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Development and feasibility testing of a time-restricted eating intervention for women living with overweight/obesity and HIV in a resource-limited setting of South Africa

Fatima Hoosen^{1*}, Majken L. Pico², Julia H. Goedecke^{1,3}, Joel A. Dave⁴, Jonas S. Quist^{2,5,6}, Kristine Færch², Louise G. Grunnet², Anniza de Villiers¹, Jens Aagaard-Hansen^{2,7} and Amy E. Mendham^{1,8}

Abstract

Background Human Immunodeficiency Virus (HIV) and type 2 diabetes (T2D) are amongst the leading causes of death in South Africa. The preferred first-line anti-retroviral treatment contains dolutegravir (DTG), shown to increase body weight, may compound the already high rates of obesity and associated risk for T2D. South Africa has widespread food insecurity, making traditional dietary strategies difficult to implement. Time-restricted eating (TRE) may be an appropriate intervention in resource-limited communities.

Methods This article outlines the development and feasibility testing of a TRE intervention to inform the design of a TRE randomised controlled trial in women (20–45 years old) living with overweight/obesity and HIV, receiving DTG-based treatment from a resource-limited community in Cape Town, South Africa. Factors influencing TRE adoption were identified using the Capability, Opportunity, Motivation – Behaviour model and the Theoretical Domains Framework, combining in-depth interviews (IDIs) and focus group discussions. Participants from the IDIs went on to participate in a single arm 4-week TRE pilot trial where feasibility was explored in terms of reach, acceptability, applicability, and implementation integrity. An iterative, thematic analysis approach was employed to analyse the qualitative data.

Results Participants included 33 *isiXhosa*-speaking women (mean age 37.1 years, mean BMI 35.9 kg/m²). Thematic analysis identified psychological capability (knowledge of fasting), social influences (cultural preferences, family support), and reflective motivation (awareness of weight, health impact, motivation for TRE) as key factors influencing adoption of TRE for weight management. In a 4-week TRE pilot trial ($n = 12$), retention was 100%. Positive outcomes perceived included improved energy, appetite control and weight loss. TRE was perceived as acceptable, easy, and enjoyable. Family support facilitated adherence, while habitual and social eating and drinking practices were barriers. Compliance was high, aided by self-selected eating times, reminders, and weekly calls. Recommendations included the incorporation of dietary education sessions and text messages to provide additional support and reminders.

*Correspondence:

Fatima Hoosen
hsnfat006@myuct.ac.za

Full list of author information is available at the end of the article



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Conclusions This study indicates that TRE is a feasible weight management strategy in women living with overweight/obesity and HIV, receiving DTG-based treatment in a resource-limited community. These findings will ensure that the forthcoming TRE randomised controlled trial is adapted and optimised to the local South African context.

Keywords HIV, Anti-retroviral therapy, COM-B model, Time-restricted eating, Weight management intervention, Type 2 diabetes, Diabetes mellitus, Nutrition, Qualitative research

Background

In 2021, it was estimated that 537 million people (9.3%) worldwide had diabetes with the prevalence expected to increase over the next two decades, the highest rates projected for sub-Saharan Africa [1]. Within sub-Saharan Africa, South Africa (SA) has the highest prevalence of type 2 diabetes (T2D) (15.3%) [2], and it has become the leading cause of death in patients with a high body mass index (BMI) [3]. Furthermore, SA has one of the highest rates of Human Immunodeficiency Virus (HIV) infection globally, with 7.6 million people living with HIV (PLWH) and a national prevalence of 17.8% among adults aged 15 to 49 years [4]. In 2019, the World Health Organisation recommended the use of dolutegravir (DTG) in combination with a nucleoside reverse-transcriptase inhibitor backbone, as the preferred first-line anti-retroviral treatment (ART) for PLWH [5]. With the inclusion of DTG-based treatment, there have been concerns regarding an increased risk of weight gain in ART naïve patients, especially in women [6]. However, in a more recent study, switching from Efavirenz to DTG-based treatment showed a more modest increase in weight (1.78 kg) over a 12-month period [7]. Regardless, an increase in weight with DTG-based treatment may compound the already high rates of obesity in South African women living with HIV and the associated risk for T2D [8, 9].

Research on strategies to prevent and manage non-communicable diseases (NCDs) has predominantly been conducted in High-Income Countries (HICs), with only 22% of randomised controlled trials (RCTs) on NCDs recruiting participants from Low- and Middle-Income Countries (LMICs) [10], with, to our knowledge, only one previously being conducted in SA [11]. There are even fewer interventions focusing on PLWH. With such a limited number of interventions in LMICs, successfully adapting interventions conducted in HICs to resource-limited settings is challenging where the unique setting and characteristics of the target population such as socio-economic status and cultural norms have not been considered [12].

Dietary strategies to manage weight traditionally focus on foods consumed, specifically dietary quality and caloric restriction, and can therefore be difficult to implement in a resource-limited setting such as SA, due to widespread food insecurity [13]. Conversely,

time-restricted eating (TRE) focuses on restricting the eating window to approximately 8–10 h in the day without caloric restriction and has shown to be an effective strategy for weight management and improving cardiometabolic health [14–18]. However, its feasibility within a resource-limited setting is unknown.

