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Exploration of the individual, social and environmental factors influencing dietary behaviour in shift workers with type 2 diabetes working in UK healthcare—The Shift-Diabetes Study: A qualitative study using the theoretical domains framework

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Abstract

Aim: To identify factors influencing dietary behaviour in shift workers with type 2 diabetes (T2D) working in UK healthcare settings.

Methods: Semi-structured qualitative interviews based on the theoretical domains framework (TDF) were conducted with a convenience sample ($n = 15$) of shift workers (32–59 years) diagnosed with T2D who worked night shifts as part of a mixed shift schedule. The TDF was applied to analyse transcripts using a combined deductive framework and inductive thematic analysis approach. Identified influences were mapped to the behaviour change technique taxonomy to identify potential strategies to change dietary behaviour in this context.

Results: Key barriers to healthy dietary behaviours were access and cost of food available during night work (TDF domain: *Environment Context* and *Resources*). Factors identified as both enablers and barriers included: availability of staff facilities and time to take a break, (*Environment Context* and *Resources*), the physical impact of night work (*Beliefs About Consequences*), eating in response to stress or tiredness (Emotion), advance planning of meals/food and taking own food to work (*Behavioural Regulation*). Potential techniques to address these influences and improve dietary behaviour in this context include: meal planning templates, self-monitoring and biofeedback, and increasing accessibility and availability of healthier food choices during night shifts.

Conclusions: The dietary behaviour of shift workers with T2D is influenced by interacting individual, socio-cultural and environmental factors. Intervention should focus on environmental restructuring and strategies that enable monitoring and meal planning.

KEYWORDS
healthcare employees, shift work, theoretical domains framework, type 2 diabetes, workplace

1 | INTRODUCTION

The prevalence of type 2 diabetes (T2D) in the United Kingdom (UK) is estimated to reach 5.5 million by 2030.[1] In parallel, there is an increase in the number of UK employees working shifts.[2] Shift workers in England are more likely to be diagnosed with T2D than day workers[3] and night workers living with T2D have been found to have higher HbA1c.[4] While the workplace is increasingly seen as an important environment for public health interventions,[5] there is an increase in the need for the management of chronic health conditions in addition to prevention. Shift workers have been shown to be less engaged with workplace well-being programmes,[6] potentially increasing health disparities. Workplace interventions should be tailored to employees' needs[7] and based on established behaviour change theory.[8] Currently, there are none for shift workers living with T2D, or their employers.

Diet is a first-line intervention in the prevention and management of T2D.[9,10] Less healthy dietary habits are frequently reported by shift workers[11] which may contribute to suboptimal diabetes self-management in shift workers living with T2D. Employees choice of what, how and when they eat at work is a behaviour that can impact on health outcomes. A pre-requisite for identifying how best to support healthier diet behaviours for shift workers with T2D is understanding what factors influence dietary behaviour in this context. Previous studies have identified that dietary behaviour is driven by a complex set of interacting factors such as shift schedule and the work environment.[12] It is not known if these influences are the same for shift workers living with T2D or if there are additional influences. Application of behaviour change theories and frameworks can help to explore such factors.

The theoretical domains framework (TDF) synthesises 128 constructs from 33 multidisciplinary behaviour change theories into 14 domains representing the broad range of potential individual, socio-cultural and environmental influences on behaviour.[13–15] Previous studies using the TDF have examined influences on the dietary behaviour of nurses working shifts in hospitals[16] and clinician's perspectives on the implementation of a Mediterranean diet for people with T2D,[17] however, no TDF-based study has explored influences on dietary behaviour of shift workers with T2D.

The TDF can help to identify behavioural influences that can facilitate subsequent intervention development. The Theories and Techniques Tool (TaTT)[18] maps the domains of the TDF to specific behaviour change techniques (BCTs)[19] that are more likely to bring about a change in behaviour, thereby providing a step-wise, systematic development of a targeted intervention, more likely to be effective.[20]

What's new

- Shift workers are less likely to make healthy food choices during night work and this can impact diabetes management.
- This study found that shift workers with type 2 diabetes (T2D) wanted to make healthier food choices during night work but were inhibited due to limited access to food and a lack of confidence in their ability to eat healthy during night work.
- There is a need to reduce the barriers to healthy eating reported by shift workers with T2D—candidate strategies include targeting the food environment and the development of practical advice around how to eat healthier during night shifts.

2 | AIMS

This study is part of the Shift-Diabetes study, a larger mixed methods project.[21] This manuscript reports the qualitative part of the study and aimed to: (1) apply the TDF to explore and characterise the factors influencing dietary behaviours of hospital and residential healthcare shift workers with T2D, as a basis for (2) identifying BCTs to support dietary behaviour change in this population.

3 | METHODS

3.1 | Study design

Guided by the qualitative content analysis methodology,[22] we conducted theory-based semi-structured qualitative interviews with individuals with T2D who work night shifts in UK healthcare settings. The reporting is in line with the consolidated criteria for reporting qualitative research (COREQ),[23] Appendix S3.

3.2 | Research ethics approval

Ethical approval was obtained from King's College London BDM Research Ethics Subcommittee (Ref: HR-19/20-14630) and registered at ISTCTN (Ref: 11764942).

3.3 | Participants and recruitment

Eligible participants were diagnosed with T2D and worked night shifts as part of a mixed shift schedule in a hospital or residential care setting. Inclusion criteria were that participants managed their diabetes by lifestyle and/or by medications that do not pose a risk of hypoglycaemia.

