

## ORIGINAL ARTICLE

# Individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes working in UK healthcare: A cross-sectional survey

Sophie Rubner<sup>1</sup> | Maria D'Annibale<sup>1</sup> | Nick Oliver<sup>2</sup> | Barbara McGowan<sup>3</sup> |  
Nicola Guess<sup>4</sup> | Fabiana Lorencatto<sup>5</sup> | Rachel Gibson<sup>1</sup> 

<sup>1</sup>Department of Nutritional Sciences, King's College London, London, UK

<sup>2</sup>Department of Metabolism, Digestion and Reproduction, Imperial College London, London, UK

<sup>3</sup>Department of Diabetes and Endocrinology, Guy's and St Thomas' NHS Trust, London, UK

<sup>4</sup>Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK

<sup>5</sup>Centre for Behaviour Change, University College London, London, UK

## Correspondence

Rachel Gibson, Department of Nutritional Sciences, King's College London, Room 4.13, 150 Stamford St, London SE1 9NH, UK.  
Email: [rachel.gibson@kcl.ac.uk](mailto:rachel.gibson@kcl.ac.uk)

## Funding information

Diabetes UK

## Abstract

**Background:** The present study aimed to understand the individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes (T2D) working in UK healthcare settings.

**Methods:** A cross-sectional study was conducted using data collected from an anonymous online survey. Participant agreement was measured using five-point Likert scale (strongly disagree to strongly agree) against 38 belief statements informed by the Theoretical Domains Framework (TDF) of behaviour change.

**Results:** From the complete responses ( $n = 119$ ), 65% worked shifts without nights, 27% worked mixed shift rota including nights and 8% worked only night shifts. The statements ranked with the highest agreements were in the TDF domains: Environment Context/Resources (ECR) – mainly identified as a barrier to healthy eating, Behaviour Regulation (BR) and intention (IN) – identified as enablers to healthy eating. For the belief statement 'the available options for purchasing food are too expensive' (ECR), 80% of night workers and 75% non-night workers agreed/strongly agreed. Taking their own food to work to prevent making unhealthy food choices (BR) had agreement/strong agreement in 73% of non-night and 70% night workers; 74% non-night workers and 80% of night workers agreed/strongly agreed with the statement 'I would like to eat healthily at work' (IN). Mixed shift workers agreed that following dietary advice was easier when working a non-night compared to a night shift ( $p = 0.002$ ).

**Conclusions:** Access and affordability of food were identified as important determinants of dietary behaviour during shifts. The findings support interventions targeting the food environment for shift workers with T2D.

## KEYWORDS

behaviour change, diet behaviour, shift work, type 2 diabetes

## Key points

- The present study investigated the individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes (T2D) working in UK healthcare settings.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2023 The Authors. *Journal of Human Nutrition and Dietetics* published by John Wiley & Sons Ltd on behalf of British Dietetic Association.

- The findings support previous findings from semi-structured interviews, with the main domain influencing dietary behaviours being Environmental Context and Resources (i.e., physical and economic availability of food during shifts).
- The findings support interventions targeting the food environment across shift workers living with T2D.

## INTRODUCTION

The number of shift workers is increasing as society is no longer constrained by the diurnal working day, with the Health Survey for England reporting around 30% of men and 20% of women work in a job requiring shift work.<sup>1</sup> Furthermore, analysis suggests that there were 151,000 more night workers in the UK in 2018, an increase of 5% from 2013, making up over 3 million people.<sup>2</sup> Although there is no official shift work definition, the term generally refers to work outside of the standard daytime hours of 7:00 AM and 7:00 PM in the UK. Shift work may include early or morning, late or afternoon, and night shifts, which may follow rotating, fixed or irregular patterns.<sup>3</sup> The UK government defines night shift workers as those who work at least 3 h between 11:00 PM and 6:00 AM.<sup>4</sup> In the UK, the health and social care sector is one of the largest employers of shift workers.<sup>5</sup>

Evidence suggests that shift work can negatively impact health as a result of physiological and behavioural changes.<sup>6</sup> Long-term night shift work has been shown to increase the risk of type 2 diabetes (T2D).<sup>7</sup> Furthermore, along with the rising number of shift workers, there is an ageing working population in which the proportion of employees aged 50 years to the state pension age is projected to increase to 34% by 2050.<sup>8</sup> Together with the already rising incidence of T2D, predicted to grow to over five million people in the UK by 2030,<sup>9</sup> these factors will likely result in a larger proportion of the shift working population living with the T2D. This is an issue as shift work can impact diabetes management. Night shift workers with T2D have been shown to have poorer glycaemic control than non-shift workers.<sup>10</sup> Diet quality is a key modifiable factor in the effective management of diabetes<sup>11</sup> and observational research has drawn associations between shift work and meal skipping, abnormal eating patterns and increased consumption of less healthy foods.<sup>12–14</sup> Night workers often report diets that are higher in sugar and saturated fat, with lower fruit and vegetable intakes than non-shift workers.<sup>15,16</sup>

Dietary behaviours are driven by a multitude of factors, including psychological, biological, socio-economic, social, cultural and environmental.<sup>17</sup> Previous studies conducted in shift workers commonly cite institutional and environmental barriers to healthy eating at work, such as long working hours, a lack of breaks,

and poor food and drink facilities.<sup>14</sup> However, there are limited studies specific to UK healthcare settings and, to our knowledge, no studies in workers with T2D. Identifying the influences on dietary behaviours in employees with T2D working varying shift patterns is important for the development of future interventions.

The Shift-Diabetes study is a mixed methods research project with the overall aim of developing targeted dietary support for shift-workers living with T2D.<sup>18</sup> This paper reports the survey findings and builds on the qualitative interview research conducted in mixed shift workers (working four or more night shifts per month and other types of shift) using the Theoretical Domains Framework (TDF).<sup>19</sup> The TDF can help identify behavioural influences that can facilitate subsequent intervention development.<sup>20–24</sup> The aim of the survey was to understand the individual, social and environmental factors influencing dietary behaviour in a range of shift workers with T2D working in UK healthcare settings.

## METHODS

### Study design

A cross-sectional study was conducted using data collected from a self-administered online open survey (see Supporting information 1 PDF of online survey) and reported in-line with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines<sup>25</sup> (see Supporting information 2 CHERRIES checklist). The survey collected responses from employees living with T2D and working in a UK healthcare setting, gathering data across four main areas: job role and working pattern, general health, food intake at work, and factors influencing food intake. Data were collected between 17 June 2022 and 5 October 2022.

### Survey development and procedures

The web-based survey was built using Qualtrics, version July 2022 (<https://www.qualtrics.com>) and divided into the following sections: (1) occupational questions (job role, working hours, shift pattern); (2) diabetes diagnosis and management (year of diagnosis, medications taken,

latest HbA1c test result if known); (3) general health and lifestyle (smoking, alcohol intake, height, body weight); (4) workplace food environment (facilities, foods eaten during night and non-night work, as applicable); (5) belief statements relating to influences on dietary behaviours at work during night and non-night shifts, as applicable; and (6) demographics (age, gender, ethnicity). If a respondent reported that they only worked night shifts, they only completed sections 4 and 5 related to night work; if they selected working a shift pattern not including night work, they only completed sections 4 and 5 in relation to non-night work. If a respondent reported working a mixed shift schedule that included night work, they were asked to complete questions in sections 4 and 5 twice; once in relation to working non-night shifts and then in relation to working a night shift.

The belief statements relating to factors influencing dietary behaviours were developed by a Behavioural Scientist (FL), based on the results of semi-structured interviews conducted in the Shift-Diabetes Study, of which the method has been reported previously.<sup>18,19</sup> The set of 38 belief statements focussed on factors influencing what employees choose to eat when working and were based on the TDF.<sup>21</sup> The TDF is a behavioural science framework, developed by integrating constructs from behaviour change theories into key domains representing the broad range of individual (e.g., knowledge, skills, intention [IN] goals, beliefs about consequences, emotions), social (e.g., social professional role and identity, social influences) and environmental (e.g., environmental context and resources) influences on behaviour. The survey included at least one belief statement related to each of the 12 theoretical domains identified as key from the semi-structured interviews (see Supporting information, Table S1). For example, 'Bringing my own food to work prevents me from making unhealthy food choices during my shift' was a theme coded to the 'behaviour regulation' domain in the semi-structured interviews, which was then phrased as the belief statement 'I bring my own food to prevent me from making unhealthy food choices' in the survey. Respondents reported their agreement level to each belief statement on a five-point Likert scale that ranged from 'strongly disagree' to 'strongly agree'. At the end of the survey, after the belief statements, there was an optional free-text box for respondents to add any further comments they had about what influences their food choices when they are at work.