The Behaviour Change Wheel (BCW) is a framework for developing behaviour change interventions and at its core lies the Capability, Opportunity, Motivation—Behaviour (COM-B) model [18]. The COM-B constructs are defined as, 1) the physical and psychological ability to adopt TRE (Capability), 2) external opportunities relating to the physical and social environment which make adopting TRE possible (Opportunity), and 3) the reflective and automatic internal processes that influence the decision-making process to adopt TRE (Motivation) [19]. The COM-B model can be further extended and elaborated upon by the Theoretical Domains Framework (TDF), a validated tool for informing the design and implementation of behaviour change interventions [20]. The TDF has 14 domains which can be directly mapped onto the COM-B model, providing comprehensive coverage of determinants of behaviour and a deeper understanding of these influencing factors.

Duijzer et al. (2014) defined four elements of feasibility related to intervention implementation, namely reach (refers to the percentage of the intended target population that actually participated in an intervention), acceptability (refers to the degree to which participants are happy with an intervention), applicability (refers to the degree to which an intervention can be implemented in a real-life scenario) and implementation integrity (refers to how well an intervention was implemented compared to the plan) [21]. This article describes the development and feasibility testing of a TRE intervention among people living with overweight/obesity and HIV in a resource-limited setting in Cape Town, SA, to inform the design of a RCT.

Methods

The Consolidated criteria for Reporting Qualitative Research Checklist was used to structure this report [22].

Study design

We addressed our study aims across two phases (Fig. 1). *The development of the intervention phase* was a theory-based process using the COM-B model and the TDF to identify potential factors influencing TRE adoption as a weight management strategy. *The feasibility testing phase* explored reach, acceptability, applicability, and implementation integrity following a 4-week TRE pilot trial.

Participants

The study was conducted in partnership with a community health centre in Khayelitsha, which monitors approximately 12,500 patients on ART. Khayelitsha is a large, peri-urban informal settlement in Cape Town, SA, of which 99% of the residents are Black

South African and *isiXhosa* speaking [23]. Inclusion criteria across both phases included men and women, between 20–45 years of age, living with HIV and having initiated DTG-based treatment within the previous 1–24 months, and a BMI ≥ 25 kg/m². Participants were recruited from the waiting area of the HIV clinic, which serves approximately 100 patients every two hours. These patients typically visit the clinic every two months to collect their HIV medication. A research assistant provided a description of the study in *isiXhosa* to all present, explaining its purpose and inclusion criteria. Individuals interested in participating in interviews only or the pilot, provided their contact details to the research assistant to arrange screening appointments at a local church. Upon screening,

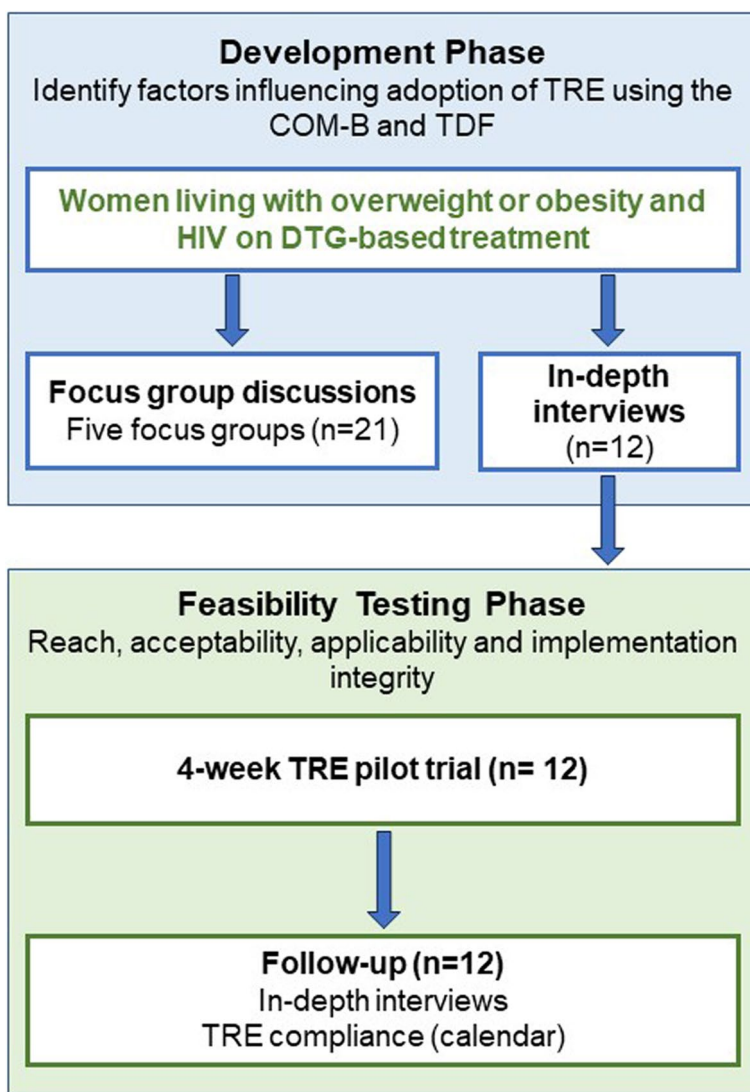


Fig. 1 Summary outline for the development and feasibility testing of a TRE Intervention

eligible participants received further written information regarding the study.

