PAAH
PHYSICAL ACTIVITY AND HEALTH

A Comparison of Physical Activity and Sedentary Lifestyle of University Employees through ActiGraph and IPAQ-LF

RESEARCH

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ABSTRACT

Introduction: The benefits of participating in physical activity (PA) are wide-ranging, such as lowering the risk of diabetes and anxiety. Employees' engagement in PA can also benefit their employers due to the potential reduction in absenteeism and increased productivity. However, the PA levels and sedentary behaviour of university employees are yet to be examined using a mixed methods approach. This study aimed to monitor the PA and sedentary lifestyle (SL) of university employees' objectively and subjectively for a whole week.

Methods: Sixty-four employees (male = 33; female = 31) wore a PA monitor for a whole week and simultaneously completed the International Physical Activity Questionnaire Long Form (IPAQ-LF) to evaluate light, moderate to vigorous physical activity (MVPA), and SL amongst employees from different job roles such as Academics, Administration, and Professionals Service.

Results: The ActiGraph results determined that employees engaged in significantly more light PA, and MVPA compared to the self-reported IPAQ-LF ($p < 0.05$). There were no significant differences in SL between ActiGraph and IPAQ-LF ($p > 0.05$). However, there were significant differences across gender light PA $Z = -6.139$, $p = .001$, MVPA $Z = -4.962$, $p = .001$ but no significant differences in SL $Z = -.869$, $p = .385$. Also, there were significant differences across job roles light PA, MVPA ($p < 0.05$) but no significant differences in SL across job roles between both tools ($p > 0.05$).

Discussion and conclusion: Findings suggest, IPAQ-LF presented lower light PA, MVPA, and SL than ActiGraph. Thus, considering the impact of prolonged SL on health and wellbeing, future research is needed to explore the challenges this population faces regarding PA engagement and propose potential interventions to reduce SL amongst university employees.

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INTRODUCTION

The benefits of participating in regular physical activity (PA) and reducing sedentary behaviour are wide-ranging, such as lowering the risk of coronary heart disease, diabetes, obesity, musculoskeletal disorders, anxiety, and depression (Church et al., 2011; Griffiths et al., 2012; Kelley et al., 2018; Rebar et al., 2015; Van Uffelen et al., 2010). Despite the well-documented health and wellbeing benefits, employees engagement in PA can also benefit their employers' and organisations due to the potential reduction in absenteeism, increased productivity, and economic growth (Bouchard et al., 2012; Manini et al., 2015; Pereira et al., 2015; Reed et al., 2014). According to the latest figures from the Office of National Statistics (ONS, 2020), approximately 119 million working days were lost due to the sickness absence in the UK. The main reasons for absence included cough, flu, musculoskeletal problems, and mental health conditions (e.g., stress, depression, and anxiety; ONS, 2020). Previous research has established that participating in regular PA can lower the risk of all causes of morbidity (Church et al., 2011; Griffiths et al., 2012). More recently research has concluded that PA promotions strategies can reduce the absenteeism at university settings (Lopez et al., 2020). Therefore, research focused on employees PA and sedentary behaviours may improve presentism and better working environments, thus improving company growth and staff health and wellbeing.

There are 162 higher educational institutions (HEI) in the UK with over 378,000 members of staff with a range of job roles (Dooris et al., 2017). HEI play an essential role in shaping and developing citizenship and societal changes (Dooris et al., 2017). However, PA and sedentary behaviour related research focused on HEI context is considerably rare, and this could be one of the reasons for lack of understanding concerning the diverse job roles (e.g., academic, professional services and administrative staff) across university settings, with the majority of the existing research merely focused on academic staff (McEwan, 2013). Moreover, previous literature focused on HEI employees PA and sedentary lifestyle (SL) has identified this population as a homogeneous group. Thus, current research outcomes may not be applicable to the broader sector of this environment (Adlakha et al., 2015; Butler et al., 2015; Cooper & Barton, 2016). More specifically, job roles in a HEI environment can substantially differ in terms of flexibility and autonomy of working practices and the physical job demands. For instance, administration staff may be required to be present at their desk in a sedentary position with a little autonomy because of their job demands. In comparison, estate staff may be required to move around the building more frequently to execute more physical tasks. Thus, it is important to consider the HEI employees as a heterogeneous regarding gender and job roles when it comes to PA and SL.

