split by demographic factors

Table 13: ActiGraph GT3X assessed MVPA (% of monitoring period) split by demographic factors (assessed via online questionnaire) for 1st Year PGR students (n=20) randomised to objective assessment of physical activity and sedentary time. Formal statistical analysis performed via ANOVAs.

Factor	Source	DF	F Value	P Value	Effect Size (ω^2)
Gender	*Gender*	2	1.43	0.267	0.04
	Error	17			
Relationship Status	*Relationship Status*	4	2.11	0.131	0.18
	Error	15			
Dependents	*Dependents*	2	0.88	0.433	0.00
	Error	17			
Ethnicity	*Ethnicity*	1	0.09	0.771	0.00
	Error	18			
University College	*University College*	3	0.64	0.599	0.00
	Error	16			
Student Status	*Student Status*	2	0.11	0.896	0.00
	Error	17			
Use of University of Glasgow (UofG) Counselling and Psychological Services (CAPS)	*UofG CAPS Use*	1	1.24	0.280	0.01
	Error	18			

As seen in Figures 6(a-g) there are no trends for differences in MVPA across the demographic factors as evidenced by similar medians and large overlap between plots. However, an interesting point to note is that there is a large spread of MVPA data for EU, MVLS and Social Science PGR students (Figures 6(e) and 6(f)). This highlights that there is wide variation within these groups, with both inactive and highly active subgroups within these populations.

Formal analysis (Table 13) found that there were no statistically significant differences in MVPA for any of the demographic factors (gender: $F(2,17)=1.43$, $p=0.267$; relationship status: $F(4,15)=2.11$, $p=0.131$; dependents: $F(2,17)=0.88$, $p=0.433$; ethnicity: $F(1,18)=0.09$, $p=0.771$; university college: $F(3,16)=0.64$, $p=0.599$; student status: $F(2,17)=0.11$, $p=0.896$; UofG CAPS use: $F(1,18)=1.24$, $p=0.280$). Despite, this small effect sizes were observed for gender (0.04) and use of UofG CAPS use (0.01) whilst a large effect size was observed for relationship status (0.18).

4.2.2 Analysis of ActiGraph GT3X Light Physical Activity split by demographic factors

Table 14: ActiGraph GT3X assessed light physical activity (% of monitoring period) split by demographic factors (assessed via online questionnaire) for 1st Year PGR students (n=20) randomised to objective assessment of physical activity and sedentary time. Formal statistical analysis performed via ANOVAs.

Factor	Source	DF	F Value	P Value	Effect Size (ω^2)
Gender	*Gender*	2	4.43	0.028	0.26
	Error	17			
Relationship Status	*Relationship Status*	4	0.42	0.794	0.00
	Error	15			
Dependents	*Dependents*	2	1.69	0.214	0.06
	Error	17			
Ethnicity	*Ethnicity*	1	0.00	0.987	0.00
	Error	18			
University College	*University College*	3	0.86	0.480	0.00
	Error	16			
Student Status	*Student Status*	2	0.23	0.796	0.00
	Error	17			
Use of University of Glasgow (UofG) Counselling and Psychological Services (CAPS)	*UofG CAPS Use*	1	0.98	0.336	0.00
	Error	18			

Table 15: Results from a two-sample t test comparing ActiGraph GT3X assessed light physical activity (% of monitoring period) in males (n=4) and females (n=15).

Gender Comparison	Mean Difference in Light Physical Activity (% monitoring period)	95% Confidence Interval	P Value
Male – Female	-7.48	(-1.27, -13.70)	0.026

As seen in Figures 6(a) and 6(c), trends show males spent less time in light PA than females and those with dependent adults spent less time in light PA than those with no dependents or dependent children.

Formal analysis (Table 14) found no statistically significant difference in light PA for relationship status ($F(4,15) = 0.42$, $p=0.794$), dependents ($F(2,17) = 1.69$, $p=0.214$), ethnicity ($F(1,18) = 0.00$, $p=0.987$), university college ($F(3,16)=0.86$, $p=0.480$), student status ($F(2,17) = 0.23$, $p=0.796$) or use of UofG CAPS ($F(1,18) = 0.98$, $p=0.336$). There was a statistically significant difference in light PA for gender ($F(2,17) = 4.43$, $p=0.028$). In terms of effect sizes, despite no significant difference in light PA for dependents, there was a moderate effect size (0.06) whilst a large effect size was observed for gender (0.26) which was statistically significant.

Results from a two-sample t test (Table 15) identified that males engaged in 7.48% less light PA than females with the true mean lying somewhere between -1.27% and -13.70%. Therefore, males engage in between 1.27% and 13.70% less light PA than females. This difference in light PA was statistically significant as confirmed by the entirely negative 95% CI and p value (p=0.026<0.05).

4.2.3 Analysis of ActiGraph GT3X Sedentary Time split by demographic factors

Table 16: ActiGraph GT3X assessed sedentary time (% of monitoring period) split by demographic factors (assessed via online questionnaire) for 1st Year PGR students (n=20) randomised to objective assessment of physical activity and sedentary time. Formal statistical analysis performed via ANOVAs.

Factor	Source	DF	F Value	P Value	Effect Size (ω^2)
Gender	*Gender*	2	4.21	0.033	0.24
	Error	17			
Relationship Status	*Relationship Status*	4	0.49	0.743	0.00
	Error	15			
Dependents	*Dependents*	2	1.72	0.208	0.07
	Error	17			
Ethnicity	*Ethnicity*	1	0.01	0.922	0.00
	Error	18			
University College	*University College*	3	0.84	0.489	0.00
	Error	16			
Student Status	*Student Status*	2	0.24	0.786	0.00
	Error	17			
Use of University of Glasgow (UofG) Counselling and Psychological Services (CAPS)	*UofG CAPS Use*	1	0.12	0.733	0.00
	Error	18			

Table 17: Results from a two-sample t test comparing ActiGraph GT3X assessed sedentary time (% of monitoring period) in males (n=4) and females (n=15).

Gender Comparison	Mean Difference in Sedentary Time (% monitoring period)	95% Confidence Interval	P Value
Male – Female	10.30	(-0.40, 20.99)	0.056

As seen in Figure 6(a) trends showed that males were more sedentary than females and in Figure 6(c) those with dependent adults were more sedentary than those with no dependents or dependent children. In addition, there is a large spread of ST data for EU students (Figure 6(f)) highlighting that there is a highly sedentary subgroup within this population.

Formal analysis (Table 16) found that there were no statistically significant differences in ST for relationship status (F(4,15) =4.21, p=0.743), dependents (F(2,17) =1.72, p=0.208), ethnicity (F(1,18) =0.01, p=0.922), university college (F(3,16) =0.84, p=0.489), student status (F(2,17) =0.24, p=0.786) or use of UofG CAPS (F(1,18) =0.12, p=0.733). Despite there being no significant difference in ST for dependents, a moderate effect size (0.07) was observed.

Results from the ANOVA found a statistically significant difference in ST for gender (F(2,17) =4.21, p=0.033). Further analysis (two sample t test) (Table 17) identified that males were 10.30% more sedentary than females. However, this difference was just outside of significance (95% confidence intervals (95% CI); -0.40%, 20.99%, p=0.056). In terms of effect sizes, a large effect size was observed for gender (0.24). Therefore, the lack of statistical significance may be due to the small sample size for males (n=4).

4.2.4 Analysis of ActiGraph GT3X assessed steps split by demographic factors

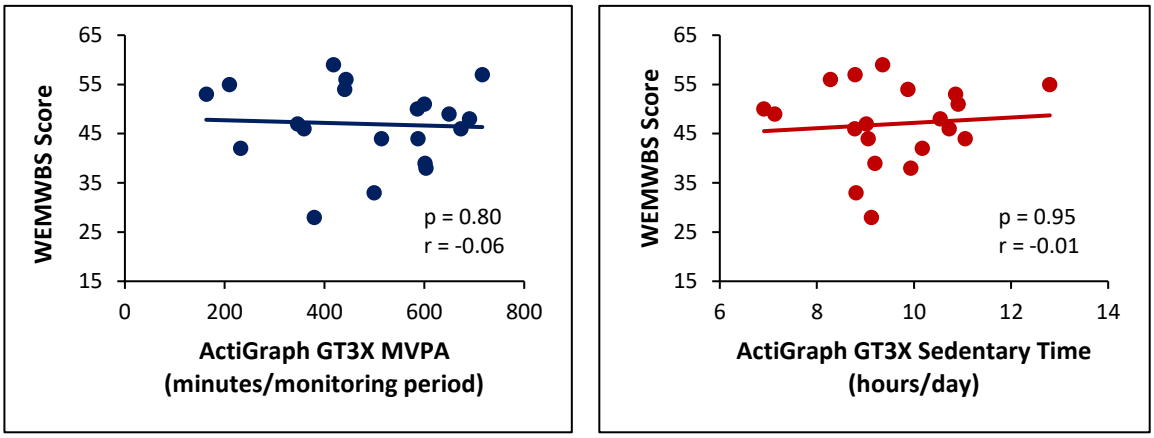
Table 18: ActiGraph GT3X assessed steps (mean steps/day) split by demographic factors (assessed via online questionnaire) for 1st Year PGR students (n=20) randomised to objective assessment of physical activity and sedentary time. Formal statistical analysis performed via ANOVAs.

Factor	Source	DF	F Value	P Value	Effect Size (ω^2)
Gender	*Gender*	2	2.13	0.150	0.10
	Error	17			
Relationship Status	*Relationship Status*	4	0.44	0.777	0.00
	Error	15			
Dependents	*Dependents*	2	0.68	0.522	0.00
	Error	17			
Ethnicity	*Ethnicity*	1	0.43	0.520	0.00
	Error	18			
University College	*University College*	3	3.02	0.060	0.23
	Error	16			
Student Status	*Student Status*	2	0.05	0.952	0.00
	Error	17			
Use of University of Glasgow (UofG) Counselling and Psychological Services (CAPS)	*UofG CAPS Use*	1	0.01	0.906	0.00
	Error	18			

No statistically significant difference was found for mean steps per day across any of the demographic factors (Table 18). Despite this, a moderate and large effect size were observed for gender (0.10) and university college (0.23) respectively.

4.2.5 Correlation between ActiGraph GT3X MVPA, Sedentary Time, Mental Wellbeing and PGR Study time.

Figure 7: Scatterplots showing the relationship between ActiGraph GT3X assessed MVPA (minutes/monitoring period), sedentary time (hours/day) and mental wellbeing (WEMWBS score) for 1st Year PGR Students randomised to the sub cohort (n=20). Lines represent line of best fit.



As seen in Figure 7 above, there is no association between ActiGraph GT3X assessed MVPA and MWB or ActiGraph GT3X assessed ST and MWB.

Figures 8(a-c): Scatterplots showing the relationship between ActiGraph GT3X assessed (a) MVPA (minutes/monitoring period), (b) sedentary time (hours/day) and (c) mental wellbeing (WEMWBS score) against self-reported PGR study time (hours/week) for 1st Year PGR students randomised to objective physical activity assessment (n=20). Lines represent line of best fit.

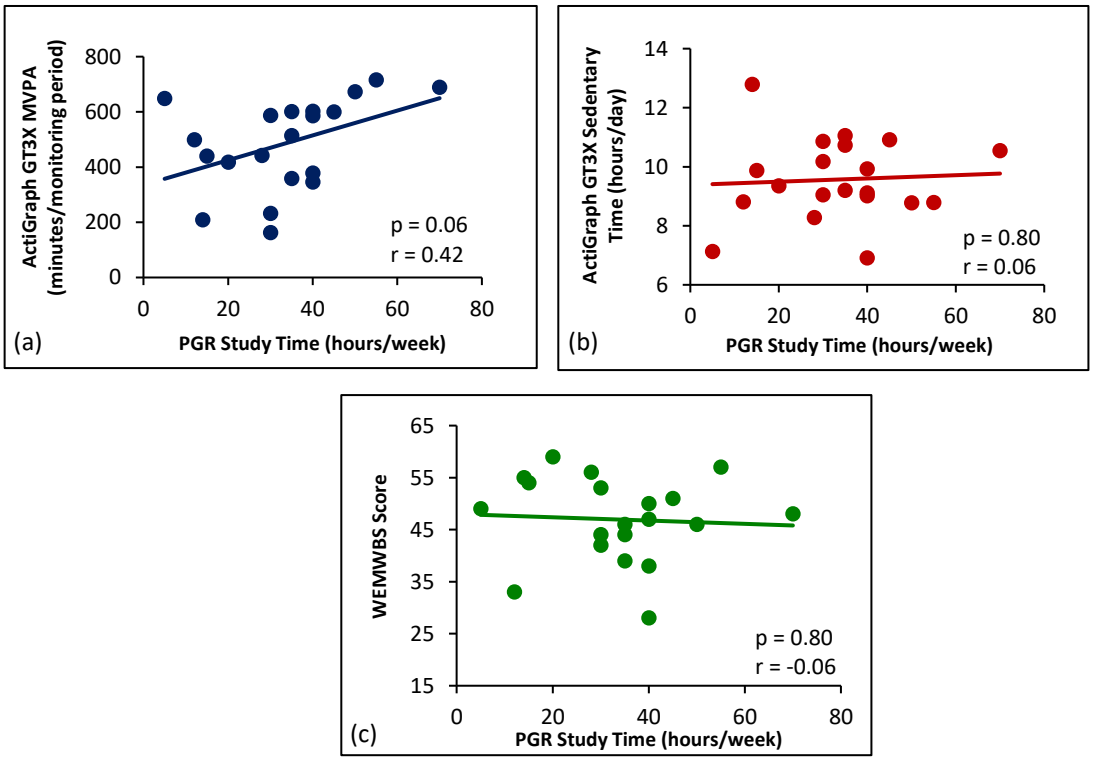
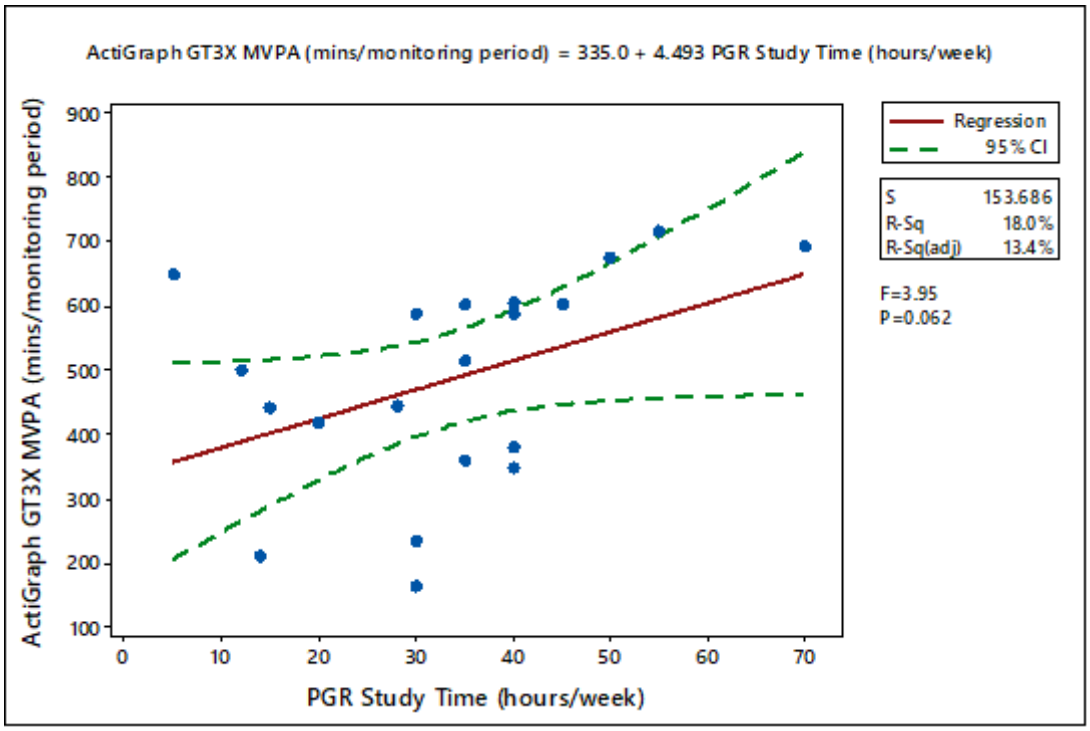


Figure 9: Linear Regression plot showing the relationship between PGR study time (hours/week) and ActiGraph GT3X assessed MVPA (minutes/monitoring period) for 1st Year PGR students (n=20) who were randomised to objective assessment of physical activity. Red line represents regression fit whilst green dotted lines represent 95% confidence intervals.



