How many calories do nurses burn at work? A real-time study of nurses' energy expenditure

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Abstract

Background: Nurses have high rates of overweight and obesity and physical inactivity is one key determinant of weight gain.

Aim: The present study aims to quantify nurses' energy expenditure over a standard 12-hour shift to establish whether activity levels at work are too low to maintain a healthy body weight.

Methods: Ward-based nurses (n=96, 90 female, mean age=36 years, mean experience = 10 years, mean body mass index=26.6) wore heart rate and physical activity monitors for the duration of one full working shift. Heart rate and activity data was used in combination with demographic information to estimate each nurses' energy expenditure over 12 hours.

Results: On average, nurses burned 2.12kcals/minute while at work, equating to 1,521 kcals/ 6,364 kJ (SD=403kcals/ 1,686kJ) per 12-hour shift. Energy expenditure over 12 hours varied markedly between nurses (from 812kcals/ 3,397kJ to 3,005kcals/ 12,573kJ) but was sufficient in 72% of participants (assuming minimal resting levels of energy expenditure for the 12 hours not at work) to burn off a daily calorie intake of 2,000kcals.

Conclusion: Three quarters of nurses expend more energy on working days than is required to maintain a healthy body weight if dietary intake does not exceed recommended levels.

Introduction

As many as 69% of registered nurses in the UK are overweight or obese (Kyle, Neall and Atherton, 2016), a figure that is higher than elsewhere in the world (Zapka et al., 2009; Han et al, 2011; Bogossian et al., 2012; Coomarasamy et al., 2014). Obesity is associated with an increased risk of a wide range of health conditions including diabetes, cancer, heart disease, musculoskeletal disorders and psychological ill health (World Health Organisation, 2018). Consequently, nurses with a higher body weight are more likely to take sickness absence from work (Goetzel et al., 2010) contributing to organisational issues such as reduced staffing and related reductions in the quality of patient care (Jafar Jalal et al., 2014; Schulte et al., 2007).

Despite expert health knowledge and a comparable physical working environment to other healthcare workers, nurses appear to be more vulnerable to weight gain than other health professional groups (Kyle et al., 2017; Kyle, Neall and Atherton., 2016). Studies exploring why nurses are more likely to gain weight typically focus on eating behaviour, finding higher consumption of calorific foods (e.g., sweet foods and snacks, Hoppe and Ogden, 1997) to be associated with work-related factors such as stress and tiredness (Torquati, Kolbe-Alexander, Payey et al., 2016), lack of regular breaks (Torquati et al., 2016), shift patterns (Marquezea, Lemosa, Soaresa et al., 2012), food gifts from patients (Cheung, 2003), and the influence of work colleagues (Phiri, Draper, Lambert et al., 2014; Persson and Martensson, 2006).

However, weight gain is typically a product of both excess energy intake (eating) and insufficient energy expenditure (physical inactivity), yet relatively little research has investigated nurses' activity levels. Most physical activity research relating to nurses focuses on leisure-time activity and indicates that nurses do not typically meet physical activity guidelines (Ahmad et al., 2015; Jung and Lee, 2015; Naidoo and Coopoo, 2007; Blake and Harrison, 2013; Blake, Malik, Mo et al., 2011), having low-moderate average leisure time activity levels (Nahm et al., 2012; Albert et al., 2014; Perry et al., 2015; Tucker et al., 2010). Importantly though, nursing is at least anecdotally, an active and physically demanding job with long working hours, so it is possible that nurses are less active in their leisure time as they have already been highly physically active at work.

A recent systematic review found only one study in the literature that had set out to measure nurses' physical activity at work, along with 14 studies which included

some measure of activity during shifts (Chappel, Verswijveren, Aisbett et al., 2017). Studies differed markedly in the methods used to capture activity level (from heart rate monitoring to self-reported estimates) but the majority concluded that nurses spent most of their shifts engaged in light intensity activity only (Chen et al., 2011; Hui et al., 2001; Irimagawa and Imamiya, 1993; Nicoletti et al., 2014; Nuikka et al., 2001; Schall et al., 2016; Takahashi et al., 1999; Wakui, 2000). Four studies found nurses to be moderately active but two of these were conducted with nurses working outside of the typical hospital environment (Babiolakis et al., 2015; Chen et al., 2014; Irimagawa and Imamiya, 1993; Makowiec-Dabrowska et al., 2000). Importantly, none of these studies were carried out in the UK and there are likely to be substantial differences in the organisational structures and systems that dictate the nature of nursing work from one country to the next.