Previous research has predominantly applied subjective (e.g., self-reported) methods and failed to evaluate the baseline PA and SL of employees prior conducting PA interventions (Bernaards et al., 2007; Davis et al., 2011). Although using the self-reported methods are easy to complete and are cost effective, they come with some limitations, such as relying on individual's memory to recall every activity, bias of either over- or under-estimation of the actual PA and SL (Craig et al., 2003). Therefore, research suggested that objectively monitoring PA and SL can represent a more accurate representation of PA and SL behaviours (Bevier et al., 2020; Schaller et al., 2016). For instance, previous research which compared accelerometer and self-reported measures concluded that accelerometers demonstrated lower PA levels and sedentary behaviour compared to self-reported data (Cradock et al., 2004; Peterson et al., 2015). Moreover, Miyachi et al. (2015) collected PA and SL data through accelerometer for a whole week and concluded the accelerometer was the most appropriate tool for evaluating the existing PA levels and sitting times. Therefore, combining ActiGraph and IPAQ-LF to assess university employees PA levels and SL may provide an accurate insight about their PA and sedentary behaviours.

Research has suggested collecting data through the combination of methods provide a more accurate representation of the time, PA, intensity, and sedentary behaviour (Dubbert et al., 2004; Sylvia et al., 2014; Taraldsen et al., 2011; van der Ploeg et al., 2015). Therefore, previous research has recommended the use of combining tools rather than using single method (Brannen and Moss, 2012; Smith et al., 2017). Indeed, a mixed-methods approach of objectively and subjectively measuring PA and SL specifically in university employees across gender and job roles are lacking. Therefore, the primary aim of this cross-sectional study was to monitor the university employees' PA and SL objectively across a whole week based on job role and gender. The secondary aim of this research was to attain a greater insight into the

potential differences between accelerometer and IPAQ-LF tools undertaken in this study when recordings PA and SL. Drawing from the recent research by Safi et al. (2021) it was hypothesised that male employees would engage in more PA than females. It was also hypothesised that university staff such as academic would participate in more PA compared to office-based roles such as professional services and administrative staff.

METHODS

PARTICIPANTS

Following an institutional ethical approval, a total of 64 employees (male = 33; female = 31) volunteered to participate in this study. ***Table 1*** provides a summary of the participants per job roles and genders.

Table 1 The breakdown of participants according to gender and job roles.

JOB ROLES	PARTICIPANTS	FEMALES	MALES
Academics	25	11	14
		44%	56%
Administrative Staff	20	13	7
		65%	35%
Professional Services	19	7	12
		37%	63%

MEASURES AND PROTOCOLS

The accelerometer used in this study was the ActiGraph wGT3X-BT, which is a valid and reliable monitor for measuring PA and SL (Aggio et al., 2015; Trost and Tudor-Locke, 2014). More information about the ActiGraph wGT3X-BT and its manufacturer can be found from this link: *https://actigraphcorp.com/support/activity-monitors/wgt3x-bt/*. The sampling rate in this study was set to 100 hertz, as a sampling rate of <100 hertz cannot suitably sum or collect short bursts of activities (Brønd and Arvidsson, 2015; Sasaki et al., 2016).