Figures 8(b) and 8(c) show that there is no association between MWB and PGR study time or ActiGraph GT3X assessed ST and PGR study time. In contrast, subjectively there seems to be a positive association between ActiGraph GT3X assessed MVPA and PGR study time (Figure 8(a)). However, correlation analysis and formal linear regression analysis (Figure 9) found that the relationship between ActiGraph GT3X assessed MVPA and PGR study time was just outside of significance (p=0.062). Furthermore, the data is highly spread and the R-Squared value (13.4%) shows that differences in objectively assessed MVPA are only weakly explained for by PGR study time.

4.3 Focus Groups

Thematic analysis identified 6 key dimensions, 29 higher order themes and 20 higher order sub-themes. The 6 key dimensions are; "Physical Activity Definition"; "Sport and Exercise Definition"; "Barriers to PA"; "Benefits of PA"; "Motivations for PA" and "Impact of Inactivity" as represented by coloured circles in Figure 10.

Dimension 1. Physical Activity Definition

Half of the participants identified that PA refers to activities that are movement focused and performed frequently.

- *Participant 4: "I think the physical activity is focused more on the movement"*
- *Participant 6: "… routine physical thing that you repeat like again and again and again on a regular basis."*

However, despite participants being aware that PA was movement focused there was some confusion over whether walking is classed as PA. There were conflicting opinions with some participants considering walking as PA whilst others did not. This highlights some underlying confusion in terms of activities that contribute to PA. Interestingly, one participant stated that even though they knew walking was PA they never really register walking as contributing towards PA.

- *Participant 3: "… if I take the time to get up from my desk and go for a walk I still consider that as being active... Yeah, I would say that walking would count."*
- *Participant 6: "For me, personally walking to and from somewhere I don't class that as physical activity, it's just general movement, but I think when you go out of your way to make an effort to do something then I class it as physical activity..."*

Dimension 2. Sport and Exercise Definition

Participants identified that sport and exercise was distinct to PA. Two participants defined sport and exercise as more structured and specific than PA, that it involved engaging in specific activities such as running, gaelic football or training for running events. In addition, four participants recognised that sport and exercise involved a greater physical stress and there was an underlying intent behind engaging in sport and exercise.

- *Participant 3: "…something that involves a specific activity so for me that would be running but for you (participant 1) maybe that's going to training and playing football."*
- *Participant 2: "Yes, that's right, eh I would agree it involves being… actually putting physical stress eh on yourself…"*

Although participants identified that sport and exercise are distinct to PA, they also identified that there is a link between the three. Two participants identified that sport and exercise are linked to PA as PA is a fundamental component of sport and exercise. It could be suggested that participants view PA as a continuum with PA the most basic form and exercise and sport as more advanced forms with additional properties.

- *Participant 3: "I saw it more on a scale that sport is the most structured form of exercise even though exercise is a more structured form of physical activity maybe."*

Three participants identified that sport and exercise involve other factors. These additional factors include competition and *"different kind of like mental and communication kind of things..."* (participant 6) and a professional aspect to sport and exercise.

A summary of the higher order themes discussed above for PA definition and sport and exercise definition and additional related quotes from PGR focus group participants can be found in Table 20(a) in Appendix 8.8.

Dimension 3. Barriers to Physical Activity

PGR students identified several higher order perceived barriers to PA. These include: PGR study/work; UofG Gym; PGR walk barriers; lack of information/awareness of opportunities; personal characteristics; undergraduate focused; menstruation; weather and seasonality and financial barriers. These higher order themes, sub-themes and additional quotations from PGR students are summarised in Table 20(b) (Appendix 8.8).

(1) PGR Study/Work

One of the main reported barriers to PA was PGR study/work. This barrier was divided down into 4 sub-themes;

(i) High Workload

Three participants (half the sample) reported that a heavy work load, deadlines and being busy with their PGR studies reduced their activity levels. One participant discussed their heavy work schedule and that they *"can't seem to fit it in"* (participant 2). This is interesting as it may reflect poor time management.

- *Participant 1: "Doing that definitely, was just so busy with it as well ehm doing my internship so that definitely stopped me being as active."*
- *Participant 3: "I think when I've got deadlines I maybe am less active."*

(ii) Working Hours

Two participants discussed PGR working hours as a barrier to PA. More specifically, it became clear that PGR students are working long, odd and antisocial hours (early in the morning and late at night), which may be linked back to the high workload that half of the PGR students reported. One participant discussed how their working hours are dependent on availability of lab space or on the current ongoing building works on campus. Furthermore, they discussed how they felt they cannot leave during lab experiments or working hours as it is disruptive to their studies.

In addition, they highlighted that between the hours of 9am and 5pm is when supervisors expect to be able to contact them and for them to be able to contact supervisors to receive help/guidance. This may also suggest that working hours are rigid in nature, lack flexibility and that supervisors' expectations may influence PA levels.

- *Participant 5: "…work from 7.30am in the morning to you know latest 9pm."*
- *Participant 6: "…research it's more like a 9-5 job, so you need those hours before and after to be able actually use the thing (gym)… cause you're not actually going to stop when you're running a lab experiment say and it's an 8 hour lab experiment, you're not going to leave half way through to go to the gym. You just can't…. that's the time of day when people expect to be able to contact you as well, so… you need to be contactable for your supervisors and things like that because that's when you're going to get the help. So… you're less inclined I would say to take 2 hours at 2pm in the afternoon to do it because it's actually interruptive to the work that you are doing and it's I guess your priority list. But for me, my PhD has to come first."*

(iii) Conferences/travelling

Two participants reported that attendance at conferences or travelling was a barrier to PA. This was suggested to be due to being unable to access equipment.

- *Participant 6: "…when you're travelling to conferences and things like that it's the ability to access equipment…"*

(iv) Later start dates than undergraduates

Half of the PGR students identified later start dates for PGR students as a barrier to PA. Unlike undergraduates, PGR students can start at any point in the year. Therefore, they miss induction sessions, tours of the UofG Sport gym, tours of UofG facilities, Fresher's and Sport's Fayres that are put on in September at the beginning of the academic year. There seems to be no specific PGR fayres and by missing these events PGR students were less aware of services and opportunities available to them. This will be discussed in further detail later in this section.

- *Participant 6: "Postgraduates tend to start a lot later… so they don't tend to arrive as early."*
- *Participant 5: "…I missed the induction…because my start date… it was after all those fayres and things."*

(2) UofG Gym

A second key barrier to PA is related to the UofG gym. Most of the participants (4 out of 6 had gym memberships at this facility). The UofG gym barriers were divided into 3 sub-themes as follows;

(i) Unexpected gym closures/class cancellations

One participant reported that the gym being closed unexpectedly was a barrier for them. Interestingly, they revealed that the gym being closed had a negative impact on their mood and they felt, *"so down"* for the remainder of the day. Another participant agreed and verified that the gym has been closed unexpectedly a few times recently.

- *Participant 6: "…way you walk in and like its shut for the day and there's no kind of… ahm like the Stevenson is really chronic for it being like oh the gyms shut today but there was no message to say. You're mentally prepared to go do something and then you get there and it's like oh…. And you just feel so down for the rest of the day."*

In addition, two participants discussed how class cancellations particularly in the summer term were a barrier to PA. More specifically, classes including dance and yoga were cancelled leading to a reduction in overall numbers of classes available. This was a key barrier as these two participants really enjoyed regularly attending these classes and class cancellations meant there were fewer classes available for them to attend.

- *Participant 4: "…in the summer vacation, so many courses are cancelled in the gym… So, the courses I love they cancelled it…. Like dance classes. There used to be four a week but for now there are only two."*

(ii) Classes full/equipment unavailable

Several participants (4 out of 6) reported that gym classes being full or gym equipment being unavailable was a barrier to their PA levels. This was reported to be a barrier in all areas of the gym (pulse cardio floor, powerplay floor, swimming pool and classes). Participants reported either not being able to attend classes, use the swimming pool, cutting their gym sessions short and/or just leaving the gym if equipment was unavailable.

- *Participant 3: "…sometimes what stops me is if I go to the gym and its really busy and you can't get on a treadmill or a class is full or something like that and then it's just too much hassle."*

(iii) Opening Hours

Opening hours of the gym were cited as a barrier to PA by a couple of participants. The main barrier in term of opening hours was not weekday opening hours but rather weekend opening hours. Two participants felt that the later opening times and earlier closing times at weekends limited their ability to access the gym. For one participant this was because they work on the weekends and the opening time was too late for them to access the facilities before work, but the closing time was also too early as the gym was closed before they finished work. For the other participant, it was more to do with the fact that they enjoy exercising late at night**.**

- *Participant 5: "…it's not open that late in the evening either… I actually really like exercising at like 10pm at night so especially on weekends as well like Saturdays it closes really early."*

However, one participant appreciated the recent change in weekday opening time to an earlier time.

- *Participant 6: "See, I like the fact that the Stevenson is now open from 6.30am in the morning because beforehand when it was only open at 7am that's really late…"*

(3) PGR walk barriers

Two barriers specific to PGR walks were highlighted. These were;

(i) Location

Two participants felt that the location of the PGR walks starting from the Postgraduate Gilchrist Café was a barrier as it was far away from their office (in the School of Education) or from their flat. One participant stated that they would rather walk from their flat rather than walk to university to go on a walk. This highlights that proximity and convenience of services/opportunities to be active influences PA.

- *Participant 1: "…easier if I'm just in my flat to do the walk myself instead of making it all the way up to uni to walk."*

(ii) Belief that walk is more social than physical

Three participants felt that the PGR walk was advertised as more of a social activity than PA and that they already have enough social opportunities to interact with other PGR students. One participant stated that they would rather do *"something like cardio".* However, walking is a cardiorespiratory activity therefore this may also tie back into the underlying confusion over whether walking is PA as discussed at the start of this section. In addition, one participant stated that they would not like to walk in a group as they walk to clear their head and would not want to make conversation with others. This highlights that PGR students have unique and individual reasons for engaging in activities. For example, some may enjoy the social interaction of walking but for others they enjoy the solitary aspect of walking alone and dealing with your thoughts.

- *Participant 6: "…walk is advertised more as a social thing than a physical thing."*
- *Participant 1: "… I wouldn't want to walk in a group because I usually go for walks to clear your head and if you're in a group you have to make conversation with people."*

(4) Lack of information/awareness of opportunities

A fourth key barrier to PA reported by 5 out of 6 PGR students was a lack of information and/or awareness of opportunities to be active. Participants reported that PGR inductions focused solely on educational matters but not on other matters such as social or health issues. There was mixed awareness of opportunities to be active on campus aside from the gym. Several participants were unaware of opportunities to be active such as the PGR walk, the UofG Daily Mile and the Glasgow Next Bike schemes.

Interestingly, one PGR student who did their undergraduate degree at Glasgow stated that they don't feel like they've been given any information since starting their PGR studies and therefore they only know what is available as they studied here previously. This was reinforced by a new PGR international student who highlighted that they have found out about opportunities/events from other PGR students who were undergraduates at Glasgow. This highlights that either there is a lack of information being provided to students and/or the way in which current information is being disseminated is ineffective.

- *Participant 6: "…postgraduate level when you're coming in you don't really get told anything more related to the social side or sporting side of the university, it's all educational. Like how your department works, what they expect for your thesis, that kind of thing."*

However, there was an agreement amongst two of the participants that it is your own personal responsibility to seek out opportunities to be active rather than the University's responsibility, particularly as research is very different to undergraduate studies.

- *Participant 3: "…because I've studied here before and I know what's here. But I think as well… that at this level or at this age it's more our own responsibility…to be seeking out the physical activity rather than the university ehm making it part of the student lifestyle at this level because research is different from doing your undergrad."*

(5) Undergraduate Focused

Several participants (4 out of 6) discussed how current facilities and opportunities are very much undergraduate focused. More specifically, two participants stated that they felt that the UofG gym was undergraduate focused as it is set up as a drop-in style for undergraduate students and many classes have been cancelled during the summer months when undergraduate students are on summer holidays, despite PGR students still being around.

- *Participant 6: "…I think the gym here at least is more set up for undergraduates to pop in and out between classes…"*
- *Participant 4: "…so many courses are cancelled in the gym because they were like mostly served for the undergraduates, so they are not thinking about us."*

One participant reported that GUSA does not encourage postgraduates to become involved in sporting teams whereas it was encouraged at undergraduate level. This may also relate back to the later PGR student start dates and missing Sports Fayres as discussed earlier. None of the focus group participants were involved in GUSA sports teams, despite two of these participants being members of GUSA teams during their undergraduate degrees.

- *Participant 5: "I think a little more needs to be done in focusing on postgrads."*

(6) Financial

Two participants reported financial barriers to PA. This related to paying for going to the gym when travelling/attending conferences, paying to upgrade to peak time gym membership and paying an additional cost for specific gym classes. Another participant agreed that finance was a barrier to PA. They discussed that where they were currently working they were able to access the gym for free but once they finished their internship they would have to pay to access the university gym.

- *Participant 5: "Yeah, I would definitely say financial as well. Well where I work I have a gym there, so I can use it for free but now that I've finished my internship and coming back to spend more time in the library and I will join the gym again the one in the Stevenson building so yeah I think it's a financial thing as well."*

(7) Weather & Seasonality

Two participants identified weather and seasonality as barriers to PA. However, both had differing opinions. One reported being less active during winter as it was dark early in the evening where as in summer it is light until late in the evening and the weather is good which encouraged them to be more active. This highlights that the extent to which weather is a barrier depends on the individual, some are encouraged by good weather whilst others are more reluctant to be active. It is worth noting that the focus groups were carried out in June when the weather was unseasonably hot for Scotland and therefore the extent to which good weather is a barrier for the second participant may be limited.

- *Participant 1: "Also, time of year as well that would stop me because whenever I was in Lennoxtown I would work until 5pm and I would get home and it was dark and didn't want to go out and do anything but now it's still light until 10pm and the weathers good you want to go out and make the most of it. Even if it is just for a walk."*
- *Participant 3: "…recently the fact that it has been so hot I've been more reluctant to exercise because I already feel so hot that I don't want to get to feel any hotter."*

(8) Menstruation

Two participants identified menstruation as a barrier to PA.

- *Participant 4: "First one is the period…"*
- *Participant 3: "…time of the month…"*

(9) Personal Characteristics

Two participants identified personal characteristics as a barrier to PA. More specifically a lack of motivation and laziness.

- *Participant 1: "Sort of in my head maybe just not motivated enough myself…"*
- *Participant 2: "My own inherent laziness I suppose…"*

Dimension 4. Benefits of Physical Activity

Participants identified that the key benefits of PA related specifically to two key areas; health and PGR study/work.

(1) Health Benefits

Participants recognised that PA was beneficial and had a positive impact on their mental health and wellbeing. Half of the participants reported that PA made them feel happier, reduced stress, reduced pressure and cleared their head.

- *Participant 3: "Eh I think not just when I'm exercising but it makes me feel so much better in the aftermath that it clear's my head and I recognise that it is so beneficial to my mental wellbeing that it's often a stress relief that if I feel myself getting to a certain point of stress and I'll think I need to just remove myself and go for a run."*

Half of the participants also recognised that PA was beneficial and had a positive impact on their physical health. One older participant discussed how PA improves his quality of life and delays ill health.

- *Participant 2: "I feel pushes your sort of pushes my eventual demise that bit further away or ensures that I believe that I have that bit better quality of life."*

Other physical benefits discussed include improved energy, improved fitness, the role of PA in weight maintenance and remaining slim. One participant discussed how their PhD involves a high level of brain functioning and that running gave her the chance to physically challenge herself as well as mentally and this was "…a way of feeling alive."

- *Participant 3: "…when doing my PhD because I spend so much time trying to keep my brain functioning at such a high level can be really nice to then go for a run and then do that with my body instead and push myself that way so it's a way of feeling alive."*

(2) PGR Study/Work Benefits

Three out of six participants identified that PA benefited their PGR study/work life. One participant (participant 3) explicitly stated, *"…I think being physically active is beneficiary for our PhD life."* More specifically, PA benefits PGR study/work life in three key ways as detailed below:

(i) More productive

One participant identified that being active improves their working efficiency and therefore they are more productive and have more time for other activities. Whereas when they are inactive, tasks take longer to complete, they are less effective, have poorer time management and often delay tasks.

- *Participant 6: "I think it just makes you more efficient, I think because you're more alert you're not taking as long to do a lot of the general things and you… I find when I'm not I tend to push things off whereas it's more I'm going to get it done so I have time to do this."*

(ii) More motivated

Two participants reported that PA improves their drive and motivation for their PGR studies.

- *Participant 5: "Yeah it does make me more motivated… if I have spent that period of time being active or in the gym doing something to then go and sit down and you know focus."*

(iii) Improved mental alertness and focus

One participant identified that being active improves their mental alertness.

- *Participant 6: "...so mentally I'm so much more alert…"*

(3) Post-exercise

Some participants reported feeling that PA/exercise was challenging or difficult during the activity. However, the majority of participants (5 out of 6) identified that post-exercise/post-PA was when they felt the benefits of PA.

