An Exploratory Study of the Relationship between Psychosocial Hazard and Ambulatory Physiological Response in Higher Education Employees.

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Abstract

Purpose: As exposure to psychosocial hazard at work represents a substantial risk factor for employee health in many modern occupations, being able to accurately assess how employees cope with their working environment is crucial. As the workplace is generally accepted as being a dynamic environment consideration should be given to the interaction between employees and the acute environmental characteristics of their workplace. The aim of this study was to investigate the effects of both acute demand and chronic work-related psychosocial hazard upon employees through ambulatory assessment of heart rate variability and blood pressure.

Design: A within-subjects repeated measures design was used to investigate the relationship between exposure to work-related psychosocial hazard and ambulatory heart rate variability and blood pressure in a cohort of higher education employees. Additionally the effect of acute variation in perceived work-related demand was investigated.

Results: Two dimensions of the Management Standards were found to demonstrate an association with heart rate variability; more hazardous levels of "demand" and "relationships" were associated with decreased SDNN. Significant changes in blood pressure and indices of heart rate variability were observed with increased acute demand.

Originality: This is the first attempt to combine the Health and Safety Management Standards Indicator Tool with physiological assessment of employees. The results provide evidence of associations between scores on the indicator tool and ambulatory heart rate variability as well as demonstrating that variation in acute perceived work-related demand is associated with alterations to autonomic and cardiovascular function. This has implications not only for

employee health and workplace design but also for future studies employing ambulatory physiological monitoring.

Introduction

The 'ivory towers' of academia have traditionally afforded relative sanctuary from exposure to occupational stress, primarily through high levels of autonomy and intellectual freedom. The role of the academic was once clearly delineated, with teaching and research constituting the majority of workload, whilst administration accounted for relatively little work time (Houston *et al*., 2006). However, in the UK, universities have been forced to prioritise fiscal performance following reductions in public funding in the wake of the Education Reform Act (1988). UK Government policy now dictates that universities must contribute to the economy (Lam, 2010) with research funding being largely dependent upon this contribution (Etkowitz *et al.,* 2000). As a result, despite no reduction in teaching or research responsibilities, academics must devote significantly more time to administrative work (Kinman and Jones, 2003; Tight, 2010) and are increasingly being tasked with securing research funding through entrepreneurial activities. Academia is therefore no longer immune from the sources of occupational stress associated with globalisation and market forces.

Recent reports of academics suffering from stress as a result of overload are ample, with work overload, task overload, and role overload, as well as the difficulty of balancing multiple roles and lack of role clarity, being commonly cited factors (Winter *et al.,* 2000; Gillespie *et al*., 2001; Kinman and Jones, 2003; Barret and Barret, 2007; Devenport, 2008). Stress has been identified as a key predictor of academics' intent to move institution (Ryan *et al.,* 2012), and is also associated with intention of leaving the profession entirely (Kinman and Jones, 2003). The deleterious effects of exposure to stress upon health, particularly the incidence of hypertension and cardiac disease, are widely known, and a study of UK academics found that one quarter had suffered from a stress related illness in the previous year (Kinman and Jones, 2003). Higher education employees have also been shown to be at greater risk of psychological illness than the general population (Winefield *et al*., 2003); and UK lecturers report poorer than average levels of psychological wellbeing (Johnson *et al*., 2005).