Before survey distribution, the survey was piloted with 10 people including steering group members, healthcare workers living with T2D, researchers and other medical professionals. Feedback was provided on the survey's clarity, content, ease, layout and logic. Amendments were subsequently made, such as adding section descriptions to provide clarity on the questions' purpose, as well as converting free-text to multiple choice

questions, where appropriate, to prevent the input of invalid values. The final survey contained 84 questions across 20 screen pages and was a combination of multiple-choice questions, Likert scales and a free-text question, with either single or multiple items per question. Branching logic was applied so that respondents would only view questions that related to their shift type/s, labelled as night or non-night shifts. Non-night shifts referred to early/morning, late/afternoon or day shifts. A forced response was set on all questions, except the free-text question, to prevent incomplete responses. A non-response option, such as 'prefer not to say' or 'unsure', was provided for body weight, height, HbA1c, gender, age and ethnicity questions.

## Participants

Eligible respondents were adults working in a UK residential healthcare setting (e.g., hospital or care home) and diagnosed with T2D. Eligibility was self-reported. This was a convenience sample with no *a priori* sample size because of the exploratory and descriptive nature of the study. The survey was promoted on social media (Facebook and Twitter), through paid targeted advertisements on Facebook and Instagram, and via researchers' LinkedIn and Twitter social media accounts (see Supporting information 3 Advertisements). A link to the survey was emailed to 61 people who enquired about the Shift-Diabetes Monitoring Study<sup>18</sup> and consented to be contacted regarding future studies. The link was not sent to Shift-Diabetes participants who had completed the semi-structured interviews. The survey was voluntary completion and participants could stop at any point during the survey; however, once submitted, participants were advised that they would be unable to withdraw their responses. As an incentive to participate, respondents were invited to enter a prize draw to win one of two £50 vouchers following completion of the survey. To participate in the prize draw, participants were directed to a separate Qualtrics survey link asking them to enter their email address and to consent to the prize draw. It was not possible to link the email addresses to the participant responses and all email addresses were deleted after the prizes had been claimed.

## Data checking and coding

The IP addresses of respondents were not collected. A built-in Qualtrics feature recorded unique site visits and prevented duplicate entry completion. This feature placed a cookie on the respondents' browsers when they submitted their final responses, preventing respondents from reaccessing the survey. During the survey, respondents were able to use 'back' button to review and amend answers. Before analysis, all incomplete responses were

excluded. Invalid or unrealistic values (outside of physiological ranges) were removed, and answers were checked for consistency for each respondent. Nominal and ordinal data was coded prior to statistical analysis, such as the five-point Likert scales which were coded as 1–5 (1 = Strongly Disagree to 5 = Strongly Agree). Nonsensical responses to the free-text question were removed. Belief statements were classified as (i) a ‘barrier’ if there was a high agreement to a belief statement negatively impacting diet behaviour or a low agreement to a statement positively impacting diet behaviour; (ii) an ‘enabler’ if high agreement to a statement positively impacting diet behaviours or low agreement to a statement negatively impacting diet behaviour; or (iii) ‘mixed’ if neither strong agreement or disagreement was shown to the belief statement.

## Data analysis

SPSS, version 27.0 (IBM Corp.) was used for data analysis. Descriptive statistics were generated, with proportions and percentages of respondents used to describe categorical data and the mean  $\pm$  SD calculated for continuous data. Participation rate was calculated by the ratio of unique visitors who agreed to participate to those who visited the first page of the survey. Completion rate was determined by the ratio of respondents who completed the survey to those who agreed to participate. To test for differences in characteristics between respondents working a shift schedule with night work compared to respondents reporting they did not work at night, Pearson's chi-squared test or Fisher's exact test were used for categorical variables and an independent samples *t*-test was used for normally distributed continuous variables. For respondents who were mixed shift workers (reported working both non-nights shifts and night shifts), analyses were conducted using McNemar's test to determine differences in the availability of facilities, and the sign test was used to calculate differences in break behaviour between night and non-night shifts. To determine within-person differences between belief statements for the different shift types, Likert scales were converted to scores (1–5, with higher score signifying stronger agreement to the statement) and mean  $\pm$  SD scores are presented. Because of the low response frequency of night shift only workers, it was not possible to compare differences between independent samples and therefore descriptive statistics for response frequencies are presented.  $p < 0.05$  was considered statistically significant.

An inductive thematic analysis approach<sup>26</sup> was used to identify common themes amongst responses to the free-text question. Similar responses were initially grouped together, and a theme label then inductively generated to summarise the shared meaning amongst

responses in each grouping. The themes were then mapped to the TDF domains.

## RESULTS

### Response rates

In total, 168 respondents started the survey, of whom 28 (17%) provided incomplete responses and 19 (10%) did not meet the inclusion criteria ( $n = 7$ , wrong work setting;  $n = 11$ , no diabetes diagnosis;  $n = 1$ , did not reside/work in the UK). Two respondents were removed from analysis because of a contradiction in their responses to night work (selected night work but ‘0’ nights worked per month) (see Supporting information, Figure S1). Therefore, 119 respondents submitted usable responses for statistical analysis. Of the total respondents, 77 (65%) reported working shifts without night work, 32 (27%) reported working a mixed shift schedule of night and non-night shifts, and 10 (8%) reported only working night shifts. Survey completion rate was 71%. The average time to complete the survey was 16.7 min (range 3.0–60.8 min).

### Respondent characteristics

Most respondents identified as female (86%), white (77%) and were aged 45–60 years (72%). The majority worked in England (92%) and in a hospital setting (76%) (Table 1). Respondents reporting night work were younger than shift workers not working nights (aged 25–44 years: 26% vs. 13%,  $p = 0.035$ ). Registered nurse or midwife was the most frequently reported job role (36%), followed by nursing/healthcare assistant (20%). Night work was most common amongst nurses and midwives and more reported working nights than no nights (55% vs. 26%,  $p < 0.001$ ). Overall, 57% of respondents worked 8–12-h shifts, with shifts lasting over 12 h more common amongst respondents with night work (36% vs. 14%,  $p < 0.001$ ).

The mean  $\pm$  SD number of years since a respondent's T2D diagnosis was  $7.5 \pm 6.9$  years and 23% of respondents stated they had attended a structured education programme, with a mean  $\pm$  SD of  $5.4 \pm 5.3$  years since attending. The DESMOND programme was the programme cited most frequently ( $n = 11$ ) (see Supporting information, Table S2). Respondents' mean body mass index (BMI) (derived from self-reported weight and height) was  $33.5 \pm 6.8$  kg/m<sup>2</sup>, with 21% classed as living with overweight (BMI 25–29.9 kg/m<sup>2</sup>) and 61% obesity (BMI > 30 kg/m<sup>2</sup>). Mean  $\pm$  SD self-reported HbA1c was  $61.3 \pm 21.4$  mmol/mol with 73.1% stating the measurement was taken within the last 6 months.

TABLE 1 Shift-diabetes survey respondent characteristics.

	All	Respondents with no night work	Respondents with night work <sup>a</sup>	<i>p</i> -value
<i>N</i>	119	77	42	
	<i>N</i> (%)			
<i>Sex</i>				
Female	102 (85.7)	65 (84.4)	37 (88.1)	0.584*
Male	17 (14.2)	12 (15.6)	5 (11.9)	
<i>Age (years)</i>				
25–34	3 (2.5)	3 (3.9)	0 (0.0)	0.035 <sup>†</sup>
35–44	18 (15.1)	7 (9.1)	11 (26.2)	
45–54	51 (42.9)	31 (40.3)	20 (47.6)	
55–60	34 (28.6)	25 (32.5)	9 (21.4)	
>60	13 (10.9)	11 (14.3)	2 (4.8)	
<i>Ethnicity</i>				
White	91 (76.5)	57 (74.0)	34 (81.0)	0.688 <sup>†</sup>
Asian	6 (5.0)	5 (6.5)	1 (2.4)	
Black	12 (10.1)	7 (9.1)	5 (11.9)	
Mixed	5 (4.2)	3 (3.9)	2 (4.8)	
Other	3 (2.5)	3 (3.9)	0 (0.0)	
Prefer not to say	2 (1.7)	2 (2.6)	0 (0.0)	
<i>Work setting</i>				
Hospital	90 (75.6)	57 (74.0)	33 (78.6)	0.581*
Residential care	29 (24.4)	20 (26.0)	9 (21.4)	
<i>Country of employment</i>				
England	109 (91.6)	71 (92.2)	38 (90.5)	0.042 <sup>†</sup>
Scotland	5 (4.2)	1 (1.3)	4 (9.5)	
Wales	4 (3.4)	4 (5.2)	0 (0.0)	
Northern Ireland	1 (0.8)	1 (1.3)	0 (0.0)	
<i>Job role</i>				
RN & Midwives	43 (36.1)	20 (26.0)	23 (54.8)	<0.001 <sup>†</sup>
Nursing/HCA	24 (20.2)	17 (22.1)	7 (16.7)	
Admin and Clerical	19 (16.0)	18 (23.4)	1 (2.4)	
Social care Staff	12 (10.1)	6 (7.8)	6 (14.3)	
Other <sup>b</sup>	21 (17.5)	16 (20.8)	5 (11.9)	
<i>Weekly working hours</i>				
<35	30 (25.2)	20 (26.0)	10 (23.8)	0.508 <sup>†</sup>
35–40	67 (56.3)	40 (51.9)	27 (64.3)	
41–48	15 (12.6)	11 (14.3)	4 (9.5)	
>48	7 (5.9)	6 (7.8)	1 (2.4)	