Data collection

Face-to-face interviews were conducted in *isiXhosa* at the same location by research assistants trained in both focus group discussion (FGD) and in-depth interview (IDI) techniques. Two senior female researchers oversaw the process: AEM and AD, both holding PhDs, with AD possessing extensive qualitative research experience. The researchers had no prior acquaintance with the participants. The data collection period occurred between September and December 2022. AEM and MLP (a research assistant with a Master's degree and extensive qualitative research experience) developed the interview guides. These guides were pilot tested ($n=2$) and, as no major revisions were required, the pilot interviews were included in the final sample. At the conclusion of each interview, the interviewer provided a summary to participants, allowing for amendments or additions as needed. The FGDs lasted between 60 and 90 min while the IDIs were between 30 and 45 min.

Development phase

A qualitative design was used to elicit factors influencing the adoption of TRE according to the COM-B model and the TDF. A combination of semi-structured IDIs ($n=12$) and five FGDs ($n=21$) were conducted to gain different perspectives and greater insights to comprehensively understand the target behaviour, the adoption of TRE [19]. FGDs were conducted with those who volunteered for interviews only while IDIs were conducted with the pilot participants. FG 1 to 5 included 4, 2, 3, 8 and 4 participants, respectively. The COM-B model was used to develop the interview guide. The final sample size was based on two key factors: 1) We aimed for a number of participants similar to other qualitative studies that used focus groups and interviews to explore dietary behaviours using the COM-B model and TDF [24, 25] and 2) We collected data until we reached saturation—the point where no new themes emerged from additional interviews or focus groups. The definitions of the TDF domains and how they map onto the COM-B constructs [26] are presented in Supplementary File 1. Data were collected on various demographics and health metrics, including age, employment status, home language, education level, housing conditions, marital status, household food security, income, date of HIV diagnosis, duration on ART, and body mass index (BMI) in kg/m^2 .

Feasibility testing phase

Participants from the development phase with whom IDIs ($n=12$) were conducted, participated in a single arm

4-week TRE pilot trial, which included a further round of IDIs conducted at the end of the trial. The IDI sample size satisfied earlier recommendations for pilot studies [27, 28] and was deemed to be large enough to provide data that was rich and complex pertaining to their experiences while adopting TRE. The elements of feasibility that were explored related to the reach of the intended target population, acceptability of the intervention, applicability to the environment and implementation integrity [21]. Participants were provided with information on TRE and instructed to eat within the same time window each day. The self-selected eating time was personalised to ensure an 8–10 h eating window and participants were allowed to amend their eating window up to 1 week into the intervention. Participants were provided with a calendar and were instructed to report when they started and stopped eating each day. Participants received a weekly telephone call to report the number of days they were compliant with their self-selected eating window and to maintain communication throughout the trial and report any issues.

Data analysis

All interviews were audio-recorded, translated and transcribed into English and analysed using NVivo qualitative data analysis software (Version 14, QSR International, Melbourne, Australia). An iterative approach to thematic analysis and framework analysis was implemented, which included data familiarisation, coding, developing a thematic framework, reviewing, and defining themes and interpretation [29]. Themes were inductively identified by FH (a postdoctoral fellow). Qualitative analysis for phase 1 required an additional step where themes were deductively mapped onto the COM-B model and the TDF domains. To ensure inter-rater reliability, AD provided quality control by assessing all code names, quotations and mapping of themes, while MLP and JAH (a senior researcher with a PhD) conducted a final, more concise validation of the data. Where discrepancies occurred, researchers discussed the coded transcripts until a consensus was reached. FH, AD, MLP and JAH are experienced researchers in qualitative data analysis. Frequencies were tallied for categorical data. Continuous descriptive data are reported as means with standard deviation or medians with interquartile range, depending on normality.

Results

Characteristics of participants

In total, 63 women and five men expressed an interest in participating in the study. However, following screening, 33 women and only one man were eligible with a $\text{BMI} \geq 25.0 \text{ kg}/\text{m}^2$. It was considered inappropriate to

present a single male perspective alongside the views of a larger female sample, and accordingly his results are not reported in the study.

In Table 1., participant characteristics for the total group, focus groups and the pilot are presented. All participants (n=33) were female and isiXhosa speaking. The majority of participants were classified with obesity (Class II). Most had completed high school, were unemployed, lived in informal housing, and experienced moderate food insecurity.

Development phase: factors influencing the adoption of TRE

The results describe the themes relating to factors influencing the adoption of TRE, categorised by the TDF domains and COM-B constructs. Thematic analysis revealed 14 sub-themes, mapped to 10 TDF domains and five COM-B micro-constructs (Fig. 2). No physical capability factors were identified along the COM-B construct.

Capability

Facilitators to adopting TRE behaviour were identified along the psychological capability micro-construct. Most participants knew about the concept of fasting and had either tried it themselves or knew someone who had fasted. Experiences with fasting were mostly obtained through the churches they attended: *“I also know about fasting. In our churches it is done, it is decided that on a particular day, we will need to fast.”* (FG4, participant 16). Participants also identified strategies that they perceived could help them adopt TRE behaviour, such as reminders (i.e., calendar), intervention support (i.e., text messages) and dietary education sessions: *“The calendars stay hanged and will be a reminder all the time for someone to do this thing, hence I think it will be right to have it.”* (FG5, participant 12) and *“I think text messages can be sent to remind them because some people do not care or do not remember, perhaps, even me, I can commit to do it now (in front of) you, but when I get home, I do not do it (TRE)... (text messages) encourage them.”* (FG2, participant 8).

