

A qualitative study of perceived barriers and facilitators to interrupting sedentary behavior among adults living with obesity

Fiona Curran  | Carol Brennan | James Matthews | Grainne O' Donoghue

School of Public Health, Physiotherapy and Sports Science, University College Dublin, Dublin, Ireland

Correspondence

Fiona Curran, School of Public Health, Physiotherapy and Sports Science, University College Dublin, Belfield, Dublin 4, Ireland.
Email: fiona.curran@ucd.ie

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Abstract

Introduction: Both obesity and sedentary behavior (SB) are associated with negative health consequences including cardiovascular disease, diabetes, certain cancers and all-cause mortality. To date, perceived barriers and facilitators to interrupting SB in adults living with obesity have not been identified.

Objective: This study aimed to identify these perceived barriers and facilitators by conducting a behavioral analysis underpinned by the theoretical domains framework (TDF) and the Capability, Opportunity, Motivation-Behavior (COM-B) model to enhance knowledge and inform future intervention development.

Methods: A purposive and snowball sample ($N = 21$) of adults living with obesity took part in semi-structured interviews, guided by the TDF, to investigate perceived barriers or facilitators to interrupt SB. Transcribed interviews were inductively coded using reflexive thematic analysis. Key themes and subthemes were generated by grouping similar and recurring codes. Finally, subthemes were mapped to the TDF and COM-B.

Results: Five key themes were identified, which influence SB across all domains of living. These relate to (i) physical and mental wellbeing; (ii) motivational readiness; (iii) roles, responsibilities and support; (iv) weight bias and stigma; and (v) the environment. These themes were then deductively mapped to all 14 TDF domains and all six of the COM-B constructs.

Conclusion: A complex interplay of individual, societal and policy factors contributes to the development and habituation of SB patterns in adults living with obesity. Factors identified in this study could assist in the development of interventions, strategies and policies designed to interrupt or reduce sedentary behavior in this population.

KEYWORDS

behavior change, COM-B, reflexive thematic analysis, theoretical domains framework

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1 | INTRODUCTION

Sedentary Behavior (SB) and obesity are inextricably linked in the scientific literature, media and societal attitudes.^{1,2} This association, simplified in the tagline, 'eat less, move more', became the panacea for obesity and maxim by which people with obesity were judged in healthcare and across society.³ However, the simplicity of the message is at odds with the complexity of the disease of obesity and indeed the behaviors with which it is linked, including SB.

Although much is known about both obesity and SB, there are many gaps in the research regarding SB in the population who have established obesity. There is little evidence regarding SB correlates or interventions to interrupt SB in this population, and to date no qualitative studies have been published regarding the barriers and facilitators to interrupting SB in this group. Moreover, no published studies have used theoretical frameworks to provide a behavioral analysis and potential intervention constructs for sedentary behavior change in this population. This study addressed these gaps.

The complexity of the factors that influence both obesity and SB and indeed the directionality of the link between SB and obesity are not well understood. Nonetheless, both decreasing SB and obesity are public health priorities globally. Currently, the World Health Organization (WHO) includes recommendations to minimize SB in their physical activity (PA) guidelines.⁴ Sedentary behavior, independent of physical activity levels, is associated with diabetes, cardiovascular risk and mortality,⁵⁻⁷ depression,^{7,8} anxiety⁹ and poor health-related quality of life.^{7,10} Studies have shown that minimizing or interrupting SB by standing and/or movement breaks can reduce cardio-metabolic risk factors, at least in the short term.¹¹

While research and knowledge regarding the determinants and correlates of sedentary behavior continues to grow,^{12,13} there is little published research specific to adults living with obesity. A recent systematic review exploring factors that are associated with SB in adults living with obesity, identified only 12 studies with few and weak associations, found no evidence for a consistent association and found no qualitative studies examining SB associations in this population.¹⁴ Furthermore, while qualitative studies have focused on perceived determinants of weight loss,¹⁵ obesity management,¹⁶ physical activity,¹⁷ healthy lifestyle or nutrition¹⁸ in adults with obesity or adolescents,¹⁹ few use a theoretical framework from study design through analysis.^{20,21}

Evidence for the effectiveness of SB interventions is also mixed or lacking, particularly outside the workplace,²² and although some non-workplace interventions show promise, few target adults with obesity or explicitly report theoretical constructs²³ which would enhance replicability. Hence, to better understand SB in adults living with obesity, it is essential to consider their perspectives to appreciate how their beliefs, experiences, events, resources and context influence this behavior. Indeed, recent guidance by the UK Medical Research Council emphasized the importance of engaging with the target population and detailing the mechanisms of action (i.e., how and in what contexts interventions are effective) when designing interventions for a complex behavior such as sedentary behavior.²⁴

The use of theoretical frameworks in research can help provide transparency regarding the inclusion of particular constructs and mechanisms of action, which provide valuable information regarding effective behavior change techniques or active ingredients for inclusion in behavior change interventions. A number of frameworks exist which can facilitate contextual behavioral analysis and intervention design processes. The behavior change wheel was developed from 19 frameworks of behavior change²⁵ with the aim of synthesizing common features to provide a model of behavior that can be applied to a range of behaviors and settings. At the core of the behavior change wheel is the COM-B (Capability, Opportunity, Motivation-Behavior) model, which holds as the central tenet, that for any behavior to occur all of the components, capability (physical and psychological), opportunity (physical and social) and motivation (reflective and automatic), must be present, while behavior change necessitates a change in at least one of the components.²⁶ This COM-B behavioral analysis provides the foundation for identifying intervention functions (i.e., means by which an intervention can change behavior e.g., education) and supportive policies (e.g., environmental/social planning).