(Continues)

TABLE 1 (Continued)

	All	Respondents with no night work	Respondents with night work <sup>a</sup>	p-value
<i>Desk-based job</i>				
Yes	25 (21.0)	23 (29.9)	2 (4.8)	0.002*
No	70 (58.8)	37 (48.1)	33 (78.6)	
50% desk-based	24 (20.2)	17 (22.1)	7 (16.7)	
<i>Current shifts worked</i>				
Morning/early	32 (26.9)	18 (23.4)	14 (33.3)	0.242*
Afternoon/late	35 (29.4)	17 (22.1)	18 (42.9)	0.017*
Night	42 (35.3)	0 (0.0)	42 (100.0)	-
Day	87 (73.1)	60 (77.9)	27 (64.3)	0.109*
<i>Shift pattern<sup>c</sup></i>				
Fixed/permanent	22 (32.4)	13 (50.0)	9 (21.4)	0.002†
Irregular	37 (54.4)	7 (26.9)	30 (71.4)	
Rotating	8 (11.8)	5 (19.2)	3 (7.1)	
Not described	1 (1.5)	1 (3.8)	0 (0.0)	
<i>Hours worked on shift</i>				
<8	25 (21.0)	23 (39.9)	2 (4.8)	<0.001*
8–12	68 (57.1)	43 (55.8)	25 (59.5)	
>12	26 (21.8)	11 (14.3)	15 (35.7)	
<i>Night shifts per month<sup>d</sup></i>				
None	68 (57.1)	68 (88.3)	0 (0.0)	<0.001†
1–3	13 (10.9)	4 (5.2)	9 (21.4)	
4–8	21 (17.6)	0 (0.0)	21 (50.0)	
9–12	7 (5.9)	2 (2.6)	5 (11.9)	
≥13	10 (8.4)	3 (3.9)	7 (16.7)	
<i>Total years night work</i>				
None	34 (28.6)	34 (44.2)	0 (0.0)	<0.001†
<1	6 (5.0)	6 (7.8)	0 (0.0)	
1–5	16 (13.4)	6 (7.8)	10 (23.8)	
>5	63 (52.9)	31 (40.3)	32 (76.2)	
<i>Attendance of structured education programme</i>				
Yes	27 (22.7)	20 (26.0)	7 (16.7)	0.389*
No	84 (70.6)	53 (68.8)	31 (73.8)	
Unsure	8 (6.7)	4 (5.2)	4 (9.5)	
<i>Diabetes medication prescription</i>				
Yes	108 (90.8)	68 (88.3)	40 (95.2)	0.324†
No	11 (9.2)	9 (11.7)	2 (4.8)	
<i>Manager awareness of diabetes diagnosis</i>				
Yes	93 (78.2)	62 (80.5)	31 (73.8)	0.477†

TABLE 1 (Continued)

	All		Respondents with no night work		Respondents with night work <sup>a</sup>		p-value
No	21 (17.6)		13 (16.9)		8 (19.0)		
Don't know	5 (4.2)		2 (2.6)		3 (7.1)		
<i>Colleague awareness of diabetes diagnosis</i>							
Yes	86 (72.3)		57 (74.0)		29 (69.0)		0.700 <sup>†</sup>
No	26 (21.8)		15 (19.5)		11 (26.2)		
Don't know	7 (5.9)		5 (6.5)		2 (4.8)		
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)	p-value
<i>Type 2 diabetes diagnosis</i>							
Years since	116 (97.5)	7.5 (6.9)	75 (97.4)	7.4 (6.8)	41 (97.6)	7.7 (7.2)	0.828**
Unsure	3 (2.5)	–	2 (2.6)	–	1 (2.4)	–	1.000 <sup>†</sup>
<i>Attendance of structured education programme</i>							
Years since	27 (22.7)	5.4 (5.3)	20 (26.0)	4.8 (4.0)	7 (16.7)	7.3 (8.1)	0.451**
<i>Last HbA1c measurement<sup>c</sup></i>							
mmol/mol	58 (48.7)	61.3 (21.4)	35 (45.5)	62.7 (23.0)	23 (54.8)	59.0 (18.8)	0.519**
Don't remember	58 (48.7)	–	39 (50.6)	–	19 (45.2)	–	0.573*
<i>BMI</i>							
kg/m <sup>2</sup>	107 (89.9)	33.8 (7.5)	69 (89.6)	34.0 (8.2)	38 (90.5)	33.5 (5.6)	0.751**

Abbreviations: HCA, healthcare assistant; RN, registered nurse.

\*Pearson's chi-squared test or <sup>†</sup>Fisher's exact test compared differences between respondents with and without night work for categorical variables.

\*\*An independent samples *t*-test compared differences between respondents with and without night work for continuous variables.

<sup>a</sup>Includes night work only (*n* = 10) and night work as part of mixed shift (*n* = 32).

<sup>b</sup>Job role 'Other' includes technical/healthcare scientists, medical and dental, general management, public health/health improvement, allied health professional, maintenance/ancillary and central functions/corporate services.

<sup>c</sup>Excludes employees who solely worked day shifts.

<sup>d</sup>Although nine respondents without night work reported some night work, they identified as non-night shift workers and only answered questions related to non-night shifts.

<sup>e</sup>The HbA1c value for one respondent was removed from the analyses because of the report of two conflicting values for HbA1c.

<sup>f</sup>*N* = 12 (10.1%) respondents did not provide height and/or weight data.

## Workplace facilities and eating behaviours

For mixed shift workers, 43.8% reported subsidised canteen access during non-night shifts, compared to 15.2% when they worked a night shift (*p* = 0.012) (Table 2). More than half of all respondents reported always bringing in food from outside of work. There was a significant difference in frequency of use of on-site cafés or canteens for food purchasing in mixed shift workers, with 81.3% reporting to never purchasing food on site during a night shift compared to 37.5% sometimes purchasing during a non-night shift (*p* < 0.001). Takeaway food was more likely to be delivered during a night shift ('some times' 21.9%) compared to 'never' delivered (65.6%) during a non-night shift (*p* = 0.021) in mixed shift workers. 'Usually' skipping a meal or rest break was reported by 33.8% non-night workers, and there was no difference between

meal or rest break skipping in mixed shift workers when working a night or non-night shift. Most non-night workers reported consuming one portion of fruit on a working day (42.9%), with no differences in fruit consumption for mixed shift workers when they worked a non-night or night shift. The results for permanent night shift workers (*n* = 10) are shown in the Supporting information (Table S3).

## Influences of dietary behaviours, all respondents – not shift specific

There were six belief statements that were not related to a specific shift type that all respondents (*n* = 119) were required to answer. An enabler to healthier dietary behaviour was 'Knowing what a healthy diet for a person living with T2D should look like' (TDF domain

TABLE 2 Available workplace food facilities and dietary habits during night and non-night shifts.