Table 1 Characteristics of study participants

Variables	Total sample (n=33)	Focus groups (n=21)	Pilot (n=12)
Age (mean, SD)	37.1 (4.8)	37.4 (4.1)	36.6 (5.9)
Marital status (n, %)			
Single	20 (60.6)	15 (71.4)	5 (41.6)
Married	7 (21.2)	3 (14.3)	4 (33.3)
Living with partner	6 (18.2)	3 (14.3)	3 (25.0)
Highest level of education (n, %)			
Primary school (grade 1-7)	1 (3.0)	1 (4.8)	
High school (grade 8-11)	21 (63.7)	14 (66.6)	7 (58.3)
Completed Grade 12	11 (33.3)	6 (28.6)	5 (41.6)
Current employment status (n, %)			
Employed	9 (27.3)	7 (33.3)	2 (16.6)
Type of housing (n, %)			
Formal housing	4 (12.1)	1 (4.8)	3 (25.0)
Government housing	9 (27.3)	6 (28.6)	3 (25.0)
Informal housing	20 (60.1)	14 (66.6)	6 (50.0)
Housing density (number of people in the house/number of rooms in the house) (median, IQR)	1.3 (0.4-4.0)	1.5 (0.4-4.0)	1.2 (1.0-2.0)
Household food security (n, %)			
Mildly food insecure	10 (30.3)	8 (38.1)	2 (16.6)
Moderately food insecure	17 (51.5)	11 (52.4)	6 (50.0)
Severely food insecure	6 (18.2)	2 (9.5)	4 (33.3)
Length of time since HIV diagnosis (years) (mean, SD)	10.1 (6.3)	10.2 (6.2)	9.8 (6.7)
Duration on antiretroviral therapy (years) (mean, SD)	8.1 (5.0)	7.9 (4.7)	8.6 (5.7)
Current weight (kg) (mean, SD)	91.1 (19.5)	88.9 (14.8)	95.0 (25.8)
BMI (kg/m ²) (mean, SD)	35.9 (7.5)	35.3 (6.7)	36.7 (8.8)

SD Standard deviation, IQR Interquartile range, BMI Body mass index

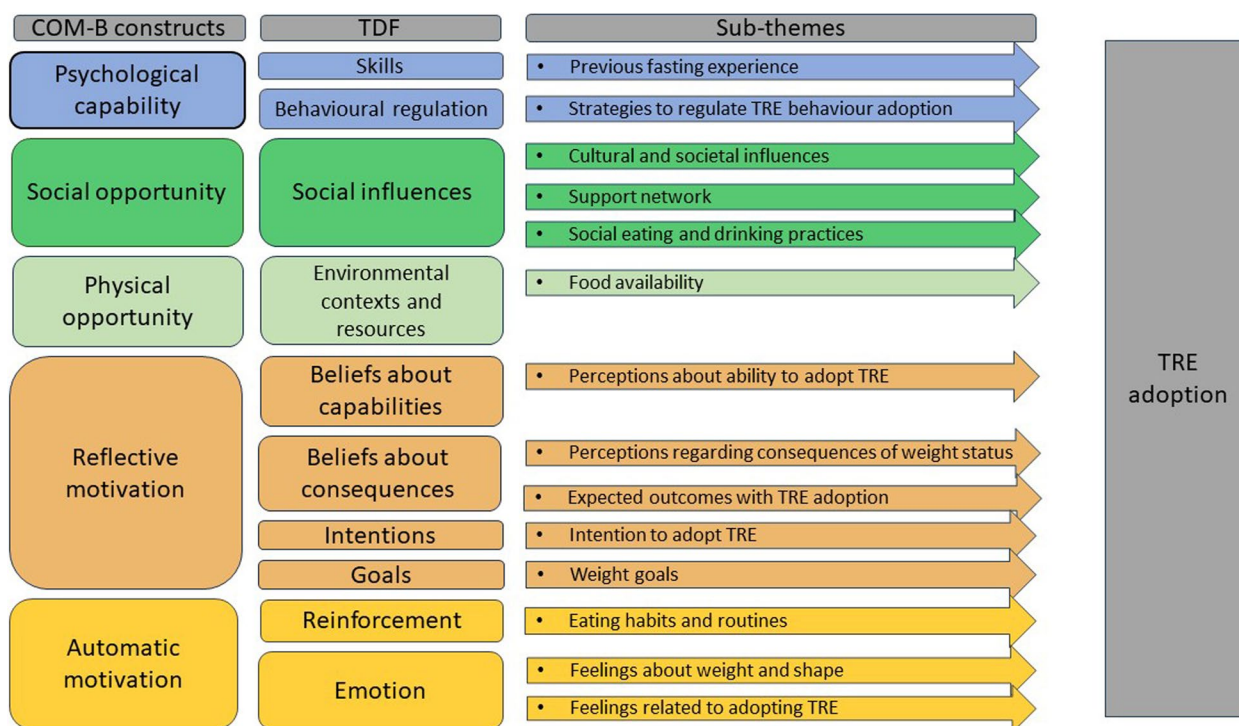


Fig. 2 Identification of factors influencing the adoption of TRE using the COM-B model and the TDF

Opportunity

Social influencers could either facilitate or inhibit the adoption of TRE (Fig. 2). The perception that weight loss was associated with sickness, specifically HIV, as well as the cultural preference for an overweight body size emerged as potential societal barriers. Quotes describing these perceptions include: “So, our culture can make someone uncomfortable when it comes to losing weight. When you are fat, they encourage you because they think that there is something that brings you contentment and that is why you are fat” (IDI, participant 26) and “at my age if you can lose weight and have a leaner body, they would start talking that you are sick” (IDI, participant 26).

