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Adherence to dietary and physical activity guidelines among shift workers: associations with individual and work-related factors

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ABSTRACT

Objectives Shift work is associated with adverse effects on the health and lifestyle behaviours of employees. This study aimed to examine factors associated with adherence among shift workers to selected indicators of dietary and physical activity guidelines.

Methods A cross-sectional study was conducted on 1300 shift workers. Data were collected using a 15 minute telephone-administered questionnaire. Logistic regression methods were used for data analysis.

Results Male shift workers (p<0.001, OR=0.55, 95% CI 0.40 to 0.74) and those of lower socioeconomic status (p=0.046, OR=0.75, 95% CI 0.57 to 0.99) were significantly less likely to consume five or more daily servings of fruits and vegetables. Shift workers with access to workplace vending machines were significantly more likely to consume soft drinks at least weekly (p=0.003, OR=1.64, 95% CI 1.18 to 2.27). Middle-aged shift workers (p=0.012, OR=0.65, 95% CI 0.46 to 0.91) and those reporting insufficient break times at work (p=0.026, OR=0.69, 95% CI 0.49 to 0.96) were significantly less likely to be sufficiently active.

Conclusions Individual, work schedule and workplace environment related factors were independently associated with selected indicators of adherence to dietary and physical activity guidelines in this cohort of shift workers.

Key messages

What this paper adds?

- This study has identified factors pertaining to the individual, shift work exposure and the workplace environment that were independently associated with adherence among a large cohort of shift workers employed on the island of Ireland to selected indicators of population dietary and physical activity guidelines.
- Overall, adherence among shift workers in this study to these guidelines was sub-optimal - less than half of the participants were adherent to each of the guideline indicators of interest.
- The optimisation of dietary intake and physical activity levels among shift workers should be a priority for occupational and public health medicine - insights provided by this study may inform the development of interventions to address this for shift workers, tailored according to individual and work-related factors.

INTRODUCTION

Shift work is defined by the Council of the European Union[1] as '*any method of organising work in shifts whereby workers succeed each other at the same work stations according to a certain pattern*'. Traditionally, only a limited proportion of the workforce was engaged in shift work—however, many employment sectors have now adopted shift work schedules.[2] In 2010, 17% of the workforce in the European Union was employed in shift work,[3] a proportion which had increased to 21% by 2015.[4] In Ireland, approximately 15% of the working population are employed in shift and/or night work.[2]

Shift work has been associated with adverse effects on the physical and mental health of those engaged in it—in particular, increased risks of being overweight or obese, the metabolic syndrome and other non-communicable diseases (NCDs) including type 2 diabetes mellitus, cardiovascular disease, gastrointestinal and mental health disorders.[5 6] In 2019, the International Agency for Research on Cancer categorised '*night shift work*' as a Group 2A carcinogen.[7] The disruptive and irregular nature of shift work schedules may also adversely affect the worker's ability and motivation to maintain health-promoting lifestyle behaviours.[8] Many such behaviours, including an unhealthy diet, physical inactivity, smoking, excess alcohol consumption, being overweight and having insufficient sleep are considered to be risk factors for

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NCDs and have been more frequently reported among shift workers.[5 9] Shift work has been shown to adversely affect the quality and quantity of dietary intake as well as meal frequency, with greater meal skipping and unconventional meal timing reported among shift workers compared with non-shift workers.[10] Shift workers may also have difficulty engaging in regular exercise due to factors such as time constraints, sleep disruption, fatigue, lack of availability of leisure facilities and opportunities to exercise outside of working hours, and internal factors such as individual motivation to exercise.[11]

The limited published data on the experience of Irish shift workers have demonstrated that shift work may negatively affect their health behaviours and psychosocial well-being.[12] Factors relating to the work environment have been identified which may act as barriers or facilitators in their effect on the ability of Irish shift workers to maintain healthy lifestyle behaviours both at work and at home. Further evidence-based insights of this nature are required to inform the development of public and occupational health measures to optimise the health and health behaviours of shift workers. The aim of this study was to examine individual and work-related factors associated with adherence among shift workers to selected indicators of national dietary and physical activity guidelines.

