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Behaviour change during dietary Type 2 diabetes remission: a longitudinal qualitative evaluation of an intervention using a very low energy diet

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What's new?

- Remission of Type 2 diabetes can be achieved through substantial weight loss.
- Very low energy diets are effective for weight loss and diabetes remission, but little is known about people's experiences with transition to weight maintenance, how weight loss and maintenance are related within people's narratives and contexts, and how behaviour change can be identified and supported in the weight management process.
- This longitudinal qualitative study identified four themes of change: behavioural autonomy, behavioural contagion, from rigid to flexible constraint, and a shift in identity.
- These contribute to theoretical and practical understanding of weight management behaviours over time.

Abstract

Aim To understand the process of behaviour change through the experiences of people with Type 2 diabetes engaged in an 8-month diabetes remission intervention including a 2-month weight loss phase with the use of a very low energy diet (VLED), and a 6-month, structured weight maintenance phase.

Methods Data were collected in three semi-structured interviews at baseline, week 8 (end of the weight loss phase), and month 8 (end of the weight maintenance phase). Longitudinal inductive thematic analysis was used to analyse participants' narratives and identify change over time.

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Results Eleven of 18 participants completed all three interviews. The following themes of change were identified in their narratives: (1) ‘Building behavioural autonomy’ as a process of growing confidence to engage in health behaviours that are independent of those of other peoples; (2) ‘Behavioural contagion’ describing how one’s new health behaviours tend to affect those of other people; (3) ‘From rigid to flexible restraint’, reflecting the changes in attitudes and behaviours required for a successful adaptation to the weight maintenance regimen; and (4) ‘Shift in identity’, representing the changes in the participants’ perceptions of themselves.

Conclusions This longitudinal qualitative study provided new insights into how behaviour change is experienced by people with Type 2 diabetes engaged on a weight management intervention using VLED, contributing to theoretical and practical understanding of weight management behaviours. The themes identify potential areas in which individuals can be supported in achieving dietary diabetes remission and long-term maintenance of weight loss.

<H1>Introduction

Approximately 8.8% of adults worldwide are currently affected by diabetes [1]. Overweight and obesity are risk factors for Type 2 diabetes mellitus [2], and substantial weight loss improves glycaemic control [3] and facilitates Type 2 diabetes remission [4].

The recommended weight loss for people with Type 2 diabetes is 10% [5]. Sustained weight loss is challenging and usually peaks at around 6 months [6], followed by weight regain [7]. The Diabetes REmission Clinical Trial (DiRECT) [8] showed that a structured weight management programme to achieve and sustain diabetes remission in primary care using a low calorie diet achieved an average weight loss of 10 kg at 12 months. Forty-six percent of intervention participants achieved Type 2 diabetes remission, and the more weight people lost, the more likely they were to reverse Type 2 diabetes. The study showed that substantial weight loss required for Type 2 diabetes remission is possible to achieve and sustain in a large proportion of people under medical supervision with tailored support.

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Understanding how weight loss and maintenance relate to each other within a person's narrative could further improve the chances of long-term success. Previous qualitative studies of experiences with weight management focused on either weight loss [9,10] or weight maintenance [11,12]. Here, we follow participants of a proof of principle study for DiRECT (the Counterbalance Study), from the beginning of weight loss through to the end of the weight loss maintenance phase of a diabetes remission intervention to understand the developments and changes in experiences in the process of dietary diabetes remission.

<H1>Methods

<H2>Design and participants

This study was conducted as part of a qualitative evaluation of the Counterbalance Study (ISRCTN88634530) [13] approved by the NHS Research Ethics Committee (REC12/NE/0208).

Counterbalance was a single-arm study aiming to achieve diabetes remission through weight loss with the use of a very low energy diet (VLED) over 8 weeks, and its stability in a structured 6-month weight maintenance programme. Here, we analyse semi-structured interviews with participants before and upon completion of the 8-week VLED, and at the end of the 6-month weight maintenance phase.