- *Participant 5: "…at the time it's sort of hard but I do love it… especially afterwards."*
- *Participant 4: "…even when I'm like it's been a struggle to get into the gym, it's… I feel better afterwards."*

(4) Accumulation of benefits

Two participants recognised that PA benefits are not just acute in nature but accumulate and build up to give chronic benefits.

- *Participant 6: "I think for me when doing physical activity, it's not necessarily the immediate after effects…it's not something that you pick up instantaneously from doing it but it's from continual like physical activity over long periods of time that you start seeing the… it's that suitable build up…"*
- *Participant 4: "…it's a gradual process…"*

Table 20(c) (Appendix 8.8) provides a summary of these higher order themes, sub-themes and additional quotes related to perceived PA benefits from PGR focus group participants.

Dimension 5. Motivations for Physical Activity

PGR students identified several higher order motivational factors for PA. These include; health benefits, PGR study/work (work life balance), sleep, balance out unhealthy eating habits, image, social interaction, external factors and age. Table 20(d) (Appendix 8.8) provides a summary of these higher order themes, sub-themes and additional quotes from PGR focus group participants.

(1) Health Benefits

These overlapped with reported benefits of PA which will be discussed later in this section. Half of the PGR students reported that the physical and MH benefits of PA was one of the key motivations for PA. Two participants specifically acknowledged that they keep active to balance out the mental load of PGR study.

- *Participant 6: "I think being in academia you do a lot of mental work and for me I need that physical work to actually balance out the amount of mental work that I'm doing so that I stay healthy like physically and mentally."*

(2) PGR Study/Work: Work Life Balance

Half of the PGR students reported healthy lifestyle beliefs in that they were aware and acknowledged the importance of being active for their PGR study/work, more specifically for maintaining a work life balance and this motivated them to be active.

- *Participant 6: "…for me it's the ability to actually do my work…"*
- *Participant 1: "…it allows me to have a good work-life balance… so I'm not just a PhD student but I have interests and hobbies and other things I would like to pursue and do well at."*

(3) Sleep

Two students identified that one of the main motivational factors for PA was in order to sleep.

- *Participant 6: "I think my number one is to actually sleep properly. Cause I know when I don't, I don't sleep properly and my whole life just kind of down spirals from there."*
- *Participant 4: "...good sleep…"*

(4) Balance out unhealthy eating habits

Several participants (4 out of 6) reported that they engage in PA in order to balance out unhealthy eating habits or feel less guilty about eating unhealthy foods. This highlights that despite engaging in PA, individuals may still be engaging in negative health behaviours (such as unhealthy diets).

- *Participant 3: "…I really enjoy my food and eat quite a lot of biscuits… more than I should a lot of times, so I feel like if I've done that, then it's important for me to go exercise."*

(5) Image

Half of the participants reported that they engage in PA in order to improve/maintain their image. It is concerning that one participant reported feeling fat and therefore they exercise to counteract that. All individuals that identified image as a motivational factor for PA were female. This may reflect the growing pressure on young adults, particularly females, to look a certain way.

- *Participant 5: "I've always known my body to be sporty if that makes sense like in a general term. So, I feel when I am doing exercise that I'm still contributing to that like I like to maintain my body in a certain way."*

(6) Social Interaction

Two participants reported that social interaction was a motivation for PA. One participant specifically reported not enjoying gyms as they are a solitary activity and instead preferred Scottish country dancing with other individuals.

- *Participant 2: "I've never been terribly keen on gyms because they are… it's a very solitary activity and I used to enjoy Scottish country dancing, so as long as you are in a set of people at the same level of competence as you are, then it is great fun."*

Whilst the other participant identified that the gaelic football team they were a member of was a key motivation for PA as they found it difficult to self-motivate but if it was a team training session, they would not miss it. This may also reflect an underlying sense of accountability and duty towards the team.

(7) Influenced by external factors

(i) Childhood/Parents

Two participants reported that their engagement in PA was influenced by their childhood background and parents. One participant spoke about how when they were completing their research masters and were in a *"psychologically dark place"* their mum, who was a swimming teacher, encouraged them to be active and go swimming. Another participant identified that their childhood involved growing up in a lot of sport which is likely to have shaped their current PA patterns.

- *Participant 6: "… I'm really lucky my mum sort of pushed me she was like you're going swimming now…"*

(ii) Occupation

Three participants identified occupation as a motivation for PA. One participant specifically discussed how they had worked as an army officer. Therefore, for them they had to be fit and active otherwise promotion opportunities and career progression was limited.

- *Participant 2: "I spent six and a half years as an army officer and em it was very important that army officers be fit otherwise your promotion gets scuppered."*

A second participant discussed how they specifically worked with elite athletes and being active themselves gave them a greater understanding and empathy within their occupational role. This was reiterated by a third participant, whose job was directly involved with understanding the physiological changes that come with sport and PA.

- *Participant 1: "… because when I work with athletes, you really know how they are feeling in a way, so when I'm asking how ehm what do they rate their training session then I can really understand the physiological aspects of it, cause I know myself what it involves."*

(8) Age

Two participants stated that age was related to their motivations for PA. One older participant (62 years old) identified that PA was more important to him when he was younger. Furthermore, another participant felt that when you were a child you could be convinced to be active. However, when you are a young adult you've either made a choice to be active or inactive. This opinion is interesting as it suggests that PA and health behaviour is changeable up until early adulthood and that experiences during early formative years may have a significant influence on health behaviours.

- *Participant 1: "I suppose maybe at this age you've already kind of, of chosen if you're going to be active or not. Do you know what I mean? Usually when you're kind of a bit younger you could be persuaded to do it but once you maybe get to a certain age you know you nearly know yourself if you're… if you enjoy being active or if you enjoy playing sports…"*

Dimension 6. Impact of Inactivity

(1) Poor Health

Participants recognised that inactivity affects both their mental and physical health. In terms of MH, 5 out of 6 participants reported that inactivity adversely affected their MH. They reported feeling frustrated, bad, less happy, that their mind is lethargic and doesn't switch off. A couple of participants also reported feeling anxious and nervous when they are inactive, particularly if they are eating unhealthy alongside being inactive.

- *Participant 6: "…when I was doing my masters research I wasn't as active as I am consciously doing for my PhD and I know that towards the end of that I ended up in a really dark dark place so mentally I was not good."*

In terms of physical health, two participants reported that inactivity made them feel more sluggish, less energetic and lethargic. One participant reported feeling anxious and concerned over their weight when they are inactive, particularly if eating unhealthily.

A summary of the higher order themes and sub-themes discussed above and additional quotations from PGR focus group participants can be found in Table 20(e) (Appendix 8.8).

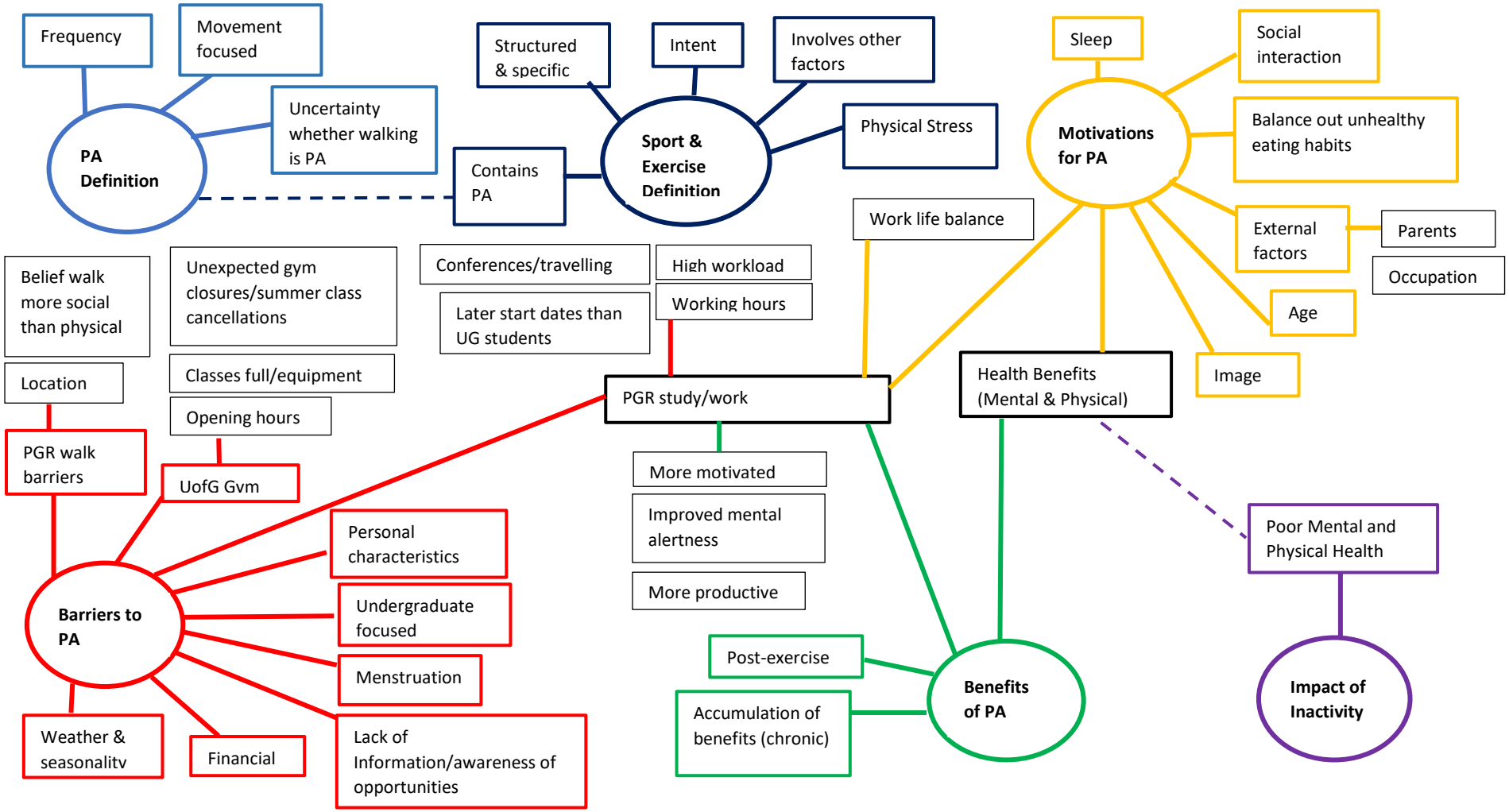
Summary of Focus Group Findings

A summary of the 6 key dimensions outlined in this section, their respective higher order themes and sub-themes and the overlap between them can be seen in Figure 10. Tables 19(a-e) also provide a summary overview of the results discussed in this section with the selected illustrative quotes from participants.

It is clear that aside from some uncertainty over whether walking was PA, PGR students had a reasonable understanding of the constructs of PA, exercise and sport. PGR students were also able to identify a wide range of barriers to PA, benefits of PA and motivations for PA. The top perceived barriers to PA were a lack of information and/or awareness of opportunities, undergraduate focused PA opportunities, PGR studies and barriers specific to UofG Sport gym facilities. Whilst the most common perceived benefits of PA were the positive impact of PA on mental and physical health and PGR students' study/work life. Balancing out unhealthy eating habits, health benefits, PGR study/work benefits and image were identified as the most commonly cited motivations for PA.

As seen in Figure 10, there is an overlap between some of the higher order themes from each dimension. For example, it is clear that PGR study/work feeds into barriers to PA, benefits of PA and motivations for PA. This shows that for PGR students their PGR study/work life plays an important role in their PA behaviours and patterns. In addition, there is some overlap for the health benefits of PA, PGR students recognised that these are not only benefits of PA but are also one of several motivational factors for PGR students to be active.

Figure 10: A thematic map of the 6 dimensions (coloured circles) and their respective higher order themes (coloured boxes) and higher order sub-themes (black non-bold boxes) discussed by PGR students (n=6) in qualitative focus groups. Dashed lines represent links between dimensions. (*PA – Physical Activity, PGR – Postgraduate Research, UG – Undergraduate).



5. Discussion

It is the author's belief that this study is one of the first that has examined physical activity, sedentary time and mental wellbeing in UK PGR students using both quantitative and qualitative research methods. Therefore, the findings form the foundation for further quantitative and qualitative research on PA and ST in postgraduate students. The main findings from this study are that 1st year PGR students are active (meeting PAG) yet highly sedentary with moderate levels of MWB. Furthermore, there were no significant correlations between PA, ST and MWB or PA, ST and PGR study time. However, a significant weak inverse correlation was found between mental wellbeing and PGR study time. Qualitative research identified PGR students' perceptions of PA, sports and exercise; perceived barriers to PA; perceived benefits of PA and motivations for PA. Discussion of these findings follows the order they are presented in the results.

5.1 Physical Activity and Sedentary Time

As stated above, findings show that 1st year PGR students are active yet highly sedentary thereby fitting into Healy et al.'s (2008) category of "active couch potatoes". The finding that PGR students are physically active (median MVPA 195 minutes/week) with 63% of the sample meeting current PA guidelines (self-reported MVPA) is consistent with previous self-report PA research by Gonzalez et al., (2014) and Racette et al., (2014) who found that 76% and 70% of their US graduate student samples were physically active. In addition, the findings show that PGR students' PA levels are consistent with Scottish national adult values (64% of Scottish adults met PA guidelines) (Scottish Government, 2016). Objectively assessed PA levels for the sub-cohort of PGR students were even higher than self-report data with 100% of the sub-cohort meeting current PA guidelines. This reflects that this sample of PGR students were highly active.

However, the findings are in direct contrast to those of Smetaniuk et al., (2017) who objectively assessed PA and ST in Canadian graduate students and found that only 26% of their graduate student sample were meeting the PA guidelines. Similarly, the PA level of PGR students is substantially higher (17% higher) than Scottish students as a whole (Scottish Student Sport, 2017).

The finding that PGR students were active and meeting PAG is consistent with the findings from the qualitative focus groups which showed that PGR students had a fairly good understanding of PA, sport and exercise and were aware of the benefits of being active for their physical and mental health and for their PGR study/work. It is important to note, the focus group sample was small (n=7) and therefore these findings may not be reflective of the entire PGR cohort.

In terms of ST, the findings that PGR students are highly sedentary (8 hours/day self-report sitting time and ~10 hours/day objectively assessed ST) are consistent with those by Smetaniuk et al., (2017) who found that graduate students were spending on average 11.2 hours per day sedentary. They are also in agreement, if not marginally lower than research on sedentary time in undergraduate student populations which has found undergraduate students spend ~12 hours/day sedentary (Moulin and Irwin, 2017; Prapavessis et al., 2015). In terms of comparison with Scottish national levels, PGR students are substantially more sedentary than Scottish adults (Scottish Government, 2016). However, as stated in the introduction, there is a significant limitation with the sedentary time SHS data in that occupational sedentary time is not assessed and the ST measure is only for leisure ST. Therefore, it is likely that the data substantially underestimates sedentary time, particularly as occupational roles have become increasingly sedentary.

In terms of demographic factors and self-report data, only university college was significantly associated with self-report sitting time. It was found that PGR students in the College of MVLS self-reported significantly less sitting time than their counterparts in the Colleges of Arts, Social Sciences and Science and Engineering. There are several possible explanations for this finding which are based upon psychological models such as Dahlgren and Whitehead's Determinants of Health Model (1991) and the Theory of Planned Behaviour (Azjen, 1985).

The Determinants of Health Model (Dahlgren and Whitehead, 1991) proposes that an individual's health is influenced by multiple factors; age, sex and hereditary factors; individual lifestyle factors; social and community network; living and working conditions and general socioeconomic, cultural and environmental conditions. Other determinants of health models exist, however, the author feels Dahlgren and Whitehead's model is the most appropriate as it is the most widely utilised and cited within the literature; is comprehensive, simplistic and effective in illustrating the range of factors involved in determining health.

The Theory of Planned Behaviour (Azjen, 1985) proposes that perceived behavioural control, attitudes and subjective norms influence behavioural intention and behaviour. These attitudes and subjective norms are influenced by the individual's knowledge, significant others in the individual's life (i.e. family, friends, colleagues and supervisors) and the level of importance they place on the expectations of significant others. Therefore, PGR MVLS students' academic knowledge on lifestyle behaviours and health outcomes, networks, working environments (mainly research laboratories rather than desk-based) and significant others may mediate the difference in sitting time for MVLS students compared to PGR students in other university colleges. Again, other behavioural theories exist, however, the Theory of Planned Behaviour is relevant as it has been widely applied in health psychology domains and is considered to be more predictive of health behaviours than other models (Taylor et al., 2006).

This finding that academic discipline may influence PA and/or ST is supported by research which found that academic programme was significantly associated with PA levels in graduate students, with those studying rehabilitation counselling being significantly more active than their other health science student peers (Gonzalez et al., 2014).

For objectively assessed PA and ST, gender was the only demographic factor significantly associated with PA. It was found that PGR male students were more sedentary and engaged in significantly less light PA compared to their female counterparts. The existing literature examining the association between gender and objectively assessed physical activity is mixed. Some evidence shows men having higher MVPA than women (Colley et al., 2011; Tucker et al., 2011) whilst other research has found no difference in physical activity levels between genders (Slootmaker et al., 2009).