	Respondents without night work <i>n</i> = 77 (%)	Respondents with mixed shift schedule of night and non-night shifts <sup>a</sup> <i>n</i> = 32 (%)		<i>p</i> -value <sup>a</sup>
		During non-night shift	During night shift	
<b>Availability of food and drinks facilities</b>				
Vending machine for food	28 (36.4)	19 (59.4)	21 (65.6)	0.625
Vending machine for drinks	30 (39.0)	21 (65.6)	22 (68.8)	0.999
Water fountain/drinkable tap water	62 (80.5)	26 (81.3)	28 (87.5)	0.500
On-site shop that sells food/drink	40 (51.9)	19 (59.4)	2 (6.3)	<0.001
Subsidised canteen or cafe	33 (42.9)	14 (43.8)	5 (15.2)	0.012
Non-subsidised canteen or cafe	25 (28.7)	11 (34.4)	3 (9.4)	0.008
<b>Break habits</b>				
Use a vending machine to purchase food or drink				
Always	1 (1.3)	0 (0.0)	1 (3.1)	0.727
Sometimes	7 (9.1)	4 (12.5)	1 (3.1)	
Rarely	8 (10.4)	6 (18.8)	6 (18.8)	
Never	61 (79.2)	22 (68.8)	24 (75.0)	
Bring a prepacked lunch or food from outside work				
Always	42 (54.5)	20 (62.5)	20 (62.5)	0.625
Sometimes	25 (32.5)	10 (31.3)	10 (31.3)	
Rarely	7 (9.1)	1 (3.1)	1 (3.1)	
Never	3 (3.9)	1 (3.1)	1 (3.1)	
Make use of employee facilities for food preparation or storage				
Always	13 (16.9)	7 (21.9)	10 (31.3)	0.791
Sometimes	26 (33.8)	15 (46.9)	12 (37.5)	
Rarely	15 (19.5)	6 (18.8)	4 (12.5)	
Never	23 (29.9)	4 (12.5)	6 (18.8)	
Purchase food from a cafe/canteen that is on-site				
Always	6 (7.8)	1 (3.1)	0 (0.0)	<0.001
Sometimes	20 (26.0)	12 (37.5)	2 (6.3)	
Rarely	18 (23.4)	8 (25.0)	4 (12.5)	
Never	33 (42.9)	11 (34.4)	26 (81.3)	
Have take-away food delivered				
Always	0 (0.0)	0 (0.0)	0 (0.0)	0.021
Sometimes	7 (9.1)	4 (12.5)	7 (21.9)	
Rarely	12 (15.6)	7 (21.9)	10 (31.3)	
Never	58 (75.3)	21 (65.6)	15 (46.9)	

TABLE 2 (Continued)

	Respondents without night work <i>n</i> = 77 (%)	Respondents with mixed shift schedule of night and non-night shifts <sup>a</sup> <i>n</i> = 32 (%)		<i>p</i> -value <sup>a</sup>
		During non-night shift	During night shift	
<i>Skip a meal or rest break</i>				
Usually	26 (33.8)	8 (25.0)	4 (12.5)	0.180
Sometimes	35 (45.5)	19 (59.4)	22 (68.8)	
Never	16 (20.8)	5 (15.6)	6 (18.8)	
<b>Dietary habits</b>				
Fruit consumption (portions per day)				
None or <0.5	18 (23.4)	7 (21.9)	9 (28.1)	0.774
1	33 (42.9)	15 (46.9)	12 (37.5)	
2–3	25 (32.5)	9 (28.1)	11 (34.4)	
≥4	1 (1.3)	1 (3.1)	0 (0.0)	
Vegetable consumption (portions per day)				
None or <0.5	21 (27.3)	8 (25.0)	12 (37.5)	0.070
1	34 (44.2)	11 (34.4)	10 (31.3)	
2–3	18 (23.4)	11 (34.4)	9 (28.1)	
≥4	4 (5.2)	2 (6.3)	1 (3.1)	
Wholegrain food consumption (portions per day)				
<1	31 (40.3)	7 (21.9)	12 (37.5)	0.289
1–2	40 (51.9)	21 (65.6)	16 (50.0)	
3–4	6 (7.8)	3 (9.4)	3 (9.4)	
≥5	0 (0.0)	1 (3.1)	1 (3.1)	
Sugar-sweetened beverages (number per day)				
None	36 (46.8)	21 (65.6)	26 (81.3)	0.063
<1	20 (26.0)	3 (9.4)	0 (0.0)	
1–2	12 (15.6)	5 (15.6)	3 (9.4)	
≥3	9 (11.7)	3 (9.4)	3 (9.4)	
Savoury/salted snacks (frequency per day)				
Always	10 (13.0)	5 (15.6)	7 (21.9)	0.388
Sometimes	44 (57.1)	13 (40.6)	17 (53.1)	
Rarely	20 (26.0)	12 (37.5)	3 (9.4)	
Never	3 (3.9)	2 (6.3)	5 (15.6)	
Sweet snacks (frequency per day)				
Always	8 (10.4)	3 (9.4)	5 (15.6)	0.727
Sometimes	38 (49.4)	15 (46.9)	15 (46.9)	
Rarely	17 (22.1)	13 (40.6)	10 (31.3)	
Never	14 (16.1)	1 (3.1)	2 (6.3)	

<sup>a</sup>McNemar's test and sign test used to determine differences between night and non-night shifts in mixed shift employees (*n* = 32).

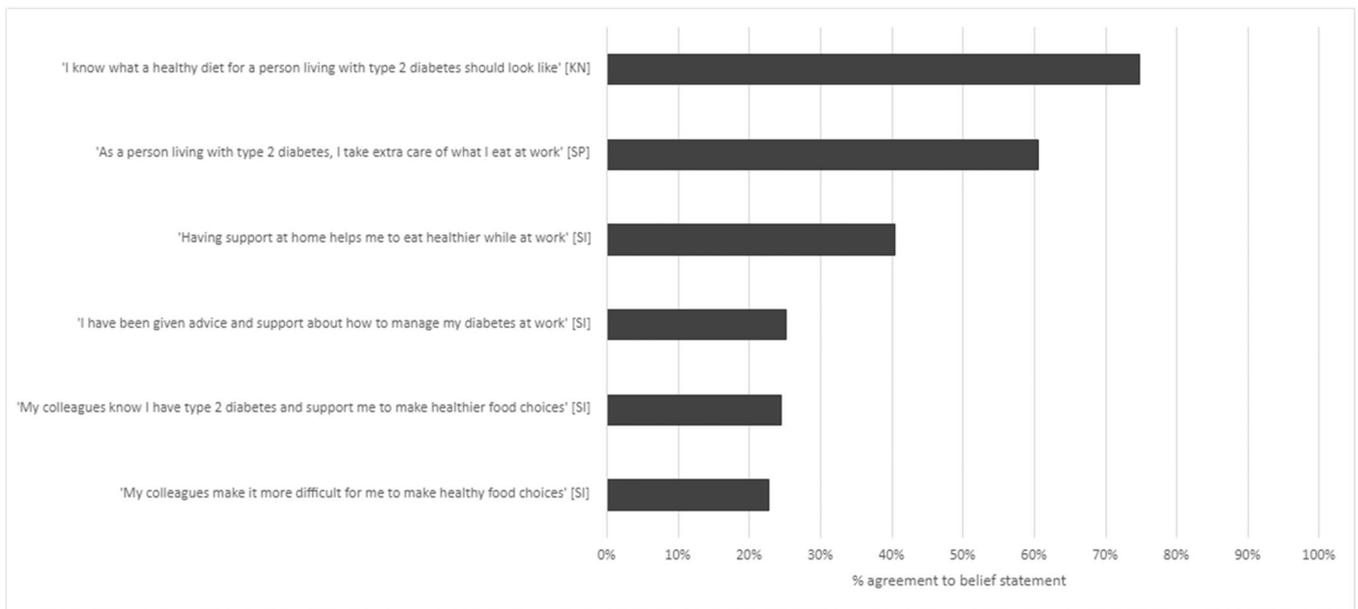


FIGURE 1 Rank order of percentage agreement ('agree' or 'strongly agree') to belief statements answered by all respondents (n = 119). (TDF domains: KN = Knowledge; SP = Social/Professional Role and Identity; SI = Social Influences).