UK nurses are estimated to spend a substantial amount of time on paperwork and clerical tasks (Royal College of Nursing, 2008) leading to concern that highly skilled nurses are spending large amounts of time on (often sedentary) clerical tasks leaving less for direct patient care (NHS Institute for Innovation and Improvement, 2012). Observational studies support this to some extent, finding that nurses spend only around a third of their time on direct patient care, with the remainder spent on other, potentially less active, tasks such as documentation, preparing medication, reviewing results, retrieving information and professional communication (Farquharson et al., 2013).

If nurses' activity levels are relatively low at work, this is one potentially key determinant of weight gain as nurses spend a substantial proportion of their waking hours at work and leisure time activity is typically low. The present study aimed to quantify nurses' energy expenditure over the course of a standard 12-hour shift to establish whether nurses' physical activity levels at work are high enough to help maintain a healthy body weight.

Methodology

Study Design

Real time, ambulatory data on nurses' physical activity and heart rate were collected as part of a larger, observational study on nursing tasks, stress and performance in 2012. Full details of the parent study protocol are available elsewhere (Farquharson et al., 2013) but in brief, as part of a larger study protocol (involving regular diary reports of current task and stress level), ward-based nurses were asked to wear heart rate and physical activity monitors for the duration of two full working shifts. The present study uses this heart rate and activity data to calculate energy expenditure for each participating nurse.

Participants and Setting

All nurses working on medical or surgical wards with more than 20 beds in a large UK teaching hospital were invited to participate in the study. Of those invited, 100 consented to take part and continuous physical activity and heart rate data were available for 96 individuals (90 female, mean age =36 years, mean experience = 10 years, mean body mass index=26.6). The sample were comparable to all nurses working on wards in the hospital under study in terms of average age and years of experience (36.9 and 11.0 years respectively).

Measures

The main study outcome variable was energy expenditure over a working shift. Energy expenditure was calculated from a combination of manually entered demographic information (gender, age and body weight) and from heart rate and physical activity data that was continuously recorded over one full work shift using an Actiheart monitor. The Actiheart (CamNTech) is a compact, lightweight (<10g) heart and physical activity monitor that clips directly to two adhesive chest electrodes. Mean acceleration, heart rate, inter beat intervals and heart rate variability were stored in 15 second epochs and were time and date stamped. The monitor has been validated for use in ambulatory participants (Brage et al., 2005).

Procedure

Nurses who indicated an interest in the study were sent a study information pack and consent form and were asked to nominate two upcoming work shifts where they would be engaged in typical activities (and not non-standard activities such as training) for participation in the study. A study researcher met participating nurses immediately before each nominated shift to attach the Actiheart monitor. Nurses wore the monitor for the full duration of each of the two nominated participation shifts. Monitors were retrieved at the end of each shift and the data downloaded from the device and subjected to the standard multi-stage Actiheart routine for editing out artefactual data. Specifically, all inter-beat intervals of 2000ms or more (indicating a missed beat) were rejected, as were beats that differed from the preceding beat by more than 20x the average difference. The last 16 good inter-beat intervals were averaged and any outside +/_ 25% of this average removed. The remaining inter-beat intervals were then re-averaged and converted to beats per minute. Finally, all 1-minute means of <40bpm or >170bpm were removed. The data were good quality and only 0.01% of 1-min means were rejected. Each participant's data were then run through the Actiheart software's in built Advanced Energy Expenditure analysis procedure which calculates energy expenditure over designated periods using group calibration co-efficients and branch parameters from the device validation study (Group Cal JAP 2007).

Analysis

Data were descriptively summarised to estimate total energy expenditure. As participating nurses worked shifts of different lengths, energy burned per minute was calculated in k/cals and k/joules and then scaled up to represent energy expenditure over a prototypical 12-hour shift to allow like for like comparison between individuals. Multi-level modelling was then used to investigate patterns in energy expenditure over the course of the working day and to examine differences in energy expenditure related to key demographic factors - age, years of experience, work location and body weight.

Results

Participating nurses (see Table 1 for demographics) had their heart rate and activity levels monitored during shifts which varied in length from 6.7-12.5 hours (mean shift length = 11.0 hours, *SD*=1.3).