The raw data of ActiGraph converted into counts and then epochs are quantified for identifying the intensity of activities such as light PA, MVPA, and sedentary behaviours for data analysis purposes (Hart et al., 2011; Rowlands and Stiles, 2012; Sasaki et al., 2016). The present study applied the commonly used cut-off points that defined sedentary behaviour from 0–99 counts per minute (CPM), light from 100–1951 CPM, moderate from 1952–5724 CPM, vigorous from 5725–9498 CPM, and anything higher than 9499 CPM are classified as very vigorous (Freedson et al., 1998). Previous research has applied and supported the use of Freedson et al. (1998) cut-off points for SL and PA intensity identification (Hart et al., 2011; Healy et al., 2008; Lyden et al., 2011; Sasaki et al., 2016; Sasaki et al., 2017; Sirard et al., 2011; van Berkel et al., 2013). Participants in this study were informed to wear the monitor on the wrist to aid adherence and as comparative results against other locations suggest the wrist provides more accurate representation of the PA and SL (Diaz et al., 2018; Dieu et al., 2017; Ellingson et al., 2017; Koster et al., 2016; Troiano et al., 2014).

For PA and sedentary behaviours data to be considered valid and reliable, the participants must wear the monitor for several hours each day (Sasaki et al., 2016). The criteria for wear time differs across studies, which could be due to the variables of interest. Nevertheless, most of the large-scale studies have reached a consensus that a minimum of three days of objective monitoring is required for consistent prediction of PA and sedentary behaviours (Aadland and Ylvisåker, 2015; Choi et al., 2012; Matthews et al., 2012; Park, 2017; Sasaki et al., 2017; van Berkel et al., 2013). Therefore, the minimum inclusion criteria for participants' data to be included in this study were three days, with ten hours of wear time each day or 1800 minutes' worth of data across the whole week. Participants were instructed that these 10 hours' needs to be during the wakeful part of the day and at work.

After returning the ActiGraph participants were sent an online survey the IPAQ-LF to record their PA and SL subjectively as outlined in ***Figure 1***. Previous research has applied the IPAQ-LF and reported that it is the most valid and reliable instrument for measuring PA levels and SL across a range of domains (Craig et al., 2003; Gustafson and Rhodes, 2006; Haskell et al., 2007). Furthermore, recent studies have compared the validity of the IPAQ-LF to accelerometers and demonstrated an acceptable level of reliability in measuring PA patterns in adults (Cleland et al., 2018; Hagströmer et al., 2006; Wanner et al., 2016; Wrzesińska et al., 2018).