It is important to note that the study sample for objective assessment of physical activity and sedentary time had a small number of male participants (n=4) which limits statistical power. Therefore, it is important to interpret the finding that males engage in significantly less light PA with caution as the small sample size may have exacerbated the difference between genders.

Despite this, it is important to highlight that LIPA is important for breaking up prolonged sedentary time and recent literature shows that LIPA is beneficially associated with all-cause mortality, waist circumference, triglyceride levels, postprandial insulin and glucose levels and prevalence of metabolic syndrome (Amagasa et al., 2018, Chastin et al., 2018; Füzéki et al., 2017). Therefore, there is a need to encourage PGR students, particularly males to engage in less prolonged sedentary time breaking it up with bouts of LIPA. The specific mechanism by which LIPA improves health outcomes is yet to be fully elucidated. However, one proposed mechanism is that light physical activity may break up the prolonged muscular unloading and increase muscle activity in major muscle groups thereby stimulating lipoprotein lipase and GLUT4 transporters in the muscle conferring a decreased cardiometabolic risk (Bey and Hamilton, 2003).

Aside from the physical benefits, there are benefits to mental health and wellbeing from breaking up and reducing prolonged sitting time. Recent research from Ellingson et al., (2018) examined ST and MWB in young healthy female adults (aged 28 years on average). These authors found that reductions in ST were associated with significant improvements in mood, stress, sleep and therefore positively influenced MWB. They suggest that decreasing ST by an hour may significantly attenuate the negative effects of an existing high ST on MWB. This is supported by research by Pronk et al., (2012) who examined prolonged sitting time in office based sedentary employees. In this study, participants in the intervention group received a sit-stand device at their workstations. Those who received a sit-stand device, reduced their sitting time by 66 minutes per day and self-reported significantly improved mood states in comparison to the control group. These changes disappeared within two weeks of removal of the sit-stand device. It is important to note, that this research should be interpreted with caution given the fact the research was carried out in partnership with a sit-stand device manufacturer and hence there may be a potential conflict of interest.

Further research by Barwais et al., (2013), examined SB and wellness changes in sedentary young adults randomised to interacting with an online PA monitor (intervention group) versus normal lifestyle activities (control group). Sedentary adults randomised to the intervention group, significantly decreased their ST by 2.3 hours/day, increased their time in light, moderate and vigorous PA and reported significantly greater total wellness scores. This study is not the only study to find that PA monitors may aid reduction in ST. Ellingson et al., (2016) also found that wearable fitness trackers led to a significant reduction in ST and improved mood. These findings are interesting, particularly given the rise in popularity of wearable PA and fitness trackers.

Another point to note is that the direction and causality of this relationship between ST and MWB has not been fully elucidated. Most of the research is cross-sectional in nature and therefore the question still remains, does poor mental health and wellbeing result in increased ST or is it due to a high ST that individuals have poorer mental health and wellbeing?

Two prospective studies (Lucas et al., 2011; Sanchez-Villegas et al., 2008) suggest that engaging in greater levels of SB predicted increased depression risk at follow-up. In contrast, Teychenne et al., (2014) found that changes in MH and MWB may result in changes in ST. Importantly, all three of these studies used TV viewing and/or computer use as a surrogate outcome for ST. Therefore, this poses another question, is it ST or these behaviours associated with ST that is associated with mental health and wellbeing?

Whilst this study found no correlations between PA, ST and MWB, there is no doubt from other literature that despite meeting current PA guidelines, the high proportion of time spent sedentary by PGR students puts them at an elevated risk of adverse physical and mental health and wellbeing (Biswas et al., 2015; Owen et al., 2010; Owen, 2012; Atkin et al., 2012; Gibson et al., 2017). As stated earlier, Ekelund et al., (2016) found that a high level of MVPA (~420-525 minutes/week) attenuated the risk of all-cause mortality associated with high ST. Interestingly, the objectively assessed sub-cohort in this study engaged in ~554 minutes/week of MVPA, which may attenuate the risk of all-cause mortality associated with high sedentary time. However, the extent to which this may be attenuated may be limited and obviously it is not eliminated. Also, there is no evidence for attenuation of risk of negative health and wellbeing. Therefore, there is still a need for PGR students to reduce their ST.

As briefly touched on earlier, objectively assessed MVPA and ST was significantly higher than that of self-report MVPA and ST. As seen in Appendix 8.9, objectively assessed MVPA was ~278 minutes/week higher than self-report MVPA whilst objectively assessed ST was ~2.6 hours/day higher than self-report ST. These differences are both significant and substantial. It is important to note that confounding factors, bias and errors in understanding of IPAQ may have exacerbated the difference between these two measurement tools. This will be discussed further in the strengths and weaknesses section.

Another factor to consider is that from the qualitative focus groups, it was evident that PGR students considered PA to be movement focused and performed frequently. However, PGR students seemed to be uncertain as to whether walking counted as PA. This uncertainty may have influenced IPAQ results in that those students who did not consider walking as PA may have underestimated their PA levels. Furthermore, PA and ST patterns may not remain stable, they may change over time due to a range of factors some of which may include; injury, illness, seasonality and weather changes, individual workload and personal circumstances.

These differences between subjectively and objectively assessed PA and ST are in line with previous studies which have found disparities between the IPAQ and ActiGraph GT3X as PA/ST measurement tools both in terms of underestimation and/or overestimation of PA and ST (Celis-Morales et al., 2012; Downs et al., 2014; Yates et al., 2015; Cleland et al., 2018). This highlights the need for future research to utilize objective measurement tools to assess PA and ST.

5.2 Mental Wellbeing

In terms of mental wellbeing, this study found that 1st year PGR students self-reported *moderate* levels of MWB (median WEMWBS score of 48). This level of MWB is consistent with SHS data for the same age group (mean WEMWBS score of 50.1 for those aged 25-34 years) and the Scottish national average for adults (49.8) (Scottish Government, 2018). However, it is important to note that there was a large range in PGR students self-reported MWB with some very low scores. This highlights that within this PGR population there are students with very low MWB.

MWB as a construct is complex and multifactorial. There are a large range of external and internal factors that are related to MWB. External factors are closely aligned with environments individuals live within, these include; socio-economic status, access to health services, good quality housing, public transport, facilities for learning and employment and green spaces (NHS Health Scotland, 2016).

Research shows that poor quality environments, poverty, debt, poor quality housing and high levels of crime reduce the wellbeing of both individuals and the wider community (National Mental Health Development Unit, 2011). Other external factors which affect mental wellbeing include; major life events (e.g. bereavement, job loss, financial worries, long term injury/illness), violence, abuse, trauma, adverse childhood experiences, discrimination, bullying, harassment (WHO, 2014). Internal factors relate to an individual's outlook on life, their self-esteem, their ability to be resilient and the social connections and networks that they are part of. Individuals who have a positive outlook, are self-confident, resilient, feel connected to others and have a sense of purpose will have a more positive MWB (NHS Health Scotland, 2016).

As far as the author is aware, there is only one study in the literature that has utilised the WEMWBS to assess psychological health and wellbeing of graduate students. Their findings are similar to this study, in that they found that graduate students self-reported moderate psychological health. However, in contrast to this study they found that African-American graduate students had significantly higher wellbeing scores than White graduate students (Wilkinson et al., 2014).

Although this study identified that Hispanic/Latino PGR students tended to have lower mental wellbeing scores there were no significant differences in mental wellbeing for different ethnicities. This finding is likely to be because the total sample size and the sample size for each ethnicity was much smaller than that of Wilkinson et al., (2014) therefore limiting statistical power. In addition, this study had a greater proportion of Asian PGR students and only one PGR student identified as Black, Asian and Minority Ethnic therefore the two studies have distinct samples.

Compared to the general 1st year PGR population, this study had a sample with a similar proportion of mixed ethnicity and Black ethnic groups. However, the sample had a higher proportion of individuals of White ethnicity (80% study sample vs. 70% general PGR population) and a lower proportion of those from Asian backgrounds (12% study sample vs 17% general PGR population) compared to the general 1st year PGR population.

Therefore, the results may not be entirely representative of the general 1st year PGR population.

In terms of ethnicity and mental wellbeing in the general UK adult population, there is a lack of evidence utilizing the WEMWBS. Unfortunately, the SHS which utilizes the WEMWBS does not provide ethnic breakdowns for MWB data. Stewart-Brown et al., (2015) analysed Health Survey for England data and found that those of African-Caribbean ethnicity had a lower odds ratio for low MWB whilst those of Indian and Pakistani and African-Caribbean ethnicities had a greater odds ratio for high MWB. These results are in contrast with other research which has found that individuals from a Black/African/Caribbean/Black British ethnicity have significantly lower self-reported life satisfaction and happiness compared to those of White ethnicity (Oguz et al., 2013). Therefore, the findings of Stewart-Brown et al., (2015) should be interpreted with caution and further research specifically assessing MWB is required.

The findings of this study in terms of PGR student MWB are broadly similar to existing literature that has utilised the WEMWBS in undergraduate student samples. Research by Davoren et al., (2013) found that Irish undergraduate students had a mean WEMWBS score of 49.8 whilst Bore et al., (2016) found Australian undergraduate students had slightly lower levels of mental wellbeing (mean WEMWBS score of 46.4).

Just under one fifth (19%) of the study sample reported use of the University of Glasgow CAPS. This proportion of students utilising MH services is considerably lower than values cited in existing literature (Hyun et al., 2006; Garcia-Williams et al., 2014; Lipson et al., 2016). For example, Garcia-Williams et al., (2014) identified that 41% of their graduate student sample had utilised MH services during their graduate studies. Similarly, other literature shows that 31% of graduates self-reported using MH services during graduate school with 26% utilising services on campus (Hyun et al., 2006). It is difficult to draw comparisons to these studies as this study only identified those who had utilised on-campus support services.

This is a limitation and therefore it is possible that if both on and off campus service use had been assessed, the proportion of PGR students reporting utilization of MH services may have been higher and in line with values cited in the literature.

This study found a weak yet significant inverse correlation between self-report PGR study time and MWB. Although the median PGR study time of 35 hours/week does not seem overly concerning, upon closer examination of the data, it is evident there is a large variation in PGR study time (as low as 5 hours/week to as high as 70 hours/week). Furthermore, a high proportion (42%) of the sample self-reported studying 40+ hours/week with 10% self-reporting working at levels above the legal UK working time regulations of 48 hours/week (European Commission, 2019).

Previous evidence supports the finding that doctoral students and academic staff often work long and irregular hours including evenings and weekends (Kinman and Jones, 2008; El-Ghoroury et al., 2012). Interestingly, the figures obtained in this study are lower than those of other previous research. For example, Tytherleigh et al., (2005) found that 78% of academic and research staff in 14 UK higher education institutions reported working 40+ hours/week with 40% reporting working 50+ hours/week.

Long and irregular working hours may be due to the current culture of research environments in which there is a substantial competition to secure research grants and funding, an expectation that researchers should strive for continual research skills development and improvement and academic success is viewed as successful publication in academic journals (Pyhalto et al., 2012; Rawat and Meena, 2014; Levecque et al., 2017).

However, research shows that long working hours does not necessarily equate to greater productivity. For example, Collewet and Sauermann (2017) examined working hours and productivity for part-time call centre handlers. Their findings were that long working hours led to decreased productivity which was suggested to be due to fatigue. In fact, call centre handlers worked ~ 6 hours/day but their effective working time was only 4.6 hours/day. This may relate to a phenomenon called Parkinson's Law which suggests that work expands to fill the time available for it (Parkinson, 1958). For example, a deadline is set a month in advance yet the night before the deadline you are finishing off the piece of work.

In terms of working hours and mental health and wellbeing, previous research supports the finding that MWB and PGR study time are significantly negatively correlated. Bannai and Tamakoshi (2014) conducted a systematic review and found that long working hours are associated with negative MH outcomes including depression, anxiety and sleep issues. More recent research supports these findings, Afonso et al., (2017) found that 'white collar' workers engaging in long working hours (>48 hours/week) had significantly greater depression and anxiety symptoms and poorer sleep quality compared to those working regular working hours. Aside from the negative MH outcomes, long working hours are detrimental for physical health outcomes, for example, long working hours is associated with an increased risk of coronary heart disease (Bannai and Tamakoshi, 2014).

It is difficult to compare the findings of this study with the majority of the existing literature on graduate student MH. This is because most studies have utilized measures to assess the prevalence of specific MH issues such as anxiety, depression and stress. However, this study specifically assessed MWB as the definition of mental health is not merely an absence of mental illness but also requires a positive component. Similarly, MWB focuses on both positive functioning and positive psychology of an individual. Perhaps in future research it would be beneficial to utilize measures to assess both MWB and specific MH issues to allow for greater understanding and comparison to existing evidence.

The nature of this study in that participants volunteered to participate, and MWB was self-reported may have led to self-report and social desirability bias with students with low levels of MWB underestimating or reporting higher levels of MWB. Alternatively, there may have been non-response bias in that those who are struggling may have chosen not to complete the survey as they already have enough on their mind. These biases may lead to data that is not reflective of the PGR population and mask the real level of MWB in this population.

5.3 Perceptions and Definitions of Physical Activity, Sport and Exercise

On the basis of qualitative analysis, PGR students had a good understanding of the key components that define PA, sport and exercise. However, there was some confusion amongst PGR students over whether walking was classified as PA. This is concerning particularly as there has been a shift away from promotion of structured exercise to promotion of lifestyle activities, such as walking, to make it easier for individuals to achieve weekly PAG. In addition, several on campus PA opportunities are focused on walking (i.e. UofG Daily Mile and PGR walk). These walking-based activities such as the Daily Mile have been successful in other settings such as primary schools and workplaces (Chesham et al., 2018). Therefore, this lack of understanding that walking is classified as PA and specific university setting factors may explain the current lack of engagement with these opportunities. Previous qualitative research in a sample of young adults of a similar age range to this study also found that several participants did not identify walking as a form of PA. Instead this sample regarded walking more as a mode of transport (Darker et al., 2007). In future, there is a need to work on clarification of walking as PA in this population.

5.4 Perceived Barriers to Physical Activity

Research shows that perceived barriers are the main predictor of whether an individual engages or not in health-promoting behaviour (Lovell et al., 2010). Although PGR students were active, they perceived several barriers to PA. The top perceived barriers to PA were; a lack of information and/or awareness of opportunities; undergraduate focused PA opportunities; PGR studies and barriers specific to UofG Sport gym facilities. Other reported barriers included; barriers specific to the PGR walk; financial barriers; seasonality and weather; menstruation, personal characteristics and traits (laziness and a lack of motivation).

These perceived barriers are consistent with research examining perceived barriers to PA in graduate student populations (Longfield et al., 2006; Yan and Cardinal, 2013; Smetaniuk et al., 2017) yet differ slightly with that of undergraduate student populations. Undergraduate student populations have cited other perceived barriers to PA including physical exertion, social and family responsibilities and parental appraisal of academic success over exercise (Grubbs and Carter, 2002; Daskapan et al., 2006; Lovell et al., 2010). Research examining perceived barriers to PA and exercise in non-clinical general adult populations has found that the general adult population also cite a few additional perceived barriers compared to PGR students. These perceived barriers include health issues and a lack of interest, enjoyment, social support and confidence (Justine et al., 2013; Hoare et al., 2017).

It is important to note, that a large proportion of research examining perceived barriers has utilised quantitative measures such as the Barriers in Physical Activity and Exercise Participation Questionnaire. One limitation of quantitative measures is that participants rate their agreement on a range of statements. These statements are fixed and therefore the individual is limited and cannot report additional barriers not on the list. In comparison, qualitative focus groups allow participants to individually identify perceived barriers to PA and exercise without prompts from specific statements and also give the individual the opportunity to discuss perceived barriers in a greater level of detail.

It is interesting that these other perceived barriers such as health issues, family or social commitments, a lack of interest, enjoyment, social support and confidence were not perceived barriers to PA in this PGR student population. This is likely to be since focus group participants were a healthy cohort (100% met PA guidelines) of predominately young adults with no dependents. Therefore, they are more likely to have an interest/enjoyment in PA, a high self-efficacy, a more flexible lifestyle and less likely to have health issues.

As stated in the introduction, it is important to understand perceived barriers so they can be addressed and PA campaigns and/or interventions are as effective and successful as possible.

In terms of a lack of information/awareness of opportunities, it became clear that PGR students felt that information was education-focused and aside from the gym, opportunities to be active were not well advertised. In addition, PGR students felt current PA facilities and opportunities were undergraduate-focused. It was not that PGR students were not eligible to participate or that they did not want to interact with undergraduate students but rather they felt that facilities and opportunities were set up and advertised to the undergraduate student population rather than postgraduate students.