When required, for example, in complex behaviors such as SB or conditions such as obesity, the Theoretical Domains Framework (TDF) provides a more comprehensive analysis of the determinants of behavior and behavior change at an individual, community, and organizational level alongside the external influences on behavior, such as the environment.^{26,27} The validated TDF of 14 behavior change domains was developed and refined by expert consensus from 33 behavior change theories of 128 theoretical constructs.^{27,28} The domains and constructs of the TDF align to the COM-B components and identify 'what needs to change' to bring about behavior change.

By mapping the perceived barriers and facilitators of a particular behavior to the TDF and COM-B, intervention functions and behavior change techniques (i.e., potentially active ingredients of interventions, e.g., instruction on how to perform the behavior),²⁹ which are likely to be acceptable and effective, can be identified and implemented. This combined approach has been used previously to investigate perceived barriers and facilitators to breaking up sitting time for desk-based workers³⁰ and to develop and implement a successful intervention to reduce sitting time in the workplace.^{31,32} No published studies have used this approach to investigate sedentary behavior outside the workplace and no qualitative studies to date have sought the perspectives of adults with obesity regarding their experience of the barriers and facilitators to interrupting SB. This qualitative study therefore, aimed to identify these perceived barriers and facilitators by conducting a behavioral analysis underpinned by the TDF and COM-B model, to enhance knowledge and inform future person and theory-based intervention development.

2 | MATERIALS AND METHODS

The Standards for Reporting Qualitative Research (SRQR) 21 items checklist was used to ensure transparency in this research from the

initial design of the study through to manuscript completion³³ (available in Appendices Table S1).

2.1 | Research paradigm

To construct a rich understanding of the factors that influence sedentary behavior among adults with obesity, a critical realist approach was adopted. This qualitative approach focuses on the core concepts of experiences, events and causal mechanisms.³⁴ Experiences are defined as the perceptions of adults with obesity, events as the things that happen in the real world (e.g., SB), and causal mechanisms are the means that produce the events (e.g., factors resulting in SB).^{35,36} Critical realism allows researchers to gain access to a complex social world of causal interactions through 'richly textured accounts of events, experiences and underlying conditions or processes'.³⁷

2.2 | Study design

Twenty-one semi-structured in-depth interviews with adults with obesity were conducted through May and June 2022. Adults with obesity are recognized by University College Dublin (UCD) Human Research Ethics Committee (HREC-LS-21-100) as a vulnerable population for research purposes; hence, individual interviews rather than focus groups were conducted to encourage openness and richness regarding the individual's lived experience. To broaden access to participation, interviews were conducted online via video-conferencing.

2.3 | Participants and recruitment

To identify potential participants, a purposive sampling strategy targeting adults with current or past history of a BMI ≥ 35 kg/m² was employed. This cut-point, was chosen to investigate challenges associated with moderate or severe obesity, since BMI and severity of obesity are potentially associated with SB and consistently associated with reduced PA.¹⁴

Initially, GO'D invited the participation of the Irish Coalition of People living with Obesity (ICPO), an advocacy group which provides education, awareness and support to people living with obesity. Thereafter, the ICPO committee acted as gatekeepers by circulating leaflets advertising the study to members across a broad demographic range of age, gender, occupation and urban/rural residence. Subsequently, FC invited potential or actual participants to snowball the advert to further potential participants at their discretion. Inclusion criteria were adults (≥ 18 years) who self-identified as living with obesity, defined in the advert for the study as *now or in the past a body mass index (BMI) ≥ 35 kg/m² which impacts health, wellbeing or enjoyment of life or activities*. To gather valuable perspectives regarding SB associated with relapse or remission of obesity,

participants who lost excess weight were included, even if their current BMI was ≤ 35 kg/m².

To determine that the sample size of 21 was sufficient to achieve the study aims, the principles of information power were applied including reflexive discussion among the research team during data collection. That is, the study aims were specific and relatively narrow (identify barriers and facilitators to interrupting SB in adults with obesity), a purposive, highly specific population was used, the interview was supported with established theory (TDF) which was applied flexibly to elicit an in-depth dialog, and reflexive appraisal for information power was conducted after every 3 interviews.^{38,39} Thus, a minimum number of 12 interviews were planned. Interviews 19–21 contained no new information determining that the sample size was sufficient. Participants received a nominal voucher in line with the UCD reimbursement policy for public/patient participation in research.

2.4 | Materials

An interview topic guide was developed using the Theoretical Domains Framework (TDF).^{26,39} Additionally, non-TDF questions were included to richly contextualize perceptions about patterns of SB, how SB and obesity interplay, and ideas about interrupting SB.⁴⁰ The questions were open ended, and the interview style was flexible and reflexive to encourage the participants' expression through their own narrative. Prior to commencing the study, FC conducted two pilot interviews observed by GO'D. This resulted in amendments to some interview questions and inclusion of additional prompts to identify perceptions about the directionality of SB associations, causal mechanisms and the TDF domains. (Interview guide available in appendices Table S2).

2.5 | Procedure

Potential participants who contacted FC via phone or email received an information sheet and a consent form for deliberation. FC answered any questions and once participants returned the signed consent form, they were sent a link to a secure online survey platform (Qualtrics), to collect demographic data prior to interview. FC conducted all the interviews. The mean duration of the interview was 48.0 min (SD = 7.6). FC documented reflective notes immediately following each interview.