<H3>Interview procedure

All participants were interviewed by one of the researchers (LR) at baseline (T1), week 8 (T2; end of weight loss, start of weight maintenance), and month 8 (T3; end of weight maintenance) (Fig. 1). The interviewer (LR) was a health psychology doctoral student with training in interviewing skills, qualitative methodology and Good Clinical Practice, and with ongoing supervision. The interviewer-participant relationship was established at the beginning of the qualitative evaluation study and the researcher had no other contact with the participants during the study. No incentive was given for participation.

The first (T1) interview focused on participants' expectations of the weight loss phase in relation to weight, diabetes and well-being. The second (T2) interview explored their actual experience with the

weight loss phase, changes in well-being and behaviour, and expectations of the weight maintenance phase. The third (T3) interview aimed to understand the participants' experience with the weight maintenance in comparison with their expectations (Appendix S1). The interviews were audio-recorded, anonymized and transcribed verbatim.

<H2>Data analysis

- Individual narratives were analysed by the lead researcher (LR) in a longitudinal fashion, using inductive thematic analysis and were discussed at various stages with the supervisors (VAS, AA, RT, FFS) [14]. The analysis focused on identification of higher order themes of change over time. Physical transcripts, audio-recordings and field notes were retrieved for each of the participants, and were reviewed several times to ensure familiarization. The data were then open-coded to identify themes of change across the three interviews for each participant. Margins of the transcripts were used to annotate initial codes, and to note down further questions, ideas, and possible themes and interpretations. The themes were then summarized manually into a table with participant identification numbers in rows and interview time points in columns, which enabled revision of data within and between individuals. We then grouped the data into themes over time across all participants to examine any broader patterns. The themes were then reviewed and refined. The content, definitions and interpretations of the themes were discussed and agreed in regular meetings with the supervisory team. In this article, we present the key themes and sub-themes identified in the analysis. Figure 2 represents the identified themes and sub-themes visually. It was developed to facilitate understanding of the data during the iterative process of theme identification, review, and refinement. Quotes representative of the themes are annotated by gender and age, respectively.

<H1>Results

Ethical permission for the qualitative sub-study was obtained after 12 of 30 participants had already been recruited into the Counterbalance Study. Of the 18 participants who consented to be interviewed

in the qualitative evaluation [15], 11 had complete longitudinal interview data (Table 1), which are analysed here. The following overarching themes were identified: (1) ‘Building behavioural autonomy’, the process of becoming more confident in making decisions about one’s own health behaviours independent of others’ behaviours within the shared social contexts; (2) ‘Behaviour contagion’, illustrating how the new behaviours of participants can spill over into social relationships, resulting in other people making changes to their behaviour as an unintended effect of the intervention; (3) ‘From rigid to flexible restraint’, reflecting the changes in attitudes and behaviours required for a successful adaptation to the different weight loss and weight maintenance regimens; and (4) ‘Shift in identity’, representing the changes in the participants’ perceptions of themselves over time. Data saturation for the main themes displayed in Fig. 2 was achieved, established by the observation that the last three cases analysed did not add to the main themes of the synthesis [16]. In addition, we concluded on the strength of the evidence over three interviews that there were no apparent uncertainties in the results from our data synthesis, suggesting saturation.

<H2>Theme 1: building behavioural autonomy

This theme was grounded in participants’ social context, and it illustrates how, in order to succeed in weight loss and weight maintenance, participants underwent a process of dissociation of their own health behaviours from those of others.

<H3>*Behavioural interdependence*

Prior to weight loss, participants often described what we interpreted as behavioural interdependence, or a limited ability to make decisions regarding health behaviours that were different from the behaviours of others in their social environment. One indicator of interdependence was the tendency to speak in terms of ‘we’ rather than ‘I’ when the participants were talking about the changes they were going to make during the weight loss phase:

We said, ‘Well if we’re going to do it we’re going to do it together’, partly because we’d be able to support one another; partly because it’s something that we’ve talked about before now and aspired to improving our health. (Woman, 61 years)

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Another indicator was that some participants were expecting other people to adjust their behaviours for the duration of the weight loss phase:

We will no longer go out for meals during that period of time. Neither of us go out to pubs and clubs and things like that, we just don't do it. (Man, 65 years)

Behavioural interdependence at this initial stage was especially pronounced in participants who were taking part with a friend or a family member; whose family members or close friends decided to lose weight at the same time; or whose partner was the main cook in the family. For example, dietary choices of participant 1 were made by his partner, who was the cook in their household.