These barriers may also be linked to later start dates for PGR students (PGR study barrier). These later start dates mean PGR students miss extracurricular and sports fayres at the beginning of the academic year. New PGR students who completed their undergraduate degree elsewhere were at a particular disadvantage as they had a more limited knowledge of opportunities. The suggestion that information is education-focused is consistent with findings from the 2017 PRES which found that only 55% of UofG PGR students felt they received appropriate non-academic support on arrival to their PGR studies (University of Glasgow Office for Research Strategy and Innovation, 2017).

This finding suggests that there is either a clear lack of information being provided to students and/or the way in which current information is being disseminated is ineffective.

To address these barriers, the author suggests that the UofG needs to be more focused on prevention of poor health and wellbeing rather than relying on support services. This would be by working in partnership with graduate schools and UofG Sport to provide information on the benefits of PA and opportunities to be active at the UofG, delivering information at PGR induction sessions and linking this information to support services online. In addition, it is well acknowledged that the relationship between PGR students and their supervisors are significant and may directly affect their wellbeing (Sambrook et al., 2008; Levecque et al., 2017). Not only do supervisors have the potential to influence wellbeing but also other health and lifestyle beliefs, attitudes and behaviours. This ties back to the Determinants of Health Model (Dahlgren and Whitehead, 1991) and Theory of Planned Behaviour (Azjen, 1985) as supervisors are significant individuals in PGR students' lives and have a role in PGR students' social, community network and working conditions. Therefore, the author considers that supervisors should also play a role in promoting PA to their students so that this information is coming from multiple sources and not just one.

Other PGR study barriers to PA were a high workload, working hours and conferences/travelling. To address these barriers, it is suggested that UofG needs to be working in partnership with graduate schools and supervisors to ensure flexible working hours for PGR students. In terms of conferences/travelling, information should be disseminated to PGR students on ways to be active with minimal equipment and promotion of the British Universities and Colleges Sport's UNIversal scheme which allows those with memberships of UofG gym to avail of facilities in a range of other university gyms across Great Britain.

In terms of UofG Sport barriers, one of the main cited barriers was that classes were full, or equipment was unavailable. One proposal to address this barrier is to widely advertise peak busy times in the gym using a traffic light system, i.e. red for peak busy times, amber less busy and green for the quietest times so that gym users can take this into consideration prior to attending the gym. In terms of summer changes to the class timetable, the author understands that classes need to be viable to be scheduled. To address this issue, it may be important to educate and provide information to PGR students on how to be active and take part in exercise outside structured classes. For example, providing information on how to keep active and exercise using minimal equipment or other equipment within UofG Sport gym facilities.

As for the PGR walks, it is suggested that the organisers vary the starting location of the walk to make it accessible for all PGR students, particularly those working in the extremities of the campus. In addition, it is suggested that they alter advertisement of the walk, promoting it not only as an opportunity for social interaction but also keeping active and improving physical health. Another suggestion it to investigate other ways and activities to promote PA to this population, such as yoga, as this seemed popular amongst PGR participants.

5.5 Perceived Benefits of Physical Activity

PGR students reported healthy lifestyle beliefs as they identified that PA had a positive impact on their mental and physical health and on their PGR study work/life. These benefits identified are largely consistent with those identified by undergraduate populations (Grubbs and Carter, 2002; Lovell et al., 2010; Muzindutsi et al., 2014). These tangible benefits are directly linked with motivations for PA which will be discussed later. Interestingly, PGR students reported that these benefits were primarily post-exercise or post-PA. This is something to consider when advertising PA and exercise opportunities. In addition, PGR students also acknowledged that acute PA brings about benefits which accumulate over time to give chronic PA benefits.

This is consistent with literature which shows that regular physical activity over an extended period of time is protective against weight gain, incidence of non-communicable diseases such as type 2 diabetes, obesity, coronary heart disease and age-related diseases such as dementia and Alzheimer's (Reiner et al., 2013).

Aside from the physical health benefits of PA, regular PA can improve MH and wellbeing both acutely and over the long term. As discussed in the introduction, regular PA can improve mood (Bray and Born, 2004), reduce the risk of depression and anxiety (Goodwin, 2003), reduce stress levels, increase life satisfaction (Schnohr et al., 2005), improve cognition and working memory (Cirillo et al., 2017; Martins et al., 2013).

There are several proposed mechanisms underpinning the MH benefits of exercise. Two commonly cited physiological hypotheses are the opioid and monoamine hypotheses which suggest that the release of endogenous opioids (particularly beta-endorphin) and monoamines (adrenaline, noradrenaline, dopamine and serotonin) during PA and exercise is responsible for mood improvement (Boecker et al., 2008; Peluso and Guerra de Andrade, 2005). Other mechanisms are psychological in nature, these include the distraction hypothesis, increased self-efficacy and social interaction. The distraction hypothesis proposes that distraction from unfavourable stimuli during PA and exercise leads to mood enhancement both during and after exercise. The self-efficacy hypothesis suggests that taking part in PA and exercise, improves an individual's mood, confidence and self-efficacy. Finally, the social interaction hypothesis proposes that social support and relationships during PA and exercise has a vital role in improving MH and wellbeing (Peluso and Guerra de Andrade, 2005). Rather than one individual mechanism underpinning the PA benefits on MH and wellbeing, it is likely to be multifaceted and involve a complex interaction of both biological and psychological processes (Peluso and Guerra de Andrade, 2005).

Another point to consider is that exercise type, duration, frequency and intensity may all influence MH and MWB benefits. Chekroud et al., (2018) examined these exercise variables and how they related to self-reported MH in adults. Their findings showed that all exercise types were linked to a more positive MH than non exercise. The greatest associations were found for popular sports (e.g. hockey, rugby, tennis, soccer); cycling; aerobic and gym activities; durations of 45 minutes and frequencies of three to five times per week. Other research by Taspinar et al., (2014) compared the effects of yoga and resistance exercise on MH and MWB of young sedentary adults. Both yoga and resistance exercise improved MH and MWB outcomes. However, each type of exercise was associated with unique improvements, for example, yoga improved fatigue, self-esteem and quality of life. On the other hand, resistance exercise improved body image whilst both yoga and resistance exercise reduced symptoms of depression. In terms of intensity of PA/exercise, it remains ambiguous what intensity is best for improving MH and MWB. For those with low fitness levels, moderate intensity exercise is considered to be associated with greater enjoyment and adherence than vigorous intensity exercise (Craft and Perna, 2004). Therefore, in future it is important to consider these aspects when promoting the benefits of PA and designing PA/exercise interventions to improve MH and MWB.

5.6 Motivations for Physical Activity

The top cited motivations for PA were to balance out unhealthy eating habits, for health benefits, PGR study/work benefits and image. In terms of the motivation to balance out unhealthy eating habits, this is interesting as it highlights that although PGR students are engaging in positive health behaviours (i.e. PA) they are also engaging in negative health behaviours. This finding is consistent with the Compensatory Health Beliefs (CHBs) model proposed by Rabiau et al., (2006). This model proposes that when an individual is faced with temptation, there is motivational conflict and cognitive dissonance due to conflict between personal desires and goals. To ease this, it is proposed that compensatory health beliefs and behaviours are activated. CHBs are thoughts that the adverse effects of an unhealthy behaviour can be counterbalanced by performance of a healthy behaviour (Rabiau et al., 2006).

For example, a PGR student who has a goal of staying healthy and not gaining weight yet wants to eat chocolate may reason that if they exercise to burn it off, eating chocolate is justifiable. Evidence shows that dieting women faced with high caloric food choices activate diet-specific CHBs and intentions to engage in compensatory behaviours (Kronick and Knauper, 2010; Kronick et al., 2011). In relation to students, research shows that more regularly active students consumed alcohol with this consumption more frequent than their inactive peers (Nigg et al., 2009).

Furthermore, it is concerning that one PGR student reported being active to feel less guilty about eating unhealthy foods as this may reflect an underlying negative attitude towards food. This combined with image as a motivation for PA may reflect underlying pressures on young adults, particularly females (5 out of 6 focus group participants were female), to look and/or be perceived in a certain way. Keeping active for weight loss and appearance is a prominent goal of physical activity in Western cultures particularly with the rise of social media in recent years. Research shows that over half of the features in women's health and fitness magazines are formatted in an appearance/weight loss frame (Aubrey, 2010). This is consistent with research which shows females are more motivated to be physically active for weight management/loss reasons than males (Furnham et al., 2002; Kilpatrick et al., 2005; Hoare et al., 2017).

PGR students reported healthy lifestyle beliefs in that they identified that they were motivated by the mental and physical health benefits and PGR study/work benefits of PA. These perceived benefits of physical activity are consistent with research which found that university office workers who were physically active felt more capable in terms of scheduling demands, performing mental-interpersonal tasks, delivering outputs and a lower lost work productivity. In addition, they also reported significantly higher wellbeing scores (Puig-Ribera et al., 2015). Similarly, Thøgersen-Ntoumani et al., (2015) found that physically inactive UK university employees who engaged in a lunchtime walking intervention had significantly higher enthusiasm and relaxation at work in the afternoon compared to control subjects.

Other reported motivations for PA included for sleep, social interaction, external factors (childhood/parental influence and occupation) and age. There is some overlap between motivations for PA in PGR and in undergraduate student samples, specifically body image, health-related factors and social interaction (Diehl et al., 2018; Eichorn et al, 2018).

It is interesting that PGR students reported being motivated by external factors such as childhood/parental influence. This reinforces existing literature which shows that healthy lifestyle beliefs and behaviours are often developed at young ages and track through to adulthood (Telama et al., 2013; Movassagh et al., 2017). Longitudinal research found that significant others whether that be parents, grandparents, siblings, teachers, sports coaches or friends influenced PA and sport attitudes and levels of participation (Thompson et al., 2003). This also relates back to the Determinants of Health Model (Dahlgren and Whitehead, 1991) and the Theory of Planned Behaviour (Azjen, 1985) discussed earlier, in that parents and other significant individuals in children's' lives shape their health and lifestyle beliefs, attitudes and behaviours.

Interestingly, most of the cited motivations for PA were extrinsic in nature. These types of motivators may be most effective for initial uptake and engagement in PA. However, intrinsic motivators are suggested to be more effective for long-term adherence to PA (Kilpatrick et al., 2005). It has been identified that extrinsic motivators may be necessary to be omnipresent as intrinsic motivation alone may be unsustainable for long term adherence (Gavin et al., 2014). This is supported by Ryan et al., (2009) who suggest that individuals adhere to PA not because PA is interesting or enjoyable but rather because there is a reward or something to gain from PA. This is important to consider when promoting PA, current PA opportunities and developing new opportunities.

5.7 Strengths and Limitations

This study has several strengths and limitations. The first major strength is that PA was assessed objectively using accelerometers for a small sub cohort which removes the potential for self-report bias or errors in recall. The randomization of PGR students to objective assessment of PA ensured that there were no biases in the selection of this sub cohort. Furthermore, as PA was measured in free living conditions, there was a low burden on participants. The completion of a PA monitor diary alongside objective assessment was beneficial in assessing compliance and removal of the device for water-based sports and/or sleep.

Another key strength of this study was that PGR students across all four university colleges were eligible to take part in this study therefore unlike the previous literature the results represent the wider PGR population and not just a narrow convenience sample. Furthermore, the online nature of the questionnaire made it easy and accessible for all PGR students to complete. This is necessary as PGR students are based in a range of locations both on and off campus. In addition, the use of both quantitative and qualitative research techniques was a strength as not only was PA and ST assessed but also associated perceptions of PA, sport and exercise; perceived barriers to PA; perceived benefits of PA and motivations for PA were assessed to give a greater level of detail and understanding into PA behaviour patterns.

In terms of limitations, one main limitation is the nature of this study being an online questionnaire using self-report measures. As highlighted previously this may lead to self-selection bias in that those who responded may have had an interest in PA, SB and/or MWB. Therefore, these respondents may have been motivated and engaged to participate, leading to a healthy cohort. Similarly, non-response bias is possible in that those who are not interested in the assessed variables or those who have low MWB and are struggling may not respond. On top of this, the use of self-report measures may be associated with errors in recall, misunderstanding of the constructs of interest (i.e. moderate intensity PA), self-report and social desirability bias.

The response rate to the online questionnaire was 12.5% which is a fairly low response rate (87.5% non-responders). All these factors may lead to data which is not entirely reflective of the general PGR population. Therefore, in future there is a need for an improved recruitment procedure with better targeting of individuals of all levels of MWB and PA to gain data representative of the general population and not just a healthy cohort.

Although the use of accelerometers is a strength there are several limitations of accelerometers in assessing PA. Firstly, the removal of accelerometers for water-based activities (i.e. swimming) may lead to an underestimation of PA levels for those who engage in a lot of water-based activities. However, the PA monitor diary acted to counteract this as device removal for water-based activities and sleep was recorded by the participant and able to be cross-checked by the author. In addition, accelerometers underestimate load-bearing activities such as cycling or walking uphill. Another limitation of accelerometers is the potential for subject reactivity, although the researcher did stress to the participants the need to keep to their normal weekly routine. Furthermore, research has found that PA differences in a sample of young adults are due to differences in weekday and weekend PA rather than reactivity (Behrens and Dinger, 2007). Therefore, the extent to which reactivity limits the results is questionable.

The current lack of standardisation in accelerometer data processing and cut-point protocols limits the ability to compare findings with other literature. Evidence shows that application of different cut points leads to variation in MVPA estimates and prevalence of those meeting the PA guidelines (Loprinzi et al., 2012). A final limitation of PA/ST assessment is that self-report PA data (via IPAQ) was predominately collected in February when there was severe wintery weather (i.e. “Beast from the East”) whereas objective assessment was in May/June which coincided with the period of very sunny and hot weather. It is already known that weather is a barrier to PA, therefore these extreme weather patterns could have confounded assessed PA levels.

Aside from weather and seasonality, other factors such as injury, illness, individual workload and personal circumstances may also lead to fluctuations in PA behaviour patterns and hence confounded assessed PA levels. In terms of workload, the author appreciates that PGR study is a time-limited busy time and therefore the findings of this study may not be valid if considered over a life time. However, there is some evidence to show that habits and behaviours developed during early adulthood may track through to later life (Trost et al., 2002) and therefore unhealthy habits and behaviours during this point in PGR students' lives may have repercussions later in life.

In this study, the IPAQ and ActiGraph GT3X were not employed at the one time point due to practicality and feasibility, objective assessment of PA and ST for 100 PGR students would have been too time intensive given the time period for research to be conducted. In future, the author recognises that it would be beneficial to employ the IPAQ and ActiGraph GT3X at the same time point to allow accurate examination and comparison of PA/ST data.

Aside from the limitations already discussed, this study had a small sample size (n=100), particularly for the qualitative focus groups (n=6). In addition, it was based in Glasgow and from the results obtained and interaction with participants, the author feels that that those who responded were a healthy cohort. Also, one limitation of focus groups is that they may be subject to groupthink and therefore participants may not give honest opinions and thoughts. Like the questionnaire, self-selection bias may also have been evident within the focus groups. In addition, the focus group cohort were highly educated and may have had a deeper understanding of PA and the importance of it. Therefore, it is important to consider that the findings must be interpreted with caution and may not be entirely representative of the wider PGR population, PGR students in other locations or populations other than PGR students.

5.8 Practical Implications and Future Research

It is clear, there is still a need to promote MVPA in PGR students however there is a much greater need to reduce ST. To facilitate this, there needs to be clarification that walking counts as PA and increased dissemination of information to PGR students. This information needs to include the benefits of MVPA, risks of inactivity and ST, opportunities for PA and strategies to increase PA and to decrease ST. There needs to be a holistic approach in promoting healthy lifestyles as PA, ST, dietary habits, alcohol and smoking are all independently associated with health and wellbeing. Therefore, it is important to consider all these factors when trying to promote and develop protective health behaviours and lifestyles.

It is important to note, reducing ST is not only related to education but also cultural change. The author appreciates that the cultural complexities of higher education and academia make this a difficult task. In order to bring about cultural change, there needs to be an integrated approach across the UofG, with engagement from each UofG College and their associated Schools and Research Institutes. As acknowledged by the Determinants of Health Model (Dahlgren and Whitehead, 1991) discussed earlier, there needs to be a multi-level approach to have an impact on health and wellbeing. Thus, information should be disseminated from multiple levels within these colleges and not just from those running PGR induction sessions but also from more senior staff (e.g. Deans of Graduate Schools) and individual PGR student supervisors.

On the topic of senior management and graduate schools, there should be some consideration whether the current research and broader UofG culture, environment, norms and expectations of supervisors are appropriate in supporting PGR students not only with academic matters but also non-academic matters to support positive physical and mental health and wellbeing and positive study-related behaviours. As described by the Theory of Planned Behaviour (Azjen, 1985), attitudes and subjective norms of significant others such as supervisors have a role in behavioural intention and behavioural performance.