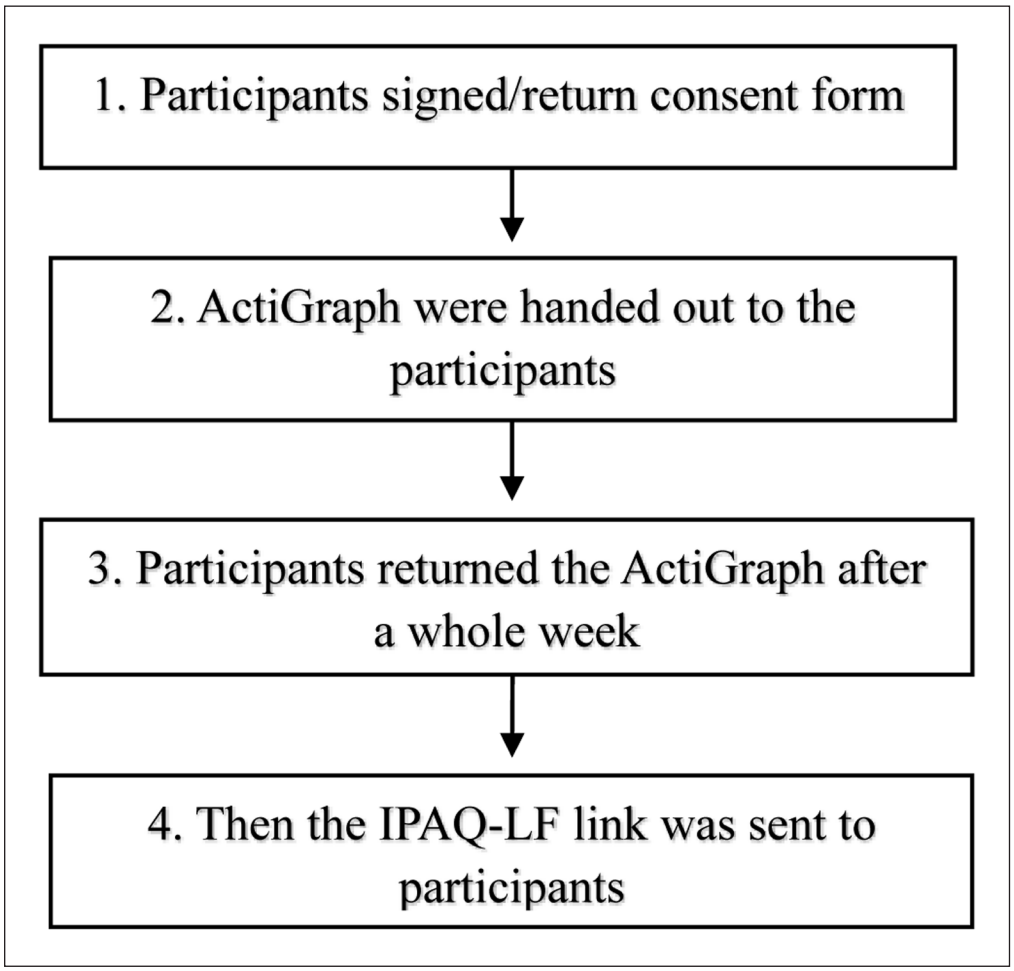

Figure 1 The procedure and experimental setup.

STATISTICAL ANALYSIS

DATA PROCESSING

Prior to the data analysis, participants were categorised according to gender (i.e., male and female) and job role (i.e., academics, administrative staff, and professional services). The ActiGraph data was downloaded via the ActiLife software as DAT and CSV excel for each participant and uploaded into the 'scoring' in ActiLife software for calculation before exporting. Similarly, responses to the IPAQ-LF's duration time in options were converted from hours into minutes as per the IPAQ-LF guidelines.

The statistical tests were conducted using IBM SPSS Statistics version 24.0 software (IBM Corporation, Armonk, NY, USA). First, the data comparison was conducted for genders and job roles within each method, followed by a comparison between ActiGraph and IPAQ-LF. The level of significance for analysis was set to ($p < 0.05$), and the data were reported as mean and standard deviation (SD). Time spent engaged in ActiGraph and IPAQ-LF light PA, MVPA, and sedentary behaviours were not normally distributed between gender as assessed by Shapiro–Wilke's test ($p < 0.05$). Therefore, a Mann-Whitney U test was conducted to determine differences between both tools light PA, MVPA and SL between genders. A Kruskal–Wallis H test was conducted to determine differences in ActiGraph and IPAQ-LF's light PA, MVPA, and SL between job roles. The Wilcoxon Signed-Rank test was also performed to evaluate the

differences between ActiGraph and IPAQ-LF light PA, MVPA, and SL across gender and job roles. The Spearman's Rank-Order Correlation was also conducted to measure any association between the ActiGraph and IPAQ-LF light PA, MVPA, and SL.

RESULTS

The descriptive statistics of the mean, SD, and inferential statistical differences for total light, MVPA, and time spent sitting across genders in ActiGraph and IPAQ-LF are presented in ***Table 2***. The ActiGraph and IPA-LF results showed no significant differences between light PA, MVPA and SL amongst genders. However, there were significant differences between light PA $Z = -6.139$, $p = .001$ and MVPA $Z = -4.962$, $p = .001$ amongst gender, but no significant differences were found in SL $Z = -.869$, $p = .385$ when both tools were compared. Moreover, there were no significant differences between light PA, MVPA, and SL between ActiGraph and IPAQ-LF amongst job roles (***Table 3***). However, the comparison of both tools demonstrated significant differences between job roles light PA and MVPA, but no significant differences were found in SL between job roles when both tools were compared (***Table 4***).