[I]f she doesn't cook it, I'll never get it! (Man, 67 years)

Some participants also reported how their partner's behaviours affected them in a negative way and made it harder to follow a healthier diet, further strengthening the notion of interdependence:

... it didn't help obviously husband at the time bringing chocolate in and things like that and 'Have it, it won't harm'! (Woman, 47 years)

<H3>*Formation of behavioural autonomy*

The achieved changes in weight, blood glucose and well-being during weight loss stimulated the participants' sense of control of their weight and health, in anticipation of transition to regular food and the weight maintenance phase. Indicators of growing behavioural autonomy were, for example, not avoiding social events, being able to cook for others without eating the food, or eating around others while having their meal replacement:

I've made barbeques, I've made bacon sandwiches, I've made meals that I would have killed for and just handed them over and said there you are, enjoy, and then I went on and just had whatever I was allowed to have. (Man, 49 years)

At the same time, some participants described still having feelings of shame, discomfort or awkwardness in social situations centred around food. This was mostly related with not wanting to be

excluded from activities others were participating in (having a meal together), or not wanting to have to explain their eating behaviour to strangers, rather than with their inability to resist temptations:

... I just used to say I'm sorry I can't and I just used to go and disappear for 10 minutes, quarter of an hour, have either one of my soups or one of my shakes and then come back.

(Man, 54 years)

Another participant described how she realized that she had different needs to her friend during the transition to regular food:

I think I've come to the conclusion that I really need to measure very carefully. We stopped measuring, we weighed the food religiously before we prepared it. But we stopped that when we came off the Optifast diet, we stopped weighing the food, partly because we'd got clear picture in our head of what it should look like. But we're beginning to feel its possible creeping up again ... (Woman, 61 years)

The participant started distinguishing between her own and 'their' needs as a social unit. Although she still spoke in terms of 'her and her friend', it is clear that at this point that she was thinking about herself more, and that her behaviours were becoming more independent of her friend's behaviours.

Most participants described a gradual shift towards behavioural autonomy by the end of the weight maintenance phase.

An example of this transition was the participants' ability to not only cook for others, but to also cook different meals for their family and for themselves without a difficulty:

I quite often cook something that looks far tastier than what I'm having for the rest of the family but it doesn't bother me at all. (Man, 54 years)

Another participant stopped meeting his friends in a pub and had them come over to his allotment instead, which meant that he still got to see his friends while leading a healthier lifestyle, dismissing

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some of the worry about missing out on social relationships and events, that many people anticipated in the beginning of the study:

I have my allotment and stuff like that and they tend to call in and get their weekly donation of vegetables and things like that so yeah, I still see them. (Man, 65 years)

<H2>Theme 2: behaviour contagion

Behaviour contagion complements the theme of behavioural autonomy. It refers to changes in other people's eating or physical activity patterns as a result of the changes the participants had made to their own behaviours during the intervention.

<H3>Minimizing discrepancy

One of the reasons for minimizing discrepancy between the participants' and other people's behaviours was to make the process of change easier for the participants or for others, mostly family members and friends. An example can be the case of a participant, whose new behaviours affected the way he socialized, and this in turn affected the behaviours of people who socialized with him:

... And I think we tend to not go for a meal and then go for a big drink afterwards. We do one or the other. Again, it's not just me and my wife, we have a group of friends and they've sort of changed. (Man, 54 years)

Other examples include the participants' significant others changing their eating and physical activity behaviours too. For example, one participant's wife started losing weight through an alternative weight loss programme, which supported a healthy competition between them:

... because my wife's on to this Slimming World thing now so there's no way I can sneak back round. (Man, 67 years)

Another participant's partner followed a similar dietary prescription to her husband while he was involved with the study, and reportedly lost similar amounts of weight:

We learned what effect the diet changes can make and we'll stick with those. I keep saying 'we' because my wife is basically in the same situation. She's been on the same diet as me, basically ... she's doing it on her own. But she's lost similar weight to me. (Man, 69)

Other participants inspired their relatives to increase their physical activity:

... she wants to get more exercise and so she wants to come out on some of the walks that I do. (Man, 49 years)

<H3>*Unintended benefits for others*

Another indicator of behaviour contagion was when other people indirectly benefitted from the participant's behaviour change. In some cases, the contagion of healthier behaviours had a positive effects on the participants' relationships. For example, the partner of one of the participants not only embarked on her own weight loss, but what was more noticeable over time was how the change in his behaviour improved his overall well-being and their relationship:

[I]t helped away with the wife and all because she was helping us (me) so I was helping her and now we're getting on great. (Man, 44 years)

What sometimes happened as a result of the mutual efforts and the increased self-efficacy of the participants was that they changed from needing to be supported to becoming the supporters. In the case of the participant above, having gone through the weight loss and maintenance made him more understanding of his wife's struggles and he started supporting her more:

Well it's made me understand her more because she's overweight and she's got bad knees and all I would say is 'oh go to the doctor'. But now I'm saying well come on a diet with me. (Man, 44 years)

Another participant planned to support her daughter in becoming more physically active:

[S]he's a bit overweight my daughter. I'm trying to, I'm going to buy her a Fitbit for Christmas. (Woman, 70 years)

The longitudinal evidence shows how positive results can affect not only on the participants' lives, but also on the lives of their families and friends, which may in turn further encourage more behaviour change and maintenance in the participants.

<H2>Theme 3: From rigid to flexible restraint

The longitudinal analysis further highlighted that the weight loss and weight maintenance periods may have required different approaches and adaptation from one phase to the other.

I expected to find it to be very difficult, particularly at the weight I was at. I was obviously eating far too much anyway so to go from that to a low calorie diet I expected it to be difficult but in fact it was quite easy. I found it very easy and I got results very quickly. I started to see weight loss fairly quickly and that's encouragement in itself ... I found it actually the reverse now is more difficult which is going back on to normal food and just making adjustments like getting portion size right. (Man, 69 years)

In contrast to the weight loss phase, it took longer for new routines to be adopted during weight maintenance, and the process required a level of flexibility to be sustainable. Participants reported that they were more prone to weight fluctuations during weight maintenance than during weight loss. This was mostly due to the length of the weight maintenance phase and a relative decrease in the intensity of the intervention, and due to reduced clinical supervision, which required the participants to take more control of their behaviours:

I like regimented things, and being told you could only have soups and shakes and so much vegetables per day was spot on for me but then it comes down to 'you take control'. I'm not very good at that. So, it's been difficult that bit. (Woman, 47 years)

Similar to the process of developing behavioural autonomy, finding the right balance during weight maintenance was challenging, with many participants still only 'getting the hang of it' (woman, 65 years) towards the end of the weight maintenance.

Yes, it was very difficult, the maintenance, well I had to be very aware of what I was eating, and I know myself that if I went in the biscuit cupboard that I would have one too many. So, I haven't sort of not had any biscuits, I have had the occasional biscuit, I've had the occasional bag of crisps and things, but not overboard. (Woman, 70 years)

Some participants also developed compensatory strategies to maintain their weight while being able to enjoy social events:

I'll have to have periods of dieting extremely hard before and after each event to put it down, but I'm prepared for that. I've bought myself some Slimfast, which is what I've been using this last month. So, every second day I go on to basically consuming 800 calories, and then it means that I can perhaps go up to about 3000 on these events and it shouldn't affect me too much. (Man, 65 years).

Irrespective of the maintained weight, the participants agreed almost unanimously that it was important to approach weight maintenance with an open and self-forgiving mind set. Including trigger foods in the diet was crucial for satisfaction of cravings and curiosity about food, as long as the participants knew they were able to get back on track:

My lifestyle has changed completely, it's changed forever, but I'm afraid I don't care what anyone says, holidays are continuing to be sacrosanct. I'm not going to force myself into abstinence during holiday periods. (Man, 65 years)

<H2>Theme 4: shift in identity

The participants' motivation to take part in the Counterbalance Study was not only determined by the potential weight loss and diabetes remission. It was rooted in the participants' desire to improve their eating habits, to look and feel better, to have more energy, to prolong life – to essentially become 'different people' from whom they were at the beginning, and many have experienced a shift in their perceived identity by the end of the intervention.