METHODS

Study design and participants

This cross-sectional study was conducted on a population of 1300 shift workers from the Republic of Ireland (RoI) (n=850) and Northern Ireland (NI) (n=450), which was demographically, geographically and occupationally representative of the estimated 270 000 shift workers on the island of Ireland. The study population was derived from a previous larger study commissioned by *safe*food entitled '*Managing Food on Shift Work*', comprised of quantitative and qualitative components.[13] The data for the original *safe*food study were collected by the market research company Millward Brown Ulster (MBU) using a 15 minute telephone-administered questionnaire, developed by the research team for the *safe*food study. The content of this study questionnaire was informed by the qualitative component of the *safe*food study, the published shift work literature and national dietary intake data. A random digit dial sample of telephone numbers in the RoI and NI was generated using a mathematical formula by MBU, then pulsed to ensure they were 'live' numbers. Random real numbers were then selected from the database via specialised telephone software. Eligibility criteria for this study included being aged 18 years or older and working in a shift work pattern at the time of contact. During the 15 minute telephone interview, participants were asked a series of questions (referring to the previous 1 month period of their lives) to obtain information on their demographic characteristics, shift work pattern, typical dietary intake, physical activity levels and workplace environment. The questionnaire used to collect data for the *safe*food study was reviewed prior to the commencement of this study, and variables relevant to the research question and the questions pertaining to those variables were chosen. The original questionnaire is available as online supplementary appendix 1 with the questions considered relevant for the current study indicated (highlighted in yellow).

Data management

On receipt of the raw data from the original *safe*food study variables not intended for use were removed and missing values were coded (these data were not included in the analysis of data for the current study). Selected variables were recoded into categorical variables. Age was recoded into three categories; 18–34 years, 35–54 years and 55+years, in order to examine age profiles of shift workers in relation to outcomes of interest. Body mass index (BMI), calculated based on self-reported height and weight measures, was recoded into four categories based on the WHO BMI classification system;[14] underweight (<18.50 kg/m^2), normal weight (18.50–24.99 kg/m^2), overweight (25.00–29.99 kg/m^2) and obese (≥30 kg/m^2). Socioeconomic status (SES) was derived in the original *safe*food study from the occupation of the head of the household, categorised according to the National Readership Survey (2015) classification system[15] into classes ABC1 and C2DE. ABC1 included those in the upper middle, middle and lower middle classes, while C2DE included those in the skilled working, working and non-working classes. Duration of exposure to shift work measured in years and the average length of shift measured in hours were recoded, respectively, into '*less than 8 years*' and '*8 years or more*', and '*less than 8 hours*', '*8–11 hours*' and '*12 or more hours*'. The predominant shift pattern of participants was recoded into '*days*', '*nights*', '*rotating*' and '*other*' (which included split, inconsistent and equal day/afternoon/night rotating shifts)—online supplementary table 1, available as online-only supplementary material, provides further information on this categorisation.

Consumption of fruits, vegetables, wholegrains and soft drinks were selected as dietary outcomes of interest for this study, representing markers of adherence to Irish dietary guidelines. These were chosen following review of the shift work literature, and of dietary intake data and guidelines for the Irish adult population. These guidelines advise consumption of a minimum of five to seven daily servings of fruits and vegetables (unsweetened fruit juice, smoothies, tinned fruit and dried fruit are also counted) and three to five daily servings of foods from the '*wholemeal cereal and breads, potatoes (cooked any way), pasta and rice*' group of the Irish food pyramid,[16] as these are highly nutrient-dense foods associated with reductions in risk of several chronic diseases and overall mortality.[17 18] The suboptimal compliance of the adult population of the RoI and NI with these specific dietary guidelines is well described,[19–21] while lower intakes of fruit, vegetables, dietary fibre and various micronutrients have been

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observed among shift workers compared with non-shift day workers.[22–24]

Consumption of fruits and vegetables was recoded in a binary manner into those who consumed five or more daily servings of these foods and those who consumed them less frequently than this. Consumption of wholegrains (a food category which included '*brown pasta, brown rice, wholegrain bread, wholegrain cereals, and porridge*' in the study questionnaire) was also recoded in a binary manner into those who consumed one or more daily servings of these foods and those who consumed them less frequently than this.

The frequency of consumption of soft drinks was recoded into those who consumed one or more servings of these beverages per week and those who consumed them less frequently than this, as Irish adults are advised to avoid daily consumption of soft drinks and to limit overall intake to a maximum of one or two servings per week.[16]

National and international physical activity guidelines advise adults to undertake a minimum 150 minutes of moderate-intensity aerobic physical activity per week.[25 26] In this study, physical activity was recorded in minutes per week per participant based on self-reported frequency of episodes of moderate-to-vigorous physical activity performed per week and the average length of each. The total time engaged in physical activity per week was then calculated and categorised according to whether the participant was meeting the above guideline or not.