Participants were recruited through advertisements via posters displayed on staff notice boards and in well-being areas or in staff newsletters across 29 NHS hospital sites (23 in England, 6 in Scotland). A targeted social media campaign used social media platforms: Twitter, Instagram and Facebook. Potential participants directly contacted the research team to express an interest in taking part.

Purposive sampling of a representative set of participants across different demographic factors was planned. However, COVID-19 placed a significant burden on health service staff and made participant recruitment extremely challenging. A pragmatic decision to use convenience sampling was taken. Participants were offered £25 for their time; payment was cash via bank transfer. Recruitment took place between September 2020 and November 2021 and interviews were conducted between November 2020 and December 2021.

Based on sample size recommendations for qualitative research and principles of thematic data saturation,[24] the initial target sample size was 15 participants. If no new influences were being reported by participants, thematic data saturation was deemed achieved.

3.4 | Materials

An interview topic guide was developed (FL, RG, NG). The topic guide included questions about participant's typical diet when working night shifts and what influences diet when working nights. The latter questions were structured around TDF domains and were also informed by the findings of previous qualitative studies that explored dietary behaviours in shift workers, healthcare workers and people with T2D,[16,25–31] (Appendix S2). The topic guide was piloted prior to data collection and refined accordingly (FL).

3.5 | Procedure

Interviews were conducted according to participant preference via video call, telephone or in person at King's College London. If a participant selected a video or telephone interview, they were asked to be in a private space with no one else present. All interviews were conducted by a female Research Assistant (MD), an Associate Nutritionist (MSc Nutrition) and trained to conduct semi-structured interviews by behavioural scientist (FL). There was no relationship between interviewer and interviewee prior to the start of the study and no repeat interviews were conducted. The purpose of the research was explained to each participant prior to consent. All interviews were audio recorded, transcribed verbatim, and fully anonymised. No field notes were taken.

3.6 | Analysis

Transcripts were analysed in NVIvo 2020 (QSR International Pty Ltd) and Microsoft Excel, according to guidance for applying the TDF in data collection and analysis.[32] This involved a combined deductive framework and inductive thematic analysis approach, that broadly followed five steps detailed in Table 1.

3.7 | Mapping to intervention strategies

To generate suggestions for potential ways to support dietary behaviour change in this context, the themes generated from the qualitative analyses were then mapped to potential BCTs, following published approaches.[33] The Theories and Techniques Tool (TaTT)[34] was consulted to identify recommendations for potential BCTs to address the influences within key TDF domains identified during analysis of interview transcripts. Potential BCTs were discussed by a behavioural scientist (FL) and dietitian (RG) to generate recommendations and examples for how these could potentially be operationalised and delivered in the context of dietary behaviour in hospital shift workers with T2D and summarised in an intervention mapping table. The feasibility and acceptability of potential interventions were subsequently presented and discussed at a multidisciplinary research advisory group which included individuals with lived experience of shift working and T2D.

4 | RESULTS

4.1 | Participants

Fifteen interviews (mean duration 58-min, range 37–79 min) were conducted (video call $n = 4$, telephone $n = 6$, in person $n = 5$). No new themes were coded between the 13th and the 15th interview indicating thematic saturation at 13 interviews. No participant terminated the interview

TABLE 1 Five-step process used for thematic analysis.

Step	Activity
1	Reading and re-reading transcripts so that researchers may become familiarised with the data.
2	Development of a codebook structured around the domains of the TDF. The codebook provided a set of heuristics to aid deductive coding and included: definitions for the 14 TDF domains, examples quotes and population. The codebook was developed in joint agreement by three study researchers with experience of using the TDF (FL, EC, MD)
3	Deductive framework analysis: Each transcript was analysed in turn, with individual participant responses deductively coded according to the TDF domain they were judged to best represent. For example, '...so I think it's actually quite difficult to maintain the shift schedules that we have and also balance that with eating healthily.' was coded to the domain 'Beliefs about capabilities.' Where appropriate, a response could be coded to more than one domain All coding was done independently by a trained researcher (MD) with frequent meetings to discuss and review coding with a behavioural scientist experienced in using the TDF (FL, EC).
4	Inductive thematic analysis: Similar responses coded to each TDF domain were then grouped by two researchers (MD and FL), and a theme label inductively generated summarising the role that domain plays in influencing dietary behaviours. FL reviewed each inductively generated theme label to check whether the label represented the shared meaning of participant responses contributing to that theme, and that the theme was allocated to the most appropriate TDF domain. Any discrepancies were resolved through discussion. Themes were classified as either a barrier, enabler or mixed influence on dietary behaviours in this context.
5	The key domains influencing dietary behaviour were identified using established criteria for TDF based studies (a) frequency (the number of participant responses contributing to that domain); and (b) elaboration (number of themes per domain).

or withdrew their data. Thirteen participants were female, and most participants ($n = 11$, 73%) worked in a hospital setting. The mean duration since T2D diagnosis was 7.2 (SD: 4.9) years. Participants, on average, had worked nights for 15.1 (SD: 10.4) years and currently worked on average 8 (SD: 3.5) night shifts per month as part of a mixed shift schedule. Summary participant characteristics are shown in Table 2.