2.6 | Data analysis

Descriptive statistics were used to summarize the demographic data. Recorded interviews were transcribed verbatim, anonymized, then analyzed in Microsoft word and Microsoft Excel using reflexive thematic analysis (TA).^{41,42} This type of analysis is aligned with the philosophical approach of critical realism which can be used to

accurately explore the participant's empirical world, while engaging with underlying themes, concepts, and theory that can inform interventionist programs.⁴³ Salient phrases, sentences and paragraphs were inductively identified to develop first order codes from all transcripts. Following review and discussion with GO'D, CB and JM, FC continued the analysis to generate second order codes, returning to the raw data to enhance understanding. Codes with a shared pattern of meaning were grouped into candidate themes by FC. The research team then refined themes and subthemes by iterative discussion and collaboratively agreed and defined final themes. Each subtheme was then deductively mapped by FC to the TDF domains and COM-B. Any disagreement over domains was resolved through discussion with the other members of the research team.

3 | RESULTS

3.1 | Participant demographics

In total, 21 adults with obesity completed interviews. Participants included 15 females and six males, ranging in age from 31 to 64 years (mean = 48.9 years SD 10.8). Most participants ($n = 19$) scored ≥ 2 on the Edmonton obesity staging system (EOSS), which incorporates the physical, psychological, functional and quality of life impact of obesity.⁴⁴ The median EOSS score was 3. Mean 'highest ever' BMI was 55.5 kg/m² (SD 10.0) and mean 'at interview' BMI 42.0 kg/m² (SD 11.6). Four participants reported BMI <35 kg/m² at interview, while 13 had prior bariatric surgery. The mean total daily sitting time of participants was 471.0 min (SD 211.7) on a weekday and 387.0 min (SD 197.1) on a weekend day, self-reported using the International Sedentary Assessment Tool (ISAT).^{45,46} Detailed information relating to participants' sedentary time and its domains is included in Table 1.

3.2 | Interview results

Five key themes comprising 12 subthemes were generated from the patterned codes relating to barriers and facilitators to minimize/interrupt sedentary behavior in adults with obesity. These subthemes were mapped to the 14 domains of TDF and the COM-B. Table 2 provides an overview and Table S3 identifies barriers and facilitators (supporting information S1).

3.3 | Theme 1 physical and mental wellbeing affects SB and the ability to move

Three subthemes are presented in relation to how physical and mental wellbeing influence participants' capability to interrupt SB and move more. Physical factors encompass both mechanics and pain and medical and metabolic factors.

3.3.1 | Subtheme 1.1 mechanics for movement and the experience of pain influences SB

All participants identified at least one mechanical factor as a barrier to interrupting SB. Musculoskeletal pain was the most commonly identified barrier and this was either due to pain with movement, pain while standing, pain transitioning to standing, or reduction of pain while sitting. Other mechanical issues reported as barriers were the effort involved in moving a larger body, the lack of ability to move, difficulty with balance/gait due to physical size and managing skin care or excess skin. Some participants who described severe physical difficulties chose mentally active sedentary behaviors over mentally passive sedentary behaviors.

'I'm not in pain when I'm sitting down, you see. So I tend to sit a lot like'. (PID006). 'Navigating steps is very difficult for me with my hip..... and just, 25 stone and 5 feet, it's very difficult for me to get back upward again'. (PID010)

3.3.2 | Subtheme 1.2 medical and metabolic factors influence SB and movement

Almost half of the participants mentioned medical or metabolic comorbidities either as barriers to interrupting SB or as primary causal factors initiating a cascade of events that resulted in a decline in health behaviors including SB. Medical and metabolic factors included diabetes, cardiovascular disease, cancer, neurological, hormonal, COVID, gastrointestinal disorders and disordered sleep. Participants associated these conditions with lower energy, fatigue, discomfort, or reduced ability to move functionally.

I have swollen legs, a lot of fluid on my legs, so I would sit on the recliner here, probably from half six in the morning through till eleven o'clock at night' (PID003)

3.3.3 | Subtheme 1.3 mental wellbeing influences SB and movement

Most participants perceived that their mental wellbeing influenced their SB. Feelings of anxiety and depression were inextricably linked to SB for some, although a minority of others were reluctant to attribute their SB to their depression. Some individuals mentioned eating disorders or PTSD as factors that influenced both SB and obesity, while others traced its origin and associated unhealthy coping skills including SB to adverse childhood events. Anxiety tended to reduce the willingness to move or be active, particularly in public, and thereby acted as a barrier to minimizing SB. Participants were anxious about a range of different activities and situations such as being on transportation, in social environments, falling, inability to get up, stigma, being seen, as well as anxiety about work productivity.

TABLE 1 Participant demographics.