Although the exact mechanisms are still to be determined, the autonomic nervous system is a likely pathway linking exposure to psychosocial strain and disease (Thayer and Lane, 2007). Heart rate variability, an independent predictor of cardiovascular mortality and cardiac events (Tsuji *et al*., 1996; Kikuya *et al*., 2000), provides a non-invasive insight into the functioning of the autonomic nervous system. Time domain measures of heart rate variability such as the standard deviation of the normal-to-normal interval (SDNN), which represents the total variability occurring across all of the components that contribute to HRV, are calculated from the intervals between successive normal heart beats, while spectral analysis allows for quantification of the variability of the signal occurring within distinct frequency components (Task Force of the European Society of Cardiology and The North American Society of Pacing and Electrophysiology., 1996). Low frequency (LF: 0.025 to 0.15 Hz), high frequency (HF; 0.15 to 0.4 Hz), and the ratio between the two (LFHF ratio) are the most widely reported components, with high frequency heart rate variability reflecting vagal parasympathetic activity. Although often claimed to provide a measure of sympathetic activity, low frequency heart rate variability actually reflects baroreflex function (Goldstein, 2011; Rahman *et al.*, 2011; Reyes del Paso *et al*., 2013). Reduced vagal tone has been found to represent a risk factor for cardiovascular disease (Liao 1997; Curtis and O'Keefe, 2002) and work-related psychosocial strain has repeatedly been associated with heart rate variability (Van Amelsvoort et al., 2000; Vrijkotte *et al*., 2000; Hjortskov *et al*., 2004; Lucini *et al.*, 2007 Chandola *et al*., 2008 Loerbroks *et al*., 2010) and increased ambulatory blood pressure (Van Egeren, 1992; Fauvel et al., 2001; Brown et al., 2006; Guimont *et al.,* 2006).

In the UK, The Health and Safety Executive, who act as the national independent watchdog for work-related health, safety and illness, currently advocate the use of a risk assessment approach to identify environments believed to invoke work stress, through the application of their management standards and associated indicator tool (Health and Safety Executive, 2005). The Indicator Tool is a 35-item self-report questionnaire which measures exposure to various dimensions of work design that, if not properly managed, are associated with poor health and well-being, lower productivity and increased sickness absence. The Indicator Tool not only differs from conventional models of occupational stress, such as the job-demand-control model (Karasek, 1979) and its subsequent adaptations (Johnson & Hall, 1988; Demerouti *et al*., 2001) or the effort-reward imbalance model (Siegrist *et al*., 1986), by assessing a greater number of dimensions, but also in the belief that each of the seven dimensions represent a potential risk to employees health and wellbeing in isolation. Despite being firmly grounded in occupational stress theory, the overarching premise of this approach is appealing in its simplicity, in that minimising exposure to factors known to represent a hazard for the experience of stress reduces the incidence of stress-related problems.

Although there is no shortage of evidence to demonstrate that exposure to work-related psychosocial strain is associated with both blood pressure and heart rate variability, to date no attempt has been made to specifically investigate the effects of exposure to psychosocial hazard using the Management Standards Indicator Tool. As a recent nationwide survey of UK higher education employees reported lower than average scores on all but one of the management standards (Kinman and Court, 2010) this cohort of employees are potentially at significant risk of experiencing unfavourable health outcomes. The main aim of the present study was therefore to investigate whether exposure to psychosocial hazard at work is associated with autonomic function in higher education employees. Additionally, although rarely attended to during ambulatory workplace assessment, there is evidence to suggest that heart rate variability is affected by acute work-related factors (Hjortskov *et al.,* 2004; Filaire, 2010). Therefore, a further aim of the study was to investigate whether work-time ambulatory assessments of heart rate variability and blood pressure are influenced by acute demand. The three hypotheses of the study were: i) academics would be exposed to greater psychosocial hazard and would demonstrate less favourable work-time cardiovascular and autonomic responses than general staff; ii) scores on the management standards indicator tool would be positively associated with physiological stress responses i.e. greater perceived exposure to psychosocial hazard would result in greater blood pressure and reduced heart rate variability; and iii) blood pressure and measures of heart rate variability will differ according to the acute work-related demand of the measurement day.

Method

Participants

Participants were recruited via an advertisement placed on Edinburgh Napier University's internal staff intranet and email. Inclusion criteria required participants to be employed by the university on a permanent full-time contracted basis and to have been working in that role for a minimum of 6 months. Participants were excluded if they smoked, exceeded the UK governments recommended safe drinking limits, reported having cardiovascular disease or mental disorders, or were taking medications which might affect cardiovascular function. This resulted in twenty participants (13 male, 7 female) volunteering to participate in the study. Given the observational nature of the study, a case-control approach was adopted whereby the case comprised academic employees (n=10, 5 male: 5 female) with general employees forming the control group (n=10, 8 male; 2 female). All academic staff had teaching responsibilities and the job title of "lecturer" whilst general staff exclusively worked in a support capacity, as administrators or technicians. The academics had a mean age of 40.6 ± 8.7yrs and non-academics a mean age of 32.7 ± 5.8yrs. All participants gave written informed consent, and approval for the study was obtained by the Research Ethics Committees of Edinburgh Napier University's Faculty of Health, Life and Social Sciences. All data collection occurred between the months of August and December 2012.