For example, working hours was one issue raised in focus groups, there may be a need for supervisors to have a more flexible approach in their expectations of PGR students' working hours and daily routines particularly as findings show PGR students' study time is significantly negatively correlated with mental wellbeing. Alternatively, there may be a need to ensure that PGR students are sufficiently trained and prepared to manage time effectively. Another point to consider is the role of the built environment in promoting PA and reducing ST. There is a need to consider PA/ST when management are deciding on design features and furniture for both refurbished and newly constructed buildings such as the new Research Hub.

In terms of future research, leading on from this study the author feels that there are five key areas for further research (points I-V below) to expand understanding of PGR students' PA, ST, MWB and the role of the supervisor in these outcomes of interest. These are:

I. **Research into the most effective way to disseminate information and engage PGR students.**

   There is a need to identify who will disseminate information, when it will be disseminated and the most appropriate method of dissemination to ensure PGR students receive an appropriate level of information and support on non-academic issues. Further, there is a need to identify the most appropriate way to engage PGR students (i.e. by social media, email, talks).

II. **Research on more representative PGR student samples.**

   There is a need for research on more representative PGR student samples. Improved recruitment procedures are required to target likely non-responders (e.g. those with low MWB and/or low PA). Furthermore, research should examine a range of PGR years and see if there is any association between year of PGR studies and wellbeing. One suggestion is for a longitudinal cohort study to assess how PGR students' wellbeing changes during the course of their PGR studies.

III. **More research required on UK PGR students with a consistent approach in assessing mental wellbeing (WEMWBS) and utilizing objective PA measures where possible.**

The current research base is primarily based upon postgraduate taught students based in the US therefore more research is required on UK PGR students to allow for a greater depth of understanding. The WEMWBS is a widely used population level used resource, e.g. Scottish Health Survey. However, in research fields there is a lack of a standardised approach to assess MWB. The author suggests that as the WEMWBS is utilised in population level surveys, there should be a standard approach to use the WEMWBS to assess MWB in research. This would lead to a greater body of research in the literature base for contrast/comparison and therefore a greater insight into mental wellbeing of specific populations.

IV. **Research into the role of supervisory relationships in terms of PGR students' mental wellbeing, physical activity and sedentary time.**

This research will allow more extensive understanding of additional factors which influence PGR students' health and wellbeing and how these factors are interrelated. This will allow for an overall picture of the determinants of PGR students' health and wellbeing to be developed so effective interventions can be designed and implemented targeting multiple levels. At the time of writing, individuals within the University of Glasgow School of Psychology are undertaking research to assess PGR wellbeing and the role of the supervisory relationship.

V. **Research to identify the determinants of sedentary behaviour in PGR students.**

Similar to point IV, to allow greater understanding of SB patterns and to consider these patterns when designing research/university environments and developing and implementing effective interventions.

6. Conclusion

In conclusion, the key finding was that PGR students are active (meeting current PAG) yet highly sedentary with moderate levels of MWB.

Although no significant associations between PA, ST and MWB were found, it is possible that the high level of time PGR students are spending sedentary may be associated with greater risk of negative physical and mental health outcomes and non-communicable diseases. Additionally, habits and behaviours of PGR students may track through to later life and therefore high ST may have further repercussions as PGR students age.

An interesting finding was the significant negative correlation between MWB and PGR study time with steps needing to be taken to address this. It is the author's belief that this study is one of the first that has examined PA, ST and MWB in UK PGR students using both quantitative and qualitative research methods. In order to accurately understand ST to make a positive change, future research should focus on identifying the determinants and underlying culture behind ST; the role supervisors play in health-related behaviours and should be conducted on more representative UK PGR student samples.

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8. Appendix

8.1. Literature Review Tables

8.1.1 Graduate Students' Mental Health and Wellbeing Papers

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Nelson et al., 2001	USA	53	Graduate Clinical Psychology Doctoral Students (32 years)	• Demographic/Stress Questionnaire • General Health Questionnaire • Multidimensional Support Scale • COPE Inventory	Highest reported stressors were academic coursework, dissertation work and financial situations. Those with higher grade point averages had significantly higher stress associated with academic coursework. Relationships with friends, peers, spirituality and relationships with academic supervisors and staff were cited as important for moderating stress. Graduate students with higher psychological distress reported greater stress over practical work and relationships with academic supervisors, staff and friends.
Noguiera-Martins et al., 2004	Brazil	146	Graduate Health Science Students (28.6 ± 4.42 years)	• Attendance at Mental Health Centre • ICD-10 (International Classification of Diseases) criteria applied	High proportion (56%) of graduate students attended mental health centre in 1st year of Master's. Of these, 18% reported suicidal ideation. Main diagnoses were depression and anxiety disorders. A small proportion (4.5%) were granted temporary leave from studies. Higher proportion of women utilized mental health services. Three main types of stress for students; professional stress (development of researcher in competitive environment where resources and funding declining), situational stress (pressures and demands of graduate training programmes) and personal stress (related to individual characteristics).
Stecker, 2004	USA	652	Graduate and Professional Students (29.6 years)	• Tool assessing satisfaction with Student Health Services, stress, coping, depression, and other lifestyle factors. • Depression – DSM-IV criteria. • Repeated twice (two samples).	Graduate and professional students report high levels of depression, stress and substance use. 25% (sample 1) and 35% (sample 2) reported depression scores indicative of depression. 10% (sample 1) and 9% (sample 2) reported suicidal thoughts. Elevated depression scores were associated with low social support and high total stress levels. Gap between self-reported mental health and mental health service use.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Hyun et al., 2006	USA	3121	Full-time Graduate Students. (28.8 ± 5.2 years) (68% Doctoral students, 22.2% Master's students, 8.7% Professional Degree students)	Mental Health Needs; • Index of Depression • Self-reported need for mental health services (if student had an emotional or stress-related problem in last year that affected wellbeing or academic performance) • Asked if student knew another graduate student who had experienced emotional or stress-related problem in last year Self-report utilization of Mental Health Services (both on and off campus)	High self-reported need for mental health services. High proportion of students reported having an emotional/stress related problem (44.7%), having a colleague with an emotional or stress related problem (57.7%) and seeking care (50.2%). Females reported significantly more problems/knowing people with problems and higher depression scores. 30.9% utilized mental health services whilst in graduate school (26% on campus, 10.5% off campus. 5.7% both) with females more likely to utilize these services (41.4% vs. 21.9%) and International and ethnic minority students significantly less likely to utilize any services. Gap between self-reported mental health needs and mental health service utilization (45% mental health need, 50% considered seeking help, 31% utilized services)
Hyun et al., 2007	USA	3121 (2493 Domestic; 551 International)	Domestic and International Graduate Students (28.8 ± 5.1 years; 28.9 ± 5.4 years respectively)	Mental Health Needs; • Index of Depression • Self-reported need for mental health services (if student had an emotional or stress-related problem in last year that affected wellbeing or academic performance) • Asked if student knew another graduate student who had experienced emotional or stress-related problem in last year • Self-report utilization of Mental Health Services (both on and off campus)	No significant difference in prevalence of emotional or stress related problems between international and domestic students. International students significantly less likely to report knowing a colleague with mental health problem within last 12 months (13% less) or consider seeking care (23% less). International graduate students had a significantly lower knowledge of on-campus counselling services (14% lower) and used significantly less services (19% less service use) with Asian students significantly less likely to use services than other ethnicities. Barriers exist for transmitting information on available services to international students, greater stigmatization of mental health issues and less open discussion may exist in international students.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Stubb et al., 2011	Finland	669	Doctoral Students (39 years)	• Open ended question: "How do you see your own role as a PhD student in your scholarly community?" • Modified MED NORD questionnaire (10-item). • Modified Inventory of General Study Orientations	Large variation in doctoral students' experiences of their academic communities with regard to socio-psychological well-being. A large proportion of students (56%) experienced the community as a source of burden. Students' reported experiences of exclusion and exteriority, feelings of unworthiness which hindered their studies. However, others (44%) felt that the academic community was a source of empowerment and felt inspired and supported. Students reported stress, exhaustion, anxiety and lack of interest in their studies. Academic community was associated with socio-psychological well-being; those who perceived the academic community as a source of empowerment had higher self-reported well-being, less study related stress, exhaustion and anxiety during the studies compared to those who perceived the community as a burden. Those with burdening experiences were significantly more likely to consider withdrawing from their studies.
Madhan et al., 2012	India	330	Master of Dental Surgery in Orthodontics and Dentofacial Orthopedics (26 ± 1.8 years)	• Depression Anxiety Stress Scales (DASS) (short version)	Students reported mild levels of depression and anxiety and moderate levels of stress compared to population norms (60.6% of the sample reported moderate stress levels with a further 22.4% and 1.2% reporting severe and extremely severe stress). 15.8% of the sample reported significantly higher levels on all 3 subscales than the general population.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Wyatt and Oswalt, 2013	USA	27,387	Undergraduate and Graduate Students (21.56 years) 11.1% of sample graduate students	ACHA-NCHA II Survey Data • Feelings and Behaviors related to poor mental health (11-item) • Diagnosed mental health issues within last 12 months • Use of mental health services (4-item) • Perceived effects of mental health on academic performance	Graduate students reported lower rates of negative feelings and behaviours in last 12 months but higher rates before the previous 12 months compared to undergraduates. Graduate students reported significantly higher tremendous stress and more than average stress than undergraduates. No significant difference in mental health diagnoses and use of mental health services between undergraduate and graduate students. However, graduate students were significantly more likely to seek mental health care in the future (9.2% more likely). Graduate students reported mental health has less of a negative effect on academic performance than undergraduates. However, graduate students reported greater disruption of thesis, research/practical work and more graduate students identified career-related issues as traumatic or difficult to handle in the last 12 months.
Garcia-Williams et al., 2014	USA	301	Graduate Students (27.98 ± 5.9 years)	• Suicide-related behaviour (3-item scale) • Patient Health Questionnaire (PHQ-9) • Anxiety (4-item scale) • Negative Emotions (5-item scale) • Service Utilization	Graduate students self-reported poor mental health; mild depression (35.2%) and high levels of anxiety and negative emotions (95.4% feel nervous or worry a lot, 86.7% become easily annoyed or irritable, 88.7% feel life is too stressful, 53.8% feel intensely lonely). A smaller proportion of students experienced suicidal thoughts (7.3%). High proportion of students currently using mental health services (22.2% on medication and 18.5% attending counselling/therapy).
Wilkinson et al., 2014	USA	505	Graduate Students (31 years)	• Assessed discrimination and lifetime discrimination • Mental Health Index 5 (MHI-5) • Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)	Graduate student reported moderate psychological health. African-American graduate students reported significantly greater psychological health compared to white graduate students (52.72 vs 50.88). This persisted even when adjusted for day-to-day discrimination and lifetime discrimination. Approx. 15% of graduate student sample reported psychological distress with a greater proportion of whites reporting psychological distress compared to African-Americans.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Cilliers and Flotman, 2016	South Africa	10	1st Year Master of Industrial and Organisational Psychology (IOP) Students (part-time) (28 years)	• Qualitative focus groups to assess experiences of 1st year part-time Master of IOP students.	Psychological well-being of IOP students characterised by distress and eustress. Students felt distressed, not coping and doubted their own competence due to the high academic workload alongside demands of jobs, families and financial matters. They reported struggling to find the balance between all these roles. In addition, students reported psychological distress caused by a lack of clarity on assessment criteria and inconsistent, unhelpful, unmotivated and rude lecturers. Conversely, students cited that positive experiences included adequate resources, positive, supportive relationships with academic staff and other students. Self-efficacy, locus of control and optimism moderated reported distress.
Lipson et al., 2016	USA	64,519	Undergraduate and Graduate Students (no age data) 25% of sample graduate students	• PHQ-9 • Generalised Anxiety Disorder-7 (GAD-7) • Questions to assess; suicidal ideation, nonsuicidal self-injury, any mental health problem and treatment utilization in last 12 months.	High prevalence of mental health problems; 26.2% of Master's students and 26.7% of Doctoral students met criteria for one mental health problem. Among students with an apparent mental problem, only 40.5% (Masters) and 40.9% (Doctoral) received treatment in the last year. Students in humanities and art and design had increased likelihood of mental health problems.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Levecque et al., 2017	Belgium	3659	Flemish PhD Students (28.37 ± 4.67 years)	• GHQ2+ and GHQ4+	High prevalence of mental health problems in PhD student population. - 51% of PhD students experienced at least 2 symptoms - 40% reported at least 3 symptoms - 32% reported at least 4 symptoms - PhD student more affected by mental health problems than highly educated general pop (2.43 times), highly educated employees (2.84 times) and higher education students (1.85 times higher). Psychological Distress greater for those: - Unsure of funding resources - In their 1st year of PhD - With an advisor with a 'laissez-faire' leadership - Work-family or family-work conflict. Psychological Distress lower for those: - Having a partner - Having one or more children - With an advisor with inspirational leadership.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Barry et al., 2018	Australia	81	Doctoral Students (38.1 ± 1.3 years)	• Screening using Kessler Psychological Distress Scale (K10) • DASS • Perceived Stress Scale (PSS) • 3 open ended questions to assess experiences of stress and candidature progress.	Higher levels of perceived stress, depression, anxiety and stress scores than age-matched general population. Despite this, mean depression, anxiety and stress scores were within 'normal' range. 3 students excluded from study as rated as extreme distress according to K10. Students who were either behind or ahead in their schedule had higher stress, depression and anxiety scores than those meeting their schedule. Students identified several challenges to studies; problems with supervision and academic community, problems related to resources, domain-specific expertise challenges, challenges with general work processes and external or personal challenges. Students reported that stress impacted academic progress through; impeded/delayed progress, reduced ability to complete academic tasks and changes to personal well-being.
Evans et al., 2018	26 Countries	2279	Graduate Students (no age data) (90% PhD students, 10% Master's students)	• GAD-7 • PHQ-9	Graduate students 6+ times more likely to experience depression and anxiety compared to general population (41% of students scored moderate-severe anxiety and 39% scored moderate-severe depression). Transgender and/or gender non-confirming population and women significantly more likely to experience depression and anxiety. A good work-life balance and supportive academic supervisors/mentors was significantly correlated with less anxiety and depression and a more positive mental health.

8.1.1 Graduate Students' Mental Health and Wellbeing Papers Continued

Reference	Country	Subjects	Student Type (Age Mean ± SD)	Measures	Findings
Rafal et al., 2018	USA	1242	Male Undergraduate and Graduate Students (25.21 ± 7.07 years) 26.2% of sample Graduate Students	• Modified Mental Health Literacy Scale • Modified Self-Stigma of Seeking Help Scale (SSOSH) • Attitudes Toward Seeking Help Scale (short form) • Subjective Norms Scale • Intention to seek professional mental health services (25-item scale)	Graduate students had significantly greater mental health literacy; greater mental health knowledge, more positive mental health attitudes, normative beliefs, higher impact of help-seeking on self-confidence, lower self-stigma toward help seeking and greater intentions to seek help than undergraduate students. Results showed statistically significant differences in mental health literacy according to race and academic discipline.
Wang et al., 2018	China	260	Graduate Students (no age data)	• Symptom Checklist-90 (SCL-90) • Coping Style Questionnaire • Social Support Revalued Scale	Graduate students' self-reported mental health was relatively good. They reported lower psychological distress on all SCL-90 subscales except for anxiety and phobic anxiety compared to Chinese national norms. Depression scores were significantly lower for graduate students than the national norm. No significant difference for anxiety and phobic anxiety between graduate students and national norms. Graduate students' mental health significantly negatively correlated with social support, problem-solving and help-seeking. In contrast mental health was significantly positively correlated with self-blame, fantasy, withdrawal and rationalisation.

8.1.2 Graduate Students' Physical Activity Papers

Reference	Country	Subjects	Student Type	Measures	Findings
Gonzalez et al., 2014	USA	100	Health Science Graduate Students (no age data)	IPAQ (short form)	Majority of sample were physically active (mean total PA was 3083 MET-mins/week; 33% classified as moderate PA; 43% classified as high PA). However, still a fair proportion of students (24% of the sample) categorised as low PA therefore not meeting current PA guidelines. No significant associations between PA and GPA, gender or ethnicity. PA scores were significantly different based on participant's program of study with rehabilitation counselling program students reporting significantly more PA than other health science graduate students.
Racette et al., 2014	USA	134	Graduate Doctor of Physical Therapy Students (23.6 ± 2.2 years)	Health Assessments (1st month of semester and before graduation) – fasted anthropometric, biometric and fitness measurements. Self-report PA in last 7 days assessed by questions from ACHA-NCHA.	Graduate students had high fitness levels, most students were rated in the outstanding fitness range (77% at beginning and 79% at end). No significant changes in fitness were observed from the beginning of studies to before graduation. At the beginning of their studies, most students (70.1%) engaged in more than 3 days/week MVPA and strengthening exercises one day per week (80.6%). However, as their studies progressed, students engaged in significantly less MVPA and strength training. Engagement in aerobic exercise was most consistently correlated with favourable cardiometabolic outcomes. At the end of the 3-year curriculum, a decrease in MVPA was significantly associated with an increase in % fat mass and a decrease in HDL cholesterol.
Smetaniuk et al., 2017	Canada	43	Master of Physical Therapy Students (24.9 ± 2.6 years)	7 Day ActiGraph GT3X+ assessment of physical activity and sedentary time	Master of Physical Therapy students were highly inactive (25.7% met 150 min MVPA/week guideline) and highly sedentary (mean ST 11.2 hours/day).