<H3>Increased awareness

Increased awareness was the first sign of a shifting identity. Participants often commented on how much more aware they had become of the triggers such as unhelpful thoughts, stress, environment or their feelings of hunger and satiety, and the calorie content of the food that they ate:

I think nowadays I concentrate far more carefully on what I'm eating than ever I've done before. I simply didn't give any consideration to what was going inside in the past. (Man, 65 years)

Many also noticed that they became more aware of other people's weight or shape and were often critical of it, thinking they should 'get a little bit of weight off, just a little bit at a time' (woman, 70 years). They started noticing changes in their own behaviour and attitudes that were different from their old ones. Thinking of oneself as 'not fat' anymore contributed to the continuous effort and motivation to keep the weight off in the future:

I would not like to get fat and the way you see an awful lot of people, especially in this country now, not even as an old man, I wouldn't like to get that way. So that might keep me on the straight and narrow. (Man, 67 years)

Participants whose identity shift was completed often referred to themselves as being 'converted', and they were determined the change was forever. They also wanted other people to recognize that they were no longer diabetic. For example, one participant described his frustration when his practice nurse did not acknowledge he was diabetes free:

...she didn't really understand or knew what was actually going on with me and she was treating me as if I was the same as every other diabetic that she sees. (Man, 49 years)

<H3>Reflection on past behaviour

Reflection on the participants' own past dietary and physical activity behaviours was another indicator of identity shift. For example, one participant reflected on his physical activity:

I've put on a bit more weight and made all the excuses you can find including not taking the dog out for a walk because it's raining. Yeah you can rapidly get to that but I'm aware of that, my head hasn't been stuck that far in the sand. I've had one eyebrow open. (Man, 67 years)

Other participants was often critical about their dietary habits in the past, and reflected on what they had learned during the study and how it changed the way they eat now:

... That swilling beer down and eating bacon and fatty things and bread and potatoes. If I'd known then what I know now I wouldn't have had diabetes, if that makes sense. I didn't know I had diabetes when I was doing all this and then when I did find out I had it they put me on tablets and they were bringing the readings down to normal-ish, so I was just still eating the same rubbish. (Man, 44 years)

I'm sorted. I'm definitely sorted. As I said, when I came here I didn't have a real clue about what to eat and all the rest of it and I didn't even know what cous was until I came here. And peppers were just the bits that I picked off when you got a salad or something, but now I eat the lot. And it's been a learning curve and I think I've come out a better person for it so happy days. (Man, 69 years).

Participants also often reflected on other positive outcomes of the intervention, such as being able to cope with stress better and feeling more confident:

... it feels like I've had a spring added into my step. I know that sounds really weird but it's just given us a lot more confidence and I feel quite confident now and I feel quite ... I feel more able to face things and more able to cope with things better, but I think it's because my mind seems to be in a more focused frame of mind. (Woman, 35 years)

Increased awareness, reflections on past behaviour, and feeling like a different person were the internal processes of a shifting identity. In addition to these, there were external processes that affirmed that the participants had gone through a change. Participants often described events in which they were reminded that they were or looked like a different person now:

The man in the waiting room said 'Are you looking for the little lady' and they said 'yes' and that was me!. So, 'little' is funny, because, well, it's had quite an impact on me because I thought I don't feel like a little person. (Woman, 65 years)

Comments from other people, compliments on appearance, changes in the size of clothes, and maintaining a diabetes- and medication-free status all served as a reminder of the new self.

<H1>Discussion

This study identified how behaviour change materializes in the context of a weight loss and weight maintenance intervention for diabetes remission over time. It identified four themes of change: (1) a change in the level of behavioural interdependence (building behavioural autonomy); (2) an unintended change in other people's behaviours as a result of one's behaviour change (behavioural contagion); (3) an adaptation process from weight loss to weight maintenance (from rigid to flexible restraint); and (4) a change in people's perceptions of themselves (shift in identity).