	Total participants n = 21	Stratified by past bariatric surgery		Stratified by gender	
		No (n = 8)	Yes (n = 13)	Male (n = 6)	Female (n = 15)
Age (years)					
Mean (SD)	48.9 (10.8)	47.6 (12.2)	49.7 (10.2)	51.2 (13.8)	48.0 (9.7)
Range	(31–64)	(34–63)	(31–64)	(34 – 64)	(31–63)
EOSS					
Median (SD)	3 (0.9)	4 (1.2)	3 (0.8)	3 (1.2)	3 (0.9)
Range	(1–4)	(1–4)	(1–4)	(1–4)	(1–4)
BMI (Kg/m ²)					
Highest ever*					
Mean (SD)	55.5 (10.0)*	55.2 (14.0)*	55.6 (7.8)	48.1 (6.7) *	57.9 (9.9)
Range	(40.1–76.4)*	(40.5–76.4)*	(40.1–66.3)	(40.1–58.0)*	(40.5–76.4)
At interview					
Mean (SD)	42.0 (11.6)	50.1 (13.9)	37.0 (6.5)	35.2 (6.1)	44.7 (12.3)
Range	(27.9–70.7)	(35.5–70.7)	(27.9–46.4)	(27.9–42.6)	(28.5–70.7)
ISAT (minutes)					
Weekday SB screentime					
Mean (SD)	304.3 (210.1)	386.3 (309.9)	253.8 (101.5)	360 (308.3)	282 (165.0)
Range	(60–960)	(60–960)	(120–480)	(60–960)	(120–720)
Weekend SB screentime					
Mean (SD)	290 (197)	386.3 (265.2)	230.8 (117.1)	320 (220.2)	278 (193.9)
Range	(0–720)	(0–720)	(0–420)	(120–720)	(0–720)
Weekday SB transportation					
Mean (SD)	189 (250.2)	300 (311.4)	120.8 (185.8)	210.0 (267.7)	180.7 (252.1)
Range	(0–840)	(30–840)	(0–720)	(60–720)	(0–840)
Weekend SB transportation					
Mean (SD)	106.7 (127.1)	101.3 (78.5)	110.0 (152.6)	170.0 (216.1)	81.3 (63.2)
Range	(0–600)	(0–240)	(0–600)	(60–600)	(0–240)
Weekday SB reading					
Mean (SD)	88.6 (138.6)	142.5 (205.2)	55.4 (65.8)	130.0 (231.3)	72.0 (85.5)
Range	(0–600)	(0–600)	(0–240)	(0–600)	(0–240)
Weekend SB reading					
Mean (SD)	75.9 (94.1)	78.8 (105.1)	74.1 (91.1)	95.5 (120.2)	68.0 (85.2)
Range	(0–300)	(0–300)	(0–240)	(0–300)	(0–240)
Weekday sitting total**					
Mean (SD)	471.0 (211.7)	557.1 (287.2)	424.6 (151.9)	530.0 (219.4)	445.7 (211.4)
Range	(120–900)	(120–900)	(240–600)	(300–900)	(120–840)
Weekend sitting total**					
Mean (SD)	387.0 (197.1)	488.6 (284.5)	332.3 (108.5)	380.0 (129.6)	390.0 (224.2)
Range	(180–960)	(180–960)	(240–600)	(240–600)	(180–960)

Abbreviations: EOSS, Edmonton Obesity Staging System⁴⁴; Interview Findings SB, Sedentary Behavior; ISAT, International Sedentary Assessment Tool.^{45,46}

*one missing value **one outlier removed.

TABLE 2 Themes and Subthemes mapped to theoretical domains framework and COM-B.

Theme	Subtheme	Mapped to TDF	COM-B
1. Physical and mental wellbeing affects SB and the ability to move; (Perceptions about physical and psychological factors affecting SB)	1.1 Mechanics for movement and the experience of pain influences SB;	Beliefs about capabilities Skills (skills, competence, ability) Reinforcement (punishment, reward)	Capability (physical and psychological) Motivation (reflective and automatic)
	1.2 Medical and metabolic factors influence SB and movement;	Beliefs about capabilities Skills (skills, competence, ability)	Capability (physical and psychological) Motivation (reflective and automatic)
	1.3 Mental wellbeing influences SB and movement;	Optimism (optimism, pessimism) Emotions (fear, anxiety, affect, stress, depression) Beliefs about capabilities	Capability (psychological) Motivation (reflective and automatic)
2. Motivational readiness to change SB; (Perceptions about motivating factors affecting SB)	2.1 Knowledge and beliefs about SB, obesity and the ability to move influence SB;	Knowledge Beliefs about capabilities Beliefs about consequences (health)	Capability (psychological) Motivation (reflective and automatic)
	2.2 Willingness, intention and action to change SB;	Intentions, (stability of intentions, stage of change) Goals (goal setting) Behavioral regulation Memory attention and decision processes	Capability (psychological) Motivation (reflective)
3. Roles, responsibilities and support for movement influence SB; (Perceptions about social and professional roles affect SB)	3.1 social and familial roles and responsibilities influence SB;	Social influences (social pressure/norms) Professional role and identity (social identity)	Opportunity (social) Motivation (reflective)
	3.2 social support for movement influences SB;	Social influences (conformity, comparison, support, identity)	Opportunity (social)
	3.3 occupational roles influence SB habit formation;	Professional role and identity	Motivation (reflective)
4. Perceptions about weight bias and stigma influence SB; (Perceptions about negative attitudes to obesity affect SB)	4.1 stigmatizing social experiences of obesity influences SB;	Social influences (social norms; comparisons) Reinforcement (punishment) 13 emotion	Opportunity (social) Motivation (automatic)
	4.2 identifying as an active or inactive person and internalized bias influences SB;	Professional role and identity (identity) Social influences (social comparison/norms) Reinforcement (punishment) Emotion (fear anxiety)	Opportunity (social) Motivation (reflective and automatic)
5. Environmental and external factors influence SB; (Perceptions about physical, cultural and policy factors affect SB)	5.1 Built and natural surroundings influence ability to change SB;	Environmental context and resources (environmental stressors, resources, climate)	Opportunity (physical)
	5.2 Financial, organizational and political factors influence ability to change SB;	Environmental context and resources (resources/culture)	Opportunity (physical)

For many participants, clinical depression or low mood was identified as a factor that led to prolonged and sustained SB in a negative cycle.

'In my 30s was when depression hit the most, and I was about 25 stone and I spent my days just watching television, sitting all day' (PID003)

A number of participants hid their SB and low mood from their family and avoided seeking healthcare. Some participants also learned mood recognition and coping skills. For this group, a decline in mood prompted SB awareness and acted as a motivator to reduce SB and move more.

Pretty much for the day, I just get up and make sure the house was clean. That was my exercise because I was embarrassed as well. I didn't want it to look to him that I was doing nothing all day, even though I was doing nothing all day. (PID011)

3.4 | Theme 2. Motivational readiness to change SB

This theme identifies participants' perceptions regarding internal and external motivators to minimize sedentary behavior and the readiness to actually change SB. Two subthemes are identified.