8.1.3 Graduate Students' Physical Activity and Mental Health/Wellbeing Papers

Reference	Country	Subjects	Student Type	Measures	Findings
Melnyk et al., 2016	USA	93	1st Year Graduate Health Science students (25.43 years)	• Healthy Lifestyle Beliefs Scale • Healthy Lifestyle Behaviours Scale • PHQ-9 • GAD-7 • Brief Inventory of Stress Scale • Self-report lifestyle behaviours (including PA) • Biometric screening	Students reported strong healthy lifestyle beliefs but were lower on their healthy lifestyle behaviours. Only 44% of graduate students self-reported exercising at least 30 min x 5 days/week with females more inactive than males (38% vs. 63%) Several graduate students reported symptoms of symptoms of elevated depression (41%), elevated anxiety (28%). A smaller proportion reported suicidal ideation (4.4%). Anxiety and depression significantly negatively correlated to healthy lifestyle beliefs and behaviours. Positive significant correlations between anxiety and stress, depression and stress and anxiety and depression.
Wan, 2017	China	1163	Graduate Students (no age data)	• SCL-90 Survey questions assessing; • Willingness to participate in sports and exercise • Participation in regular exercise • Motivations for exercise	Graduate students had a poor self-reported mental health. Self-reported significantly higher levels on all SCL-90 subscales (including anxiety, depression, paranoia and psychic disorder) than the general population. High proportion of students stated they had a strong desire to participate in sports and exercise (95.9%) yet only 28.7% were regular exercisers. The top three motivations for sports and exercise participation were; for physical and mental health, diverse cultural life and social interaction.

8.1.4 Graduate Students' Perceptions, Facilitators and Barriers to Physical Activity Papers

Reference	Country	Subjects	Student Type	Measures	Findings
Longfield et al., 2006	Canada	47	Full-time Graduate Students (no age data)	Focus groups assessing how graduate school affected students' self-worth and participation in social and physical activities.	Changes in physical activities since becoming graduate students. 5 key findings; - Seasonality influences PA. - PA has become more structured and planned to maximise free time. - Availability of resources positively impacted students' PA levels (less barriers). - Feelings of guilt influenced PA levels. Some had feelings of guilt with being active (time away from studies) but others had feelings of guilt if they were not active. - Mixing both physical and social activities together to maximise free time.
Yan and Cardinal, 2013	USA	20	Chinese Female International Graduate Students (27.5 ± 2.1 years)	One to one semi-structured interviews assessing facilitators, barriers and perception of physical activity.	PA provided students an opportunity for a break from work, time to be alone and a sense of accomplishment. Students cited facilitators of PA to be; social influences, ample available resources, changing perceptions of femininity, a motivation for health improvement and differences in leisure/social activities between China and the US. The main barriers cited were; lack of time, lack of self-efficacy, lack of social support, cultural barriers and a lack of information about PA and available resources on campus.
Smetaniuk et al., 2017	Canada	43	Master of Physical Therapy Students (24.9 ± 2.6 years)	Photovoice to document facilitators and barriers to PA and ST. Follow up focus groups discussing selected photos.	4 key themes related to facilitators and barriers for PA and ST; - **Priorities and life balance** Students reported academic studies priority and workload was a barrier to PA. Finding life balance identified as a facilitator to PA. - **Commitment and accountability** Accountability to someone/something (eg. friends and family), social support, commitment to sports teams, financial investment in exercise classes and structured exercise classes all facilitated PA participation. - **Environment** Weather reported as both a facilitator and barrier to PA. Built environment (proximity of resources, layout of buildings, active transportation links to campus) cited as both a facilitator and barrier. - **Master of Physical Therapy programming** Time intensive nature of course, long working hours, studying, placements off campus and long sitting time during classes cited as barriers to PA and facilitators of SB.

8.2 Focus Group Participant Information Sheet

University of Glasgow | College of Medical, Veterinary & Life Sciences

PARTICIPANT INFORMATION SHEET

Assessing and Understanding the Relationship between Physical Activity and Mental Wellbeing in Postgraduate students studying at the University of Glasgow.

Invitation to take part:

The University of Glasgow invites you to take part in focus group for a research study examining the physical activity and mental wellbeing of postgraduate students. Please read the following information carefully to give you an understanding as to why the research is being undertaken and what taking part will involve. If you have further questions about participation in this study please get in touch (contact details are provided at the bottom of this sheet). Take your time to decide if you wish to participate or not.

What is the purpose of the study?

The aim of this study is to further understand physical activity levels and mental wellbeing in postgraduate students. Gaining an understanding of these measures is of interest as currently there is limited research into these variables for postgraduate students. Furthermore, the findings will be of interest to the University of Glasgow and GU Sport for the planning of future projects and interventions.

Why have I been invited?

You have been invited to this focus group as you have already completed previous parts of this study, e.g. the online questionnaire and had returned your email address with the questionnaire as someone who would be interested in being involved in the focus groups.

Do I have to take part?

Participation in this focus group is voluntary. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. You are free to withdraw from this study at any time and without giving a reason. If you decide not to take participate in this study or to withdraw at any time, this will not affect your postgraduate studies in any way.

What will happen to me if I take part?

You will be asked to attend a focus group session which will last approximately 60 minutes and be facilitated by Kathryn Bleakney (KB) and attended by other participants. The focus group will be an informal and open discussion. The aim of the focus group is to give participants the platform to discuss their perceptions of physical activity, exercise and sport, access and facilities for physical activity and sport at the University of Glasgow and the benefits and barriers specific to postgraduate students with regards to being physically active.

What are the possible disadvantages and risks of taking part?

There are minimal risks to taking part in this research. The only disadvantage is the focus group will take up some of your personal time.

What are the possible benefits of taking part?
By taking the time to engage in the focus group you will further develop our and your understanding of what barriers you may face to being physically active and identify what motivates you to be active. Furthermore, your contribution will help guide the University of Glasgow and GU Sport in future projects and interventions to help post-graduate students with opportunities and facilities to be physically active.

Will my taking part in this study be kept confidential?
All information collected about you or responses you provide in focus groups will be kept strictly confidential. You will be identified by an ID number and any information about you will have your name and contact details removed to ensure anonymity. Please note that assurances on confidentiality will be strictly adhered to unless evidence of serious harm, or risk of serious harm, is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.

Please note, other participants will be present in the focus group session. It will be highlighted at the start of the session that all opinions and comments should be respected and remain confidential between those present.

What will happen to the results of the research study?
The findings will be written up for submission to the University toward part fulfilment of a MSc(R). They will also be written up as an article to submit to a scientific journal in the hope the findings will be published. A presentation of results may be made at scientific conferences. Should you wish to obtain a copy of the published results let Kathryn Bleakney know. Please note, your details will not be included in any of these presentations or publications, all participants will remain anonymous.

Who is organising and funding the research?
The research will be carried out by Kathryn Bleakney, a postgraduate student studying for a MSc(R) in Sport and Exercise Science under the supervision of Victoria Penpraze at the University of Glasgow. The project is funded by the Research Strategy and Innovation Office at the University of Glasgow and Glasgow University Sport.

Who has reviewed the study?
This study has been reviewed and approved by the College of Medical, Veterinary and Life Sciences Research Ethics Committee at the University of Glasgow.

Contact for Further Information

Kathryn Bleakney	Tel:	Email: k.bleakney.1@research.gla.ac.uk
Victoria Penpraze	Tel:	Email: Victoria.Penpraze@glasgow.ac.uk

Thank you for taking the time to read this information sheet and for participation in the focus group should you decide to participate.

Please keep a copy of this information sheet and a signed consent form should you wish to take part.

8.3 Focus Group Participation Consent Form

University of Glasgow | College of Medical, Veterinary & Life Sciences

CONSENT FORM for FOCUS GROUP

Assessing and Understanding the Relationship between Physical Activity and Mental Wellbeing in Postgraduate students studying at the University of Glasgow.

Name of Researcher(s): Kathryn Bleakney, Victoria Penpraze, Elizabeth Adams and Julie Hughes.

Please initial box

I confirm that I have read and understand the information sheet dated 12th Jan 2018 (version 1) for the above study and have had the opportunity to ask questions.	☐
I understand that my participation in the focus group is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected.	☐
I agree to take part in a focus group for this study.	☐

Name of subject	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

(1 copy for subject; 1 copy for researcher)

8.4 International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days.** Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   No vigorous physical activities → **Skip to question 3**

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?
   _____ hours per day
   _____ minutes per day
   □Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ days per week
   No moderate physical activities → **Skip to question 5**

4. How much time did you usually spend doing **moderate** physical activities on one of those days?
   _____ hours per day
   _____ minutes per day
   □Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ **days per week**
   No walking → **Skip to question 7**

6. How much time did you usually spend **walking** on one of those days?
   _____ hours per day
   _____ minutes per day
   □Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ hours per day
_____ minutes per day
□Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

8.5 Warwick Edinburgh Mental Wellbeing Scale

Below are some statements about feelings and thoughts.

Please tick the box that best describes your experience of each over the **last 2 weeks**.

Statements	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future					
I've been feeling useful					
I've been feeling relaxed					
I've been feeling interested in other people					
I've had energy to spare					
I've been dealing with problems well					
I've been thinking clearly					
I've been feeling good about myself					
I've been feeling close to other people					
I've been feeling confident					
I've been able to make up my own mind about things					
I've been feeling loved					
I've been interested in new things					
I've been feeling cheerful					

8.6 Physical Activity Monitor Diary

University of Glasgow | College of Medical, Veterinary & Life Sciences

Mental Wellbeing and Physical Activity in 1st Year University of Glasgow Postgraduate Researchers.

Physical Activity Monitor Diary
Subject Number: _____
Date of Device Monitoring: _____

Please fill out this table when you remove your device and reason for removal.
Devices should only be removed;

- When sleeping
- When showering/bathing
- Swimming

Date	Time of Removal	Reason for Removal	Time of Device Replacement

8.7 Focus Group Semi-Structured Question Guide

Table 19: Focus group semi-structured question guide

Question Type		Question(s)
Opening		• Can I ask that you introduce yourself briefly to the group and what you are studying?
Definitions/Perceptions	Main	• **What does physical activity mean for you?** • **What does exercise mean for you?** • **What does sport mean for you?**
	Potential follow up	• Do you think there is any difference between these terms? • Do you consider housework, home remodelling, gardening etc physical activity or exercise? • Can you give some examples of what you consider physical activity?
Benefits	Main	• **How do you feel about yourself when you are active?** (probe for physical & psychological) • **How do you feel about yourself when you are not active?**
	Potential follow up	• What about physically? • Is there anything specific to being active that helps you in your university life?
Barriers	Main	• **What stops you/prevents you from being physically active?** (probe for internal and external suggestions (e.g. internal – feelings, beliefs, personal traits. external – family, friends, resources etc)
	Potential follow up	• How does your university life impact on being active? • What would help you to be more physically active? • What could the UofG do to help you be more active in everyday life?
Motivations	Main	• **For you personally what motivates you to be physically active?**
Facilities/Opportunities to be Active	Main	• **What facilities are you aware of that you can access to be active, exercise/ play sport as a student at the UofG?**
	Potential Follow Up	• Do any of you have memberships with UofG sports facilities? • If so, what do you think of the facilities provided? Have you attended classes/ drop-in sessions? • Do any of you have memberships with private gyms? • What is important for you when choosing a gym? • Has anyone attended the UofG daily mile or the PGR walk? Or heard/seen these advertised on social media/campus? What stops you from attending? • Do any of you play sports with GUSA affiliated teams? Many PGRS in GUSA teams? Sports Freshers Fayre? • Do any of you actively travel to and from University? i.e. walk/cycle to University? (Glasgow Uni Next Bikes?)
University-Related		• As a university do you think UofG is encouraging you to be active? • What could the UofG do to help you be more active in everyday life? • When you began your PGR studies was there ever anything sent to you about importance of PA for health? Anything in your induction day?
Ending		• Has anyone got anything else they would like to add before we finish up, any last thoughts or opinions?

8.8 Summary Tables for Qualitative Focus Group Dimensions

Table 20(a): A summary table of dimension 1 (Physical Activity Definition) and dimension 2 (Sport and Exercise Definition) and their respective higher order themes and selected illustrative quotes of 1st Year PGR students who participated in qualitative focus groups (n=6) (*PA: Physical Activity).

Dimension	Higher Order Themes	Selected Illustrative Quotations
PA Definition	Uncertainty whether walking is PA	• *Participant 3: "… if I take the time to get up from my desk and go for a walk I still consider that as being active... Yeah, I would say that walking would count."* • *Participant 6: "For me, personally walking to and from somewhere I don't class that as physical activity it's just general movement..."* • *Participant 5: "… I don't really register that, I don't think you know I'm walking from the car I better get in my [physical activity] …"*
	Movement focused	• *Participant 5: "…physical activity technically is the movement of the body…"* • *Participant 4: "I think the physical activity is focused more on the movement"*
	Frequency	• *Participant 6: "… routine physical thing that you repeat like again and again and again on a regular basis."*
Exercise & Sport Definition	Physical stress	• *Participant 3: "…I would say that anything that gets your heart rate up…"* • *Participant 2: "Yes, that's right, eh I would agree it involves being… actually putting physical stress eh on yourself…"*
	Structured and specific	• *Participant 1: "…a set kinda thing that you've thought about doing."* • *Participant 3: "…something that involves a specific activity so for me that would be running but for you (participant 1) maybe that's going to training and playing football."* • *Participant 3: "I saw it more on a scale that sport is the most structured form of exercise even though exercise is a more structured form of physical activity maybe."* • *Participant 3: "…I like to run and that involves doing either like 5 or 10Ks and then I'm training for a half marathon so that's the exercise that I do."*
	Intent	• *Participant 1: "…a set kinda thing that you've thought about doing."* • *Participant 6: "Intentful physical activity. [Laughter]. Mentally register doing it."*
	Contains PA	• *Participant 5: "Yeah, I think exercise and sport they just sound like a lot more intense than physical activity, but I guess they all kind of come under the physical activity bracket."* • *Participant 6: "For me, I think both exercise and sport contain physical activity in them but I think there's other classifications that go onto them as well and so it's a component but it's not necessarily the whole thing."*
	Involves other factors	• *Participant 5: "…sports got that kind of competitive edge to it."* • *Participant 6: "Different kind of like mental and communicative kind of things that come into it as well…"* • *Participant 3: "…I think sports and exercises link more to professional side, like trainers or gyms."*

Table 20(b): A summary table of Dimension 3 (Barriers to Physical Activity), higher order themes, sub-themes and selected illustrative quotes of 1st Year PGR students who participated in qualitative focus groups (n=6) (*PGR: Postgraduate Research; UG: Undergraduate).