Measures

The Health and Safety Executives Management Standards Indicator and Analysis Tools

Full details of the development of the management standards indicator tool are available elsewhere (Cousins *et al*., 2004). However, the indicator tool quantifies the following dimensions of work strain: Demands (workload, work pattern work environment); Control (autonomy over working practices); Managerial Support (encouragement and resources); Peer Support (colleague encouragement and support); Relationships (positive working, avoidance of conflict); Role (understanding of role or clarity, non-conflicting roles); and Change (how effectively is change managed and communicated). Participants indicate the extent to which various statements reflect their experiences at work over the preceding six month period, for example "I have a choice in deciding how I do my work" and "I have to work very intensively". Responses are provided on a 5-point scale: 1 (never), 2 (seldom), 3 (sometimes), 4 (often) and 5 (always). The Indicator Tool has a high level of reliability, with a goodness of fit index of 0.92 (Edwards, Webster, Van Laar, and Easton, 2008), and Chronbach's alpha values ranging from .78 to .87 for individual scales (Cousins, Mackay, Clarke, Kelly, Kelly, and McCaig, 2004). Responses were analysed using the management standards analysis tool (Health and Safety Executive, 2007), in accordance with the methodology previously reported by Houdmont *et al.* (2012). Scores range from 1 (poor) to 5 (desirable) for each of the seven dimensions, with lower scores representing greater risk exposure. The management standards analysis tool also compares the data with the UK

Health and Safety Executive benchmark data, from 136 organisations. This latter comparison provided a measure of risk for each dimension (excellent, good, poor, very poor).

Acute Psychosocial Demand

A visual analogue scale was used to measure the perceived strength of acute psychosocial demand as this method has previously been shown to provide a meaningful and useful assessment of occupational stress (Lesage and Berjot, 2011). The scale had a range of 100mm and was anchored at the midpoint by the term 'average demand', whilst 0mm and 100mm were labelled as representing "not at all" and "very" demanding days respectively. Scores obtained from the scale were then used to differentiate between the demands of the two days at an intra-individual level.

Physiological Measures

Ambulatory blood pressure and heart rate variability were measured using a combined ambulatory blood pressure monitor and electrocardiogram with a sampling rate of 200Hz (Cardiotens, Meditech, Budapest, Hungary). The five electrocardiogram leads were attached using Ambu Blue VLC long term monitoring electrodes (Ambu Ltd, St Ives, UK) at the following locations: left anterior axillary line, intercostals space 5 (x2), sternum, manubrium sterni, right anterior axillary line, intercostals space 5. The device was programmed to automatically obtain readings of diastolic and systolic blood pressure at 30 minute intervals. Participants also wore an Actiheart (Camntech, Cambridge) to measure physical activity over the assessment period. This is a one dimensional accelerometer which was programmed to measure activity levels at one minute intervals.

Procedures

Participants completed the UK Health and Safety Executive's Management Standards Indicator tool once, prior to undergoing an ambulatory assessment of heart rate variability and blood pressure on two non-consecutive work days. The participants selected these days based upon the expectation that the two days would contain different levels of work-related demand. The distance between repeated measures was between 3 and 14 days. Upon arrival at the laboratory, participants were fitted with the monitoring device (Figure 1). The signal integrity was checked in real time and a manual blood pressure reading was performed in the laboratory to ensure integrity of the cuff prior to commencing the ambulatory recording. Participants were instructed to go about their working day as normal until their return to the laboratory, when the instrumentation was removed and data uploaded. To check whether the predicted differences in acute characteristics between days were present, at the end of each study day participants provided a rating of how demanding they perceived the day to have been on the visual analogue scale.