It was mostly perceived that family and friends would support weight loss and TRE, as reflected in the following quote: “yes, they (family) can support me, I don’t anticipate any problems. They are the people that support me most of the time, especially my sister, she really likes to support me. Whatever I want to do, I just explain it to her, she supports me all the way” (IDI, participant 33).

Participants recognised that socialising over weekends, special occasions, holidays or generally when others are eating during the fasting period may make adherence to TRE difficult. These barriers are reflected in the following quotes: “it will not be possible, because during holidays and in traditional ceremonies you are forced to do certain rituals whether you like it or not, like you are told

to drink alcohol even when you normally do not drink, you are forced to eat certain ritual meats whether you like it or not” (FG5, participant 12) and “my challenge will be on weekends because it will mean that I cannot join my family when they are eating in the morning” (IDI, participant 29).

With regards to environmental influencing factors, participants perceived that food availability in the home may influence TRE adoption. Participants reported that limited food availability could act as a barrier by increasing hunger, while abundant food availability could facilitate TRE by reducing perceived hunger. This perception is illustrated in the following quote: “for me it is the idea that we do not have food available that makes me feel hungry, but when there is food available, I do not get hungry” (FG4, participant 22).

Motivation

Although participants perceived that TRE adoption may initially be difficult, they believed that they would be able to successfully adopt the behaviour, as reflected in the following quote: “For as long as it (TRE) does not stop me from eating the entire day, then I think it is easy because I will know that at such and such time I am supposed to eat and at such a time I must not eat.” (IDI, participant 32). Reflective motivators to adopt TRE included participants being aware of 1) their overweight status; 2) the

physical, emotional and health implications related to an overweight status; and 3) the lifestyle factors such as diet and physical activity which can influence weight status. These are reflected in the following quotes: “I do not feel alright because I feel like I am obese” (IDI, participant 31); “Sometimes I feel my body is too heavy for me and it drains me emotionally and then the weighing scale would confirm the feeling that I already had. It is physically and emotionally draining” (IDI, participant 29). and “it is said that being overweight is not good for someone’s health, that it is good to maintain a slender healthy body, trying to exercise, and the like because when you are overweight, you can be a risk to contract diseases” (IDI, participant 33). Most participants made firm intentions to adopt TRE and expressed their motivation and willingness to try it. This is illustrated in the following quotes: “Yes, it is my desire to try it (TRE) (IDI, Participant 25).” and “I can do it (TRE) because I want to lose weight, feel alright, look great and be what I always wanted to be” (FG1, participant 7). Although participants expressed a strong desire to lose weight, some did not want extreme weight loss.

Most participants reported having unstructured mealtimes and patterns and some acknowledged having uncontrolled eating practices with late-night snacking and waking up during night to eat. Participants also reported an increased feeling of hunger and appetite associated with DTG-based treatment and turning to food during times of stress. These existing eating habits and routines of participants may deter TRE adoption and are reflected in the following quotes: “So, I eat whenever I have the appetite, I don’t have a specific time to eat.” (IDI, participant 29); “I love food, if you are eating before me and there is enough for both of us, I will eat I cannot resist it.” (FG4, participant 19); “Even at 01:00 am or 03:00 am (I am eating) because I listen to the story program on the radio at 03:00 and I must eat something while listening.” (FG5, participant 10) and “Since I started with this HIV treatment, my appetite for food is very high, I want to eat all the time... I feel dizzy because I am hungry.” (FG2, participant 8).

Participants expressed unhappiness about their weight and shape and preferred a smaller body size. They were particularly unhappy with the weight accumulating in their abdominal region, which they also associated with the commencement of DTG-based treatment. In addition, participants expressed very positive feelings about the concept of adopting TRE behaviour. These emotions can therefore facilitate TRE adoption and are illustrated in the following quotes: “I have gained a lot... it stresses me a lot because I do not want to gain instead, I want to lose weight. That is my dilemma.” (IDI, participant 33); “I blame it on the treatment because since I started with it my tummy is getting bigger and bigger without easing”

(IDI, participant 30) and “I think, if I can consistently do it, it can help me...for me I think this is doable because it is not like it is stopping us from eating at all” (FG1, participant 6).

Feasibility phase: reach, acceptability, applicability, and implementation integrity of pilot trial

Those who volunteered in the IDI ($n=12$) went on to participate in a 4-week TRE trial modified according to the main findings of the development phase, where elements of feasibility, namely reach, acceptability, applicability and implementation integrity were explored.

Reach

There was a 100% retention rate for the 4-week pilot trial. Only one man was willing and eligible, with a BMI ≥ 25 kg/m², to participate in the pilot trial. As previously noted, his results are not reported in the study.