Table 2 Descriptive statistics and statistical differences of ActiGraph and IPAQ – LF light PA, MVPA, and sedentary behaviour in minutes between genders and both tools.

Note: IPAQ-LF = International Physical activity Questionnaire Long Form; PA = Physical activity; MVPA = moderate to vigorous physical activity and mins = minutes.

		TOTAL	MALE	FEMALE	
TOTAL	**COMPONENTS**	**MEAN (*SD*)**	**MEAN (*SD*)**	**MEAN (*SD*)**	***INFERENTIAL STATISTICS***
ActiGraph	Light PA (mins)	1784 *(1007)*	954 *(534)*	830 *(473)*	$U = 446.000$, $z = -0.880$, $p = 0.379$
	MVPA (mins)	1593 *(1106)*	856 *(607)*	737 *(499)*	$U = 464.000$, $z = -0.638$, $p = 0.523$
	Sedentary time (mins)	5592 *(2695)*	2670 *(1403)*	2922 *(1292)*	$U = 467.000$, $z = -0.598$, $p = 0.550$
IPAQ-LF	Light PA (mins)	747 *(637)*	349 *(311)*	398 *(326)*	$U = 582.000$, $z = 0.948$, $p = 0.343$
	MVPA (mins)	792 *(754)*	372 *(332)*	420 *(422)*	$U = 521.000$, $z = 0.218$, $p = 0.898$
	Sedentary time (mins)	4989 *(4739)*	2595 *(2359)*	2394 *(2380)*	$U = 569.500$, $z = 0.780$, $p = 0.436$
ActiGraph & IPAQ-LF	Light PA (mins)				$Z = -6.139$, $p = .001$*
	MVPA (mins)				$Z = -4.962$, $p = .001$*
	Sedentary time (mins)				$Z = -.869$, $p = .385$

Table 3 Descriptive statistics and statistical differences of ActiGraph and IPAQ –LF light PA, MVPA and sedentary behaviour amongst job roles.

Note: IPAQ-LF = International Physical activity Questionnaire Long Form; PA = Physical activity and MVPA = moderate to vigorous physical activity.

		ACADEMIC	ADMINIS-TRATION	PROFESSIONAL SERVICES	
TOOLS	**COMPONENTS**	**MEAN (*SD*)**	**MEAN (*SD*)**	**MEAN (*SD*)**	***INFERENTIAL STATISTICS***
ActiGraph	Light PA (mins)	920 (467)	882 (593)	872 (480)	$\chi2\ (2) = 0.647$, $p = 0.723$
	MVPA (mins)	876 (604)	692 (528)	809 (531)	$\chi2\ (2) = 2.684$, $p = 0.261$
	Sedentary time (mins)	2467 (2323)	2493 (2378)	2542 (2489)	$\chi2\ (2) = 0.258$, $p = 0.879$
IPAQ-LF	Light PA (mins)	385 (379)	426 (411)	374 (351)	$\chi2\ (2) = 0.803$, $p = 0.669$
	MVPA (mins)	792 (754)	372 (332)	420 (422)	$\chi2\ (2) = 0.897$, $p = 0.639$
	Sedentary time (mins)	2821 (1511)	2610 (1111)	2947 (1389)	$\chi2\ (2) = 0.439$, $p = 0.803$

Table 4 The statistical differences comparison of ActiGraph and IPAQ –LF light PA, MVPA and sedentary behaviour amongst job roles.

Note: IPAQ-LF = International Physical activity Questionnaire Long Form; PA = Physical activity and MVPA = moderate to vigorous physical activity.