Data analysis

SPSS (IBM V.24) was used for data management and statistical analysis. A descriptive analysis of the study population was initially conducted. Pearson's χ^2 tests were used to compare categorical variables and examine associations between these. Logistic regression methods were chosen for the analysis of this study as the selected outcomes were binary in nature, that is, meeting the relevant guideline or not. Univariable binary logistic regression analyses were then performed for the four (three dietary and one physical activity) outcomes of interest using the same independent variables for each outcome. Independent variables pertained to the individual (gender, age category, SES and BMI), shift work exposure (occupational sector, duration of shift work exposure, average shift length and predominant shift pattern) and the workplace environment (availability of food preparation, food storage and leisure facilities, vending machines and adequate break times, whether participants were satisfied with healthy food options at work and whether they felt their workplace helped them lead a healthy lifestyle). Health and social work was chosen as the reference occupational sector for the analysis as it is acknowledged that these shift workers may have achieved greater levels of health literacy and education compared with those working in other sectors.[27] Independent variables significantly associated with the four outcomes in the univariable regression analyses were added to separate multivariable logistic regression models for the four outcomes. All independent variables were mutually adjusted for in the multivariable models for each of the four outcomes of interest. Significant results were determined by a value of $p<0.05$.

Table 1 Demographic and health-related characteristics of shift workers (n=1300)

Variables	N	%
Country of residence		
Ireland	850	65.4
Northern Ireland	450	34.6
Gender		
Male	672	51.7
Female	628	48.3
Age category*		
18–34 years	490	38.2
35–54 years	606	47.2
55–65 years	187	14.6
Marital status		
Single never married	528	40.6
Married and living with spouse	637	49.0
Civil partnership	27	2.1
Married and separated from spouse	47	3.6
Divorced	45	3.5
Widowed	16	1.2
Socioeconomic status†‡		
ABC1	599	48.2
C2DE	644	51.8
Calculated BMI§¶		
Underweight	30	2.7
Normal weight	504	45.4
Overweight	397	35.8
Obese	179	16.1

*Valid denominator=1283
†Based on the occupation of the head of household. ABC1 denotes upper middle class, middle class and lower middle class. C2DE denotes skilled working class, working class and non-workers[15]
‡Some participants declined to respond (n=57)
§Calculated based on self-reported height and weight and categorised according to the WHO BMI classification[14]
¶Valid denominator=1110
BMI, body mass index.

RESULTS

Demographic characteristics

Table 1 provides information on the shift workers' demographic characteristics. There was a similar proportion of men and women, and of those in both categories of SES. Middle-aged (35–54 years old) shift workers comprised the largest proportion of participants.

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Shift work schedule and work environment characteristics

Table 2 provides information on the characteristics of the shift workers' work schedule and work environment. The most common average shift length reported was 8–11 hours. In terms of the predominant pattern of shifts worked, those in the '*other*' category and those working predominantly day shifts comprised the largest groups. Over half of participants had access to food preparation and storage facilities at work. Less than one-third had access to vending machines. Most participants reported receiving adequate work break times. The majority did not have access to leisure facilities at work.

Dietary and physical activity characteristics

Table 3 provides information on the shift workers' dietary behaviours and physical activity levels. Approximately 40% reported consuming five or more daily servings of fruits and vegetables, while 61% did not consume wholegrains on a daily basis. Over one-third consumed soft drinks at least once per week. Thirty-nine per cent adhered to national aerobic physical activity guidelines, while 59% were engaged in minimal physical effort at work and approximately one-fifth reported mostly sedentary occupational behaviour.

Multivariable regression analysis

The univariable regression analyses which informed the multivariable regression models are available as (online-only) online supplementary tables 2–5. Tables 4 and 5 combined present the four multivariable regression models with all independent variables listed.

Fruit and vegetable intake

Male shift workers (relative to women) and those in the lower C2DE social class (relative to those in the upper ABC1 class) were 45% (p<0.001, OR=0.55, 95% CI 0.40 to 0.74) and 25% (p=0.046, OR=0.75, 95% CI 0.57 to 0.99) less likely to consume five or more daily portions of fruits and vegetables, respectively.

Wholegrain intake

Those exposed to shift work for 8 years or more (compared with those exposed for less) were 38% more likely (p=0.02, OR=1.38, 95% CI 1.05 to 1.82) to consume wholegrains at least daily, while compared with those working mostly day shifts, participants working predominantly nights, rotating or other shift patterns were each over a third less likely to do so (p=0.011, OR=0.61, 95% CI 0.41 to 0.89, p=0.026, OR=0.65, 95% CI 0.45 to 0.95 and p=0.002, OR=0.65, 95% CI 0.50 to 0.86, respectively). Retail shift workers were 35% less likely (p=0.022, OR=0.65, 95% CI 0.44 to 0.94) to consume wholegrains on a daily basis compared with those working in health and social work services.