Acceptability

After the 4-week trial, a healthy lifestyle and weight loss were still a goal for participants, and they believed TRE could help achieve this goal. Some participants reported positive outcomes since adopting TRE such as an improved change in shape and weight, energy levels, ability to move around and appetite. Some quotes include: “Because I want to lose weight, and secondly, I really want to be healthy in the best way I feel” (IDI, participant 32); “for sure things have changed somehow because these days I feel fresh with energy unlike before when I would wake up and feel tired without knowing the cause of that” (IDI, participant 23); “With this program, I expected to lose weight. I really want to lose weight so much. Even now, I want to know how much weight I have lost so I can be motivated more” (IDI, participant 33); and “I am happy and when I look at my shape, it feels like I have lost some weight.” (IDI, participant 31). Participants perceived the intervention positively finding it easy and enjoyable. The concept of an eating window was found to be appealing and participants said it taught them self-discipline. These notions are reflected in the following quotes: “It is easy because it is not like I am not allowed to eat at least 2 times a day. I know that I can eat at a certain time and stop at a set time. So, that was not difficult.” (IDI, participant 33); and “It disciplined me in a way because as a person, I should have the time to eat and the time to stop eating; not to eat throughout the 24 h” (IDI, participant 29). Participants were willing to continue with the intervention and most would recommend it to others, as reflected in the following quotes: “Because I am hopeful that I can continue longer with this program, I can realise what I expected.” (IDI, participant 26); “Yes, I will

continue doing it (TRE). (IDI, participant 32) and “I can recommend it to somebody else because I am able to do it myself.” (IDI, participant 22).

Participants considered the weekly telephone call as supportive. Recommendations going forward included the addition of a dietary education component as well as text messages. The following quotes illustrate the participant opinions regarding intervention support: “They (telephone call) worked. He asked me if wanted to change the time of my eating window. I said no because I was comfortable with my current time, there was no need to change.” (IDI, participant 25); “I would love it if we can be advised on what we can do (eat).” (IDI, participant 33) and “I think I can be okay with phone calls or text message. I would be encouraged through messages reminding me of my eating time and the like. Because I would have explained it to the people that I live with, they would also be reminding me. I think it can right that way.” (IDI, participant 22).

Applicability

Most family and friends were supportive of TRE with some even following it themselves. Family accommodated eating times to align with those of the participant, provided encouragement and even reminding them of eating times. Quotes reflecting social support received while adopting TRE include the following: “They (family and friends) are interested, and they support and encourage me to continue with it. They don’t have problems with the program.” (IDI, participant 26) and “What I liked about the support was to see that other people were interested in what I was doing, that encouraged me to continue with the program.” (IDI, participant 22).

Uncontrolled eating practices and avoiding food when it was available in the home were challenging. Quotes describing these findings include: “The one thing that has not changed is the urge to eat something when I am stressed.” (IDI, participant 26); “In the beginning, I was challenged, when there was leftover food after 9 pm” (IDI, participant 31); “I would wake up in the morning feeling hungry but had to wait for the starting time of 10 am. I felt the urge to eat before time.” Although feeling hungry during the fasting period was reported, participants identified and implemented behavioural strategies to overcome this. In addition to adopting TRE, some also simultaneously implemented dietary changes to assist with weight loss. These notions are reflected in the following quotes: “Whenever I would feel hungry, I would drink water or drink tea without sugar.” (IDI, participant 24) and “Even the amount of food that I eat, because my intention is to lose weight, I have had to learn to reduce the food portions that I eat (IDI, participant 29).

Implementation integrity

Participants admitted that there were times when it was difficult to adhere to the eating window, especially at the start of the intervention. Setting their own convenient eating times that were similar to their usual eating times or their families was considered helpful. Participants realised the importance of planning mealtimes to achieve compliance. These quotes illustrate these notions: “In the beginning it was difficult, but as the days went by, I got used to it.” (IDI, participant 24); “So, it easy for you if you can set the time to do the program for yourself” (IDI, participant 25); “I chose the time that was similar to the household way of life” (IDI, participant 29); and “I would push myself when time allowed to cook early so, I could be able to keep within the time restrictions.” (IDI, participant 29).

The weekly telephone calls allowed interaction with the intervention team during which the self-selected eating times could be discussed and amended if needed. Compliance with completing the daily eating times on the calendar was good. During week 1, nine participants reported being compliant with TRE for the 7 days, while three participants reported compliance for a range of 3 to 6 days. These less compliant participants changed their eating window within the first week. All participants reported eating in their eating windows for the remaining 3 weeks. Reminders of the eating times, such as the calendar or setting an alarm were found to be helpful. The following quotes reflect participants experiences with support offered during the intervention: “He would call to ask how I am doing with the program; he would encourage me. That is how he supported me. He was indeed incredibly supportive, he wanted me to always continue following the program.” (IDI, participant 28); “Even during the first 3 days when it was difficult for me, when he called and I explained that I had difficulty with time, he said that I can change the time to that with which I am comfortable” (IDI, participant 27); “It was the alarm and that thing (calendar) that I hanged on the fridge. It would remind me whenever I see it about what I should and should not eat” (IDI, participant 29) and “I had set an alarm. It would alert me when it was my time to eat.” (IDI, participant 28).