4.2 | Influences on eating behaviours during night shifts

Reported influences on dietary behaviour were mapped onto 12 of the 14 TDF domains, with no influences identified within two TDF domains (*Skills* and *Reinforcement*). Table 3 ranks the domains in terms of importance according to frequency and elaboration of themes per domain. The most important domains were: *Environmental Context* and *Resources*, *Emotion*, *Beliefs About Consequences*; and *Behavioural Regulation*. Table 4 provides an example of a sub-set of themes generated within each domain, alongside supporting quotes. Table S1 provides a full list of generated themes within each domain. A narrative summary of the top seven themes identified within each domain is outlined below, the remaining five themes are summarised in Appendix S1.

4.2.1 | Environmental context and resources

Influences identified within *Environmental context and resources* were largely barriers. All participants commented on the limited number of places to purchase food on site during night work. Several mentioned that although there were staff canteens and food retail in their workplace, these closed before they started their night shift. Some mentioned that there was no food available on site at night while others mentioned that night-time access to food was solely vending machines or, for some participants, on-site 24-h coffee shops. Mostly, participants indicated a lack of 'healthy' food options available to them at night. Instead, foods like 'cola', 'chocolate', 'crisps' were typically available (i.e. from vending machines). Over half of respondents also reported a lack of places to purchase food off-site during night work, due to either location of their work not being near outlets or outlets not being open 24 h. The cost of food was a barrier to purchasing food during night work, with participants perceiving the cost of foods available during night work as '*expensive*' and '*geared towards visitors*'. Several participants compared onsite café or vending prices to high street retailers, with the latter perceived as cheaper. Onsite facilities for staff to store and prepare their own food were an enabler when they were deemed adequate. Most reported access to a fridge, kettle and microwave; however, some indicated that the facilities were not sufficient for the number of staff. Facilities to take a break had mixed influence, with participants reporting eating standing up or at their desk when there were a lack of staff eating/rest areas. Adequate time to take a break was a mixed influence, one participant commented that there was less opportunity to take a break during a night shift compared to a day shift, while another commented that night shifts were sometimes quieter compared to day shifts. Two participants commented that during night shifts they were not able to take the breaks they

TABLE 2 Participant characteristics.

	N (%)
Age range, years	
25–34	1 (7)
35–44	4 (27)
45–54	6 (40)
55–60	4 (27)
Gender	
Males	2 (13)
Females	13 (87)
BMI (kg/m^2)	
25.0–29.9	4 (27)
30.0–39.9	8 (53)
≥40.0	2 (13)
Ethnicity	
White	9 (60)
Black/African/Caribbean/Black British	4 (27)
Asian/Asian British	2 (13)
Work environment	
Hospital	11 (73)
Residential	4 (27)
Job role	
Registered nurse and midwife	7 (47)
Nursing or healthcare assistant/social care staff	4 (27)
General management	2 (13)
Admin and clerical	1 (7)
Other	1 (7)
Attended diabetes education programme	
No	13 (87)
On diabetic medication	
Yes	13 (87)
	Mean (SD)
Years after T2D diagnosis	7.2 (4.9)
Years of night-shift work	15.1 (10.4)
Night shifts per month	8.1 (3.5)

Abbreviation: BMI, body mass index.

are entitled to. Several participants indicated they think more about, or are more engaged with, healthy behaviours when not working nights, '*thinking about it more when I am at home*', '*I plan a little better at home*', '*I'm a lot better when I am not working*'.

4.2.2 | Emotion

Most themes within *Emotion* were mixed. Eating in response to hunger or to stress was common influence on eating habits. Several participants reported not feeling hungry during a night shift, while others expressed feelings of hunger influencing eating more during the night shift or the days following a night shift. Several participants reported eating more during a shift when they felt stressed '*I eat bigger when I am stressed*' or eating sweet foods '*if it is very stressful I want something quite sweet and quick to eat*' others participants commented they did not eat when they were stressed and one participant described levels of stress with a '*little bit stressed*' leading to grazing, while '*really stressed*' would lead to loss of appetite and not eating. Eating in response to tiredness was also mixed, several participants reported this led to 'snacking' or 'picking' eating patterns or selecting foods or drinks (e.g. chocolate, biscuits, coffee, energy drink) for a 'boost' when feeling tired during a night shift. Craving sweet foods was a mixed theme, although most respondents indicated when they had cravings this led to more unhealthy food choices, '*sometimes you just want to eat rubbish*'. Eating in response to boredom during a shift was consistently reported as a barrier. However, this varied between night and day shifts, with several participants expressing eating more due to boredom during a day shift compared to a night shift. Additional themes within *Emotion* concerned feelings of guilt after eating foods perceived as unhealthy (e.g. cake, chocolate) and feelings of shame when eating in front of others, with one participant describing not wanting anyone to see them eat a '*heavy meal*'.

4.2.3 | Beliefs about consequences

Beliefs about consequences was a mixed influence on healthy eating behaviours. Most respondents reported that they perceived eating during the night shift to have a negative impact on the management of T2D, mainly this was reported as eating unhealthy foods and poorer blood glucose management. The physical impact of eating at night was identified as a barrier, with heartburn/indigestion preventing eating specific foods at night. About half of respondents reported a perceived need to maintain their 'energy levels' during night work. For most respondents, this was a barrier, as they indicated snacking on higher energy dense foods like chocolate while a '*salad will not sustain me*'. Two participants indicated making considered food choices that were '*slow burning high protein… to fill you up*'. Physical consequences ('*feeling crap*', '*physically feel bad*') of eating 'unhealthy foods' (burger, sweet sugary foods, '*too much carby stuff*') were identified as an enabler to making healthier food choices by four participants.