Soft drinks intake

Middle-aged shift workers (35–54 years old) were half as likely (p<0.001, OR=0.50, 95% CI 0.34 to 0.73) to consume soft drinks at least weekly relative to the

Table 2 Shift schedule and work environment characteristics of shift workers (n=1300)

Variables	N	%
Occupational sector		
Accommodation and food services	218	16.8
Health and social work	355	27.3
Retail	229	17.6
Manufacturing	110	8.5
Other*	388	29.8
Pattern of SW		
Predominantly days	460	35.4
Predominantly nights	164	12.6
Predominantly rotating	168	12.9
Other	508	39.1
Duration of exposure to SW		
<8 years	622	47.8
≥8 years	678	52.2
Average length of shift		
<8 hours	379	29.2
8–11 hours	622	47.8
≥12 hours	299	23.0
Availability and use of food preparation facilities		
Yes	685	52.7
No	327	25.2
Not available	288	22.1
Availability and use of food storage facilities		
Yes	784	60.3
No	267	20.5
Not available	249	19.2
Availability and use of vending machines		
Yes	355	27.3
No	408	31.4
Not available	537	41.3
Receiving adequate break times†		
Agree	776	69.7
Disagree	337	30.3
Satisfied with healthy meal/snack availability‡		
Agree	551	59.3
Disagree	378	40.7
Availability of leisure facilities		
Yes	142	10.9
No	1158	89.1

*Denotes those employed in sectors of transport/communications, agriculture/animals, construction, call centre/telesales, computer-related activity, distribution and logistics and finance/banking/insurance
†Valid denominator=1113
‡Valid denominator=929
SW, shift work.

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Table 3 Dietary behaviours and physical activity levels of shift workers (n=1300)

Variables	N	%
Fruit and vegetable consumption*		
≥5 servings/day	522	40.2
<5 servings/day	778	59.8
Wholegrain consumption*		
≥1 serving per day	512	39.4
<1 serving per day†	788	60.6
Soft drink consumption*		
≥1 serving per week	487	37.5
<1 serving per week‡	813	62.5
Type of occupational PA		
Mostly sitting	262	20.2
Minimal physical effort	762	58.6
Moderate physical effort	212	16.3
Vigorous physical effort	64	4.9
Time spent in MVPA per week§¶		
≥150 min	509	39.2
<150 min	789	60.8

*Denotes frequency of consumption according to the Food Safety Authority of Ireland dietary guidelines[16]
†Denotes consumption multiple times per week, less than weekly or not at all
‡Denotes consumption less than weekly or not at all
§Based on national and international physical activity guidelines[25 26]
¶Valid denominator=1298
MVPA, moderate-vigorous physical activity; PA, physical activity.

youngest participants (18–34 years old), while the oldest age group of shift workers were 67% less likely to consume soft drinks at least weekly relative to the youngest group (p<0.001, OR=0.33, 95% CI 0.18 to 0.59). When compared with those working in health and social work, manufacturing employees were just over twice as likely (p=0.019, OR=2.03, 95% CI 1.12 to 3.68) to consume soft drinks at least once per week. Shift workers with access to vending machines at work (compared with those without) were 64% (p=0.003, OR=1.64, 95% CI 1.18 to 2.27) more likely to consume soft drinks at least once per week.

Physical activity

Middle-aged shift workers were 35% (p=0.012, OR=0.65, 95% CI 0.46 to 0.91) less likely to adhere to national physical activity guidelines relative to the youngest participants, while those who did not receive adequate break times at work (relative to those who did) were 31% (p=0.026, OR=0.69, 95% CI 0.49 to 0.96) less likely to do so.

DISCUSSION

This study identified factors pertaining to the individual, shift work exposure and the workplace environment that were independently associated with adherence among a large cohort of shift workers employed on the island of Ireland to selected indicators of population dietary and physical activity guidelines. Overall, adherence among participants to these guidelines was suboptimal—less than half were adherent to each of the indicators of interest. With respect to dietary intake, this supports previous studies which have demonstrated lower intakes of fruits, vegetables and dietary fibre[22–24] among shift workers compared with day workers, as well as lower than recommended intakes of carbohydrates.[28] Consistent observations of higher intakes of soft drinks, and of poorer dietary quality and quantity, have also been reported among shift workers compared with non-shift workers.[10] In contrast, previous research has yielded conflicting results regarding the leisure physical activity of shift workers,[5] making comparison with our findings challenging. The low level of occupational activity, however, among participants is consistent with some previous data[29] although others have reported greater levels of the same compared with day workers.[30] Such differences may be explained by variable methodological approaches to measuring physical activity levels across these studies—nonetheless, there are significant risks to physical and mental health associated with physical inactivity and sedentary lifestyles.[31]

