The Association Between Shift Work and Unhealthy Weight: A Cross-Sectional Analysis From the Nurses and Midwives' e-Cohort Study

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Objective: To examine the association between shift work and unhealthy weight among female nurses and midwives. **Methods:** A cross-sectional study. Measurement outcomes included shift work, unhealthy weight (underweight: body mass index [BMI] < 18.5; overweight: BMI 25.0 to 29.9; obesity: BMI > 30.0), diet quality, physical-activity level, alcohol consumption, and smoking status. **Results:** Among the 2494 participants (1259 day and 1235 shift workers), only 1% of the participants were underweight, 31.8% were overweight, and 26.9% were obese. After adjusting the selected confounders, shift workers were 1.15 times more likely to be overweight/obese than day workers ($P = 0.013$, 95% confidence interval, 1.03 to 1.28; $P = 0.02$, 95% confidence interval, 1.02 to 1.30, respectively). **Conclusions:** Shift work is associated with higher risk of being overweight/obese. Longitudinal studies are being undertaken to better understand the causal relationship between shift work and unhealthy weight.

In response to an increasingly 24-hour society, over the last several decades, there has been a rapid increase in the number of shift workers all over the world.[1] According to 2004 data from the Bureau of Labour Statistics, almost 15% of full-time wage and salary workers were shift workers.[2] Similarly, a national survey of Australia found that more than one million employees (14%) had worked in shift in the previous 4 weeks. Of these shift workers, 46% had worked a rotating shift.[3] Industries with the highest proportions of shift workers in Australia were mining (44%); health and community services (32%); and accommodation, cafes, and restaurants (31%).[3] The health and community services sector consisted of hospitals and nursing homes, medical and dental services, community care services, child care services, veterinary services, and other health services.[4] The health workforce is estimated to be about 7% of the entire Australian workforce, and nurses and midwives comprise the single, largest health professional group at 54%.[5]

According to the classification of body mass index (BMI) by World Health Organization (WHO),[6] *healthy weight* refers to a BMI of 18.50 to 24.99 (reference range). *Unhealthy weight* refers to a BMI that falls out of the reference range, classified as underweight (BMI < 18.50), overweight (BMI: 25.00 to 29.99) and obese (BMI ≥ 30.00). There are health consequences of having unhealthy weight. Being underweight increases one's risk of suffering from bone loss and osteoporosis, and heart arrhythmias.[7] Recognizing this need, the World WHO is conducting a study to report "Estimates of Underweight Adult" and it will be released soon on the WHO Web site (http://apps.who.int/bmi/index.jsp?introPage=intro_4_2.html).[8] The prevalence of female adulthood underweight was 8.9% in Australia, 3.6% in New Zealand, and 6% in the United Kingdom.[9–11] On the contrary, people are more aware of many chronic health conditions that are associated with being overweight and/or obese, including Type II diabetes, cardiovascular disease, osteoarthritis, hypertension and stroke, and certain forms of cancer.[12–24] Obesity has reached epidemic proportions globally, with more than 1 billion adults who are overweight, and at least 300 million of these are clinically obese.[25] Obesity rates have increased threefold or more since 1980 in some areas of North America, the United Kingdom, Eastern Europe, the Middle East, the Pacific Islands, Australia, and China.[25] In 2004 to 2005, there was a 9% increase in the Australian adult population being either overweight or obese since 1995.[26] Among Australian women, 25% of women aged 18 years and older were overweight and 17% were obese.[27] The prevalence of being overweight and/or obese has also increased in the United Kingdom and New Zealand over the past decades.[10,11] Many studies have been conducted to identify the causes and risk factors associated with overweight/obesity,[28,29] and interventions have focused on treating or modifying these conditions to reduce the health consequences.