TABLE 3 Domain importance ranking.

TDF domain	Frequency (number of participants reporting contributing enablers/ barriers within that domain)	Elaboration, number of themes per domain
Environmental context/ resources	15	10
Emotion	15	7
Beliefs about consequences	15	6
Behavioural regulation	15	6
Social influences	15	4
Memory, attention, and decision making	15	2
Beliefs about capabilities	15	2
Knowledge	14	3
Goals	13	6
Intention	11	1
Optimism	9	1
Social/Professional role and identity	6	1
Skills	0	0
Reinforcement	0	0

4.2.4 | Behavioural regulation

Behavioural regulation had a mixed influence on eating behaviours. Planning meals in advance was commonly viewed as an enabler to better food choices, but several participants commented that this was difficult, or they were less likely to do this for a night shift. Taking own food in to work either pre bought or prepared at home was generally seen as an enabler to avoid '*eating junk food*' or to '*not get tempted by chocolate or cakes*' and to 'get healthy choices'. Self-monitoring strategies included monitoring blood sugar during a shift which was considered an enabler to help avoid making less healthy food choices. Monitoring dietary intake was a mixed theme, several participants reported it acted as an enabler, '*so I know what's going in*' or using smaller plates to manage portions, one participant reported monitoring diet intake made them '*unhappy*'. Self-monitoring responses to hunger was an enabler with three out of four participants reporting drinking fluid in response to feelings of hunger, while another participant reported hunger was a prompt to '*prepare something*' to eat. Deciding to eat at fixed times was seen as an enabler to being able to have a meal or break during a night shift, two participants mentioned that taking medication enabled a fixed break schedule. Several participants acknowledged that when to eat was influenced by feelings on hunger, or feelings of low blood sugar.

4.2.5 | Social influences

A common barrier within *Social influences* was not being able to resist sweet foods bought into the workplace by visitors or patients. Participants frequently mentioned that foods such as biscuits, chocolates, cakes, '*nibbly stuff*', were '*always there*'. The influence of colleagues on food choices during a night shift was mixed. Some stated it was quite high and acted as a barrier to healthy eating. One participant described it as '*coercing each other.[.]*', while another commented on managers rewarding staff with boxes of chocolates or a cake. Other participants reported no influence from colleagues, and one participant felt colleagues encouraged healthier eating habits.

When participants reported that colleagues were aware of their diabetes diagnosis, the influence was variable. One participant commented that as a colleague also had T2D, they supported each other to make healthier food choices. Conversely, other participants described the views of colleagues in more negative language '*... can't have that because she is diabetic*', '*they would probably say you're diabetic*'. Peer support was also an enabler, with one participant starting a diet trial with a colleague and finding it helpful. Support from family was also an enabler to healthy eating behaviours, for instance, family members cooking and preparing food. Similarly, the need to prepare and cook a meal for other family members enabled healthier eating behaviour, with some participants mentioning

TABLE 4 Barriers and enables to healthy eating within each theoretical domain.

TDF domain	Theme	Barrier/enabler/mixed	Frequency (max $N=15$)	Example quote(s)
Knowledge	Knowing what a healthy diet for a person living with type 2 diabetes should look like	Enabler	13	*"Basically trying to eat a healthy diet, try and balance it out and have low carbs and try and avoid sugary stuff as much as you can... eat fibre, high protein meals and drink lots of water...more a normal routine, like a healthy pattern... And try and lose some weight with that as well" (Enabler)*
	Not having information provided in the workplace about healthy eating	Barrier	8	*"They have lots of stuff about well-being and stuff but not about healthy eating, no."(Barrier)*
Social/professional role and identity	Needing to take more care with diet as someone with Type 2 diabetes	Enabler	6	*"So having diabetes I think I've got to look after myself but I know I do not look after myself 100%" (Enabler)*
Beliefs about capabilities	Ability to adjust eating patterns to shift schedule	Mixed	13	*"It's quite easy I think because I've been doing it for so many years so I'm now used to it... it does not really affect me anymore. It's no different from how I would eat in the day" (Enabler)* *"Not easy! It's really not easy, especially because I tend to do runs of nightshifts and then I'll do an occasional dayshift, so I get very used to my nightshift eating and sleeping pattern and then I'm on a dayshift and I cannot make that switch that quickly"(Barrier)*
	Difficult to apply dietary advice to working at night	Barrier	10	*"I have had advice from a nutritionist regarding eating...but it's just been very difficult to try and incorporate it during shift work"* (Barrier)
	Ability to make healthy food choices during night work	Mixed	9	*"before I started nightshift I was really eating healthy, I had a regular healthy plan that I was going by, but since I started nightshift I have abandoned that" (Barrier)* *"I think I'm more sensible with choosing much better food choices now. I think it's changed a bit from what it used to be years ago." (Enabler)*
Optimism	It is not possible to eat healthily when working at night	Mixed	9	*"I think I'm quite good with my diet. It's probably not 100% sometimes, I probably indulge in too many, like, fruit sometimes and if there's cake yes I'll have it, but I do not think I'm going too bad." (Enabler)* *"...you just fall back into the same routine of how it was before and now I do not make any [healthy food] choices and I wish I could, but it just feels like nights make it a lot harder for people with diabetes. "(Barrier)*

(Continued)