<H2>Strengths and weaknesses of the study

The longitudinal nature of this study enables observation of behaviour change over time and provides a better understanding of the weight management experience. The analysis is based on the narratives of participants who attended all three interviews only. It is possible that participants who did not attend all interviews may have been less successful in their weight loss or weight maintenance and had different experiences. Although the reasons for not attending the interviews were mostly related to lack of time, it is possible that some participants preferred not to talk about their experience, or that they did not like to be interviewed. In addition, data analysis was performed by the first author alone.

To minimize the potential impact of the lack of second-coding on the results, interpretations of the data were regularly discussed with the supervisory team, who had been involved in the study from the beginning of the project and had appropriate knowledge the narratives.

<H2>Research in context

<H3>*Behaviour autonomy and contagion*

We found that participants in this study gained more control over their eating behaviours (behavioural autonomy), and eventually often influenced the behaviours of others (behaviour contagion). They are two

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sides of the same coin, one describing the process of dissociation from other people's behaviours, and the other describing the spill-over effect of change. Previous research on the development of eating patterns indicates that socially connected individuals influence each other's food choices and diets [17,18]. Modelling, or adjusting one's food intake according to that of one's companion may be one of the mechanisms of shared eating patterns [19] that may facilitate or hinder weight management efforts. The effect of modelling is increased when people want to create a social bond with the model, or perceived themselves to be similar to the model [20]. The importance of social bonds in eating behaviour was further supported by the study of Christakis and Fowler [21], who evaluated the nature and extent of obesity within a social network of 12 067 people over 32 years. They found that over time, the chance of a person becoming obese increases with their significant other becoming obese. Among the different family relationships, spouses tend to be the most concordant in eating patterns over time [22]. Participants in this study often reported how the support from their spouses and friends, in the form of changing their own behaviours that were more concordant with the participants' new behaviours, facilitated adherence with the weight loss and weight maintenance regimens. The themes of behavioural contagion and autonomy identified in this study further highlight the importance of one's relationships in one's effort to lose and maintain weight, and it may be possible that engagement of significant others in similar studies may facilitate adherence to interventions using VLEDs.

<H3>From rigid to flexible restraint

We also found that weight loss and weight maintenance required different cognitive and behavioural approaches. Whereas the prescribed nature of the weight loss phase required strict adherence, weight maintenance required a more flexible approach in order to be sustainable. This was reflected in the participants adopting a more flexible set of behaviours, including consumption of trigger foods or treats during weight maintenance. According to Goal Conflict Theory [23], having to resist temptations for periods would lead to using up of one's self-regulatory resources, leading to a lapse eventually. This lapse might then be more serious than if one allowed himself the occasional treat [24]. Similarly, the Counteractive Control Theory [25] suggests that exposure to food temptations can enhance self-regulation by strengthening the importance of the dieting goal, goal intentions and goal-

directed behaviour, as long as the long-term outcomes are valuable, and the short-term cost of a lapse is moderate. Flexible restraint was previously found to be associated with more weight loss and better weight maintenance than rigid restraint [26], and studies further show that avoidance of dichotomous thinking, adopting a more flexible approach to weight maintenance, and a self-forgiving attitude are important for successful weight maintenance [27–30]. This suggests that avoiding deprivation might be key to successful weight maintenance.

<H2>Identity shift

A shift in identity was indicated by increased awareness of current behaviours and reflections on past behaviours. Reflection on the past as part of the reconstruction of one's old identity after weight loss was also found in previous studies [31] across a range of health behaviours [32]. Before weight loss, people often perceive themselves as restrained, which affects their social interaction, eating habits and the perception of themselves. After weight loss, the narratives of identity reflect improved social interactions and self-image, and more relaxed dietary habits, without the feeling of deprivation [33].

In their work on loss aversion in people's behaviours, Kahneman and Tversky [34] suggested that values, preferences and behaviour may change depending on a reference point from which people make evaluations with regards to the advantages or disadvantages of certain behaviours, and that people tend to prefer avoiding loss to acquiring equivalent gains. This is due to the increased value of what they already have, and because losses have approximately twice the weight of gains of the same value [35]. Applied to weight management behaviour, this could mean that people who have lost and maintained weight may value this achievement, from the current reference point of lower weight, more than people who have been less successful and regained weight. The length of time their weight is maintained for may further increase this value, supporting maintenance of the new behaviours and identity.