We found that men and those of lower SES were significantly less likely to consume the recommended daily servings of fruits and vegetables. Social class and gender differences in intake of these foods have been described previously in the general Irish adult population[19 32]—however, to the authors' knowledge, this is the first time this finding has been confirmed specifically in a range of shift workers. One study conducted on airline shift workers found lower fruit and vegetable intake among men without in-flight work compared with day and in-flight workers.[23]

Differences in dietary quality according to age among shift workers have been reported previously.[33] Age category also emerged as a significant factor in our analysis. Younger shift workers, compared with those who were middle-aged and older, were more likely to consume soft drinks at least weekly. In the general Irish population, young adults aged 15–34 years have been shown to have the highest intakes of sugar-sweetened beverages, many of which are soft drinks.[19] In contrast, middle-aged shift workers, compared with the youngest group, were less likely to adhere to aerobic physical activity guidelines. Declining levels of awareness of and adherence to these guidelines with age have been reported in the Irish adult population which may in part explain this finding.[34]

We examined several factors pertaining to shift work exposure—duration of exposure, occupational sector, average shift length, and predominant shift pattern. We found, relative to those working in health and social work, retail sector shift workers were less likely to consume wholegrain foods daily, while manufacturing workers were more likely to consume soft drinks at least weekly—the latter supports prior research demonstrating greater

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Table 4 Multivariable analysis of individual and workplace factors independently associated with dietary behaviours and physical activity levels of shift workers (n=1300)*

	Fruit/vegintake ≥5 servings/day†		Wholegrain intake ≥1 serving/day†		Soft drink intake ≥1 serving/week†		Physical activity ≥150 minutes/week‡	
	(n=522)		(n=512)		(n=487)		(n=509)	
Variables	P value	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)
Gender (ref: female) Male	**<0.001**	**0.55 (0.40 to 0.74)**	N/A		ns	1.29 (0.93 to 1.80)	N/A	
Age category (ref: 18–34 years)§								
Middle-aged (35–54 years)	N/A		ns	0.93 (0.70 to 1.24)	**<0.001**	**0.50 (0.34 to 0.73)**	**0.012**	**0.65 (0.46 to 0.91)**
Older age (55–65 years)	N/A		ns	1.27 (0.87 to 1.86)	**<0.001**	**0.33 (0.18 to 0.59)**	ns	0.74 (0.46 to 1.18)
BMI (ref: normal)¶								
Overweight/obese	ns	0.80 (0.61 to 1.07)	N/A		N/A		N/A	
SES (ref: ABC1) C2DE**	**0.046**	**0.75 (0.57 to 0.99)**	N/A		N/A		N/A	
Vending machines (ref: None)								
Available at Work	N/A		N/A		**0.003**	**1.64 (1.18 to 2.27)**	**0.025**	**0.71 (0.52 to 0.96)**
Break time adequate (ref: agree)††								
Disagree	N/A		N/A		N/A		**0.026**	**0.69 (0.49 to 0.96)**
Satisfied with healthy food availability (ref: agree)‡‡								
Disagree	N/A		N/A		ns	1.01 (0.71 to 1.44)	N/A	
Workplace helps lead a healthy lifestyle (ref: agree)§§								
Disagree	**0.028**	**0.73 (0.55 to 0.97)**	N/A		**0.047**	**1.43 (1.01 to 2.04)**	ns	0.75 (0.55 to 1.02)

Significant ORs (p<0.05) are denoted in bold font (these remained significantly associated with the outcome of interest after multivariable analysis)
*The full list of covariates included in the analysis is represented by those in the left-hand columns of tables 4 and 5
†According to the Food Safety Authority of Ireland dietary guidelines[16]
‡Minutes per week based on national and international physical activity guidelines[25 26]
§Valid denominator=1283
¶BMI calculated based on self-reported height and weight and categorised according to the WHO BMI classification[14] ('Underweight' participants were excluded (n=30))
**SES based on the occupation of the head of household. ABC1 denotes upper middle class, middle class and lower middle class. C2DE denotes skilled working class, working class and non-workers[15] (valid denominator=1243)
††Valid denominator=1113
‡‡Valid denominator=929
§§Valid denominator=1035
BMI, body mass index; N/A, not applicable (not significantly associated with the outcome of interest in univariable analysis); ns, not significant in the multivariable analysis; SES, socioeconomic status.