Shift work is defined as work performed primarily outside typical daytime hours and includes evening shifts, rotating shifts, irregular shifts, and flexitime.[30] It has been identified as one of the factors that may have an impact on being overweight and/or obese, and research findings suggest that shift work may increase the likelihood of being overweight and/or obese by at least 39%.[31–34] Conversely, despite the potentially serious health consequences, research on underweight has been limited, perhaps reflecting the comparatively lower prevalence of being underweight in the population. Therefore, research that examines causes and risk factors associated with unhealthy weight in shift workers should be extended to include underweight.

The primary aim of this study was to examine the association between shift work and unhealthy weight among nurses and midwives. The secondary aim was to explore the relationship between shift work and modifiable lifestyle factors, including diet quality, physical activity, smoking, and alcohol consumption as potential confounders.

METHODS

Subjects

This study is a sub-study of the Nurses and Midwives' e-cohort Study (NMeS), which is a longitudinal population-based study funded by the Australian Research Council and a range of industry partners. The purpose of NMeS is to examine factors associated with both workforce and health outcomes in a cohort of nurses and midwives in Australia, New Zealand, and the United Kingdom. The NMeS is conducted completely electronically from recruitment to follow-up. Recruitment procedures have been published elsewhere.[35] The baseline survey (survey 1) was launched in April 2006 when the study recruitment began. Registrations to the on-line study via the study Web site (www.e-cohort.net) continued over a 2-year period until April 2008. There have been 10,120

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DOI: 10.1097/JOM.0b013e318205e1e8

total registrants to date, of whom, 7604 registrants completed survey 1 (75%) and 5280 registrants completed survey 2 (follow-up rate, 69%). Survey 3 was opened on-line on May 18, 2010, and it is continuing now.

This sub-study is cross-sectional in design, using data from the baseline survey. To be included in the study sample, a respondent must be currently working as a nurse and/or midwife who is not pregnant at the time of data collection and has to meet one of the following two criteria:

1. Working shifts (such as continuous shift work, evening shifts only, night shifts only, morning and evening shifts only, or evening and night shifts only); and

2. Working in day shift (including day shifts only without weekends or day shifts only with weekends).

Among the 7604 registrants who completed survey 1, 2612 (34%) nurses and/or midwives met the inclusion criteria and provided information on the modifiable lifestyle factors (smoking, alcohol consumption, physical activity, and diet quality). Among this sample, 2494 (95%) were female nurses and/or midwives. Because of the small number of male participants, the decision was made to analyze data collected from only female participants. Other reasons for selecting only women as the sub-study sample was to counterbalance the existing male dominance in populations drawn for shift-work research[36] and to remove the effects of gender as a potential confounding variable.

Variables

Exposure variable (shift work)

In the NMeS, work schedule was measured by asking the respondent to identify which of the following categories described her/his current shift schedule: (1) day shifts only without weekends; (2) day shifts only with weekends; (3) continuous shift work; (4) evening shifts only; (5) night shifts only; (6) morning and evening shifts only; and (7) evening and night shifts only. For the purposes of this sub-study, the first two response categories were considered as day work and the remaining five categories as shift work.

Dependent variables (modifiable lifestyle factors and unhealthy weight)

Unhealthy weight included underweight, overweight, and obese, which were defined according to the BMI classification standards by WHO.[37] These cutoff points are as follows: (1) underweight: less than 18.5; (2) normal: 18.5 to 24.9; (3) overweight: 25.0 to 29.9; and (4) obese: 30.0 or more.

Unhealthy weight is caused by energy imbalance, which is affected by people's diet, physical activity level, and other lifestyle habits.[38] The association between smoking and unhealthy weight is complex,[39] and the impact of alcohol consumption on one's weight change is not yet established.[40] Therefore, in this study, diet quality, physical activity, smoking, and alcohol consumption were selected as modifiable lifestyle factors to better understand the impact of the interaction of those factors and shift work on unhealthy weight.

Diet quality was measured by using the Australian Recommended Food Score (ARFS).[41] The ARFS is a 74-item instrument in which each item has a "Yes-No" response format. This instrument has been developed and validated to be a quick and easy way to assess individuals on the quality of diet on the basis of a set of dietary targets.[41,42] The maximum ARFS is 74 and scores are categorized into five categories according to different cut-points, in which higher scores are indicative of higher diet quality.