TABLE 4 Continued

TDF domain	Theme	Barrier/enabler/mixed	Frequency (max $N=15$)	Example quote(s)
Beliefs about consequences	Negative impact of eating during a night shift on diabetes management	Mixed	12	*"Oh, it's really bad. They do, they [food choices] affect it [T2D] really bad. I mean sometimes you can eat that much chocolate and crap at work, you feel sick afterwards, you know, if you ate that much." (Barrier)* *"I do not think it does. I think sometimes obviously my blood sugars will go up in the night because sometimes I take them myself and I think oh that's a bit high, but it'll be like 10, but then when I get home I'll take my medication, go bed, and it has not affected me, I've got good skin, feelings in my feet, you know what I mean, I'm all together OK. "(Neutral)*
	Perceived need to maintain energy levels during night shifts	Mixed	7	*"I'm choosing foods that are not going to make me feel tired or sluggish or heavy. I'm choosing foods that are slow burning so that they will sustain me." (Enabler)* *"[referred to things they eat and drink during a night shift] Initially quite energised and then I do tend to have a bit of a kind of drop and then a sluggishness, but obviously when the initial sugars have worn off and I get a little bit of a crash and I'll slump for a little while" (Barrier)*
Intention	An intention to make healthier choices	Mixed	11	*"I try my best as I can to just have a healthy meal as much as I can." (Enabler)* *"I try, but whether that will stick in or not I do not know, I keep saying I'm going to join a gym but then I think do I really want to." (Mixed)*
Goals	Priority of healthy eating	Mixed	14	*"it's probably top priority because if I do not feel good I'm not going to be able to give good care because I'm going to be thinking oh I'm still hungry... or I'm going to feel heavy and I'm not going to maybe move as fast as I normally would or even feel like I want to work, I'd probably feel quite sleepy" (Enabler)* *"To get things done and to ensure that nobody dies! ... That's my priority" (Barrier)*
	Priority to improve diabetes management	Enabler	11	*"Yeah, I do, definitely. I really want to start eating a lot healthier and getting back to how it was when I was on the straight and narrow and I was eating and I lost a bit of weight. That's what my goal is, yeah" (Enabler)* *"Weight loss and for my diabetes to be completely reversed. The aim is to come off medication and go into remission" (Enabler)*

TABLE 4 Continued

TDF domain	Theme	Barrier/enabler/mixed	Frequency (max $N=15$)	Example quote(s)
Memory, attention, and decision making	Forgetting to eat/skipping meals	Mixed	13	*"Forget to eat...sometimes, yeah, when it's so busy, I'll take in my packed lunch with me and it's been so busy I've not had the chance to eat that, yeah, so there are times when it's just too busy. I do not think I forget such a thing but I will miss that meal because it's just busy." (Barrier)* *"No, I do not think I can ever forget to eat, because food is one of the biggest things in my life." (Enabler)*
	Convenience important factor in food choice decisions	Barrier	8	*"Eating healthily? Oh, none whatsoever. I think I'm just lazy and I just do not think about it and it's just convenience. "(Barrier)*
Environmental context/resources	Limited number of places to purchase food and drink on site during night work	Barrier	15	*"There's a [supermarket chain] in the hospital so we go there for sandwiches. [...] Nothing is available after 9 o'clock because that's when the [supermarket chain] closes...[...]" Just vending machines [open at night time]" (Barrier)*
	Availability of healthy food choices on site during night work	Mixed	14	*"I would say it's easy enough to have a healthy diet, because they can make you up a salad, that the chefs or the cooks on day staff, if you request it..." (Enabler)* *"...[...] so all you get is the vending machine and it's just chocolates, crisps, soft drinks and that's it... it's the only thing you can find around." (Barrier)*
	Cost of food and beverages available during night work	Barrier	13	*"it's very expensive. A sandwich is £5.50. The microwave meals start at £5/£6. And they are the same ones you'd get in [Supermarket chain] for probably £2.50." (Barrier)*
	Availability of onsite facilities to store and prepare food	Mixed	13	*"Fridge. It's not a nice fridge, it's a very small fridge and it's always cramped, so yeah, no, that's another one of the reasons why I cannot really take in anything for too long because, no, there is a fridge there, but I do not really use it because it's always full, there's never any space in it." (Barrier)* *"There's a fridge, two big fridges and there's three microwaves. [...] And there's a toasted sandwich maker" (Enabler)*
	Having enough time to take a meal break during a night shift	Mixed	15	*There are some evenings I do not get a break at all because I'm constantly busy all night and my office is the other end... And that's worse during the night because if I do not eat I'll starve, whereas during the day there is more opportunity for me to go and take a break, whereas at night there's a limited opportunity because there's less people and there's more call upon my time." (Barrier)* *"Yes, always. [...] you do not have to have your food on your break, you can have it whenever you want. [...] now we have bigger wards, we have more staff and it's just run better." (Enabler)*

(Continued)