Analysis

Analysis of heart rate variability was performed using Cardiovisions software (Meditech, Hungary) which utilises a Fast Fourier Transformation. The following indices of heart rate variability were obtained: SDNN, low frequency (LF: 0.04-0.15Hz), high frequency (HF: 0.15-0.4Hz) and the ratio between these (LFHF ratio). Low frequency and high frequency values are expressed in both absolute terms and also as normalised units i.e. LFnu is equivalent to LF / (LF+HF) x 100. The raw data were visually inspected and any periods of recording where a normal QRS complex could not be identified were marked accordingly and not included in any subsequent analysis. The period of ambulatory recording was manually selected and spectral analysis of heart rate variability was performed for both frequency bands. Half hourly blood pressure readings were also obtained from the same software. Scores on the visual analogue scale were used to differentiate between the less and more demanding days at the individual level according to the participant's subjective appraisal.

Statistical analysis was performed using SPSS Version 20.0.0. As the Shapiro-Wilk test of normality revealed the heart rate variability data to be non-normally distributed, a logarithmic transformation was applied prior to further analyses. The effect of day upon perceived acute demand and physical activity were investigated with mixed ANOVAs, with job type entered as the between subjects factor. The effects of day upon blood pressure and parameters of heart rate variability were investigated by means of mixed ANOVA, with job type the "between" and day the "within" subject factors, controlling for the effects of age and gender. Partial Pearson's correlations were performed to determine the relationship between scores on the Management Standards Indicator Tool and physiological parameters (SBP, DBP LF, HF, LFnu, HFnu, LFHF ratio and SDNN) controlling for the effects of age.

Results

Mean scores for the cohort as whole revealed varied levels of perceived exposure to psychosocial hazard for different dimensions of the management standards, according to the categorical scores provided by the UK Health and Safety Executive's analysis tool. Scores for the dimensions of, Demand, Control, Management Support and Peer Support fell within the "excellent" category (being at, above or close to the 80^{th} percentile), relationships and control were categorised as being "good", whilst "role" received a "poor" score (below average but above the 20th percentile) (Table 2). There was a clear group effect however, with general staff reporting "excellent" scores for all 7 dimensions of the indicator tool, whilst the academic group only achieved "excellent" scores for the Control and Peer Support. The academics also reported "poor" scores for both Management Support and Relationships, and fell in the "very poor" category (below the 20th percentile) for both Role and Change.

The average duration of ambulatory recording was 421 ± 39 minutes and all mean blood pressure readings were within normal ambulatory ranges (Mancia *et al.,* 1995**).** In all cases the participants correctly anticipated the respective demands of the two study days, as all individual scores on the visual analogue scale were greater on the more demanding day than on the less demanding day. The results of the ANOVA revealed there to be a significant main effect of day upon perceived acute demand F(1, 18) = 4.59, p=.046. There was also a significant main effect of day upon the following physiological measures: [SBP, F(1,15) = 5.207, p=.038] [HR, F(1,15) = 5.749, p= .030] [SDNN, F(1,15) = 9.967, p=.007] [LFnu, F(1,15) = 18.339, p=.001] [HFnu, F(1,15) = 21.231, p=.001] [LFHF ratio, F(1,15) = 28.006, p=.001] but not upon DBP, F(1,15) = 3.214, p= .093, or activity level, F(1,15) = 2.265, p= .153. There were no main effects of gender, age, or job type upon any measures of blood pressure, heart rate variability or activity. There was a significant interaction between the effects of day, gender and job type upon LFnu, F(1, 15) = 5.555, p= .032 and LFHF ratio, F(1, 15) = 4.761, p= .045. Post hoc tests revealed LFnu to be lower among male academics compared to female academics on the less demanding day F(1, 15) = 5.029, p=.040 but there was no difference between these groups on the more demanding day F(1, 15) = 1.705, p=.211. Similarly the LFHF ratio was reduced among male academics compared to female academics on the less demanding day, F(1, 15) = 4.913, p=.043 but there was no difference on the more demanding day F(1, 15) = 1.097, p= .312.