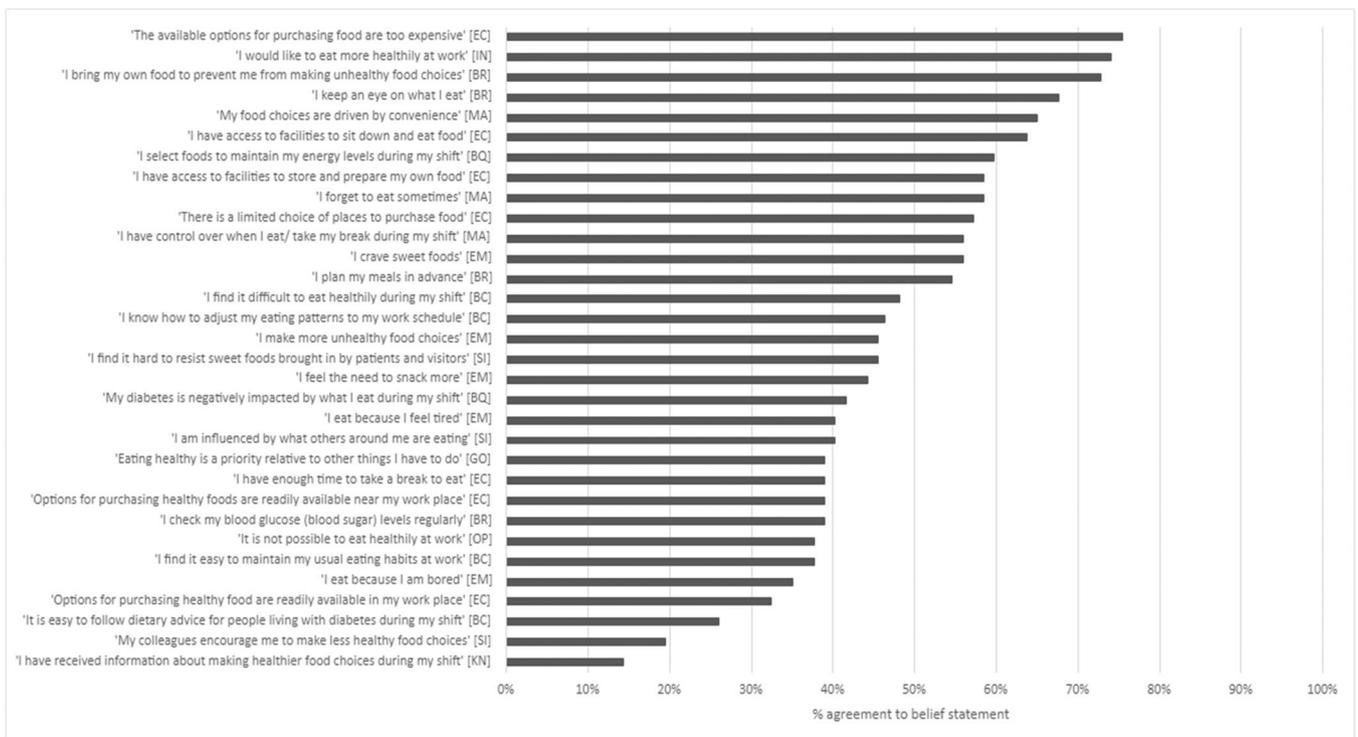


FIGURE 2 Rank order of percentage agreement ('agree' or 'strongly agree') to belief statements answered by workers with non-night work only (n = 77). (TDF domains: EC = Environmental Context and Resources; IN = Intention; BR = Behavioural Regulation; MA = Memory Attention Decision Making; BQ = Beliefs about Consequences; EM = Emotions; BC = Beliefs about Capabilities; KN = Knowledge; SI = Social Influences; GO = Goals; OP = Optimism).

'Knowledge'), with 75% of participants agreeing/strongly agreeing with this belief statement (Figure 1). The low percentage of respondents agreeing/strongly agreeing with the statement 'I have been given advice and support about

how to manage my diabetes at work' (TDF domain 'Knowledge') indicates this was a potential barrier to healthy eating. Themes in the domains of 'social/professional role and identity' and 'Social influences' were mixed,

**TABLE 3** Comparison of mean scores for belief statements relating to influences on dietary behaviours during non-night shifts and night shifts for respondents working a mixed shift schedule ( $n = 32$ ).

Belief statement by TDF domain	Mean (SD)		<i>p</i> -value <sup>a</sup>
	Non-night shift	Night shift	
<i>Knowledge</i>			
'I have received information about making healthier food choices during my shift' (B)	1.84 (1.08)	1.66 (0.94)	0.125
<i>Beliefs about capabilities</i>			
'I know how to adjust my eating patterns to my work schedule' (M)	3.19 (1.09)	3.09 (1.15)	0.549
'It is easy to follow dietary advice for people living with diabetes during my shift' (B night shift)	2.50 (1.19)	1.84 (0.88)	0.002
'I find it easy to maintain my usual eating habits at work' (M)	2.47 (1.19)	2.19 (1.12)	0.125
'I find it difficult to eat healthily during my shift' (B)	3.59 (1.10)	3.72 (1.09)	0.453
<i>Social influences</i>			
'I find it hard to resist sweet foods brought in by patients and visitors' (B)	3.41 (1.41)	3.41 (1.41)	0.999
'My colleagues encourage me to make less healthy food choices' (M)	2.66 (0.90)	2.66 (0.90)	0.999
'I am influenced by what others around me are eating' (M)	2.84 (1.32)	2.88 (1.31)	0.317 <sup>†</sup>
<i>Beliefs about consequences</i>			
'My diabetes is negatively impacted by what I eat during my shift' (B)	3.41 (0.91)	3.56 (1.16)	0.549
'I select foods to maintain my energy levels during my shift' (B)	3.56 (0.76)	3.56 (0.91)	0.999
<i>Behavioural regulation</i>			
'I bring my own food to prevent me from making unhealthy food choices' (E)	3.94 (0.91)	3.84 (1.02)	0.500
'I plan my meals in advance' (E)	3.50 (1.39)	3.50 (1.46)	0.687
'I keep an eye on what I eat' (E)	3.44 (0.88)	3.44 (0.98)	0.999
'I check my blood glucose levels regularly' (M)	2.38 (1.50)	2.31 (1.47)	0.999
<i>Emotions</i>			
'I feel the need to snack more' (B night shift)	2.63 (1.07)	3.59 (1.21)	<0.001
'I crave sweet foods' (B non-night shift)	3.03 (1.38)	2.53 (1.37)	0.021
'I eat because I am bored' (M)	2.25 (1.39)	2.59 (1.54)	0.125
'I eat because I feel tired' (B night shift)	2.53 (1.22)	3.09 (1.49)	0.002
'I make more unhealthy food choices' (B)	3.34 (1.21)	3.50 (1.27)	0.774
<i>Memory attention decision making</i>			
'My food choices are driven by convenience' (B)	3.31 (1.23)	3.47 (1.24)	0.687
'I have control over when I eat/take my break during my shift' (M)	2.34 (1.49)	2.41 (1.50)	0.999
'I forget to eat sometimes' (B)	3.25 (1.24)	3.19 (1.20)	0.754
<i>Environmental context and resources</i>			
'Options for purchasing healthy food are readily available in my workplace' (B night shift)	2.84 (1.35)	1.25 (0.57)	<0.001

(Continues)

TABLE 3 (Continued)

Belief statement by TDF domain	Mean (SD)		p-value <sup>a</sup>
	Non-night shift	Night shift	
'Options for purchasing healthy foods are readily available near my workplace' (B night shift)	2.53 (1.48)	1.38 (0.75)	<0.001
'There is a limited choice of places to purchase food' (B)	3.53 (1.16)	4.34 (1.10)	<0.001
'The available options for purchasing food are too expensive' (B)	4.06 (1.05)	3.91 (1.28)	0.727
'I have enough time to take a break to eat' (M)	2.50 (1.32)	2.81 (1.53)	0.109
'I have access to facilities to store and prepare my own food' (E)	3.87 (1.13)	3.91 (1.15)	0.317 <sup>†</sup>
'I have access to facilities to sit down and eat food' (E)	4.19 (1.18)	4.22 (1.10)	0.999
<i>Goals</i>			
'Eating healthy is a priority relative to other things I have to do' (M)	2.97 (1.20)	2.78 (1.34)	0.125
<i>Intention</i>			
'I would like to eat more healthily at work' (E)	4.41 (0.71)	4.50 (0.67)	0.250
<i>Optimism</i>			
'It is not possible to eat healthily at work' (M)	2.63 (1.07)	2.94 (1.24)	0.063

Abbreviation: TDF, Theoretical Domain Framework.

<sup>a</sup>Sign test <sup>†</sup>Wilcoxon signed ranks test used instead of sign test. Scores based on Likert scale 1–5 (1 = strongly disagree, 5 = strongly agree). Likely influences on dietary behaviours: (B) Barrier, (E) Enabler, (M) Mixed.

based on >75% agreeing/strongly agreeing to the belief statements in these domains.