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Table 5 Multivariable analysis of shift work exposure factors independently associated with dietary behaviours and physical activity levels of shift workers (n=1300)*

	Fruit/veg intake ≥5 servings/day (n=522)†		**Wholegrain intake ≥1 serving/day** (n=512)†		**Soft drink intake ≥1 serving/week** (n=487)†		**Physical activity ≥150 minutes/week** (n=509)‡	
Variables	P value	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)
Occupational sector (ref: health and social work)								
Accommodation and food	ns	1.06 (0.67–1.66)	ns	0.85 (0.58 to 1.23)	ns	ns	ns	0.70 (0.39 to 1.26)
Retail	ns	0.80 (0.52–1.24)	**0.022**	**0.65 (0.44 to 0.94)**	ns	0.81 (0.48 to 1.35)	ns	1.52 (0.85 to 2.71)
Manufacturing	ns	1.05 (0.60–1.82)	ns	0.91 (0.58 to 1.42)	**0.019**	**2.03 (1.12 to 3.68)**	ns	1.34 (0.66 to 2.75)
Other	ns	0.90 (0.61–1.33)	ns	1.17 (0.86 to 1.58)	ns	1.11 (0.71 to 1.75)	ns	1.33 (0.79 to 2.24)
Duration of SW exposure (ref: <8 years)								
≥8 years	N/A		**0.02**	**1.38 (1.05 to 1.82)**	ns	0.89 (0.62 to 1.30)	ns	1.15 (0.74 to 1.80)
Average shift length (ref: <8 hours)								
8–11 hours	N/A		ns	0.99 (0.75 to 1.32)	ns	0.73 (0.50 to 1.06)	ns	0.99 (0.63 to 1.55)
≥12 hours	N/A		ns	1.26 (0.89 to 1.79)	**0.032**	**0.59 (0.37 to 0.96)**	ns	1.12 (0.64 to 1.96)
Predominant SW pattern (ref: days)								
Nights	N/A		**0.011**	**0.61 (0.41 to 0.89)**	N/A		N/A	
Rotating	N/A		**0.026**	**0.65 (0.45 to 0.95)**	N/A		N/A	
Other	N/A		**0.002**	**0.65 (0.50 to 0.86)**	N/A		N/A	

Significant ORs (p<0.05) are denoted in bold font (these remained significantly associated with the outcome of interest after multivariable analysis)
*The full list of covariates included in the analysis is represented by those in the left-hand columns of tables 4 and 5
†According to the Food Safety Authority of Ireland dietary guidelines[16]
‡Minutes per week based on national and international physical activity guidelines[25 26]
N/A, not applicable (not significantly associated with the outcome of interest in univariable analysis); ns, not significant following multivariable analysis.

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energy intake and poorer dietary quality in the manufacturing occupational subgroup.[22] Participants working predominantly non-day shifts were less likely to consume wholegrain foods daily, which is somewhat consistent with previous findings of poorer dietary quality among night and rotating shift workers compared with day workers.[33 35] However, we did not observe any significant differences in consumption of fruits and vegetables or soft drinks across shift pattern. Cumulative years employed in shift work also emerged as a significant factor in relation to daily wholegrain intake even when adjusted for age category, which may suggest improvements in health and nutritional knowledge among those with greater experience working in shift systems.

With regard to the work environment of participants, we observed two main findings. Those with access to vending machines at work, compared with those without, were more likely to consume soft drinks at least weekly—an important finding given improvements in availability (and price) of healthier choices in vending machines have been shown to improve sales of healthier products.[36 37] In addition, those who reported that they did not receive adequate break times at work were less likely to be sufficiently active compared with those who did, supporting previous Irish research which identified a perceived lack of time to be a barrier to physical activity among shift workers.[38]

Implications of findings

The gender, age and social class differences we observed across specific dietary behaviours highlight that nutritional aspects of health education and interventions for shift workers which seek to improve their adherence to population dietary guidelines should be developed with these characteristics in mind. Our findings also highlight the need to target middle-aged shift workers with workplace interventions which aim to improve their adherence to population physical activity guidelines.

Our findings regarding the shift work schedule and occupation of participants in relation to their adherence to selected indicators of dietary and physical activity guidelines may help employers to devise and adapt workplace policy and interventions which aim to improve adherence among employees to such guidelines. The workplace is a social context within which shift workers may spend a large amount of time and should support health-promoting lifestyle behaviours.[39] This study has highlighted that provision for shift workers of healthy vending machines, food preparation and storage facilities, and adequate break times should be a priority for employers.

Strengths and limitations

The study population was large in size, and was demographically, geographically and occupationally representative of the Irish shift work population, about whom little is known from a research perspective to date. Factors independently associated with adherence among participants to selected indicators of dietary and physical activity guidelines were identified, the optimisation of which is of importance from a public and occupational health perspective. Although a non-shift worker control group was not available to us against which the adherence of participants could be compared, nationally representative data for the general adult populations of RoI and NI were included, where appropriate, for comparison and context.