The Health and Safety Executive's Management Standards was found to be associated with SDNN: the relationships standard was positively associated with SDNN on both assessment days (r=.467, p=.04 and r=.493, p=.03 for the less and more demanding days respectively) while the demand standard was associated with SDNN on the less demanding day (r=.632, p=.004) (Table 5).

Discussion

The aim of the present study was to investigate exposure to psychosocial hazard in higher education employees and the physiological consequences of this exposure. It was hypothesised that: i) academics would be exposed to greater psychosocial hazard and would demonstrate less favourable work-time cardiovascular and autonomic responses than general staff; ii) scores on the management standards indicator tool would be positively associated with physiological stress responses i.e. greater perceived exposure to psychosocial hazard would result in greater blood pressure and reduced heart rate variability; and iii) blood pressure and measures of heart rate variability will differ according to the acute work-related demand of the measurement day. The study found that academics reported poorer scores than the general staff, but this was not reflected in work-time physiological functioning, as no differences were found in either blood pressure or heart rate variability between occupational groups. Therefore, the findings do not completely support the first hypothesis. As SDNN was associated with both the demand and relationships standards, the second hypothesis is at least partially supported. Additionally, daily work-related demands were shown to influence work-time ambulatory heart rate variability and blood pressure which supports the third hypothesis of the study.

This appears to be the first study to report upon the disparity in perceived exposure to psychosocial hazard according to role type amongst higher education employees, using the

Indicator Tool. The unfavourable scores reported by the academics for all dimensions of the management standards, with the exception of control and peer support, suggests that this group of employees may be subjected to potentially harmful levels of work-related psychosocial hazard. The dimension of Role received a particularly poor score, lending weight to the contention that academics are now expected to balance multiple roles and supporting previous findings regarding role as a source of stress amongst academics (Winter, Taylor and Sarros, 2000; Gillespie *et al.,* 2001; Kinman and Jones, 2003; Barret and Barret, 2007; Devenport, 2008). The "excellent" level of Control reported by both occupational groups is arguably indicative of the high level of autonomy that has historically been considered to characterise academic work, suggesting this favourable aspect of the job remains prominent, and also appears to extend to non-academic roles, possibly as a result of the institutional culture. Certainly, high levels of control have previously been reported amongst academics (Winter *et al.*, 2000; Winefield and Jarrett, 2001). Equally, the "excellent" level of Peer Support reported by academics and general staff alike may reflect the collegiate culture of academic institutions.

Despite reporting different levels of exposure to psychosocial hazard, academic and general staff did not differ in terms of their physiological response to work on either day. Although this may be artefactual, arising from the small sample size and subsequent lack of statistical power, there are also a number of possible theoretical explanations for this, the most simplistic being that different exposures to psychosocial hazard, as quantified by the Indicator Tool, do not significantly influence work-time autonomic functioning. Alternatively there may be a discrepancy between actual, or perceived, and reported psychosocial hazard, with academics reporting inflated exposures. However, neither of these explanations satisfactorily accommodates previous claims that the Indicator Tool has been associated with stress (Gyllensten and Palmer, 2005; Bevan *et al.*, 2010) and stress related health outcomes

(Kerr *et al*., 2009). A final explanation, provided by the inter-individuality of the physiology underlying the stress response, may therefore be more plausible. It has previously been demonstrated that measures of heart rate variability can differ substantially between individuals (Thayer and Lane, 2007) and the present study certainly supports this inter-individuality in autonomic function. Additionally, Ilies *et al*. (2010) recently reported that a between-individuals analysis failed to find an association between workload and blood pressure, whilst the within-individual approach revealed positive associations between the two variables. Therefore, traditional cross-sectional analysis may not provide the optimal means of investigating the physiological response to work-related psychosocial hazard unless consideration is given to individual baseline values. However, this raises its own methodological challenges and it has yet to be established whether reactivity to acute laboratory stressors bears any correlation to reactivity during exposure to chronic, naturally occurring, stressors (Ho *et al*., 2010).