### Shift-specific influences on dietary behaviours in non-night shift and permanent night shift workers

Participants were asked to rate their agreement to an additional 32 belief statements that related to influences on dietary behaviours specific to night or non-night shifts. Figure 2 shows the rank order of percentage agreement to belief statements answered by non-night shift workers. The results for night-only workers ( $n = 10$ ) are shown in the Supporting information (Figure S2). The percentage agreement to each belief statement for non-night shift and permanent night shift workers is also shown in the Supporting information (Table S4). The domain 'Environmental Context and Resources' was considered a barrier, with 80% shift workers working nights and 75% not working nights agreeing/strongly agreeing with the belief statement 'The available options for purchasing food were too expensive'. For shift workers only working nights, 90% agreed with the statement that 'There is a limited choice of places to purchase food' suggesting a specific barrier to night workers as <60% of non-night shift workers agreed/strongly agreed with this statement. No night workers agreed/strongly agreed with the statement 'Options for

purchasing healthy food are readily available in my workplace', signifying this was an important barrier, whereas this was considered a mixed influence for non-night shift workers, with 32% agreeing/strongly agreeing with the statement. The domain 'Intention' was an enabler, with 90% of night workers and 74% of non-night workers agreeing/strongly agreeing with the statement 'I would like to eat more healthily at work'. Less than 25% of non-night shift and permanent night workers agreed/strongly agreed with the statement 'I have received information about making healthier food choices at work' (TDF: 'Knowledge').

### Comparison of influences on dietary behaviours across night and non-night shifts in mixed shift workers

Analyses in the group of mixed shift workers ( $n = 32$ ) allowed within-person comparison of belief statements across night and non-night shifts using the mean of the Likert scores (1 = strongly disagree to 5 = strongly agree) (Table 3). Higher scores (stronger agreement) were reported during night work compared to non-night work for belief statements 'I feel the need to snack more' (mean  $\pm$  SD scores:  $3.59 \pm 1.21$  vs.  $2.63 \pm 1.07$ ,  $p < 0.001$ ) and 'I eat because I am tired' (mean scores:  $3.09 \pm 1.49$  vs.  $2.53 \pm 1.22$ ,  $p < 0.002$ ) suggesting that the domain 'Emotions' may pose more of a barrier during night

work. There was greater agreement to 'I crave sweet foods' reported in during non-night work compared to night work (mean scores:  $3.03 \pm 1.38$  vs.  $2.53 \pm 1.37$ ). Three belief statements in the domain of 'Environmental Context and Resources' had significantly different levels of agreement between night and non-night work. Higher agreement scores were observed during non-night shifts compared to night shifts for the statements 'Options for purchasing healthy food are readily available in my workplace' (mean score:  $2.84 \pm 1.35$  vs.  $1.25 \pm 0.57$ ,  $p < 0.001$ ) and 'Options for purchasing healthy foods are

readily available near my workplace' (mean score:  $2.53 \pm 1.48$  vs.  $1.38 \pm 0.75$ ,  $p < 0.001$ ). A higher agreement was reported during night work for 'There is a limited choice of places to purchase food' compared to during non-night work (mean score:  $4.34 \pm 1.10$  vs.  $3.53 \pm 1.16$ ,  $p < 0.001$ ). One statement in the domain 'Beliefs About Consequences' had significantly higher agreement during non-night work compared to night work 'It is easy to follow dietary advice for people living with diabetes during my shift' (mean score:  $2.5 \pm 1.19$  vs.  $1.84 \pm 0.88$ ,  $p = 0.002$ ).

**TABLE 4** Summary of free-text collected to describe other influences on eating behaviours at work.

TDF domain	Subthemes	Example text	Number of mentions <sup>a</sup>
<i>Environmental context and resources</i>			
	Limited time to eat and the lack of breaks (B)	Don't get time to have food breaks. eat on the run mostly. Try to eat healthy but can be difficult	27
	Lack of facilities to eat, store, or prepare food (B)	There are no facilities to take a break where I work. The expectation is that we will eat at the computer whilst working	5
	Available food options are expensive and/or unhealthy (B)	The healthiest option at my work is a [retailer] salad, this costs around £6. The subsidised canteen used to have a salad bar which was removed completely. I'll often have a sandwich and crisps	5
<i>Emotions</i>			
	Eating in response to stress and tiredness (B)	Stress and tiredness affects my eating	6
	Eating in response to hunger (B)	Sometimes I get so hungry I just snack on anything available to keep me going.	3
<i>Social influences</i>			
	Lack of support and understanding by managers (B)	I feel my employer doesn't understand the need for breaks and the need to eat balanced and regularly while at work	4
	Hard to resist food given by patients/colleagues (B)	Patients and staff bring in sweets chocolates cakes crisps biscuits unhealthy foods	4
<i>Beliefs about capabilities</i>			
	Ability to adjust eating patterns to shift schedule and workload (B)	Short staffing means no chance for proper breaks on many occasions so meals are missed or not eaten at regular times; 12-h shifts makes eating regular meals difficult	6
	Ability to make healthy food choices during at work (B)	Sometimes I find I don't have enough time to eat my food so will grab a biscuit and drink when I can. Not always able to have a proper break and will then feel hungry leading to me making unhealthy choices	12
<i>Beliefs about consequences</i>			
	Negative impact of shift work on health (B)	... sadly this has left me with an eating pattern that relies on breakfast, then a late meal – no food during the day or it leaves me bloated and sluggish	4
<i>Memory, attention and decision making</i>			
	Convenience drives food choices (B)	Lack of time, I only have 30 min for lunch and I am a slow eater so usually pick quick options like sandwiches and so forth. Have brought in salads, better options but they take too long to eat	11

Abbreviation: TDF, Theoretical Domain Framework.

<sup>a</sup>Times mentioned in any response provided as free-text. Likely influences on dietary behaviours: (B) Barrier, (E) Enabler, (M) Mixed.

## Thematic analysis of free-text responses

Of the total respondents, 54 (45%) provided free-text responses that were included in thematic analyses. The most frequent themes mentioned are listed in Table 4. The text provided by respondents related to barriers rather than enablers to healthy dietary choices. Lack of time, lack of breaks and lack availability of healthy food choices were frequently mentioned barriers (TDF domain: 'Environmental Context and Resources'). Eating in response to stress and hunger (TDF domain: 'Emotion') were barriers mentioned in regarding to food choices and eating patterns. A frequently mentioned barrier in the domain 'Beliefs About Capabilities' was not feeling able to make healthy food choices during work shifts.

## Synthesis of results

Belief statements that were consistently graded as a barrier to diet behaviours were related to the availability of healthy foods, at or close to the workplace, and the cost of foods (TDF domain: 'Environmental Context and Resources'). These themes were also reported as barriers in the free-text responses. In mixed shift workers, access to food was reported as more of a barrier when working a night shift compared to a non-night shift. Food choices driven by convenience (TDF domain: 'Memory, Attention and Decision Making') showed consistently high agreement and was classified as a barrier, and this was also supported by the free-text responses. There was high level of disagreement to the statement regarding the receiving of information about making healthier food choices during work shifts (TDF domain: 'Knowledge') suggests this is a barrier. Enabling factors were mainly in the 'Behavioural Regulation' domain and related to taking own food to work, planning and self-monitoring diet intake. Access to facilities for food preparation and eating ('Environmental Context and Resources') showed consistently strong agreement ratings and were potential enablers, and free-text responses suggested a lack of facilities as a barrier. IN to eat healthier at work showed consistently high agreement and was classified as an enabler. Themes in the 'Emotions' domain were generally mixed across the different shift work groups, although, in mixed shift workers, snacking more and eating as a result of tiredness had higher ratings of agreement when working night compared to non-night shifts.

## DISCUSSION

The present study aimed to understand the individual, social and environmental factors influencing dietary behaviour in shift workers with T2D working in UK healthcare settings. The observations from the survey

corroborate the findings of the semi-structured interviews in a wider range of shift workers with T2D working in a healthcare setting. In agreement with the semi-structured interview findings, 'environmental context and resources', 'behavioural regulation' and 'emotions' were found to be important TDF domains influencing dietary behaviour.<sup>19</sup>

Within 'Environmental Context and Resources', the high cost and availability of healthy food were perceived as barriers to healthy dietary behaviours – a finding previously reported in a general shift population in Ireland.<sup>27</sup> The present study also found that this was also a key domain influencing dietary behaviours in healthcare sector workers with T2D who do not work night shifts. Access and affordability to foods during shifts has been previously reported in hospital workers in the UK.<sup>28</sup> Although this may not be unique to employees with T2D, the lack of healthy food availability may disproportionately impact the health of employees with T2D. The NHS England National Standards for healthcare food and drink states that NHS Trusts should provide suitable 24-7 food provision.<sup>29</sup> However, our data suggests that these standards are not yet universally implemented. The perceived cost of food against the current cost of living crisis is of concern as economic barriers to healthier food choices may have increased in importance since data collection. A number of NHS Trusts have established on-site food banks<sup>30</sup> to support staff. Although these are a response to wider political and economic drivers, it is important that access is considered for staff working outside of regular day time hours.