3.4.1 | Subtheme 2.1 knowledge and beliefs about SB, obesity and the ability to move influence SB

When asked to explain SB, no participant included all of its three components (energy, posture and awake) in their definition. Most participants had some knowledge about sedentariness and sedentary lifestyle, including associated health risks, but associated it with physical inactivity and were unaware of the benefit of sedentary breaks or minimizing SB independent of physical activity. When asked about reducing SB, participants consistently spoke about PA, either walking, increasing steps, or more formal exercise and most participants were unaware that standing or short breaks from prolonged SB (e.g., comfort breaks) were beneficial.

'First, well, sedentary behaviour would be a lifestyle that isn't very active, really. It would be either you don't have a job that's very active, or you don't participate in a lot of sports after working in the evening's. (PID019)

Participants' beliefs about their ability to move and about the causes of obesity influenced their confidence and willingness to minimize SB. Many participants believed that being a heavier weight means they cannot move or cannot move easily, due to physical, medical, or wellbeing factors including stigma. A small number of participants felt that excess weight did not impact their ability or willingness to be non-sedentary either at a younger age or until an injury, illness or life event

occurred. Participants tended to believe that SB is associated with escalating obesity, poorer mental health and poorer nutrition in the long term, and most participants linked their weight status with SB.

People think that people living with obesity are lazy, and they don't move because they don't want to. But very often we don't move because we can't, or we can do much, much less movement than a thinner person could do. (PID004)

3.4.2 | Subtheme 2.2 willingness, intention and action to change SB

For most participants, knowledge or awareness about their SB was not necessarily consistent with reductions in SB. Most described difficulty in changing their SB despite stating that they understood, were motivated to, or intended to do so. For most people, getting up from sitting was not a conscious thought but rather prompted by the need to do something, for example, household chores. Longer term lifestyle changes of unhealthy behaviors including SB tended to be prompted by a critical realization that their health and quality of life had already deteriorated or were imminently threatened. Participants tended to reduce their engagement in SB more consistently if they accepted the need to move for health, mobility and quality of life independent of weight loss, and those who accepted obesity as a disease tended to identify movement for health and wellbeing rather than for weight-loss.

But for me, the big changer has been the coming to the understanding that this is not completely my fault. (PID009)

3.5 | Theme 3. Roles, responsibilities and support for movement influence sedentary behavior

Participants described how their roles and responsibilities contributed to the development of their SB and influenced their ability to minimize SB. Familial/social responsibility, occupational and voluntary roles, including providing formal or informal support for others with obesity, were cited both as barriers and facilitators to minimizing SB. Three subthemes are identified.

3.5.1 | Subtheme 3.1 social and familial roles and responsibilities influence SB

Some participants who worked in sedentary roles often felt compelled to work long hours because of financial responsibility to provide for their children. Additionally, children could act as barriers to active transportation and thereby to minimizing SB, particularly in rural areas, when parental time is limited, in the evening, or if

children have challenging behavior. Caring for an elderly parent was cited as a barrier to interrupting SB, while visiting a parent or doing occasional chores for them was cited as a facilitator. Participants who owned a pet identified them as facilitators to interrupt SB.

I found myself caring for my father. This is where the sedentary lifestyle starts biting. My father suffers from dementia. As he declined and became more needy, my life shrunk. I was sitting in the house all day long, looking after dad (PID010)

3.5.2 | Subtheme 3.2 social support for movement influences SB

Participants frequently mentioned lack of obesity-sensitive social support for exercise or movement appropriate to ability as a barrier to interrupting SB across all domains of living including with family, peers, in the workplace, healthcare and online. Participants who had accessed specialist weight services felt unanimously encouraged to minimize or interrupt SB as part of a spectrum of movement, although most participants mentioned the lack of local access to or frequency of these services as a barrier. Participant preferences for the type of social support varied often due to social comparisons or ability. Appropriate social support, in person or online, was cited as a facilitator for reducing SB.

I do think having encouragement, having people to move with you or supporting you and it doesn't have to be in any great shakes. (PID017)

3.5.3 | Subtheme 3.3 occupational roles influences SB habit formation

Participants described the variation in SB habits in all domains of living; however, occupational SB habits developed based on the type of occupation, that is, occupations where considerable amounts of time were spent in front of a computer screen or where driving constituted a large part of the occupational role versus non-sedentary (e.g., some healthcare/education standing roles) or active occupations. Participants who formed habits to move more/interrupt SB were generally prompted to or supported by occupational policy, education and provision of equipment or digital reminders. The rigidity of work practice also influenced the development of habitual SB. Long occupational hours (whether sedentary or non-sedentary) and non-sedentary or low-activity occupations (e.g., standing roles in healthcare, education or service industry) were consistently associated with feeling fatigued leading to habitual SB after work or when they returned home.

'It's a long, long day. So I'd be working from 9:00 until 7:00. I'd be just wrecked when I get home. I'd be really

tired, really sore, and the next day, I probably wouldn't get up out of bed until midday. I'd be awake, but I wouldn't get out of bed until midday. So, I suppose that counts as sitting as well'. (PID004)

3.6 | Theme 4. Perceptions about weight bias and stigma influences SB

This theme relates to perceptions about negative attitudes, stereotypes, and stigmatizing experiences of living with obesity, which influence the willingness to minimize SB. Two subthemes are identified.

3.6.1 | Subtheme 4.1 stigmatizing social experiences of obesity influences SB

Many participants spoke about pervasive societal overt and micro-aggressions and stigmatizing experiences related to their obesity as a barrier to interrupting SB. Perceived micro-aggressions included looks of contempt, body scans, avoidance by others and unsolicited and often incorrect assumptions and advice. Participants described feeling judged, ashamed, embarrassed and afraid, which led to the avoidance of standing, moving, or being active when in public places, on transportation, or in the workplace or complete avoidance of activity, transport or particular places. Participants particularly avoid active transportation or moving on public transport.