Notwithstanding the somewhat rudimentary method of quantifying the acute demand of the two study days in relative terms, the present study demonstrated that perceived levels of daily work-related demand influence the physiological response to work amongst higher education employees. Kamark *et al*. (2005) have previously shown various dimensions of psychosocial stress, including "task demand", to be associated with ambulatory blood pressure and cardiovascular risk while Ilies *et al*. (2010) found daily levels of negative effect to be associated with blood pressure over a ten day period. The present findings demonstrate that amongst higher education employees acute work-related demand influences both ambulatory blood pressure and heart rate variability in the expected direction. Although ambulatory blood pressure did not fall out with the normal range, even on the more demanding day, this should not necessarily be interpreted as evidence that increases in acute work-related demand are unlikely to represent a risk to long-term cardiovascular health. The levels of perceived demand reported on the more demanding day were actually relatively moderate and it is certainly possible that exposure to greater levels of acute demand would result in greater elevations in blood pressure. Additionally, there is evidence that the relationship between cardiovascular outcome and blood pressure is continuous (Lewington *et al*., 2002), with any elevation in blood pressure being potentially harmful. Similarly, despite the absence of clinical guidelines for heart rate variability it has been adequately demonstrated that decreased heart rate variability is associated with long term health risks. Fundamentally, diminished heart rate variability is indicative of a reduction in the flexibility and adaptability occurring within an individual's regulatory systems which are normal characteristics of healthy functioning (Shaffer *et al*., 2014). As SDNN provides a measure of the fluctuation occurring across all of the factors contributing towards HRV, a reduction in this parameter can be interpreted as representing an unfavourable physiological response. This, coupled with an increased LFHF ratio on the more demanding day, suggests that exposure to greater demand may have long-term implications for the health of higher education employees.

Irrespective of potential long-term consequences, the variation in physiological function in response to acute demand is an important finding with significant methodological implications for future research. Such a finding suggests that in order to meaningfully interpret ambulatory physiological data, during work time at least, consideration must be given to the acute characteristics of the assessment day and how representative they are of the norm. Whilst this may seem somewhat obvious, given the main purpose of ambulatory monitoring is to obtain an assessment within the environment of interest, workplace investigations seldom attempt to quantify the acute psychosocial characteristics of the environment, beyond that which is typical to the specific occupation. However, there is a growing acknowledgement of the dynamic nature of the work environment (Ilies and Judge, 2002; Ilies and Judge 2004; Beal and Weiss, 2003; Ilies *et al.,* 2010) which should not be overlooked for the sake of simplicity, and assessments should therefore be conducted on multiple work days of varying demand. Additionally, adopting such an approach would simultaneously go some way to addressing the issue of inter-individuality by enabling analysis to be performed at the within-individual level. Differences in individual physiological response across days of varying demand may potentially provide a more meaningful insight into the extent to which employees are coping with the demands of work than attempting to incorporate baseline values obtained in the laboratory.

According to the conceptual basis of the management standards, the dimensions which obtain the lowest categorical score could be considered to represent the greatest threat to employee health and wellbeing. In the present study role received the lowest categorical score, followed by relationships and change. Perhaps surprisingly then, role was found not to be associated with heart rate variability, suggesting that amongst higher education employees, high levels of role uncertainty may not directly influence autonomic function. The association between relationships and SDNN appears to be more in keeping with the underlying premise of the management standards, although the association between demands, which received an excellent score, and SDNN points to a more complex relationship. The demands dimension of the Indicator Tool has previously been shown to be a significant predictor of the subjective experience of stress (Gyllensten and Palmer, 2005) and the present findings offer support for exposure to demand being implicated in the relationship between workplace strain and stress related ill-health. This may have potential implications for the interpretation of the management standards indicator tool or for prioritising workplace interventions, which has been identified as a consideration where respondents report poor scores across several dimensions of the Indicator Tool (Bevan *et al.,* 2010).

The possible interaction between chronic and acute exposure to psychosocial demand certainly lends further weight to the argument that the single-shot approach to investigating the autonomic and cardiovascular response to the psychosocial work environment is limited by its inability to account for the dynamism that is inherent in many occupations. In conclusion this exploratory study provides initial evidence of a relationship between the management standards indicator tool and ambulatory heart rate variability and adds to the existing body of literature demonstrating that intra-individual variation in acute work-related demand is associated with altered blood pressure and heart rate variability. Further investigations should attempt to more accurately establish the interactions between the management standards, acute psychosocial demand and autonomic and cardiovascular functioning.