Table 1

Demographic characteristics of the sample

n	96
Gender	90 Female, 6 Male
Current Ward	7 Medical, 7 Surgical
	Mean (SD)
Age (years)	36.2 (9.8)
Body Mass Index (BMI)	26.6 (5.4)
Years Since Qualified	10.3 (9.2)
Years on Current Ward	5.2 (4.9)

Energy expenditure over a standard 12-hour shift

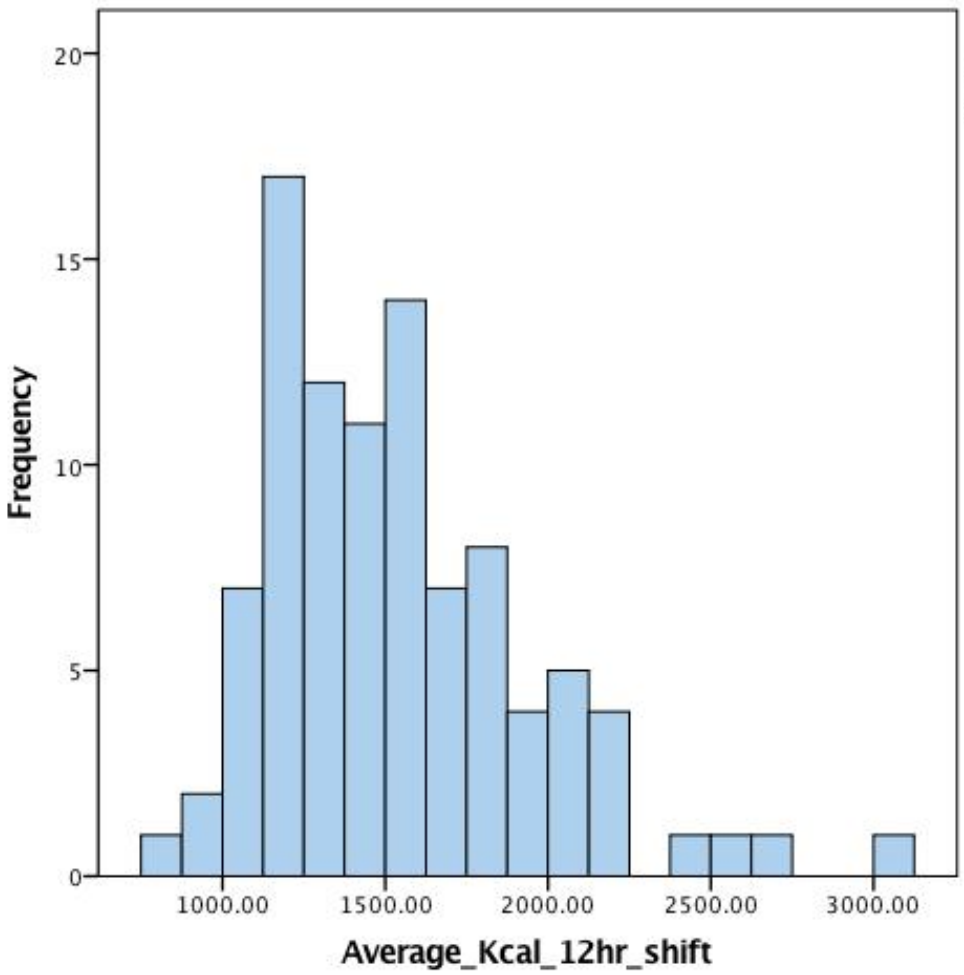
On average, participating nurses burned 2.12kcals / 8.87kJ per minute while at work, equating to an average of 1,521 kcals / 6,364kJ (*SD*=403kcals/ 1,686kJ) per 12-hour shift. While the energy burned per minute (2.12kcals / 8.87kJ) equates to 'light intensity' activity (<3 METs; Ainsworth, Haskell, Whitt, Irwin, Swartz et al, 2000), the total energy expended in a 12-hour shift is roughly equivalent to someone working in 'moderate activity' of 3 METs for 8 hours.

As illustrated in Figure 1, although mean energy expenditure was 1,521kcals / 6,364kJ per 12-hour shift, calories burned by different individuals over a shift ranged from 812kcals / 3,397kJ to 3,005kcals / 12,573kJ. Energy expenditure was not recorded during leisure time in the present study, but even if participants spent the 12 remaining non-work hours asleep or totally sedentary, an average weight (150lb/10st5) woman would be expected to burn a further 63kcals / 264kJ an hour or 756kcals / 3,163kJ (approx.). Adding this minimal baseline energy expenditure to the estimates of energy expenditure recorded during the work period indicates that 72% of participating nurses

would be active enough on a work day to burn off the recommended (female) daily calorie intake of 2,000kcals.