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Barriers to PA	PGR Studies	High workload	• *Participant 1: "Doing that definitely, was just so busy with it as well ehm doing my internship so that definitely stopped me being as active."* • *Participant 2: "…a heavy work schedule… if you've had an extremely long day you're just tired and can't seem to fit it in."* • *Participant 3: "I think when I've got deadlines I maybe am less active."*
		Working hours	• *Participant 6: "…for me it's like work or work hours depending on when I have lab time booked so when you can get in when you can't, you've got to work around it."* • *Participant 6: "…certain times when we can use certain equipment… use it before building works start or finish so you're working really really odd hours so that you're not actually not sort of ruining your experiment."* • *Participant 5: "…work from 7.30am in the morning to you know latest 9pm."* • *Participant 6: "…research it's more like a 9-5 job, so you need those hours before and after to be able actually use the thing (gym)… cause you're not actually going to stop when you're running a lab experiment say and it's an 8 hour lab experiment, you're not going to leave half way through to go to the gym. You just can't…. that's the time of day when people expect to be able to contact you as well, so… you need to be contactable for your supervisors and things like that because that's when you're going to get the help. So… you're less inclined I would say to take 2 hours at 2pm in the afternoon to do it because it's actually interruptive to the work that you are doing and it's I guess your priority list. But for me, my PhD has to come first."*
		Conferences/travelling	• *Participant 6: "…when you're travelling to conferences and things like that it's the ability to access equipment…"* • *Participant 3: "…weekend I was away somewhere at a conference or something that I couldn't exercise…"*
		Later start dates than UG students	• *Participant 6: "Postgraduates tend to start a lot later… so they don't tend to arrive as early."* • *Participant 4: "…problem is my accommodation only starts one week after so I have to like miss it (Sports & Freshers Fayres)."* • *Participant 5: "…I missed the induction…because my start date… it was after all those fayres and things."* •

Table 20(b) Continued

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Barriers to PA	University of Glasgow Sport Gym	Unexpected gym closures/ summer class cancellations	• *Participant 6: "…way you walk in and like its shut for the day and there's no kind of… ahm like the Stevenson is really chronic for it being like oh the gyms shut today but there was no message to say. You're mentally prepared to go do something and then you get there and it's like oh…. And you just feel so down for the rest of the day."* • *Participant 4: "…second one is especially in the summer vacation, so many courses are cancelled in the gym…"* • *Participant 3 "…changed the timetable recently so there's a lot less classes, there's a lot fewer yoga classes than there used to be which is disappointing…"* • *Participant 4: "…in the summer vacation, so many courses are cancelled in the gym… So, the courses I love they cancelled it…. Like dance classes. There used to be four a week but for now there are only two."*
		Classes full/equipment unavailable	• *Participant 3: "…sometimes what stops me is if I go to the gym and its really busy and you can't get on a treadmill or a class is full or something like that and then it's just too much hassle."* • *Participant 1: "…sometimes I cut my session short as well cause if I'm on the treadmill then and I want to do something on the mat or stretching or core work and if there's no room I tend to just go home."* • *Participant 4: "…swimming pool they have all kinds of club exercises during certain hours so sometimes… we can't go there."* • *Participant 5: "Although again if you go during a busy time it's…. you're kind of fighting for weight lifting space…"*
		Opening hours	• *Participant 6: "See, I like the fact that the Stevenson is now open from 6.30am in the morning because beforehand when it was only open at 7am that's really late…"* • *Participant 5: "…it's not open that late in the evening either… I actually really like exercising at like 10pm at night so especially on weekends as well like Saturdays it closes really early."* • *Participant 6: "It opens at 9...I'm at work by then so that cuts out… I can't swim on a morning on those days and then I don't finish work until sort of 10pm at night and it's closed again."*
	PGR Walk Barriers	Location	• *Participant 1: "…easier if I'm just in my flat to do the walk myself instead of making it all the way up to uni to walk."* • *Participant 4: "…meet up in front of the Gilchrist café so it is a little bit far away from my office."*
		Belief that walk is more social than physical	• *Participant 6: "…walk is advertised more as a social thing than a physical thing."* • *Participant 3: "…I'd rather do something like cardio and I feel that as a PhD student you get a lot of opportunities to sit with other PhD students and chat small talk and in general about your research and I wouldn't want to spend time doing that in a walk."* • *Participant 1: "… I wouldn't want to walk in a group because I usually go for walks to clear your head and if you're in a group you have to make conversation with people."*

Table 20(b) Continued

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Barriers to PA	Lack of information/ awareness of opportunities		• *Participant 6: "…postgraduate level when you're coming in you don't really get told anything more related to the social side or sporting side of the university, it's all educational. Like how your department works, what they expect for your thesis, that kind of thing."* • *Participant 1: "I haven't heard of the postgraduate one (PGR walk)."* • *Participant 2: "I can't remember anything… on the induction day last year."* • *Participant 5: "…haven't heard of the walk (PGR walk)."* • *Participant 5: "It kind of sounds like the uni almost expects you to be an undergrad student like you've already experienced where everything is and what's available so it's almost like they've kind of expected you guys to know… as a postgrad I don't feel like I've been given any extra information that… I didn't get as an undergrad so it's almost like you guys have missed out on that."* • *Participant 6: "You kind of have to ask people and usually the people you find it out from are the people who were undergraduates."* • *Participant 3: "…because I've studied here before and I know what's here. But I think as well… that at this level or at this age it's more our own responsibility…to be seeking out the physical activity rather than the university ehm making it part of the student lifestyle at this level because research is different from doing your undergrad."*
	Undergraduate focused		• *Participant 4: "…so many courses are cancelled in the gym because they were like mostly served for the undergraduates, so they are not thinking about us."* • *Participant 6: "…I think the gym here at least is more set up for undergraduates to pop in and out between classes…"* • *Participant 5: "I think a little more needs to be done in focusing on postgrads."* • *Participant 1: "…postgrads not really encouraged as much as you are in your first year of uni…" (GUSA)*
	Financial		• *Participant 6: "I just can't afford to pay to just go into the gym. There's a financial thing as well."* • *Participant 6: "I don't like that a lot of the classes you have to pay extra for…. I'm not likely to go actually to attend something if I have to pay more money cause I just can't afford that."* • *Participant 5: "Yeah, I would definitely say financial as well. Well where I work I have a gym there, so I can use it for free but now that I've finished my internship and coming back to spend more time in the library and I will join the gym again the one in the Stevenson building so yeah I think it's a financial thing as well."* • *Participant 6: "I couldn't afford the £25 (to upgrade to peak gym membership)."*

Table 20(b) Continued

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Barriers to PA	Seasonality & weather		• *Participant 1: "Also, time of year as well that would stop me because whenever I was in Lennoxtown I would work until 5pm and I would get home and it was dark and didn't want to go out and do anything but now it's still light until 10pm and the weathers good you want to go out and make the most of it. Even if it is just for a walk."* • *Participant 3: "…recently the fact that it has been so hot I've been more reluctant to exercise because I already feel so hot that I don't want to get to feel any hotter."*
	Menstruation		• *Participant 4: "First one is the period…"* • *Participant 3: "…time of the month…"*
	Personal characteristics		• *Participant 1: "Sort of in my head maybe just not motivated enough myself…"* • *Participant 2: "My own inherent laziness I suppose…"*

Table 20(c): A summary table of Dimension 4 (Benefits of Physical Activity), higher order themes, sub-themes and selected illustrative quotes of 1st Year PGR students who participated in qualitative focus groups (n=6) (*PGR: Postgraduate Research).

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Benefits of PA	PGR Study & Work *Participant 3: "I think being physically active is beneficiary for our PhD life."*	Improved mental alertness	• *Participant 6: "...so mentally I'm so much more alert…"*
		More productive	• *Participant 6: "I think it just makes you more efficient, I think because you're more alert you're not taking as long to do a lot of the general things and you… I find when I'm not I tend to push things off whereas it's more I'm going to get it done so I have time to do this."*
		More motivated	• *Participant 5: "Yeah it does make me more motivated… if I have spent that period of time being active or in the gym doing something to then go and sit down and you know focus."* • *Participant 6: "…more driven…"*
	Health Benefits	Positive Mental Health	• *Participant 4: "…key thing to make me happy… as long as I'm taking exercises I feel happy and my pressure goes away."* • *Participant 3: "Eh I think not just when I'm exercising but it makes me feel so much better in the aftermath that it clear's my head and I recognise that it is so beneficial to my mental wellbeing that it's often a stress relief that if I feel myself getting to a certain point of stress and I'll think I need to just remove myself and go for a run."* • *Participant 5: "I do feel happier when exercising."*
		Positive Physical Health	• *Participant 2: "I feel pushes your sort of pushes my eventual demise that bit further away or ensures that I believe that I have that bit better quality of life."* • *Participant 4: "…I feel more energetic…"* • *Participant 4: "…being fit, slim, healthy yeah."* • *Participant 3: "…when doing my PhD because I spend so much time trying to keep my brain functioning at such a high level can be really nice to then go for a run and then do that with my body instead and push myself that way so it's a way of feeling alive."*
	Benefits Post-Exercise		• *Participant 1: "Yeah, but after it you see the benefits more, feel the benefits of it."* • *Participant 3: "…makes me feel so much better in the -aftermath…"* • *Participant 4: "…I feel more energetic like after I do sports…"* • *Participant 5: "…at the time it's sort of hard but I do love it… especially afterwards."* • *Participant 6:" Afterwards though afterward when you get out."* • *Participant 4: "…even when I'm like it's been a struggle to get into the gym, it's… I feel better afterwards."*

Table 20(c) Continued

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Benefits of PA	Accumulation of Benefits		• *Participant 6: "I think for me when doing physical activity, it's not necessarily the immediate after effects…it's not something that you pick up instantaneously from doing it but it's from continual like physical activity over long periods of time that you start seeing the… it's that suitable build up…"* • *Participant 4: "…it's a gradual process…"*

Table 20(d): A summary table of Dimension 5 (Motivations for Physical Activity), higher order themes, sub-themes and selected illustrative quotes of 1st Year PGR students who participated in qualitative focus groups (n=6) (*PGR: Postgraduate Research).

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Motivations for PA	Health Benefits		• *Participant 6: "I think being in academia you do a lot of mental work and for me I need that physical work to actually balance out the amount of mental work that I'm doing so that I stay healthy like physically and mentally."* • *Participant 4: "…good sleep and being fit, slim and healthy yeah."* • *Participant 5: "Ehm motivations, probably a lifestyle thing so that I have a good balance with work, keeping myself healthy ehm mentally and physically."*
	Balance out unhealthy eating habits		• *Participant 3: "…I really enjoy my food and eat quite a lot of biscuits so obviously more than I should a lot of times so I feel like if I've done that then it's important for me to go exercise."* • *Participant 1: "Sort of justifying eating more chocolate cause I know that I'm going to training tonight and going to go for a run."* • *Participant 5: "Being able to eat what you want."* • *Participant 4 "Less guilty (about what eating)."*
	Image		• *Participant 4: "…being fit, slim, healthy yeah."* • *Participant 1: "…sometimes I get it in my head that I feel fat so I need to go and run and do something even though it's probably just all in my head…"* • *Participant 5: "I've always known my body to be sporty if that makes sense like in a general term. So, I feel when I am doing exercise that I'm still contributing to that like I like to maintain my body in a certain way."*
	Sleep		• *Participant 6: "I think my number one is to actually sleep properly. Cause I know when I don't, I don't sleep properly and my whole life just kind of down spirals from there."* • *Participant 4: "...good sleep…"*
	Social Interaction		• *Participant 2: "I've never been terribly keen on gyms because they are… it's a very solitary activity and I used to enjoy Scottish country dancing, so as long as you are in a set of people at the same level of competence as you are, then it is great fun."* • *Participant 1: "I always go to my training cause I'm committed to the team, so I'll always do that, but if there's a day that I'm off and I'm not training I think aw I should go for a run or if I'm just sitting on the couch. Sort of in my head maybe just not motivated enough myself, but when it's a team environment I won't miss it…"*

Table 20(d) Continued

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Motivations for PA	PGR Study/Work	Work Life Balance	• *Participant 6: "…for me it's the ability to actually do my work…"* • *Participant 5: "…motivations, probably a lifestyle thing so that I have a good balance with work…"* • *Participant 1: "…it allows me to have a good work-life balance… so I'm not just a PhD student but I have interests and hobbies and other things I would like to pursue and do well at."*
	External factors	Childhood/Parents	• *Participant 6: "… I'm really lucky my mum sort of pushed me she was like you're going swimming now…"* • *Participant 2: "…growing up in a lot of sport."*
		Occupation	• *Participant 2: "I spent six and a half years as an army officer and em it was very important that army officers be fit otherwise your promotion gets scuppered."* • *Participant 1: "… because when I work with athletes, you really know how they are feeling in a way, so when I'm asking how ehm what do they rate their training session then I can really understand the physiological aspects of it cause I know myself what it involves."* • *Participant 5: "…almost like my job, so eh my eh degree is in Physiology and Sports Science so understanding all how the body works and changes with sport and physical activity…"*
	Age		• *Participant 2: "Well, for me at my age physical activity is simply remaining mobile ehm it was very much more important to me in my early adulthood…"* • *Participant 1: "I suppose maybe at this age you've already kind of of chosen if you're going to be active or not. Do you know what I mean? Usually when you're kind of a bit younger you could be persuaded to do it but once you maybe get to a certain age you know you nearly know yourself if you're… if you enjoy being active or if you enjoy playing sports…"*

Table 20(e): A summary table of Dimension 6 (Impact of Inactivity), higher order themes, sub-themes and selected illustrative quotes of 1st Year PGR students who participated in qualitative focus groups (n=6).

Dimension	Higher Order Themes	Higher Order Sub-Themes	Selected Illustrative Quotations
Impact of Inactivity	Poor Health	Poor Mental Health	• *Participant 6: "…when I was doing my masters research I wasn't as active as I am consciously doing for my PhD and I know that towards the end of that I ended up in a really dark dark place so mentally I was not good."* • *Participant 5: "Yeah and probably not as happy either."* • *Participant 1: "I feel quite bad…"* • *Participant 5: "…my mind… is lethargic as well…"* • *Participant 6: "…don't switch off (mind)."* • *Participant 6: "…you wouldn't recognise until all of a sudden it's missing. And then it's like this big void and you're like why do I feel like rubbish?"* • *Participant 3: "…that I couldn't exercise and it was almost frustrating me that I hadn't got my heart rate up so it just becomes part of everyday life for me and part of my routine and when I can't do it, it's really frustrating."* • *Participant 5: "Yeah, no I feel the exact same. Like if you've had a couple of… that period of time whenever maybe you haven't eaten the best and you haven't exercised it makes me feel nervous as well… if I go on holiday and I haven't exercised and you've just kind of been eating what you want as well then… it makes me nervous that I've not exercised. I'm dying to get home and go back to the gym."* • *Participant 4: "I think for me, I will feel quite nervous for not doing it regularly especially when I was in a very like busy schedule and not eating that healthy, too much sugar and junk food and see my weight and I will feel very nervous and I think I really need to go like do sports as soon as possible that make me feel relaxed."*
		Poor Physical Health	• *Participant 5: "…my body just feels like lethargic and yeah just not as energetic…"* • *Participant 3: "Sluggish."* • *Participant 4: "I think for me, I will feel quite nervous for not doing it regularly especially when I was in a very like busy schedule and not eating that healthy, too much sugar and junk food and see my weight and I will feel very nervous and I think I really need to go like do sports as soon as possible that make me feel relaxed."*

8.9 Difference between IPAQ and ActiGraph GT3X as Measurement Tools

Figure 11: Scatterplots of IPAQ self-report variables (MVPA (mins/week) and sitting time (hours/day)) against corresponding ActiGraph GT3X objectively assessed variables (ActiGraph predicted MVPA (mins/week) and sedentary time (hours/day)) for 1st year PGR students (n=20) randomised to the sub-cohort. Lines represent line of equality.

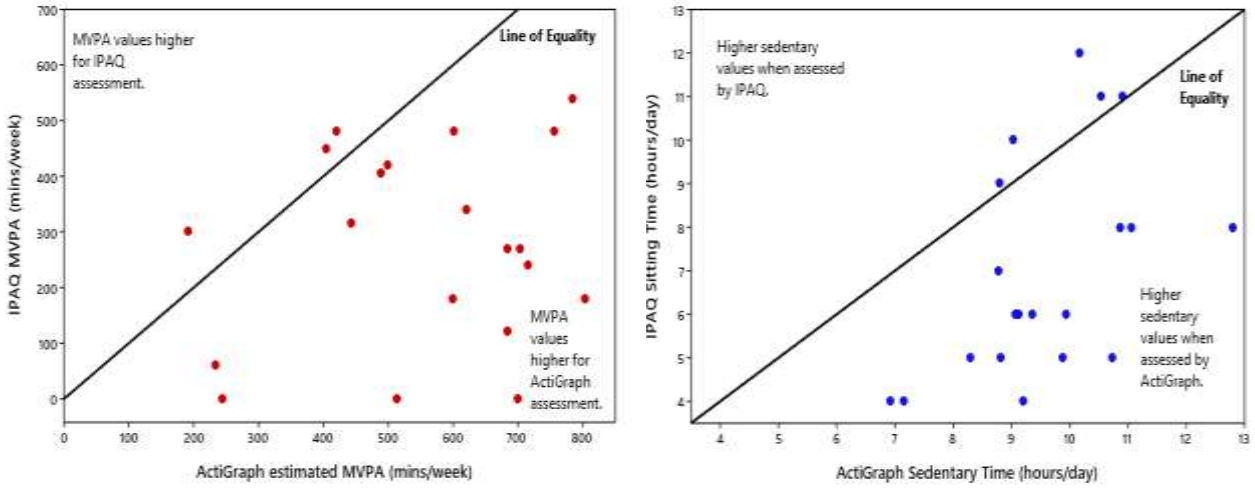

Table 21: Results from formal analysis (paired t tests) comparing MVPA and sedentary time measured by two different measurement tools (IPAQ and ActiGraph GT3X) for the randomised sub cohort of 1st year PGR students (n=20). Data are presented as mean ± standard deviation.

	N	IPAQ	ActiGraph GT3X	Mean Difference (IPAQ – ActiGraph GT3X)	95% CI	P Value
MVPA (mins/week)	20	276.5 ± 175.9	554.3 ± 187.1	-277.8 ± 234.8	(-387.7, -168.0)	0.000
Sedentary Time (hours/day)	20	7 ± 2.51	9.57 ± 1.38	-2.57 ± 2.17	(-3.58, -1.55)	0.000