Limitations

Given the small sample size, and selective nature of the sample the results presented are of limited external validity. Additionally, the possibility of self-selection bias cannot be ruled out and, despite the protocol being designed to be as minimally invasive as possible, employees exposed to very high levels of psychosocial work-related hazard may be less likely to participate in research which places additional demands upon them during the working day. Additionally, as the participants selected the study days, it is reasonable to assume they may have deliberately precluded participation on days they anticipated being unusually high in acute demands, given the time required to have the instrumentation attached and removed. Certainly, variation in the acute demands of the two study days was relatively small, so the full extent of variation in autonomic function in response to acute demands may not have been captured by the present study.

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Table 1. Participant characteristics grouped by job type.

	Academics (n=10)	Non-Academics (n=10)
Age (years ± SD)	40.6 ± 8.7	32.7 ± 5.8*
Gender (M/F)	5/5	8/2
Physical Activity (METS ± SD)†	3055 ± 2281	6159 ± 6030
BMI (kg/m^2 ± SD)	24.99 ± 4.06	22.48 ± 1.57
Work Ability ††	41.3 ± 3.64	44 ± 3.5

† Weekly METS calculated from the International Physical Activity Questionnaire. †† Self-reported Work Ability from the Work Ability Index (7-27= poor; 28-36=moderate, 37-43=good, 44-49=excellent). * Independent t-test revealed significant difference between groups (p<.05).

170x68mm (96 x 96 DPI)

Table 2 A comparison of mean Management Standards scores with benchmark data by occupational groups

Dimension	Academics (n=10)		General Staff (n=10)		All Staff (n=20)	
	Score	Category†	Score	Category	Score	Category
Demands	2.99	Poor	3.68	Excellent	3.33	Excellent
Control	3.95	Excellent	4.00	Excellent	3.98	Excellent
Management Support	3.46	Poor	4.06	Excellent	3.76	Excellent
Peer Support	3.95	Excellent	3.93	Excellent	3.94	Excellent
Relationships	3.65	Poor	4.15	Excellent	3.9	Good
Role	3.84	Very Poor	4.48	Excellent	4.16	Poor
Change	2.77	Very Poor	3.37	Excellent	3.07	Good
Global	3.51	††	3.96	††	3.73	††

† Category: derived from comparison with benchmark data from 136 organisations. Excellent: at, above or close to the 80^{th} percentile, Good: Better than average but not yet at, above or close to the 80^{th} percentile. Poor: Below average but above 20^{th} percentile. Very Poor: below the 20^{th} percentile - Urgent action needed. †† UK HSE do not provide categorisation of a global score.

176x101mm (96 x 96 DPI)

Table 3. Self-reported acute demand by occupation and self-reported chronic psychosocial demand.

Group	Less Demanding Day	More Demanding Day
All Staff (n=20)	3.64 ± 1.97	4.93 ± 1.93*
Academics (n=10)	3.27 ± 1.54	5.60 ± 2.56*
General Staff (n=10)	3.72 ± 1.99	4.57 ± 1.22*

* Mixed ANOVA revealed significant difference from less demanding day (p<0.05)

175x56mm (96 x 96 DPI)

Table 4. Ambulatory data for less demanding day and more demanding day presented by occupational group