ACTIGRAPH & IPAQ-LF INFERENTIAL STATISTICS			
	LIGHT PA	**MVPA**	**SEDENTARY TIME**
Academic	$Z = -4.278$, $p = .001$*	$Z = -3.404$, $p = .001$*	$Z = -.713$, $p = .476$
Administration	$Z = -3.342$, $p = .001$*	$Z = -2.165$, $p = .030$*	$Z = -.224$, $p = .823$
Professional Services	$Z = -2.736$, $p = .006$*	$Z = -2.938$, $p = .003$*	$Z = -.724$, $p = .469$

RELATIONSHIP BETWEEN ACTIGRAPH AND IPAQ-LF

Spearman's rank-order correlation analysis determined the relationship to be monotonic, from the scatterplot visually examined. There was no significant correlation between both tools light PA across employees, r_s (64) = 0.442, p = 0.098. However, there was a significant weak to moderate correlation between the ActiGraph and IPAQ-LF MVPA, r_s (64) = 0.321, p = 0.010. There was no significant correlation in ActiGraph and IPAQ-LF SL, r_s (64) = 0.047, p = 0.711. The Wilcoxon Signed-Rank test data showed significant differences between ActiGraph and IPAQ-LF light PA, z = –6.139, p = 0.0005. There were also significant differences in ActiGraph and IPAQ-LF MVPA, z = –4.962, p = 0.0005. However, differences between sedentary behaviour were not significant in both methods, z = 0.869, p = 0.385.

DISCUSSION

The primary aimed of this cross-sectional study was to monitor the university employees' PA and SL objectively and subjectively across a whole week based on their job roles and gender. The key findings from this study revealed that employees reported lower levels of PA and SL in the self-reported IPAQ-LF compared to the ActiGraph results between gender and job roles ($p < 0.05$). The lower levels of PA in the IPAQ-LF indicated that participants may not have considered reporting all activities, such as walking to a meeting, kitchen, or lecture room, as part of the PA. In comparison, the ActiGraph recorded all types of physical movements that may not have been captured by the IPAQ-LF. The additional reason for employees reporting an underestimation in the self-reported, light, and MVPA could be that IPAQ-LF did not regard activity conducted less than ten minutes; in contrast, the ActiGraph continually collected the data. Employees underestimating their time spent sitting in the IPAQ-LF compared to the ActiGraph may indicate the social desirability and recall bias (Fountaine et al., 2014). The current findings are in-line with previous research, suggesting that the self-reported methods underestimate findings because of the social desirability and individuals' ability to recall every activity and precise time (Fountaine et al., 2014; Malik et al., 2014).

Regarding the differences between genders being significant across both tools with the ActiGraph results showing male employees engaged in a higher amount of light PA, MVPA, and spent more time being sedentary than females. While the IPAQ-LF demonstrated that female employees engaged in a greater amount of light PA but also spent higher volume of time being sedentary. This is in-line with previous research suggested that social support, such as moving together in a walking group or engaging in less intense activities, were favoured by females, whereas males were more interested in high-intensity activities (Guthold et al., 2018; Morris et al., 2019). Although employees spent most of their time being sedentary and this was consistent between genders, the findings indicated that females were spending a substantial amount of time being sedentary, which could undesirably affect their health and wellbeing. Overall, the outcome of this study in line with previous research supports the hypothesis that male were more active than females (Lindsay et al., 2016; Olney et al., 2018; Sallis et al., 2016; Safi et al., 2021). Further investigation to rationalise the comparative differences and reasons behind the discrepancies reported by males and females are required.

The significant differences between job roles shows that academic staff engaged in greater light PA and MVPA than the administration and professional services staff. This could be due to the job roles of academics as they were more likely to conduct light PA through their daily responsibilities, including walking to and from the lectures, practical sessions, and student engagement activities (Safi et al., 2021). Whereas, the administration and professional services staff are required to be presented at their desk, which may contribute to their lack of engagement in light PA and MVPA. The current findings support the hypothesis demonstrating that academic staff spent more time being active compared to professional services and administrative staff. Although academic staff spent higher volume of time engaged in light and MVPA, they still appeared to be spending a large amount of their time being sedentary which is surprising results compared to professional services and administrative staff. Spending prolonged time sedentary could reduce work productivity, negatively affect mental health, and contribute to obesity (Puig-Ribera et al., 2015; Zhu et al., 2020). Thus, it is essential to consider potential work-related interventions to reduce sedentary behaviour.