TABLE 4 Continued

TDF domain	Theme	Barrier/enabler/mixed	Frequency (max $N = 15$)	Example quote(s)
Social influences	Not being able to resist sweet foods brought in by patients and visitors	Barrier	12	*"If somebody's brought in some cake or something and you are going to try it out." (Barrier)*
	Food choices being influenced by colleagues at work	Mixed	14	*"Well it's quite high really because it's like a treat, is not it? You know, you get to sit down and they'd be like 'what have you got?' and then you have got biscuits or crisps or something. So yeah, they do influence it..." (Barrier)* *"Not a lot, no, they do not really. Sometimes we'll have a shift and the girls will be like 'oh shall we order pizza'... but I'm not hungry, so I'm going to opt out of that because I do not need to eat, I 'm not going to force myself to eat. I'll sit with them whilst they are eating but I'm not going to actively eat. So they do not really influence me, no" (Neutral)*
	Support from healthcare professionals to understand diabetes	Mixed	11	*"outside of work, I know I can get hold of a nutritionist if I need to speak to my GP and stuff." (Enabler)* *"it wasn't informative as in it was just no you are not meant to – your plate size should not be this big, your plate size should be that – well everybody knows that, we do not need to be told that, we all know that." [following diabetes education session] (Barrier)*
Emotion	Craving sweet foods during night work	Barrier	7	*"It (sugary snack) satisfies the sugar craving for a while. It's not to satisfy the appetite or anything, it's not to help me feel full, it's just to satisfy a craving and that's it." (Barrier)*
	Eating in response to hunger	Mixed	14	*"I'd say it wasn't proper hunger, it's more what I call peckish, so you want something but nothing much" (Barrier)* *"Not really. Not really. As I say, I'm not as hungry in the night as in the day, so I can go through a night shift with just maybe coffee and tea and I'll be fine" (Enabler)*
	Eating due to feeling tired during night work	Mixed	11	*"It's chocolate when I'm tired at work. It's the magic food, is not it, chocolate, it perks everybody up." (Barrier)* *"No, I would not really, I would not eat because I'm tired, it's more drink coffee, to keep me awake."*
	Eating due to feeling stressed during night work	Mixed	14	*"It's the shift work that make it hard, the shift work that make me feel like oh god I'm stressed, you know, like, I need to eat to make me happy, I need to eat at any time, anything to make me happy." (Barrier)* *"I do not really eat for stress. If I'm stressed it's usually because I'm busy!" (Enabler)*

TABLE 4 Continued

TDF domain	Theme	Barrier/enabler/mixed	Frequency (max $N = 15$)	Example quote(s)
Behavioural regulation	Planning meals in advance when working nights	Mixed	13	*"but I find it hard to prepare meals in time, if that makes sense, it's just it's not there. […] So I think part of it is laziness in cooking food when I'm working because I do not seem to have enough hours in the day." (Barrier)* *"I think it's trying to organise myself better because I know that my shift patterns are going to be the ones that are going to ruin my diet, so it's having a plan for those days. (Enabler)*
	Taking own food into work to eat during my shift	Mixed	12	*"It's temptation really. The biggest influence really is what's available on a night if you do not take your own food." (Enabler)* *"No, everything from home. […] so at the moment it's generally I pinch all the kids' naughty food that's small and snacky that comes in snack packs, so whatever's for their lunchboxes, then I will pinch for my box at night I think." (Barrier)*
	Eating at fixed times	Enabler	11	*"It's become like habit. Because what I find is if I have it earlier […] I suddenly become hungry and you know, yourself, it's uncomfortable to be hungry, so that's why I always make sure five o'clock I have something" (Enabler)*

the importance of eating healthy as an influence on their children. Support from healthcare professionals to understand T2D was mixed, some reported good support at diagnosis but then limited ongoing support. One participant reported that there was ongoing support available via their GP if needed.

4.2.6 | Memory attention and decision processes

A common *Memory attention and decision process* barrier to healthy food choices was the need for convenience in the process of food choice on night shifts. Participants indicated that '*speed*' and '*easiness*' were important influences on food choice, and this was linked with foods such as chocolate, packets of crisps, purchases of prepared food from local retail outlets, or takeaway deliveries. Most participants reported forgetting to eat or missing breaks during a shift due to being too busy, with two participants reporting occasions when they had not eaten at all. Only one participant reported not forgetting to eat during a shift. Making the decision to take a break when the shift is quiet was an enabler reported by three respondents, as this ensured that they were able to eat some food during their shift. Three respondents indicated that there were notices in the workplace to draw attention to healthy food choices in canteens and retail outlets. However, two of these participants reported that the food offer available did not reflect the healthy eating messages promoted.

4.2.7 | Beliefs about capabilities

Beliefs about capabilities was a mixed influence on eating behaviours. A frequently reported barrier was the difficulty in applying healthy eating advice received to working at night. Some participants indicated that even though they had told their healthcare professional they worked shifts this was ignored or not considered in the advice provided, with advice reflecting '*normal day to day living*' or *'just giving you a protocol to follow*'. The ability to adapt eating patterns (e.g. time and frequency of eating) between different types of shifts had a mixed influence. Some participants reported that they found it easy to adapt, with some commenting that they found it easy as they had been working shifts for a long time. Others reported it was a barrier to maintaining regular eating patterns, finding it difficult to switch between night and day shifts. Most participants perceived their ability to be able to make healthy food choices during night work was a barrier, commenting on lack of availability of healthy food choices and the difficulty in managing changing shift

schedules. One participant indicated they had abandoned healthy eating when they started working night shifts.