Discussion

This study showed that TRE is a feasible weight management strategy in women living with overweight/obesity and HIV, receiving DTG-based treatment in a resource-limited community. Women wanted to lose weight and perceived this could be achieved with TRE. When reflecting on the 4-week pilot, women found it challenging to manage habitual and social eating and drinking practices, but valued support provided by their families

and the intervention team. Recommendations for the RCT included incorporating dietary education sessions and text messages providing additional support and reminders.

South African women present with a higher prevalence of overweight and obesity compared to men, both in the general population (68% vs. 31%, respectively) [30] and in PLWH (75% vs. 43%, respectively) [8]. Furthermore, women are at higher risk for weight gain when starting DTG-based treatment [6]. Similarly, most men attending the HIV clinic in our study were found to have a normal body weight and were therefore ineligible to participate in the study. In addition, the men attending the clinic were not interested in participating in the study. A recent review showed that men appeared less concerned about their weight or less likely to attempt weight loss than women and considered weight loss interventions as part of the “female world” [31]. Accordingly, TRE may be more appropriate for women who present with the largest burden of overweight and obesity in SA.

The preference for a larger body size for women within the African culture is well documented as being thin is associated with poverty and ill-health [32, 33]. In addition, there is a stigma of thin individuals being ‘identified’ in the community as living with HIV [34]. A South African study conducted in a resource-limited community with a high HIV prevalence showed that PLWH preferred to be a bigger size to avoid these negative perceptions [35]. Despite participants in the present study recognising these same barriers, most demonstrated that individuals could have preferences that contradict the socio-cultural norms. Similarly, another South African study found that despite participants believing that obesity was acceptable within their culture, they did not support the same perceptions as they were aware of the health benefits associated with a healthy weight [36]. Our study shows that TRE was an acceptable intervention that aligned with the health and weight goals of women in the community.

According to the Health Belief Model [37], the first step to behaviour change is health awareness. This is fundamental to the success of any weight management strategy as the acknowledgement of a problem is required to find a solution. This was demonstrated by the women firstly acknowledging their overweight status and then recognising that their current eating habits were contributing to their weight, resulting in some women simultaneously implementing dietary changes when adopting TRE. A previous TRE study showed that there may be a spontaneous reduction in energy intake when the eating window is shortened [38]. The current study suggests that this change in energy intake may be more intentional and requires further investigation.

TRE was found to be an acceptable weight management approach in this population who were well acquainted with the concept of fasting as it was reportedly common practice within the local church community. In fact, not only were participants positive about the concept of TRE before even trying it, but this positivity remained after the 4-week pilot trial, with participants willing to continue with TRE and to recommend it to others. However, while TRE taught some participants discipline to control their eating, others found it difficult to manage. This variability has been shown previously, with difficulties in stopping late-night eating due to negative emotions such as stress [39]. Participants may therefore have very individual responses to TRE in terms of habitual eating practices and assessing appetite control may provide more insight into controlled and uncontrolled eating behaviours. Indeed, the Theory of Planned Behaviour posits that intention is a direct predictor of behaviour and Perceived Behavioural Control (PBC) [40]. One could argue that the presence of these important constructs, with participants making firm intentions to adopt TRE and believing that this was something they could do (PBC), were translated in our 4-week pilot trial with the successful adoption of TRE by all women. This supports the initial process of assessing intention and uptake before the implementation phase of a larger intervention; however, the impact that this has on program sustainability is yet to be determined in this resource-limited community.

Social influences can be both a facilitator and a barrier to adopting healthy behaviours. Lee et al., (2020) showed that participants adopting TRE had such good support from their families that they even synchronised eating times to support the participants [41]. A similar response was found in the present trial where families were very supportive, accommodating and encouraging towards TRE, demonstrating the acceptability, applicability and implementation integrity, respectively of the intervention. However, our study and others report that managing social eating and drinking situations, including alcohol intake, during the fasting period was found to be difficult [41–43]. It is therefore important to provide intervention support to participants and empower them with strategies and skills to manage social environments. This support should include guidance on managing occasional deviations for social gatherings, emphasising that flexibility for these events can enhance long-term adherence without compromising overall benefits. Additionally, allowing water, sugarless black tea, and sugarless black coffee during the fasting period can significantly improve adherence, as reported by participants in the present study and corroborated by a recent systematic

review [42]. These permissible beverages can help manage hunger and social situations during fasting hours, making TRE more sustainable in various social contexts.

During the trial, telephonic intervention support provided participants an opportunity to discuss and amend their eating window if needed and was perceived as supportive and acceptable. Timely and personalised feedback was enabled, which was particularly important during the initial phase of the intervention, thereby preventing attrition or non-compliance and supporting the applicability and implementation integrity of the intervention. Similarly, weight management studies have been effectively managed with phone calls by team members who provide support, information and skills to promote behaviour change and self-efficacy [44, 45]. Completion of the daily calendar, served as a cue to action, a reminder of the intended behaviour and enabled self-monitoring. Participants also identified and implemented strategies that could be incorporated into their daily routine to overcome the feeling of hunger, thereby demonstrating applicability of TRE adoption. These effective strategies, associated with successful behavioural weight management interventions [46–48] illustrate how TRE compliance and implementation integrity of the intervention was maintained.