In agreement with the semi-structured interview findings, the 'Emotion' domain had a mixed influence on eating behaviours. Mixed shift workers reported greater agreement to snacking more and eating as a result of tiredness on night shifts compared to day shifts; however, there was no difference in eating as a result of boredom between shift types. 'Emotions' was also a mixed influence domain for non-night and permanent night workers, with no strong indication of it being a barrier or enabler to healthy diet behaviours. This may be the result of different coping strategies or responses to tiredness and stress. Previous observational research indicates that inadequate rest breaks during long working hours can negatively impact a range of health outcomes,<sup>31</sup> and this may be of particular concern in this population group as a result of the long duration of shifts reported – typically over 8 h. The free-text responses aligned with the perception of a lack of time to take breaks or to prepare and plan food in advance, and this may relate to the long duration of work shifts and the current healthcare staffing shortages. In terms of self-reported health parameters, over two thirds of respondents reported body measurements that would indicate living with overweight or obesity and three quarters who reported a HbA1c measurement reported a

value above 48 mmol/mol which is the recommended treatment target.<sup>32</sup> The Working Time Society consensus statement in 2019 stated strong evidence for the link between shift work and negative metabolic health outcomes.<sup>33</sup> Observational evidence from the Nurses' Health Study has shown an association between a shift schedule that includes night shifts and T2D risk, partially attributed to increased body weight.<sup>34</sup> Studies in employees with T2D is limited, but a small study in workers in Thailand with T2D demonstrated higher HbA1c in night compared to day workers.<sup>10</sup> Although the present study did not aim to determine differences between health outcomes, there was no difference in BMI or HbA1c between respondents based on current shifts worked. However, over half who reported not currently working night shifts reported a history of night shift work. Research is needed to understand if historic night shift exposure can impact blood glucose management.

Although there were limited reported differences between dietary behaviours when working a night or non-night shift, overall, the intake of fruits, vegetables and whole grains was low compared to dietary guidelines and the general intake of the UK population.<sup>35</sup> Previous studies have reported night workers consume less healthy diets<sup>12,36</sup> compared to non-night workers. The difference might be explained by other studies having compared groups of non-night workers to night workers whereas the present study compared diet behaviours in the same worker across different shifts.

Understanding the impact of inadequate rest breaks and less healthy food choices at work in employees with T2D is important because a Danish study found that, over a 30-year period, employees with diabetes compared to those without had shorter working life expectancies and a higher number of working years lost.<sup>37</sup> Although social disparities contributed to some of the differences, enabling employees with diabetes to make healthier food choices and to take adequate rest breaks may improve health outcomes and contribute to maintaining economic activity for longer.

Most respondents agreed that they knew what a healthy diet should look like 'knowledge' and wanted to eat more healthily at work 'intention' – key enablers to making healthier dietary choices; however, most disagreed with the statement that they had been provided with information about how to eat healthy during their shift 'knowledge'. Shift workers were more likely to agree that dietary advice was difficult to follow during a night shift and therefore, tailoring the content of structured diabetes education programmes to the atypical working hours worked in the healthcare sector may also be important to programme efficacy in shift workers.

The present study found that 70% of respondents reported not attending a structured diabetes education programme. Surprisingly, more shift workers reported

attending than the general population with approximately 90% non-attendance reported by the National Diabetes Audit.<sup>38</sup> This might be the result of this population group being more health literate and therefore more likely to attend. However, this value is below the 89% offered structured diabetes education.<sup>38</sup> Previous qualitative studies have reported practical barriers (e.g., work commitments) to declining or non-attendance of structured education programmes.<sup>39</sup> Paid time off from work or convenience of attending sessions out-side of regular working hours may be important considerations in this employee population.

## Strengths and limitations

A strength of the present study is the data collection from an under-represented employee group who are at increased risk of suboptimal blood glucose management and are more likely to make less healthy dietary choices. The healthcare sector is one of the main employers in the UK and employees in this sector are likely to be employed in jobs requiring shift work. Capturing data from this employee group is important given the current recruitment and retention challenges across the sector. A methodological strength of the present study is the application of the theory-informed TDF to the survey question design. The application of TDF provides a theoretical basis to guide the development of tailored behaviour change strategies that are more likely to be effective.<sup>40</sup> The response to the belief statements was further supported by the free-text comments collected, strengthening the validity of the belief statements derived from semi-structured interviews.

There are several study limitations. Because T2D is not a notifiable condition, it is not possible to determine the generalisability of our findings to the UK healthcare sector shift working population living with T2D. Although the demographics (gender, age, ethnicity, job role) from survey respondents are comparable to the Shift-Diabetes interview study sample, there is a lack of ethnic diversity compared to the wider UK healthcare work force.<sup>41</sup> The heterogeneity of shift schedules and low response rate from permanent night shift workers limited the sample size available for statistical comparisons; however, the aims of the survey were descriptive rather than hypothesis driven. Most respondents worked in England and care should be taken in applying the findings outside of England because of the devolved organisation of healthcare. The aim of the Shift-Diabetes study is to develop a targeted intervention for shift workers with T2D working in hospital or residential care settings and, as such, additional research would be needed in occupational groups with different working environments (e.g., mobile workers such as transport, police, etc.) and in shift workers living with type 1 diabetes.

## Implications for practice

Further to previously suggested interventions from the Shift-Diabetes study for mixed shift workers with T2D,<sup>19</sup> the survey findings suggests that interventions targeting environmental, context and resources (e.g., implementation of the NHS England National Food Standards and practical advice about how to support healthier food choices during shift work) would benefit a wider section of the workforce living with T2D.

## CONCLUSIONS

It is important to understand how the work environment influences dietary behaviours in people living with T2D especially in employees who work shifts. The findings of the survey, taken together with the previous qualitative study, support interventions targeting the food environment and tailored dietary advice for all shift workers living with T2D.

## AUTHOR CONTRIBUTIONS

Rachel Gibson, Nicola Guess, Nick Oliver, Fabiana Lorencatto and Barbara McGowan developed the study design and research question. Sophie Rubner, Maria D'Annibale, Rachel Gibson, Nicola Guess, Nick Oliver and Fabiana Lorencatto designed the survey. Sophie Rubner analysed the data. All authors contributed to data interpretation and manuscript writing.

## ACKNOWLEDGEMENTS

We thank all the respondents who completed the survey and to the Shift Diabetes steering group members. The Shift-Diabetes study is supported by Diabetes UK (Grant No. 19/0005979). Diabetes UK do not/will not have any role in the study design, management, data analysis and interpretation, writing of the report, or the decision to submit the report for publication.

## CONFLICTS OF INTEREST STATEMENT

RG is a member of the British Dietetic Association Work Ready Steering Group.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICAL STATEMENT

Ethical approval was obtained from King's College London BDM Research Ethics Panel (Ref: LRS/DP-21/22-28986). Respondents were provided with an online copy of a participant information sheet that outlined the aims of the study. All respondents were required to give informed consent and confirm that

they had read the participant information sheet before commencing the survey. All survey responses were anonymous.

## TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained (Ethical reference LRS/DP-21/22-28986).

## ORCID

Rachel Gibson  <http://orcid.org/0000-0002-5823-6468>

## PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/jhn.13198>.

## REFERENCES

1. Health and Social Care Information Centre. Health Survey for England—2013. 2014 [cited 2014 Dec 26]. Available from: <https://files.digital.nhs.uk/publicationimport/pub16xxx/pub16076/hse2013-ch6-sft-wrk.pdf>
2. Trade Union Congress. Number of people working night shifts up by more than 150,000 in 5 years. 2018 [cited 2022 Dec 20]. Available from: <https://www.tuc.org.uk/news/number-people-working-night-shifts-more-150000-5-years>
3. Health and Safety Executive. New guidance on managing shift work. Vol. 2013. 2006 [cited 2022 Dec]. Available from: <https://www.hse.gov.uk/pubns/priced/hsg256.pdf>
4. UK Government. Night working hours: hours and limits. <https://www.gov.uk/night-working-hours>. Accessed 26 Dec 2016.
5. Trade Union Congress. Number of people working night shifts up by more than 250,000 since 2011. 2016 [cited 2022 Oct 30]. Available from: <https://www.tuc.org.uk/news/number-people-working-night-shifts-more-250000-2011-new-tuc-analysis-reveals>
6. Costa G. The impact of shift and night work on health. *Appl Ergon*. 1996;27:9–16.
7. Gao Y, Gan T, Jiang L, Yu L, Tang D, Wang Y, et al. Association between shift work and risk of type 2 diabetes mellitus: a systematic review and dose-response meta-analysis of observational studies. *Chronobiol Int*. 2020;37:29–46.
8. Letwin O Future of an ageing population. 2016 [cited 2022 Oct 30]. Available from: [https://www.ageing.ox.ac.uk/files/Future\\_of\\_Ageing\\_Report.pdf](https://www.ageing.ox.ac.uk/files/Future_of_Ageing_Report.pdf)
9. Diabetes UK Diabetes statistics. [cited 2022 Dec 20]. Available from: <https://www.diabetes.org.uk/professionals/position-statements-reports/statistics>
10. Manodpitipong A, Saetung S, Nimitphong H, Siwasaranond N, Wongphan T, Sornsiriwong C, et al. Night-shift work is associated with poorer glycaemic control in patients with type 2 diabetes. *J Sleep Res*. 2017;26:764–72.
11. NICE. Type 2 diabetes: prevention in people at high risk | Guidance and guidelines. 2017 [cited 2017 Nov 26]. Available from: <https://www.nice.org.uk/guidance/ph38>
12. Hemiö K, Puttonen S, Viitasalo K, Härmä M, Peltonen M, Lindström J. Food and nutrient intake among workers with different shift systems. *Occup Environ Med*. 2015;72:513–20.