4.3 | Mapping identified barriers/enablers to intervention strategies

Table 5 presents the results of mapping the identified influences onto proposed BCTs to support dietary behaviour change in this context. A range of potential strategies were identified. Some proposed strategies focus on building individual capability, knowledge, confidence and self-regulatory capacity in how to best alter dietary patterns in response to changing shift patterns (i.e. meal planning templates, suggested foods and sample diet plans for different shift patterns, supported by testimonials and tips from credible sources such as other shift workers with T2D). Other strategies focus on increasing individual awareness, challenging misconceptions and encouraging self-monitoring and reflection (i.e. food diaries, glucose monitoring, biofeedback). Some proposed strategies target collective behaviour of peers in the workplace to increase social opportunity (i.e. local champions and team challenges). Lastly, given the key influence of environmental context and resources, it is likely that organisational level environmental restructuring strategies will be needed that target physical opportunity and increase the accessibility and availability of healthier food choices during night shifts (e.g. healthier food choices in vending machines, 24-h canteens, pre-ordering meals for staff during night shifts, healthier packed lunches).

5 | DISCUSSION

This study aimed to identify the factors that influence dietary behaviours in shift workers with T2D working in residential healthcare settings, one of the main employment sectors of shift workers in the UK.[2] The key domains identified as influencing diet behaviour were *Environmental Context and Resources*, *Emotion*, *Beliefs About Consequences* and *Behavioural Regulation*.

In line with the findings reported here, a previous study in people without diabetes found poor availability of healthy food during shift work, with some participants reporting the irony of promoting healthy food without provision during night work.[35] There have been a number of studies in healthcare workers inside and outside the UK that corroborate the importance of the food environment and the cost of available food.[16,28,31]

Emotional factors had a mixed influence on food choices—potentially due to individual coping mechanisms or susceptibility to different emotional states. In agreement with this research, other studies in healthcare/social care shift workers also reported a stressful working environment impacting on health behaviours.[31,35] Stress has been shown to influence food choice in women by increasing sugar and saturated fat intake[36]—which some of the participants reported, while others reported a suppression of appetite. Boredom was a consistent barrier to healthy eating during a shift. Previous research has shown boredom promotes less healthy food choices;[37] in the workplace setting, this may lead to an interaction with the food environment (e.g. frequent availability of cakes and chocolates) potentiating the likelihood to make less healthy food choices. This study demonstrates the importance of convenience in making food choice decisions during night work and agrees with previous findings in Australian nurses who reported a lack of time to prepare healthy meals due to long hours and tiredness.[29] While convenience foods may vary in nutritional quality, participants in the current study tended to equate convenience foods with less healthy foods (e.g. chocolate). It was interesting the differing response to maintaining energy levels with some selecting energy dense foods while others chose slower burning foods, for example, complex carbohydrates the latter being a part of structured diabetes education. It is important to acknowledge that appetite is also driven by complex endocrine pathways which may act in concert with the food environment in driving energy dense food choices during night work. A small study in night and day shift workers found alterations in ghrelin and xenin which could reduce post-prandial satiation in night workers[38] however, more research is needed to understand the contributing role of disruption to the endocrine system in food choice during night work.

Most participants felt that what they ate during a night shift negatively influenced their diabetes management. These concerns conflicted with feelings that participants reported about the need to look after themselves more as a person living with T2D. While understanding the impacts of night work on their health, participants felt that the dietary advice provided was not readily applicable to working at night. This may be due to the lack of evidence-based dietary guidelines for shift workers or a lack of awareness about the impact of shift work challenges by healthcare professionals.

Barriers to healthier lifestyle choices identified in previous general shift working populations have included disrupted routine, tiredness and time management.[12] These are broadly in line with the findings in the present study. The identified enablers of *Behavioural regulation* work to address these barriers with meal planning, taking food into work, and deciding to eat at fixed times. Potentially unique to this study population, self-monitoring was also viewed as an enabler for healthier diet choices—a strategy established in weight management interventions.[39]

TABLE 5 Mapping of identified influences to potential behaviour change techniques.

Proposed intervention package	Reported influences on dietary behaviour in shift workers with T2D that this proposed intervention addresses	Corresponding TDF domain(s)	Behaviour change technique(s)	Example operationalisation
Educational and planning resources	Ability to adjust eating patterns to shift schedule Difficulty applying dietary advice to working at night Pessimism around whether possible to eat healthily when working night shifts Forgetting to eat/ skipping meals Planning meals in advance when working nights Taking own food to eat during a shift Eating at fixed times	Beliefs about capabilities Optimism Memory, attention, decision making Behavioural regulation	Instruction on how to perform the behaviour Demonstration of the behaviour Credible source Action planning Prompts and cues	Create a set of resources to support shift workers to develop focused plans for how to adjust their eating patterns according to shift schedules. These could include a set of example meal plans for different and alternating shift patterns. Each meal plan could include suggested foods that are diet and culturally appropriate, and suggested meal times. Resources could include blank meal planning templates and action plans. To enhance credibility, these resources could be accompanied by advice and testimonials from other shift workers with type 2 diabetes who meal plan and/or prepare food in advance to bring to work. These materials could be delivered in paper form (i.e. a handbook) or digitally (i.e. an app, or web-based intervention). If an app, could include notifications to remind to meal plan and/or eat at fixed intervals.
Structured education and healthcare provider support	Support from healthcare professionals to understand diabetes Ability to adjust eating patterns around shift schedules	Knowledge Social influences	Social support (practical) Instruction on how to perform the behaviour Information about health consequences	Incorporate advice on how to adjust dietary behaviour according to factors such as shift worker into targeted training and education for type 2 diabetes self-management (e.g. DESMOND or X-PERT). Include information on the impact of diet on diabetes management. This advice could incorporate some of the resources described above (e.g. sample meal plans/meal planning templates). This advice could alternatively be delivered in consultations with specialist diabetes dietitians, and/or discussed during routine diabetes reviews/consultations.
Biofeedback and self-monitoring	Mixed perceptions around impact of dietary behaviour during a night shift on diabetes management Perceived need to eat to maintain energy levels during night shifts Improving diabetes considered management a priority Eating in response to hunger, tiredness, stress, cravings	Beliefs about consequences Goals Emotions	Self-monitoring (behaviour) Self-monitoring (outcome of behaviour) Biofeedback Behavioural experiments Information about health consequences Instruction on how to perform the behaviour Action planning	As individuals to keep a food diary during a pre-determined period involving a mixture of shift patterns. Keep a log of what is eaten, at what time, how they felt (e.g. energy levels, tiredness, stress, hunger). Concurrently, individuals asked to wear a continuous glucose monitors to gather data on blood glucose patterns throughout that time period. Provide biofeedback on glucose levels throughout shifts and in response to different types of foods. Challenge perceptions that less healthy foods might make one feel better (i.e. high sugar content foods). Suggest alternatives (i.e. slow release energy foods/ low glycaemic index) and monitor biological, psychological and emotional response. Accompany by advice and resources (i.e. meal plan templates and suggested foods).