Physical activity was assessed by the International Physical Activity Questionnaire (IPAQ). This questionnaire is used internationally to obtain the comparable estimate of physical activity and to measure the prevalence and impact of the sedentary lifestyle. The validity of IPAQ as an estimate of the level of physical activity has been established,[43–46] and the test–retest reliability has been evaluated in other studies.[43,45,47–49] The guidelines for data processing and scoring of IPAQ are available on-line (http://www.ipaq.ki.se/scoring.pdf), and IPAQ can be treated as a continuous variable or a categorical variable (low, moderate, and high).[50] For the purposes of this sub-study, IPAQ scores have been treated as a categorical variable.

Smoking status was assessed by items from Nurses' Health Studies (http://www.channing.harvard.edu/nhs/).[51] In this sub-study, the items relating to smoking required the respondents to identify as a "current smoker," "former smoker," or "never smoker."

Alcohol consumption was assessed by asking respondents to indicate how often, on average, they drink one glass, bottle, can of beer (heavy) or beer (light), red or white wine, or spirits (eg, vodka). These items were based on the semiquantitative Food Frequency Questionnaire.[52] The validity and reliability of Food Frequency Questionnaire have been reported.[53–58] In Australia, the National Health and Medical Research Council has developed population guideline for low-risk drinking.[59] The guidelines address both short-term and long-term risks in terms of "standard drinks" consumed per week. In this sub-study, four categories were proposed on alcohol consumption, which included "abstains from alcohol consumption," "low-risk drinkers," "risky drinkers," and "high-risk drinkers."

STATISTICAL METHOD

All statistical analyses were undertaken by using Stata version 9.2 (StataCorp, College Station, TX).[60] A significance level of 0.05 was determined for all statistical tests. At the univariate level of inferential statistics, mean and standard deviation were calculated for the only continuous variable (age), and Pearson's chi-squared tests were used for the other categorical variables. Multivariate modeling was performed by using a modified Poisson regression approach.[61] In this approach, dichotomous variables (underweight—yes/no; overweight-–yes/no; obesity-–yes/no) were created. Two models were constructed in the multivariate analysis. Model 1 included age as a covariate in analyzing the association between shift work and each dependent variable. In the second model, the modifiable lifestyle factors that had reached statistical significance in model 1 were also included in the analysis in addition to age.

RESULTS

In the sub-study sample, there were 2494 nurses and midwives aged 20 to 70 years (42.8 ± 9.9). Shift workers were about 4 years younger than day workers (41.3 vs 45.1 years, $P < 0.0001$). Among those who indicated the country where they were working at the time of data collection, 70.9% (1768 of 2494) of the participants were working in Australia, and participants in New Zealand and the United Kingdom were equal (14.1%). Of the participants, there were 1259 day workers and 1235 shift workers. Only 1% of the participants were underweight, 31.8% of the participants were overweight, and 26.9% were obese. Regarding diet quality and physical activity, the majority of the participants reported having high quality of diet (61.5%) and high level of physical activity (52.6%). Of the participants, 12.3% were current smokers, 32.5% were former smokers, and 55.2% were nonsmokers. About 10% of the total participants were risky or high-risk drinkers.

Crude comparisons between shift workers and day workers indicated that the prevalence of having low physical activity was higher in shift workers (Table 1). Shift workers were found to have lower prevalence of being risky and/or high-risk drinkers (Table 1). With regard to their smoking status, there was a higher prevalence of current smokers and never smokers in shift workers (Table 1). After removing the effect of age on those associations, the differences between shift and day workers on their smoking status were no longer statistically significant (Table 1).