Whereas I know for a fact, at my full weight, if I was traveling on a train, I'd hate kind of walking down that aisle. I'd dread it you know. So I would sit. Again, I'd sit there really, really tensely. (PID006)

3.6.2 | Subtheme 4.2 identifying as an active or inactive person and internalized bias influences SB

Most participants identified either as naturally active and enjoying physical activity or as naturally inactive describing themselves as lazy or sedentary and not enjoying physical activity. Those who identified as inactive struggled to be motivated out of SB, particularly at higher weights, but post bariatric surgery were motivated to maintain excess weight loss and felt able to reduce SB despite the lack of enjoyment. Participants who identified as naturally active or sporty felt frustrated and embarrassed by their declining ability, inability to participate in sport or vigorous exercise, and struggled with movement that lacked enjoyment or thrill. A small number of participants who had undergone bariatric surgery, described themselves as 'fidgety' or 'wiry' or 'just the way I would have been' since the surgery, prompting spontaneously SB breaks. Others described themselves as 'all or nothing' and periods of physical inactivity were usually accompanied by prolonged SB. For some, stigmatizing experiences

led to the avoidance of activity and increased SB accompanied by a decline in mental health and development of a façade.

How tiring is it every day to pretend you're okay? To put a smile on and be all like, we see it for years, the fat, jolly person. When the majority of it is a front. And that takes a whole different energy in itself to get through the day. (PID003)

3.7 | Theme 5. The environment and external factors influence SB

The majority of participants identified environmental factors which contribute to the development of SB or act as barriers or facilitators to reduce SB. Two subthemes are identified.

3.7.1 | Subtheme 5.1 built and natural surroundings influence ability to change SB

Participants spoke about equipment, access, climate, places and spaces, at home, in the community, in transport, and in the workplace affecting their SB. Stairs, low chairs, and uneven surfaces present particular barriers, while distance without a resting place discouraged participants from using services or facilities across healthcare, social settings and transportation such as trains or buses. Some mentioned the need for appropriate seating along walks to rest briefly and when not present, participants were unsure if they would manage the physical environment. Hence, they relied on using their car for transport or to have it nearby should they need it. Many participants highlighted the lack of access to swimming pools or services and facilities suitable for people with obesity to be active for example, gyms and classes. Social spaces, present particular difficulty with some participants describing sitting tensely, not taking even comfort breaks for fear that they would not be able to return to their place without embarrassment and disturbing others.

Flat, and good foot paths. Yeah. It makes it a whole lot easier. (PID008). Just to have a seat on any bench or something for a couple of minutes. (PID022)

3.7.2 | Subtheme 5.2 organizational, financial, and political factors influence ability to change SB

A number of perceived policy and financial barriers, predominantly related to obesity care and inclusion, were identified by participants. The majority of participants had prior bariatric surgery, were awaiting surgery, or were refused surgery and all perceived the delay or lack of access to this service as a barrier to sustained reductions in SB, although some mentioned that the requirement to participate in a physical and psychological program prior to surgery acted as a

facilitator to minimize SB. Participants also mentioned a lack of organized local inclusion initiatives and urban and rural planning policies as a barrier to minimizing SB for people living with obesity.

Bariatric surgery in this country is very expensive. You're talking €20,000 or something like that. But obesity is a condition and as well, when you're going for this surgery, you have to have comorbidities as well. (PID014)

4 | DISCUSSION

This qualitative study identifies perceived barriers and facilitators to interrupting sedentary behavior for adults living with obesity, mapping them to the TDF and the COM-B model. Five key themes were identified, which influence SB across all domains of living, relating to (i) physical and mental wellbeing; (ii) motivational readiness; (iii) roles, responsibilities, and support; (iv) weight bias and stigma; and (v) the environment.

4.1 | Physical and mental wellbeing

The most challenging perceived barriers to minimizing SB identified lay within the theme of physical and mental wellbeing, namely pain (attributed predominantly to inadequately or untreated musculoskeletal conditions), lack of energy (attributed predominantly to medical or metabolic conditions), and the impairment of mental wellbeing. Pain, lack of energy and reduced mental wellbeing have previously been indicated as barriers to PA and healthy lifestyle in adults with obesity^{47,48} and cited as contributory to sedentary lifestyle for adults with obesity⁴⁹ while the number of co-morbidities was associated with increased sedentary time for adults with severe obesity.⁵⁰ Perceived poor physical functioning is also associated with seeking bariatric surgery versus lifestyle intervention for severe obesity.⁵¹ Moreover, mobility limitations, pain or discomfort, impairments in sleep or energy, and anxiety are reported to mediate the relationship between SB and depression.⁵² Similar to previous studies, participants experienced delayed, ineffective or lack of treatment, and lack of access to care for underlying medical or mental health conditions^{53,54} which they perceived affected their ability to reduce their SB. This care gap precipitated a prolonged and significant deterioration in SB for many participants, associated with a decline in health, function, quality of life and obesity. This is an important consideration for intervention designers as it is likely that even when motivated and focused on behavioral change targets, adults with obesity may lack physical or psychological capability to engage in non-SB.