We also found that participants who lost weight became more aware of and judgemental towards the weight or shape of others. According to the Social Comparison Theory [36], people are driven to gain accurate self-evaluations of their opinions and abilities by comparing themselves with others. Making

such comparisons may therefore have served as a process of anchoring of the new identity and behaviour maintenance. Previous studies have found that downward comparisons (comparison with a heavier person) are associated with increased thoughts of physical activity and with an increased likelihood of dieting [37], explaining why downward comparison may have helped the participants sustain their weight in the current study.

<H2>Conclusions and future research

Findings from this study highlight the changes that occurred in behaviours of participants' with Type 2 diabetes over time during a weight management intervention, making a unique contribution to the limited longitudinal qualitative evidence. We identified changes in behavioural autonomy, identity and levels of restraint during weight loss and weight maintenance in the participants' narratives, and we found that these changes also affected the physical activity and dietary behaviours of other people in some instances. Providers of weight management programmes using VLEDs could use these findings to support people. For example, they could provide appropriate guidance with respect to the level of flexibility in restraint during weight loss and maintenance; or by identifying barriers to success in people's social environments and helping them develop effective coping strategies. Future research could focus on the development of measures of behavioural autonomy and identity shift as indicators of behaviour change success. They could further explore whether tailoring of weight management interventions using VLEDs based on these measures, or engagement of significant others would improve adherence and outcomes. Future studies could also explore whether the identified themes and understanding of behaviour change during weight loss and maintenance could be applied to supporting people without Type 2 diabetes, or people trying to change other health behaviours.

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Competing interests

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FIGURE 1 Timing of the T1, T2 and T3 interviews within the Counterbalance Study. VLED, very low energy diet; forward/backward orientation of arrows indicates orientation of the interview questions on future/past, respectively.

FIGURE 2 A mind-map of themes of change. Core themes are highlighted in dark blue and sub-themes in light blue. An overlap indicates greater connectedness of themes in the narratives. The size of the oval does not represent richness of data or how substantial a theme was.

<H1>Supporting Information

Additional Supporting Information is available in the online version of this article:

Appendix S1. Interview topic guides.

Table 1. Participants` characteristics

| ID | Gender | Age (years) | Diabetes duration (years) | BMI at T1 (kg/m ²) | BMI at T2 (kg/m ²) | BMI at T3 (kg/m ²) | Remission at T2 | Remission at T3 |
|----|--------|-------------|---------------------------|--------------------------------|--------------------------------|--------------------------------|-----------------|-----------------|
| 1 | Man | 67 | 3.5 | 34.6 | 29.1 | 29.8 | ✓ | ×* |
| 2 | Woman | 61 | 11 | 33.1 | 28.2 | 31.3 | × | × |
| 3 | Woman | 65 | 3 | 33.5 | 29.0 | 26.1 | ×* | × |
| 4 | Man | 44 | 2.5 | 36.4 | 32.0 | 32.5 | ×* | ✓ |
| 5 | Man | 54 | 0.5 | 32.4 | 26.6 | 27.4 | ✓ | ✓ |
| 6 | Man | 65 | 13 | 41.0 | 35.3 | 35.0 | ×* | ✓ |
| 7 | Man | 49 | 9.5 | 31.8 | 26.4 | 25.4 | ✓ | ✓ |
| 8 | Woman | 47 | 2.5 | 39.0 | 32.9 | 30.7 | ✓ | ✓ |
| 9 | Man | 69 | 8.5 | 32.9 | 27.7 | 27.7 | ✓ | ✓ |
| 10 | Man | 69 | 3.5 | 33.1 | 26.4 | 26.9 | ✓ | ✓ |
| 11 | Woman | 70 | 15 | 31.5 | 27.8 | 27.2 | ✓ | × |

ID, participant identification number; T1, beginning of the weight loss phase; T2, end of the weight loss phase; T3, end of the weight maintenance phase. ✓, achieved normal-range fasting plasma glucose levels (<7.0 mmol/l) at the respective time points. ×*, achieved borderline normal fasting plasma glucose levels (maximum was 7.7 mmol/l) at the respective time points.