Results reflecting acceptability, applicability, and implementation integrity of the TRE intervention support feasibility of the intervention in women from a resource-limited community in SA. After adopting TRE for 4 weeks, women continued to express a clear desire for weight loss and perceived that TRE would be able to assist with achieving this goal. Indeed, recommendations were centred around the need for nutritional education and mechanisms for support such as text messages throughout the intervention to ensure the adoption and sustainability of TRE in the community. The inclusion of in-person contact sessions and technology in lifestyle management interventions is considered appropriate as it is strongly associated with the success of such interventions [49]. Dietary education sessions would allow the opportunity to address dietary concerns that emerged during this formative phase while text messages provide additional layers of support and reminders. Strategies proven to be effective in the pilot trial, namely the calendar, the telephone call and allowing the amendment of the self-selected eating window, will remain in the forthcoming RCT.

The forthcoming RCT has therefore been optimised to the specific needs of the target population, taking into consideration their unique setting and characteristics. More research investigating sustainable weight management strategies in PLWH in resource-limited settings is needed. In addition, future research should aim

to incorporate participatory strategies to facilitate an improved engagement of men.

This pilot study demonstrates several strengths in its approach to testing TRE as a weight management strategy. By utilising the COM-B model and the TDF, the study is grounded in established behavioural science theory, addressing capability, opportunity, and motivation for change. The focus on feasibility is appropriate for a pilot study and provides valuable foundational insights for future research. The findings are unique to this setting and target population, and it is a strength for the implementation phase of the RCT, specifically regarding the adoption and sustainability of TRE. However, the study has some limitations. The generalisability of the findings may be restricted due to the specific setting and target population, primarily focusing on women LWH. While this limits applicability to all PLWH, including men, it's noteworthy that 75% of women living with HIV are overweight or obese compared to 43% of men [8]. Thus, the study sample reflects the population group with the largest burden of overweight and obesity. Additionally, weight loss interventions typically require extended periods to demonstrate meaningful and lasting effects. The short duration of this 4-week trial may not capture the full spectrum of challenges and adaptations participants might experience over time. However, the intervention's long-term feasibility and effectiveness will be assessed in the forthcoming RCT.

Conclusions

Although there is a growing body of evidence supporting the implementation of TRE as an effective weight management strategy in people living with overweight/obesity, none have investigated its implementation in PLWH in resource-limited settings. Our findings inform the design and implementation of a RCT in this population group. The findings from our study support feasibility of a TRE weight management intervention. Accordingly, the protocol for our forthcoming 1-year RCT has been amended to include only women, provide dietary education sessions in combination with TRE, and weekly contact with the participants via text messages and phone calls to support individual compliance and program sustainability.

Abbreviations

SA	South Africa
T2D	Type 2 Diabetes
BMI	Body Mass Index
HIV	Human Immunodeficiency Virus
PLWH	People Living with HIV
DTG	Dolutegravir
ART	Anti-Retroviral Therapy
NCD	Non-Communicable Diseases
HIC	High-Income Countries
RCT	Randomised Controlled Trial

LMIC	Low- and Middle-Income Countries
TRE	Time-Restricted Eating
BCW	Behaviour Change Wheel
COM-B	Capability, Opportunity, Motivation - Behaviour
TDF	Theoretical Domains Framework
FGD	Focus Group Discussions
IDI	In-Depth Interviews
PBC	Perceived Behavioural Control

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20228-y>.

Supplementary Material 1.

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Authors' contributions

FH, MLP, JHD, JAD, JSQ, KR, LGG, AD, JAH and AEM contributed to the conceptualization of the project, writing, and reviewing of the manuscript. AEM, AD and MLP developed the methodology and managed the data collection. FH, AD, MLP and JAH completed data analyses and validation. All authors approved the final version for submission.

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Availability of data and materials

The data presented in this study are available upon reasonable request to the corresponding author, pending ethical approval from the Faculty of Health Sciences Human Research Ethics Committee, University of Cape Town.

Declarations

Ethics approval and consent to participate

The study has been conducted in accordance with the Declaration of Helsinki and was approved by the Human Research Ethics Committee of the University of Cape Town (628/2021). Informed verbal and written consent were obtained before any data were collected and confidentiality was ensured throughout the research process.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Division of Physiological Sciences, Sports Science Institute of South Africa, Department of Human Biology, Faculty of Health Sciences, Health through Physical Activity, Lifestyle and Sport Research Centre (HPALS), University of Cape Town, Boundary Road, Newlands, Cape Town 7700, South Africa. ²Steno Diabetes Center Copenhagen, Capital Region, Borgmester Ib Juuls Vej 83, Herlev 2730, Denmark. ³Biomedical Research and Innovation Platform, South African Medical Research Council, Francie Van Zijl Drive, Parowvallei, Cape Town 7505, South Africa. ⁴Division of Endocrinology, Department of Medicine, University of Cape Town, J Floor, Groote Schuur Hospital, Old Main Building, Observatory Cape Town 7925, South Africa. ⁵Department of Biomedical Sciences, University of Copenhagen, Blegdamsvej 3B, Copenhagen, Copenhagen N 2200, Denmark. ⁶School of Psychology, University of Leeds, Leeds LS2 9JT, UK. ⁷South African Medical Research Council Developmental Pathways for Health Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Private Bag X3, Wits, Johannesburg 2050, South Africa. ⁸Riverland Academy of Clinical Excellence, Riverland Mallee Coorong Local

Health Network, Riverland General Hospital, 10 Maddern Street, Berri, South Australia 5343, Australia.

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