This study suggests that when adults living with obesity believe they lack the capability to change their SB, it could be considered a red flag in obesity care since they may already lack the physical or psychological capability to engage in adequate non-SB or may be on the precipice of a marked decline in their physical and/or mental

wellbeing. In either case, clinical investigation or intervention may be warranted. A further challenge exists in identifying this red flag, since this stigmatized group may hide the extent of their SB, as revealed by a number of participants in this study. A recent study by Dolezal suggests that the experience of living with a health-related stigma is best characterized by shame anxiety or the chronic anticipation of shame, that is, fear of one's shameful secret, circumstances or personal history being discovered by a health professional.⁵⁵

It is also worth noting that while perceptions about physical and mental wellbeing revealed a lack of self-efficacy or confidence to change their SB, for most participants these beliefs about capabilities were based on an assumption that non-sedentary behavior is synonymous with physical activity, sport, or exercise. At an individual level, intervention components which target beliefs about capabilities, particularly self-efficacy, offer potential to interrupt SB, and have previously shown potential for physical activity engagement,⁵⁶ while a key component may be instruction on how to perform the behavior, a promising behavior change technique in the review of interventions to reduce sitting time by Gardner et al.²²

4.2 | Motivational readiness

One of the most evident, and perhaps more easily addressed barriers to minimizing SB in this population is lack of knowledge, a barrier also reported in a recent systematic review of non-workplace SB interventions.⁵⁷ The knowledge deficit related to sedentary behavior, guidelines about SB, the negative consequences of SB, the independent health benefit to non-SB, as well as how to interrupt the behavior. Despite the lack of specific knowledge, similar to prior studies of workplace sitting time^{30,32} participants were often aware that they were sitting too much, that too much sitting was not good and some expressed a willingness to change it. Participants were mostly unable to discriminate between being non-sedentary versus physically active, spoke almost exclusively about PA when asked about interrupting SB, and discounted short breaks in SB for example, comfort breaks or standing. However, some participants who described a value on mobility or belief that 'all movement matters' tended to participate in less SB or less prolonged SB, particularly in the home. This approach developed following periods of poor mobility or poor function due to health. A similar 'value on mobility' was recently reported for adults with osteoarthritis who perceived that the physical and psychological aspects of SB were interwoven with those of physical activity and who were trying to preserve mobility by keeping active.⁵⁸ This 'value on mobility' may be a particularly important maxim for adults with obesity during times of injury or when mobility has declined or is at risk of decline due to obesity related complications such as osteoarthritis.

Disconnecting non-sedentary behavior from physical activity may also be an important consideration for obesity care. Clinicians should tailor advice to adults with obesity regarding non-sedentary behavior versus physical activity as this may be an important

management tool in the maintenance of function, mobility, and quality of life, particularly when pain or co-morbidity is present. Furthermore, systematic reviews suggest that interventions specifically designed to reduce SB show more promise to reduce SB²² or are more effective to reduce sedentary time⁵⁹ than PA interventions or combination interventions. Intervention designers should also include educational components, including various ways to interrupt/minimize SB and in various contexts. While 'goal setting behavior' may be a promising behavior change technique for SB interventions,⁶⁰ setting SB goals independent of weight loss may be important since participants tended to have less prolonged SB if their motivation to move was not for weight loss. Indeed, many adults with obesity hold unrealistic weight loss expectations, and when unsuccessful, unhealthy lifestyle behaviors including SB deteriorate.⁴⁹

4.3 | Roles, responsibilities and support

Social and professional responsibilities tended to be prioritized over the participants' health or wellbeing, contributing to the development of habitual SB, unhealthy habits and weight gain, which is similar to prior research.⁶¹ Competing family responsibilities have previously been cited as a barrier to physical activity.^{17,62} Appropriate social support tended to be perceived as a facilitator to minimizing SB, across all settings, which is similar to a recent study where individualized healthcare support, fellowship and peer support were perceived by participants as essential to the success of a lifestyle behavioral change self-management program for adults with obesity.⁶³ While lower levels of social support have previously been identified as a barrier to physical activity engagement for overweight and obese women,⁶⁴ lack of access to appropriate social support was identified in this present study as a barrier to interrupting SB. Intervention components which enable self-care while balancing competing responsibilities should be investigated for future SB interventions for adults with obesity. Positive encouragement and reinforcement, may enhance acceptability and adherence to SB guidelines for adults with obesity.

4.4 | Weight bias and stigma

While weight bias and stigma experienced by adults with obesity is increasingly reported in the literature and contributes to poor health outcomes,^{65,66} and feelings of guilt, embarrassment, shame and worthlessness,⁶⁷ it has also been reported to contribute to poorer lifestyle choices and increased sedentary time.⁵³ Almost all participants perceived bias or stigma as a barrier to interrupting SB with experience of negative emotions, prior negative experiences, or negative social influences acting as negative reinforcement. Similar to prior research^{54,68-70} participants reported weight bias in all domains of life, social and physical activity avoidance due to weight bias and stigma⁷¹⁻⁷³ and experienced shame and humiliation while dining out.⁷⁴ Additionally, participants in this study revealed remaining sedentary, avoiding even basic comfort breaks while in public, in

social settings, or on public transport due to fear of not fitting, embarrassment, weight bias, and stigma. This complex barrier will require the development of person-centered intervention components at multiple levels to address both internal and external biases. Therapeutic approaches which include self-compassion and self-acceptance may be indicated. Acceptance and commitment therapy has been indicated to help individuals to develop coping skills in other chronic conditions^{75,76} and obesity acceptance and management,^{77,78} while narrative inquiry and development of counter-narratives have the potential to assist adults with obesity to resist damaged social identities and demand respect, dignity, and fair treatment.⁷² However, a parallel approach to reducing societal weight bias and development of environments and policies which are accessible and inclusive for adults with obesity is essential.⁷⁸⁻⁸⁰

4.5 | The environment

Access to care for co-morbidities and specialist obesity care should be a priority for policy makers and public health providers since participants associated delayed care or lack of care with SB and poor health outcomes. In contrast, participants who had prior bariatric surgery tended to sit less, experience less pain and exert less effort to move, particularly in the home and community environment, encountered fewer environmental barriers and experienced less weight bias. They also perceived an improved quality of life, and physical function. Although bariatric surgery results in small reductions in SB,⁷⁹⁻⁸¹ all participants who accessed bariatric surgery reported that the parallel support provided by engaging with a weight specialist service, which included behavioral, psychological and lifestyle components, was critical to sustained reductions in SB, as suggested in prior research.⁷⁹