	Academics (n=10)		General Staff (n=10)		All Staff (n=20)	
	Less Demanding	More Demanding	Less Demanding	More Demanding	Less Demanding	More Demanding
SBP	120.72 ± 7.67	125.08 ± 5.59	122.52 ± 6.28	127.66 ± 9.55	121.62 ± 6.89	126.37 ± 7.73*
DBP	75.18 ± 5.85	77.95 ± 5.63	76.48 ± 4.62	79.25 ± 4.51	75.83 ± 5.18	78.60 ± 5.01
HR	76.94 ± 10.61	84.81 ± 13.58	67.24 ± 6.67	68.34 ± 6.47	72.09 ± 9.96	76.58 ± 13.36*
SDNN	90.38 ± 33.21	77.35 ± 24.93	111.49 ± 25.06	98.58 ± 28.29	100.94 ± 30.61	87.97 ± 28.15**
LF	1497.9 ± 674.00	1857.5 ± 1150.0	2069.2 ± 1078.58	2096.8 ± 1036.3	1783.5 ± 923.10	1977.15 ± 72.45
LFnu	74.80 ± 13.85	81.5 ± 10.15	74.0 ± 9.98	77.5 ± 7.28	74.4 ± 11.76	79.50 ± 8.83**
HF	558.50 ± 620.19	457.3 ± 489.07	757.0 ± 807.42	586.0 ± 333.71	657.75 ± 708.08	521.65 ± 412.81
HFnu	24.10 ± 12.99	18.10 ± 9.10	24.6 ± 9.43	21.60 ± 6.88	24.35 ± 11.05	19.85 ± 8.00**
LFHF ratio	4.15 ± 2.32	6.25 ± 4.47	3.6 ± 1.89	4.33 ± 2.55	3.87 ± 2.08	5.29 ± 3.67**
Activity†	34.29 ± 9.45	49.03 ± 18.59	44.50 ± 40.17	47.96 ± 32.44	39.40 ± 28.88	49.49 ± 25.74

* Significantly different from less demanding day (Mixed ANOVA controlling for age and gender, $p<0.05$). SBP: systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, LF: low frequency power, LF(nu): low frequency power in normalized units, HF: high frequency power, HF(nu): high frequency power in normalized units, LFHF ratio: low to high frequency ratio. † Mean activity counts calculated over period of ambulatory assessment from.

178x132mm (96 x 96 DPI)

Table 5. Partial Correlations between HSEMS and Heart Rate Variability adjusted for age (n=20)

	Time	Global	Demands	Control	M Support	P Support	Relationships	Role	Change
LF (log10)	LD	.092	.104	.075	-.091	.062	.272	-.048	.176
	MD	-.174	-.044	-.180	-.346	-.017	-.014	-.213	.071
HF (log10)	LD	.125	.310	.193	-.089	.067	.309	.010	-.123
	MD	-.074	.152	-.119	-.268	.013	.153	-.140	-.069
LFHF ratio (log10)	LD	-.071	-.431	-.263	-.077	-.058	-.286	-.148	.266
	MD	-.114	-.447	-.078	-.050	-.162	-.449	-.003	.115
SDNN (log10)	LD	.295	.632**	.171	.020	.098	.467*	.045	-.029
	MD	.210	.436	.120	-.036	.140	.493*	-.045	.068

. LD = Less Demanding Day. MD = More Demanding Day. Δ = Change from LD to MD. *Significant at $p < 0.05$, ** significant at $P < 0.01$, Partial Pearson's correlation controlling for effect of age.

180x99mm (96 x 96 DPI)

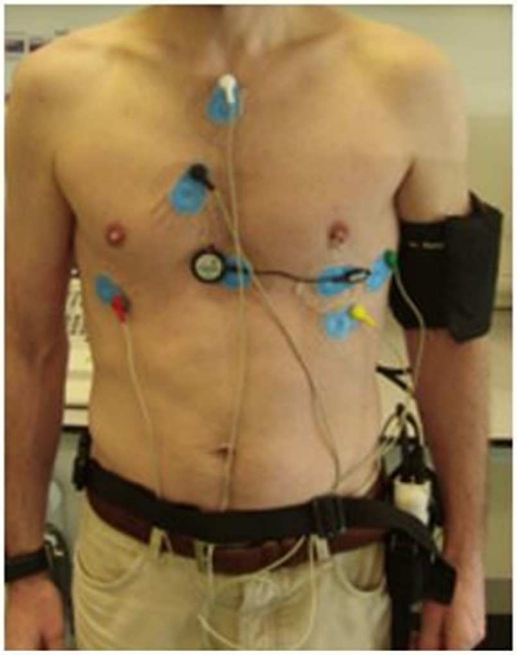

Figure 1. Participant instrumented with both a Cardiotens combined ABPM and ECG monitor and an Actiheart monitor.

76x111mm (96 x 96 DPI)