13. Souza RV, Sarmento RA, de Almeida JC, Canuto R. The effect of shift work on eating habits: a systematic review. *Scand J Work Environ Health*. 2019;45:7–21.
14. Nea FM, Kearney J, Livingstone MBE, Pourshahidi LK, Corish CA. Dietary and lifestyle habits and the associated health risks in shift workers. *Nutr Res Rev*. 2015;28:143–66.
15. Bonnell E, Huggins C, Huggins C, McCaffrey T, Palermo C, Bonham M. Influences on dietary choices during day versus night shift in shift workers: a mixed methods study. *Nutrients*. 2017;9:193.
16. Peplonska B, Kaluzny P, Trafalska E. Rotating night shift work and nutrition of nurses and midwives. *Chronobiol Int*. 2019;36:945–54.
17. Booth SL, Sallis JF, Ritenbaugh C, Hill JO, Birch LL, Frank LD, et al. Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points. *Nutr Res*. 2001;59:S21–36.
18. Gibson R, Oliver N, McGowan B, Vetter C, Palla L, D'Annibale M, et al. Towards targeted dietary support for shift workers with type 2 diabetes (Shift-Diabetes study): a mixed-methods case study protocol. *Diabetic Med*. 2022;39:1–9.
19. Gibson R, D'Annibale M, Oliver N, McGowan B, Forbes G, Crayton E, et al. Understanding of the individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes working in UK healthcare: a qualitative study using the Theoretical Domains Framework. *Diabet Med*. 2023.
20. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implement Sci*. 2012;7:37.
21. Atkins L, Francis J, Islam R, O'Connor D, Patey A, Ivers N, et al. A guide to using the theoretical domains framework of behaviour change to investigate implementation problems. *Implement Sci*. 2017;12:77.
22. Atkins L, Michie S. Changing eating behaviour: what can we learn from behavioural science? *Nutr Bull*. 2013;38:30–5.
23. Mulligan K, McBain H, Lamontagne-Godwin F, Chapman J, Haddad M, Jones J, et al. Barriers and enablers of type 2 diabetes self-management in people with severe mental illness. *Health Expect*. 2017;20:1020–30.
24. McBain H, Begum S, Rahman S, Mulligan K. Barriers to and enablers of insulin self-titration in adults with Type 2 diabetes: a qualitative study. *Diabetic Med*. 2017;34:253–61.
25. Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res*. 2004;6:e34.
26. Braun V, Clarke V. What can 'thematic analysis' offer health and wellbeing researchers? *Int J Qual Stud Health Well-Being*. 2014;9:26152.
27. Nea FM, Pourshahidi LK, Kearney J, Livingstone MBE, Bassul C, Corish CA. A qualitative exploration of the shift work experience. *J Occup Environ Med*. 2017;59:1153–60.
28. Power BT, Kiezebrink K, Allan JL, Campbell MK. Understanding perceived determinants of nurses' eating and physical activity behaviour: a theory-informed qualitative interview study. *BMC Obes*. 2017;4:18.
29. NHS England. National standards for healthcare food and drink. 2022 [cited 2023 Mar 30]. Available from: <https://www.england.nhs.uk/long-read/national-standards-for-healthcare-food-and-drink/>
30. NHS Providers. Rising living costs: the impact on NHS staff and patients. 2022 [cited 2022 Nov 24]. Available from: <https://nhsproviders.org/rising-living-costs-the-impact-on-nhs-staff-and-patients/how-trusts-are-supporting-people>
31. Park S, Lee JH, Lee W. The Effects of Workplace Rest Breaks on Health Problems Related to Long Working Hours and Shift Work among Male Apartment Janitors in Korea. *Saf Health Work*. 2019;10:512–7.
32. National Institute for Health and Care Excellence. Type 2 diabetes in adults: management NICE guideline NG28. 2022 [cited 2023 Jul 06]. Available from: <https://www.nice.org.uk/guidance/ng28/chapter/Recommendations>
33. Moreno CRC, Marqueze EC, Sargent C, Wright Jr. KP, Ferguson SA, Tucker P. Working Time Society consensus statements: evidence-based effects of shift work on physical and mental health. *Ind Health*. 2019;57:139–57.
34. Pan A, Schernhammer ES, Sun Q, Hu FB. Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women. *PLoS Med*. 2011;8:e1001141.
35. Public Health England. National Diet and Nutrition Survey (NDNS) results from years 7 and 8 (combined). 2018 [cited 2023 Mar]. Available from: <https://www.gov.uk/government/statistics/ndns-results-from-years-7-and-8-combined>
36. de Assis MAA, Kupek E, Nahas M, Bellisle F. Food intake and circadian rhythms in shift workers with a high workload. *Appetite*. 2003;40:175–83.
37. Nexø MA, Pedersen J, Cleal B, Andersen I, Bjørner JB. Working life expectancies among individuals with type 1 and type 2 diabetes over a 30-year period. *Scand J Work Environ Health*. 2021;47:540–9.
38. NHS Digital. National Diabetes Audit. A summary report of the National Diabetes Audit: Care Processes and Treatment Targets 2018–19. 2020 [cited 2023 Mar 30]. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-audit/report-1-care-processes-and-treatment-targets-2018-19-full-report>
39. Coningsby I, Ainsworth B, Dack C. A qualitative study exploring the barriers to attending structured education programmes among adults with type 2 diabetes. *BMC Health Serv Res*. 2022;22:584.
40. Michie S, Atkins L, West R. The behaviour change wheel. In: A guide to designing interventions. 1st ed. Great Britain: Silverback Publishing; 2014.
41. NHS Digital. NHS workforce. 2020 [cited 2023 Mar 30]. Available from: <https://www.ethnicity-facts-figures.service.gov.uk/workforce-and-business/workforce-diversity/nhs-workforce/latest>

## AUTHOR BIOGRAPHIES

**Sophie Rubner, BSc (Hons), MSc.** Sophie is a recent graduate of the Nutrition master's course at King's College London. Nutrition interests include diabetes and lifecycle nutrition.

**Maria D'Annibale, MSc.** Maria is a research assistant at the Department of Nutritional Sciences at King's College London. Primary areas of research are shift work and cardiometabolic health.

**Nick Oliver, FRCP.** Nick is the Wynn Professor of Metabolism. His principal area of research is the development and implementation of novel technologies for people living with diabetes.

**Barbara McGowan, MBBS, PhD.** Barbara is a Consultant Endocrinologist at Guy's and St Thomas' Hospital London and Professor of Endocrinology at Diabetes at King's College London. Primary areas of research are gut hormones, appetite control and pharmacotherapy for weight loss.

**Nicola Guess, RD, MPH, PhD.** Nicola is the Research Programme Manager at University of Oxford, primary areas of interest are in type 2 diabetes prevention and management.

**Fabiana Lorencatto, PhD.** Fabiana is a behavioural scientist and the Research Lead at the Centre for Behaviour Change at University College London. Primary areas of interest are identifying influences on health behaviour and designing and evaluating theory-based interventions.

**Rachel Gibson, RD, PhD.** Rachel is a Lecturer in Nutrition and Dietetics at King's College London. Primary areas of research are workplace diet and health and dietary assessment.

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Rubner S, D'Annibale M, Oliver N, McGowan B, Guess N, Lorencatto F, et al. Individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes working in UK healthcare: A cross-sectional survey. *J Hum Nutr Diet.* 2023;1–18.

<https://doi.org/10.1111/jhn.13198>