The second aim of this study was to draw comparisons between the ActiGraph and IPAQ-LF. The findings demonstrated a distinct difference between both tools. For instance, the IPAQ-LF shows under-reporting the light PA, MVPA and SL. The differences were observed between both job roles and gender. The outcome of this study differs from previous research reporting that the self-reported measure displayed an overestimation of the MVPA, and sedentary behaviour compared to the accelerometer (Cradock et al., 2004; Peterson et al., 2015). Regarding the application of which tool should be applied for measuring PA and SL, this study supports previous research regarding using an objective device for collecting detailed insight compared to the subjective methods (Aggio et al., 2015; Trost and Tudor-Locke, 2014).

The present findings demonstrated a very weak correlation between both tools when assessing light PA (r = 0.098), MVPA (r = 0.321), and sedentary behaviour (r = 0.047) amongst university employees. The outcome of this study contrast with previous studies examining the validity of IPAQ-LF against an accelerometer to assess MVPA and sedentary behaviour (r = 0.43–.56; Cleland et al., 2018). The current findings contributes to the rare literature about comparing and contrasting the ActiGraph and IPAQ-LF It further contributes to the scarce research about university employees PA and SL. Furthermore, this is one of the fewest studies to evaluate PA levels and SL of university employees concurrently through objective and subjective methods. This study contributes to the limited knowledge related to the evaluation of PA levels and sedentary behaviour of university employees across gender and job roles by applying two extensively established objective and subjective methods. The current findings further contribute to informing best practices of evaluating PA levels and SL. This practice can support the WHO global action for overcoming physical inactivity trends by 2025 and the global action plan of PA 2018-2030 by offering various combinations of measurement tools.

Despite its novel contribution, the present study is not without limitations. The advantages of ActiGraph involves collecting precise data and a high battery life of 25 days, with 4 GB memory and data storage capacity for an extensive amount of time. Although there are a range of benefits when using the ActiGraph, it may fail to identify activities individuals participated, such as cycling, swimming, or loadbearing exercise (Strath et al., 2013). Furthermore, ActiGraph does not provide information about the purpose of activities unless PA log-books, diary, or interviews are combined (Matthews et al., 2012). Moreover, the cost of ActiGraph and ActiLife software are also burdensome that may limit its viability, whereas collecting data via IPAQ-LF is easier to complete and cost-effective. However, there is a possibility of bias recall and potential for underestimating the actual data as evident in this study.

CONCLUSION

This study suggests that employees reported lower levels of light PA, MVPA, and SL in IPAQ-LF compared to ActiGraph. ActiGraph data showed that male employees were spending more time engaged in light PA, MVPA, and SL. Whereas, females reported to be spending more time engaged in light PA and SL in IPAQ-LF. Since both male and female employees were spending higher amount of time being sedentary across both tools it could be recommended that workplace PA and health interventions focused on reducing SL tailored to genders need could offer useful outcomes.

Although academics were more active than administration and professional services; they were spending more time being sedentary. Despite the PA engagement, this population appeared to spend a considerably higher volume of their weekly time sedentary. Moving forward, the management of universities must strive to reduce sitting time and encourage employees to adopt a healthy and active lifestyle by enabling their needs and providing PA and health-related interventions that can support an active and inclusive working environment. Thus, the present findings suggested PA, SL and health-related interventions may require a gender and role-specific approach. Nevertheless, the current study offers a benchmark for employees within a university based in the UK, whilst providing recommendations for future research within this particular domain. Thus, future research is needed to explore barriers university employees face concerning PA engagement both within and outside of the workplace and target potential interventions for the under-research population.

COMPETING INTERESTS

The authors have no competing interests to declare.

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