An umbrella review of SB interventions found that, for adults with overweight or obesity, interventions targeting the physical environment are the most effective, followed by personal behavior interventions.⁸² By comparison, the results presented here suggest that both environmental and behavioral intervention components may be necessary to ensure that capability, opportunity and motivation exist for this population to minimize SB. Appropriate behavior change techniques such as action planning and self-monitoring delivered via mobile technology have the potential to enhance environmental interventions for adults with obesity.⁸³

Indeed, the WHO identifies that an obesogenic physical environment promotes sedentary behavior and reduces opportunities for physical activity⁸⁴ and many environmental interventions have been successful in increasing physical activity, particularly active transportation.⁸⁵ However, some participants in this study, those with less mobility or functional ability, felt further excluded from built and natural environments due to population level or inclusive initiatives. When developing population and policy interventions, consideration must be given to potential unintended consequences which could exclude vulnerable groups, such as adults with obesity, resulting in poorer health outcomes.

5 | STRENGTHS AND LIMITATIONS

The strength of this study lies in its robust methodology. The TDF informed the interview guide, was applied flexibly with open-ended questions during interviews to elicit perceptions beyond the TDF framework, and during analysis, inductively coded subthemes were mapped to the domains of the framework.⁴⁰ Inductively coding interviews before coding into the TDF ensures that important cross data patterns are identified, and not limited to the domains or constructs of the framework.⁸⁶ The value of the TDF is thus maximized by both inductive and deductive coding, and expresses the richness of the data which was evident at the interview. Identifying the theoretical domains and constructs which act as barriers or enablers of behavior change can provide the foundation for targeted effective interventions.^{26,86}

Furthermore, perceived barriers and facilitators to interrupting SB across all domains of living (occupational, leisure, domestic, transportation) are identified for this population. Further mapping of the COM-B identified barriers and facilitators in all six components of the COM-B (Physical and Psychological Capability, Reflective and Automatic Motivation, Social and Physical Opportunity). This highlights opportunities for both individually targeted interventions and multicomponent, system-level interventions, which are likely to contribute to positive change in SB in this population.

Furthermore, the inclusion of a broad age range (31–64 years), both male and female perspectives, and that of participants with experience of moderate to very high BMI or severe obesity, enhances the transferability of the research to the greater population of adults living with obesity. However, since more than half of the participants had prior bariatric surgery, this sample may not be representative of all adults with obesity, thereby limiting the generalizability. The collection of further demographic data could have improved the generalizability of the results, for example, time since bariatric surgery and number of co-morbidities.

Some further limitations must also be acknowledged. Firstly, participant characteristics were entirely self-reported. The use of objective and clinical measures would improve the methods and results. While, this study purposively targeted adults with moderate or severe obesity, participants self-selected based on self-reported current or past BMI >35 kg/m² and perceived impact of obesity (on health, social, quality of life). Although experiences of pain, and impact on function and quality of life were described by all participants, some may under-report or minimize the impact of obesity as a coping mechanism or shame response and BMI may differ from objective measures. Continued efforts to understand the outcomes of importance to and the perspectives of this population, who often disengage from healthcare, are necessary.

Similarly, all measures of SB were self-reported, which may differ from objectively measured SB.⁸⁶ Indeed, the mean total weekday and weekend sitting time reported by participants is aligned with sedentary recommendations (<8 h/day) although cross-case variation was large, similar to prior mixed method research.⁸⁷ This mean sedentary time, may be explained at least in part, by the number of

participants who had prior bariatric surgery or lost excess weight. Notably, by design, inclusion was not limited to a highly sedentary sample, since doing so could potentially eliminate valuable perspectives regarding facilitators to minimizing SB. Nonetheless, objective SB measurement would enhance the results and future mixed-method studies are warranted to investigate sedentary time and patterns of accumulation of SB in this population and indeed potential differences pre and post-bariatric surgery.

Additionally, some relevant data may have been missed, for example, no participant mentioned 'smoking breaks' as a motive for sedentary breaks or sedentary behavior, but smoking behaviors were not included in the data collection. This raises interesting questions about other health behaviors; using smoking as an example, does this population modify smoking behavior to reduce health risk or mask it as a stigmatized group? Finally, by comparison with quantitative studies concern regarding generalizability due to small sample and researcher subjectivity may exist. However, rigor from study design to analysis coupled with the willingness of participants to engage with difficult topics provided rich and nuanced data, results and interpretation about SB in this population.

6 | CONCLUSION

This study uses a rigorous reflexive thematic analysis to identify the perceived barriers and facilitators to interrupting sedentary behavior in adults living with obesity. The study was theoretically underpinned by both the COM-B model and the TDF from design through analysis. This behavioral analysis allows researchers to understand sedentary behavior in this particular population and identifies multiple opportunities at the individual, community, political, and environmental levels to implement the change. Future development of intervention functions and behavior change techniques aligned to this behavioral analysis will ensure theory and person centered interventions to interrupt sedentary behavior in adults living with obesity.

AUTHOR CONTRIBUTIONS

Fiona Curran: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; validation; writing – original draft preparation. **Carol Brennan:** Formal analysis, methodology, validation, writing – review & editing. **James Matthews:** Formal Analysis; methodology; supervision; validation; writing – review & editing. **Gráinne O' Donoghue:** Conceptualization; formal analysis; funding acquisition; methodology; project administration; supervision; validation; writing – review & editing.

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CONFLICT OF INTEREST STATEMENT

All authors declare no conflicts of interest.

ORCID

Fiona Curran  <https://orcid.org/0000-0003-0956-5123>

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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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