TABLE 1. Characteristics of Study Participants ($N = 2494$)

	All Participants, Mean (SD)	$N = 2494$, No. (%)	Day Workers, Mean (SD)	$N = 1259$, No. (%)	Shift Workers, Mean (SD)	$N = 1235$, No. (%)	P	P^*
Age	42.8(9.9)		45.1 (8.7)		41.3 (10.3)		<0.0001	
Diet quality							0.254	0.747
≤24		83 (3.3%)		48 (3.8%)		35 (2.8%)		
25−30		234 (9.4%)		104 (8.3%)		130 (10.5%)		
31−34		233 (9.3%)		118 (9.4%)		115 (9.3%)		
35−39		409 (16.4%)		209 (16.6%)		200 (16.2%)		
≥40		1535 (61.5%)		780 (62%)		755 (61.1%)		
Physical activity							<0.001	0.005
Low		234 (9.4%)		133 (10.6%)		101 (8.2%)		
Moderate		949 (38.1%)		544 (43.2%)		405 (32.8%)		
High		1311 (52.6%)		582 (46.2%)		729 (59.0%)		
Smoking status							0.003	0.217
Current smoker		308 (12.3%)		137 (10.9%)		171 (13.8%)		
Former smoker		810 (32.5%)		445 (35.3%)		365 (29.6%)		
Never smoked		1376 (55.2%)		677 (53.8%)		699 (56.6%)		
Alcohol consumption							<0.001	0.009
Abstains from alcohol		385 (15.4%)		162 (12.9%)		223 (18.1%)		
Low-risk drinkers		1863 (74.7%)		948 (75.3%)		915 (74.1%)		
Risky drinkers		176 (7.1%)		110 (8.7%)		66 (5.3%)		
High-risk drinkers		70 (2.8%)		39 (3.1%)		31 (2.5%)		
BMI							0.421	< 0.001
Underweight		26 (1.0%)		13 (1.0%)		13 (1.1%)		
Normal		1006 (40.3%)		528 (41.9%)		478 (38.7%)		
Overweight		792 (31.8%)		386 (30.7%)		406 (32.9%)		
Obese		670 (26.9%)		332 (26.4%)		338 (27.4%)		

BMI, body mass index.
*Age adjusted P values.

Shift workers were found to have a higher prevalence of being overweight or obese as compared with day workers (Table 1) and were about 4 years younger than day workers ($P < 0.0001$). After adjusting age as a confounder, shift workers were 1.15 times more likely to be overweight and 1.14 times more likely to be obese than day workers, respectively ($P = 0.008$; 95% confidence interval [CI], 1.04 to 1.28 and $P = 0.03$; 95% CI, 1.01 to 1.28, respectively) (Tables 2 and 3). Physical activity, alcohol consumption, and age were all adjusted in the final analysis; shift workers were found to be 1.15 times more likely to be overweight/obese than day workers ($P = 0.013$; 95% CI, 1.03 to 1.28; $P = 0.02$, 95%, CI 1.02 to 1.30, respectively) (Tables 2 and 3). Although the relative risk of being overweight/obesity was 1.15, shift workers can be about 1.3 times more likely to be overweight/obesity compared with day workers.

DISCUSSION

This sub-study found that 1% of the total participants were underweight (Table 4), 31.8% were overweight, and 26.9% were obese, which suggests that the nursing and midwifery population face the problem of having unhealthy weight, especially being overweight or obese. As this was an adult female-only sample, the previously mentioned statistics were compared with the prevalence of unhealthy weight in the three countries. In the Australian female population 25% of females aged 18 years and older were overweight and 17% of adult females were obese.[27] The prevalence of overweight and obesity among the female population in New Zealand was 28% and 21%, respectively.[10] In the United Kingdom, the prevalence of overweight and obesity among females was 32.6% and 23.0%, respectively.[11] The results of this sub-study clearly demonstrated that the nursing and midwifery population had a higher prevalence of overweight and obesity as compared with the general population across the three countries, except that the prevalence of overweight among women in the UK general population was about the same as the study sample. Unhealthy weight in groups of health professionals is surprising, given that they may be considered more informed than the general population. Moreover, the prevalence of being overweight or obese among shift workers in the present study was even higher (32.9% and 27.4%, respectively). On the contrary, only 1% of the participants were found to be underweight, and this finding was much lower than that in the general population in the three countries (Australia: 8.9%; New Zealand: 3.6%; and United Kingdom: 6%).[9–11] Although the problem of underweight was less serious than that of overweight and obesity, one should not neglect the health complications of being underweight.