Figure 1

Average energy expended (kcals) over a prototypical 12 hour shift

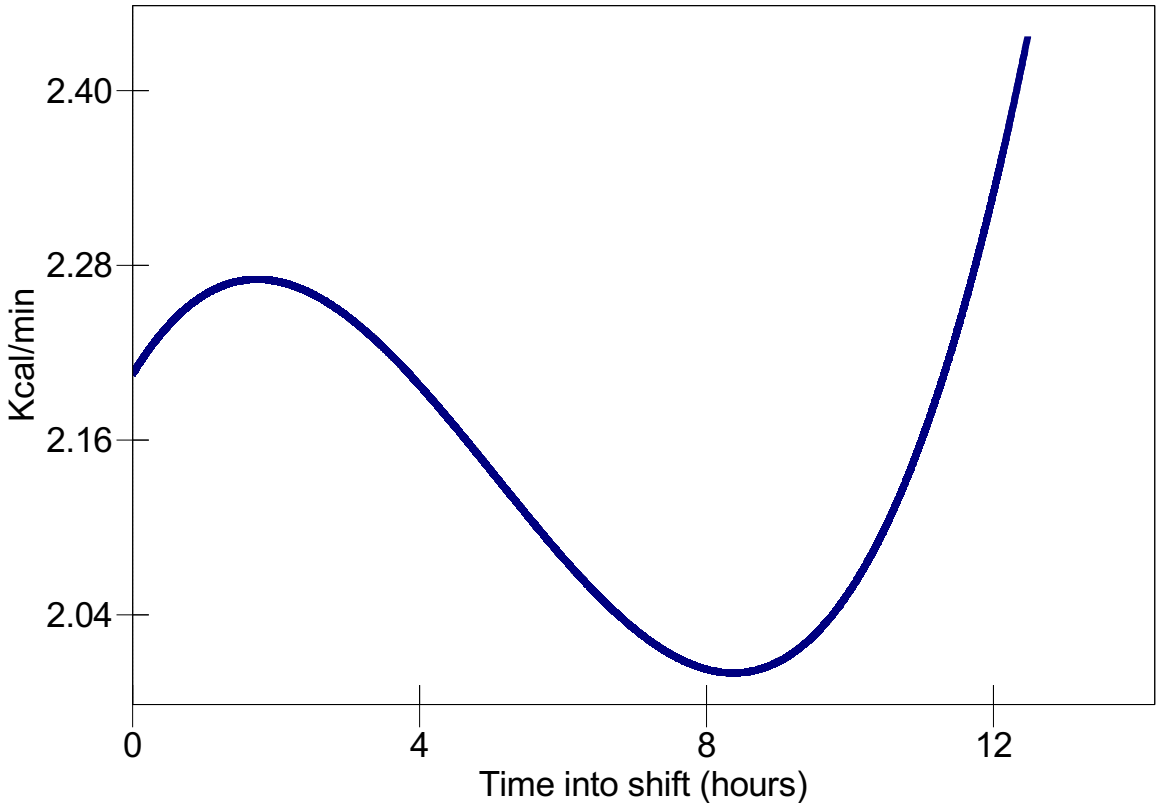


Energy expenditure patterns over the working day

Multi-level analysis determined that while patterns of energy expenditure varied between individuals, in general energy expenditure followed a cubic trend over the work shift. As shown in Figure 2, energy expended rose initially after coming on shift, dropped mid shift before climbing again and peaking towards the end of shift.

Figure 2

Average pattern of energy expenditure (kcals per minute) over the work shift



Energy expenditure and demographic factors

Energy expenditure in kcals/min at work was unrelated to nurses' age (beta weight = 0.005, *p*= .358), grade/seniority (grade 5 =2.10, grade 6= 2.16, grade 7= 2.30, *p*= .606) or ward type (medical versus surgical; 2.191 versus 2.034 *p*= .153) but was significantly higher in nurses with higher body mass indices (BMI; beta weight= 0.068 *p* <.001). This greater energy expenditure in nurses with a higher BMI is not due to a higher activity level (nurses with a higher BMI are slightly but not significantly less active than others; beta weight= -0.159, *p*= .137), but rather to higher average heart rate and greater physical effort required during activity (beta = 0.901, *p*= .001) which leads to greater energy expenditure.