The cross-sectional design of this study precludes the potential to draw causal inferences from findings. Data were collected using a questionnaire, raising the possibility of recall and self-report bias pertaining to potential misreporting of weight, height, dietary behaviours and physical activity. Minor differences between the dietary and physical activity guidelines used and the corresponding questions in the questionnaire may have led to a slight underestimation or overestimation of adherence to the selected indicators of the guidelines among participants. The study questionnaire did not capture all domains of shift work—further research is needed to examine dietary and physical activity behaviours across different shift schedules and systems. Occupational physical activity, although not examined as an outcome in our study, remains an important consideration in relation to the health of shift workers. The possibility of residual confounding due to factors not included or measured in our analysis cannot be excluded. Finally, multicollinearity was not examined—as such the possibility of correlation between independent variables remains, which may have affected the validity of our findings.

CONCLUSIONS

Individual, work schedule and workplace environment-related factors were independently associated with selected indicators of adherence to dietary and physical activity guidelines in this cohort of shift workers. Shift workers face unique challenges to their health at the biological, psychological and social level. Tailored occupational health measures are required which address these challenges and provide solutions for them. This study has provided insights which may contribute to the development of such measures, targeting individual and organisational factors to protect the health of this vulnerable subpopulation of the global workforce.

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Patient consent for publication Not required.