The findings from the present study suggested that shift work might increase the likelihood of being overweight and/or obese by 15% or it could be as high as 30%. Similar results have been obtained from a prospective cohort study conducted among female nurses concerning the impact of shift work on weight gain,[31] which showed that more female nurses on night work exhibited excessive weight gain than nurses on day work (>7 kg; odds ratio [OR], 2.9; 95% CI, 1.2 to 6.9). The results were also in line with some studies on overweight and obesity in men and women employed in shift work in other occupational groups. For instance, Karlsson et al[32] reported that shift work was found to be associated with an increased OR in being obese among women (OR, 1.39; 95% CI, 1.25 to 1.55). Parkes et al[33] reported that increase in BMI was more marked in shift work over successive years of exposure ($r = 0.19$; $P = 0.0025$). Shift workers were found to be 1.6 times more likely to be overweight than day workers.[34] In three of the previously mentioned studies,[31,33,34]

TABLE 2. Relative Risks and 95% Confidence Intervals Predicting Being Underweight in Shift Workers and Day Workers

	Overweight							
	Yes	**No**	**RR**	**95% CI**	**RR***	**95% CI***	**RR†**	**95% CI†**
Day	13	528	1.00					
Shift	13	478	1.10	0.52–2.35	1.00	0.99–1.01	1.00	0.99–1.01

CI, confidence interval; RR, relative risk.
*Age-adjusted *P* values. $P = 0.949$.
†Age, physical activity, and alcohol consumption were all adjusted in the multivariate model. $P = 0.774$.

TABLE 3. Relative Risks and 95% Confidence Intervals Predicting Being Overweight in Shift Workers and Day Workers

	Overweight							
	Yes	**No**	**RR**	**95% CI**	**RR***	**95% CI***	**RR†**	**95% CI†**
Day	386	528	1.00					
Shift	406	478	1.08	0.98–1.21	1.15	1.04–1.28	1.15	1.03–1.28

CI, confidence interval; RR, relative risk.
*Age adjusted *P* values. $P = 0.008$.
†Age, physical activity, and alcohol consumption were all adjusted in the multivariate model. $P = 0.013$.

TABLE 4. Relative Risks and 95% Confidence Intervals Predicting Being Obese in Shift Workers and Day Workers

	Obeseweight							
	Yes	**No**	**RR**	**95% CI**	**RR***	**95% CI***	**RR†**	**95% CI†**
Day	332	528	1.00					
Shift	338	478	1.07	0.95–1.21	1.14	1.01–1.28	1.15	1.02–1.30

CI, confidence interval; RR, relative risk.
*Age tadjusted *P* values. $P = 0.03$.
†Age, physical activity, and alcohol consumption were all adjusted in the multivariate model. $P = 0.02$.

shift work was defined as working outside typical daytime hours, including night work. Nevertheless, the definition of shift work was ambiguous and imprecise in the study by Karlsson et al.[32] Diet and exercise were regarded as fundamental causes to overweight/obesity; however, none of the four studies adjusted both factors in their analysis.

A systematic review on the associations between shift work and people's modifiable lifestyle factors (diet, physical activity, smoking, and alcohol consumption) and BMI reported that shift workers were more likely to be smokers or smoke more and to have a poorer diet when compared with day workers.[62] Nevertheless, the present study found that the majority of the participants reported having high quality of diet (61.5%), despite the fact that almost 60% of the study participants were found overweight or obese. It should be noted that the ARFS used to measure diet quality did not assess the amount of the food consumed, which could raise the question whether only measuring diet quality was the appropriate approach to assess its association with unhealthy weight. Nevertheless, after controlling age as a confounder, the present study did not find statistically significant differences in smoking or diet quality between day workers and shift workers. The systematic review reported heterogeneous findings on the impact of shift work on level of physical activities and alcohol consumption.[62] This study found lower level of physical activity among shift workers compared with day workers. Shift workers were also found to be less dominant in "risky" or "high-risk" drinkers in the study. Future analytical studies should be conducted to better understand the causal relationships between shift work and physical activity and alcohol consumption.