Discussion

Of 100 ward-based nurses studied continuously for a full working shift, 72% were expending enough energy to burn off food consumption of 2,000kcals a day. Average energy expenditure per 12-hour shift in the present study (1,521kcals / 6,364kJ) was comparable to previous estimates from studies of physical workload and stress in U.S. nurses (1454kcal/12 hrs; Chen et al., 2011), indicating that ward-based nurses engage, on average, in light to moderate activity across the working day. This is broadly in line with literature demonstrating that while nurses often walk long distances in the course of their jobs (Welton, Decker, Adam et al., 2006) and may have to complete physically demanding tasks, this is balanced out by spending a considerable amount of time on activities that are less active (e.g., documentation, professional communication etc; Farquharson et al., 2013).

Given the high rates of obesity and overweight in the nursing population, there has been increased interest in the development and implementation of weight management interventions for this group. The present results demonstrate that most nurses (a predominantly female workforce) are active enough on work days to burn off the recommended daily calorie intake for women (2,000kcals), which suggests that any workplace based weight interventions aimed at nurses may be better focused on reducing dietary intake than on increasing activity levels while on shift (e.g. with workplace walking groups). While many weight management interventions designed specifically for nurses are targeted at the workplace (Power et al., 2014; Chan and Perry, 2012), there is currently little evidence to suggest that unhealthy behaviours are more likely to occur within (as opposed to outside of) the workplace. In fact, it is possible that nurses are more likely to engage in unhealthy behaviours in the hours after coming off shift than during the working day. While the present study did not test this directly, it will be vital for the development and appropriate targeting of weight loss interventions for nurses that future research pinpoints when, where and why nurses are most likely to consume unhealthy foods / be inactive.

Qualitative data in this population suggests that nurses may be particularly likely to eat unhealthy convenience foods and to engage in sedentary behaviours after coming off shift and / or in days off following busy or stressful shifts (Power et al., 2017) and that ‘self-licencing’ (i.e. the tendency to engage in behaviours like perceived as ‘bad’ on the basis that one has recently done something ‘good’; de Witt Huberts, Evers and de Ridder, 2014), may play a role in overconsumption and inactivity on days off

work. Future studies should investigate patterns of activity over full 24 hour periods and over multiple days to determine when and where nurses are most likely to be inactive

The present study has a number of strengths and limitations. Energy expenditure was estimated from objectively and continuously measured heart rate and physical activity, removing any bias that would be associated with self-report measures. There was very little missing data and the sample of nurses who participated were representative of the wider nursing workforce in terms of their demographic characteristics. However, simply wearing activity monitors may have prompted nurses to be more active (the Hawthorne effect) and nurses who volunteered to participate may have been more active than those who did not, potentially leading to an overestimation of activity level. In contrast, physical activity outside of working hours was not directly measured, and was instead estimated at a minimal (sedentary) level so total energy expenditure over 24 hours is likely be higher than estimated here. The latter underestimation would not change our conclusions (as higher levels of energy expenditure would make it even more likely that activity levels are sufficient to maintain a healthy body weight), but should be noted. Furthermore, while the objective measures used in the current study give a well-controlled estimate of energy expenditure, accounting for nurses' age and weight, it should be noted that true energy expenditure will also be influenced by several unmeasured factors (such as temperature, physical fitness etc). Finally, as weight loss and maintenance of a healthy body weight depends on energy balance, future studies should aim to simultaneously assess both energy expenditure and intake.

In terms of implications for policy and practice, the present results suggest that workplace health initiatives should look at patterns of energy expenditure and intake both within and outside of the working environment in order to understand and address the factors producing weight gain in the nursing population.

Conclusion

Most nurses expend enough energy on working days to maintain a healthy weight if dietary intake does not exceed recommended levels. Further studies are needed to investigate nurses' eating and activity patterns in real time, both at work and at home, to determine how best to target healthy weight interventions.

Key points

- Nurses expend on average 1,521kcals / 6,364kJ over the course of a 12 hour shift.
- 72% of nurses expend enough energy to maintain a healthy body weight if dietary intake does not exceed recommended levels (for females).
- Most studies of eating and activity level in nursing focus on the workplace and more comprehensive studies of when and where unhealthy behaviours occur is required.

Ethical permissions

The present study was approved by the NHS North of Scotland Research Ethics Committee (reference 10/S0801/87).

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