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REFERENCES

1 The Council of the European Union. Directive 2000/34/EC of the European Parliament and of the Council of 22 June 2000 amending Council Directive 93/104/EC 'concerning certain aspects of the organisation of working time to cover sectors and activities excluded from that Directive.'. *Official Journal* 1993;l195:41–5.
2 Health and Safety Authority. *'Guidance for Employers and Employees on Night and Shift Work.'*. Dublin: Health and Safety Authority, 2012. https://www.hsa.ie/eng/Publications_and_Forms/Publications/Healthcare_Sector/Night_and_Shift_Work_2012.pdf
3 Eurofound. *'Changes over time – First findings from the fifth European Working Conditions Survey.'*. Luxembourg: Publications Office of the European Union, 2010. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf
4 Eurofound. *'First findings: Sixth European Working Conditions Survey'*. Luxembourg: Publications Office of the European Union, 2015. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf
5 Nea FM, Kearney J, Livingstone MBE, *et al*. Dietary and lifestyle habits and the associated health risks in shift workers. *Nutr Res Rev* 2015;28:143–66.
6 Vogel M, Braungardt T, Meyer W, *et al*. The effects of shift work on physical and mental health. *J Neural Transm* 2012;119:1121–32.
7 IARC Monographs Vol 124 group. Carcinogenicity of night shift work. *Lancet Oncol* 2019;20:1058–9.
8 Lowden A, Moreno C, Holmbäck U, *et al*. Eating and shift work - effects on habits, metabolism and performance. *Scand J Work Environ Health* 2010;36:150–62.
9 Zhao I, Turner C. The impact of shift work on people's daily health habits and adverse health outcomes. *Australian J of Adv Nursing* 2008;25:8–22.
10 Souza RV, Sarmento RA, de Almeida JC, *et al*. The effect of shift work on eating habits: a systematic review. *Scand J Work Environ Health* 2019;45:7–21.
11 Atkinson G, Fullick S, Grindey C, *et al*. Exercise, energy balance and the shift worker. *Sports Med* 2008;38:671–85.
12 Nea FM, Pourshahidi LK, Kearney JM, *et al*. A qualitative exploration of the shift work experience: the perceived effect on eating habits, lifestyle behaviours and psychosocial wellbeing. *J Public Health* 2018;40:e482–92.
13 Safefood. *Managing food on shift work: an exploration of the eating patterns, related lifestyle behaviours and experiences of shift workers on the island of Ireland*. Co. Cork, Ireland: Safefood, 2016. http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications/Research%20Reports/Managing-food-on-shift-work_Island-of-Ireland-October-2016.pdf
14 World Health Organisation. Body mass index: BMI [World Health Organisation website], 2019. Available: http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi [Accessed 14 Feb 2020].
15 National Readership Survey. Social grade [National Readership Survey website], 2015. Available: http://www.nrs.co.uk/nrs-print/lifestyle-and-classification-data/social-grade/ [Accessed 14 Feb 2020].
16 Food Safety Authority of Ireland. *Healthy eating, food safety and food legislation: a guide supporting the healthy Ireland food pyramid*. Dublin, Ireland: FSAI, 2016.
17 Wang X, Ouyang Y, Liu J, *et al*. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ* 2014;349:g4490.
18 Reynolds A, Mann J, Cummings J, *et al*. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet* 2019;393:434–45.
19 Department of Health. *Healthy Ireland 2018: a summary of findings*. Dublin, Ireland: Government Publications, 2018. https://www.hse.ie/eng/about/who/healthwellbeing/healthy-ireland/publications/healthy-ireland-survey-2018.pdf
20 Corrigan D, Scarlett M. *Health survey (NI): first results 2017/18*. Belfast, Northern Ireland: Department of Health, 2018. https://www.health-ni.gov.uk/sites/default/files/publications/health/hsni-first-results-17-18.pdf
21 Irish Universities Nutrition Alliance. *National adult nutrition survey: summary report*. Cork, Ireland: Irish Universities Nutrition Alliance, 2011. https://irp-cdn.multiscreensite.com/46a7ad27/files/uploaded/The%20National%20Adult%20Nutrition%20Survey%20Summary%20Report%20March%202011.pdf
22 Nakamura M, Miura A, Nagahata T, *et al*. Dietary intake and dinner timing among shift workers in Japan. *J Occup Health* 2018;60:467–74.
23 Hemiö K, Puttonen S, Viitasalo K, *et al*. Food and nutrient intake among workers with different shift systems. *Occup Environ Med* 2015;72:513–20.
24 Balieiro LCT, Rossato LT, Waterhouse J, *et al*. Nutritional status and eating habits of bus drivers during the day and night. *Chronobiol Int* 2014;31:1123–9.
25 Department of Health. *Get Ireland active: national physical activity action plan for Ireland*. Ireland: Department of Health, 2016. https://www.getirelandactive.ie/Professionals/National-PA-Plan.pdf
26 World Health Organisation. *Global recommendations on physical activity for health*. Geneva, Switzerland: WHO, 2010. https://apps.who.int/iris/bitstream/handle/10665/44399/9789241599979_eng.pdf;jsessionid=283A70241353F8D9193F6FA2EA6B8B53?sequence=1
27 Profis M, Simon-Tuval T. The influence of healthcare workers' occupation on health promoting lifestyle profile. *Ind Health* 2016;54:439–47.
28 Heath G, Coates A, Sargent C, *et al*. Sleep duration and chronic fatigue are differently associated with the dietary profile of shift workers. *Nutrients* 2016;8:E771.
29 Hulsegge G, Gupta N, Holtermann A, *et al*. Shift workers have similar leisure-time physical activity levels as day workers but are more sedentary at work. *Scand J Work Environ Health* 2017;43:127–35.
30 Loef B, van der Beek AJ, Holtermann A, *et al*. Objectively measured physical activity of hospital shift workers. *Scand J Work Environ Health* 2018;44:265–73.
31 Guthold R, Stevens GA, Riley LM, *et al*. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. *Lancet Glob Health* 2018;6:e1077–86.
32 National Nutrition Surveillance Centre. *Dietary habits of the Irish population: results from SLÁN*. Dublin: University College Dublin, 2003. http://www.ucd.ie/issda/static/documentation/slan/diethab.pdf

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33 Morikawa Y, Miura K, Sasaki S, *et al*. Evaluation of the effects of shift work on nutrient intake: a cross-sectional study. *J Occup Health* 2008;50:270–8.
34 Department of Health. *Healthy ireland: survey report 2019*. Dublin: Government Publications, 2019. https://assets.gov.ie/41141/e5d6fea3a59a4720b081893e11fe299e.pdf
35 Bonnell EK, Huggins CE, Huggins CT, *et al*. Influences on dietary choices during day versus night shift in shift workers: a mixed methods study. *Nutrients* 2017;9:E193.
36 Gupta CC, Coates AM, Dorrian J, *et al*. The factors influencing the eating behaviour of shiftworkers: what, when, where and why. *Ind Health* 2019;57:419–53.
37 Grech A, Allman-Farinelli M. A systematic literature review of nutrition interventions in vending machines that encourage consumers to make healthier choices. *Obes Rev* 2015;16:1030–41.
38 Nea FM, Pourshahidi LK, Kearney J, *et al*. A qualitative exploration of the shift work experience: the perceived barriers and facilitators to a healthier lifestyle and the role of the workplace environment. *J Occup Environ Med* 2017;59:1153–60.
39 Lassen AD, Fagt S, Lennernäs M, *et al*. The impact of worksite interventions promoting healthier food and/or physical activity habits among employees working 'around the clock' hours: a systematic review. *Food Nutr Res* 2018;62:1115.

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