This sub-study drew on a large representative sample of female nurses and midwives across Australia,[63] New Zealand, and the United Kingdom ($N = 2494$) and considered the role of modifiable lifestyle factors (diet quality, physical activity, smoking, and alcohol consumption) in determining the association between shift work and unhealthy weight. Although some studies have reported that these modifiable lifestyle factors are related to BMI,[64–66] no study in the available literature has adjusted for their confounding effects when determining the association between shift work and unhealthy weight. This sub-study was the first of its kind to adjust for modifiable lifestyle factors in the analysis of the association between shift work and unhealthy weight and concluded that shift workers were 1.15 times more likely to be overweight or obese as compared with day workers.

This sub-study relied on cross-sectional data, which precluded the possibility to draw definite conclusions regarding causality and temporal relationships between the exposure and outcome variables. Future research should use study designs that yield higher levels of evidence about the complex associations between exposure to shift work and unhealthy weight. Furthermore, consideration of potential "healthy-worker effect" bias due to selection out of the study cohort is important. In this sub-study, it may be that work scheduling may have been impacted by individual health status, for example, some shift workers may have had given up working shifts because of health reasons, which may result in underestimation of the reported associations. In addition, study results were based on self-reported data that might be affected by social desirability (eg, responses on smoking and alcohol questions) and the ability to report information accurately (eg, height and weight data); however, there should be

no reason to expect that response bias would differ between shift workers and day workers. Moreover, there were other factors that could have been controlled to strengthen the results, such as stress, sleep, circadian factors, availability of foods, metabolic changes, duration of shift work, past experience of shift work, and female reproductive factors. Variables, including participants' mental health, sleep menopause, and the use of hormone replacement therapy, are being considered in the subsequent longitudinal analysis undertaken to better determine the causal relationship between shift work and unhealthy weight. Informations on participants' circadian factors, metabolic changes, duration and past experience of shift work, and food availability were not collected in the baseline survey, however there is potential to explore these in future sub-studies. With respect to shift work, night work specifically has been associated with excessive weight gain among female nurses in a prospective cohort study.[31] The association between night work (including the duration of working nights) and unhealthy weight is currently being examined in the NMeS as the focus of a subsequent article. Finally, this sub-study included only female nurses and midwives. If the effects of gender can be controlled, then the association between shift work and unhealthy weight can be determined more conclusively.

CONCLUSIONS

To the best of our knowledge, this is the first study conducted among nurses and midwives across Australia, New Zealand, and the United Kingdom, examining the association between shift work and unhealthy weight, adjusting the modifiable lifestyle factors as confounders. Our findings suggest that shift work is associated with higher risk of being overweight and/or obese in female nurses and midwives. Studies that may yield higher levels of evidence are being undertaken by the authors to better understand the causal relationship between shift work and unhealthy weight.

ACKNOWLEDGMENTS

This project is supported by grants from the Australian Research Council (LP0562102) and (SR0566924), Australian National Health and Medical Research Council (2005002108), and New Zealand Health Research Council (456163). Industry Partners providing additional funding include Queensland Health, the South Australian Department of Health, Injury Prevention and Control Australia (Pty Ltd), Nursing Council of New Zealand, and the Macquarie Bank Foundation. Industry partners providing in kind support for the project include Queensland Nursing Council, Nurses and Midwives Board of New South Wales, Nurses Board of Tasmania, Nurses Board of Western Australia, Nurses Board of the Australian Capital Territory, and the Nursing Council of New Zealand. Corporate sponsors include Virgin Blue, Virgin Atlantic, and MessageNet.

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