Continues

TABLE 5 Continued

Proposed intervention package	Reported influences on dietary behaviour in shift workers with T2D that this proposed intervention addresses	Corresponding TDF domain(s)	Behaviour change technique(s)	Example operationalisation
Workplace campaigns	Lack of workplace initiatives or information on healthy eating Needing to take more care with diet as someone with type 2 diabetes Forgetting to eat/ skipping meals Taking breaks/making time to have a meal break during a night shift	Knowledge Memory, attention, decision making Environmental context and resources	Prompts and cues Framing/Reframing Information about health consequences Instruction on how to perform the behaviour	Work place initiatives, campaigns and posters to encourage well-being and healthier dietary behaviour. Message reframing and cues ('look after oneself to look after others').
Team challenges and support	Food choices influenced by colleagues at work	Social influences	Credible source Social support (emotional) Social support (practical) Demonstration of behaviour Social comparison Restructuring social environment	Introduce a local well-being/dietary behaviour peer champion to encourage taking breaks and healthier dietary behaviour during night shifts. Informational campaigns/ posters with testimonials from other shift workers with T2D. Establish team challenges and competitions around healthier dietary behaviour during night shifts.
Increasing accessibility and availability of healthier food choices during night shifts	Limited number of places to purchase food and drink on site during night shifts Limited availability of healthy food choices during night shift Cost of food and beverages available during night work Convenience important factor in food choice decisions	Environmental context and resources Memory, attention, decision making	Restructuring the physical environment Adding objects to the environment Behavioural substitution	Increase accessibility and availability of healthier food options during night shifts. This could include: staff canteens open for 24 hours, including healthier food options in vending machines, providing subsidies for healthier food options, restricting availability of unhealthier options, providing 'packed lunches' for shift workers or opportunities to diet and culturally appropriate meals.

5.1 | Strengths and limitations

This research addresses an important gap to understand what influences diet behaviours in an at-risk population living with T2D. A strength of this study is that it was designed using the TDF enabling subsequent mapping to potential interventions. Recruitment challenges were exacerbated by COVID-19—in response a convenience sample was recruited. As there are no data that describe the characteristics of shift workers living with T2D working in the healthcare sector, it is not possible to determine generalisability of our findings. This study was conducted during COVID-19 pandemic and therefore responses may have been influenced by the pandemic. However, common themes were identified through the collection period—the main comments related to COVID-19 were that access to food was increased at night during the start of the COVID-19 pandemic, and COVID-19 being a catalyst for diet change.

5.2 | Implications for policy and practice

Mapping to behaviour change techniques identified potential interventions and suggests multilevel complex interventions that are required to support shift workers living with T2D. At an individual level, practical advice to develop skills and knowledge will be important—this may be through meal plans adapted to different shift patterns and peer support of sharing tips. Adapting current structured education programmes to accommodate shift workers' specific needs is another option, the delivery of the education as well as the content would need to be considered. To support shift workers wanting to make healthier food choices at work, addressing the food environment will be key. Environmental change needs engagement by key stakeholders responsible for food provision (e.g. facilities, contractors, finance). The NHS England National Food Standards states healthy food should be available to staff 24–7.[40] However, the findings from this study suggest that this is not universal. The findings of this study support the implementation of these recommendations.

5.3 | Future recommendations

This study highlights the complexity of factors that influence food choice in shift workers with T2D in healthcare. There is a need to co-develop and test candidate interventions to establish feasibility, acceptability, and efficacy. It is also recommended that other occupational groups are investigated, for example, employees with T2D working outside bricks and mortar workplaces—for example, paramedics, police and transport workers.

6 | CONCLUSION

This study has found that the dietary behaviour of shift workers with T2D is influenced by interacting individual, socio-cultural and environmental factors. These influences represent targets for potential multilevel interventions to change dietary behaviour and improve management and outcomes for T2D in shift workers.

AUTHOR CONTRIBUTIONS

NG, RG, FL, BM and NO developed the initial idea for the Shift-Diabetes Study. FL, RG, NG and MD designed qualitative study protocol. MD conducted the interviews. MD, FL, RG, GF and EC completed the analysis. RG, FL, MD and NG drafted the manuscript. All authors contributed to the manuscript for important intellectual content. All authors read, amended and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

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SUPPORTING INFORMATION

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

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