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Exploring the Barriers and Enablers to Implementing a 16-Week Low-Carbohydrate Diet for Patients With Diabetic Cardiomyopathy

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Aims: Cardiac dysfunction in patients with diabetes, referred to as diabetic cardiomyopathy, is primarily precipitated by dysregulations in glucose and lipid metabolism. Diet and lifestyle changes are considered crucial for successful heart failure and diabetes management and are often difficult to achieve. Low-carbohydrate diets (LCDs) have gained popularity for the management of metabolic diseases. Although quantitative research in this field is evolving, little is known about the personal experience of patients with diabetic cardiomyopathy on specific diets. The aim of this qualitative study was to identify enablers and barriers of patients with diabetic cardiomyopathy who engage in an LCD. It further explored patients' perception of dietary education and dietary support received while in hospital. **Methods and Results:** Participants who previously consented to a 16-week LCD trial were invited to share their experiences. Nine patients agreed to be interviewed. Semistructured interviews and a focus group interview were conducted, which were transcribed verbatim. Data were analyzed by using the 6-step approach for thematic analysis. Four themes were identified: (1) nutrition literacy (2) disease-related health benefits, (3) balancing commitments, and (4) availability of resources and support. **Conclusion:** Improvements in disease-related symptoms acted as strong enablers to engage in an LCD. Barriers such as access to resources and time constraints were identified. These challenges may be overcome with efficient communication and ongoing dietary support. More research exploring the experience of patients with diabetic cardiomyopathy on an LCD are warranted.

KEY WORDS: heart failure, low-carbohydrate diet, thematic analysis, type 2 diabetes mellitus

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Ethical approval was granted from the study hospital and the University Human Research Ethics Committee (ND 69645/2020). Written informed consent was obtained from all participants. This qualitative research was conducted in accordance with the 1964 Helsinki Declaration.

Author Contributions

S.K.-M. was responsible for the conceptualization, design of methodology, and writing of original draft. S.K.-M. analyzed the data, B.R. checked codes and themes, and B.R., A.O., C.Z., and A.D. all provided supervision and critical feedback, and helped to shape the research for this article. All authors read and approved the final version of the article.
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The data underlying this article cannot be shared publicly to protect the privacy of the participants who were interviewed. Some data may be shared on reasonable request to the corresponding author.

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The global prevalence of heart failure was recently estimated to be 64.3 million cases.[1] Owing to improvement in heart failure management and increasing global average life expectancy, it is forecasted that its prevalence will continue to rise.[1] Equally, the prevalence of type 2 diabetes mellitus has increased by 30% worldwide over the last 10 years,[2] with over 1.3 million people being affected in Australia alone.[3] Heart failure and type 2 diabetes mellitus are closely connected. The manifestation of heart failure in patients with type 2 diabetes mellitus may not only be linked to the complications of coronary artery disease but develop independent of its common risk factors such as hypertension or valvular disease. Referred to as diabetic cardiomyopathy (DMCM), it describes cardiac dysfunction chiefly precipitated by insulin resistance, which includes consequences of glucose and fatty acid toxicity.[4] A mild limitation to physical activity may be the first sign of DMCM. In the late stages of DMCM where both diastolic and systolic cardiac functions are severely impaired, patients often present with the full clinical picture of decompensated heart failure.[5]

Because of the impact of health behavior on the progress of disease in both heart failure and type 2 diabetes mellitus, multiple lifestyle changes are usually recommended at the time of diagnosis.[6] Tailored nutrition therapy exerts its effect through multiple cardiometabolic pathways and represents a crucial therapeutic strategy in patients with DMCM.[7]

Current heart failure self-care recommendations, especially for patients with recurrent congestion, include stringent fluid and sodium restriction.[8] This is despite insufficient evidence in the literature supporting it. In the most recent systematic review and meta-analysis regarding the effects of sodium and fluid restrictions in patients with heart failure, Stein et al[9] found that limiting dietary sodium intake, regardless of the level of restriction, was not associated with a decrease in hospitalizations or death. In addition to this, the authors claim that limiting sodium intake compromises the eating experience and may contribute to malnutrition in patients with heart failure.[9] To date, there is little scientific evidence from human clinical trials regarding diet and heart failure. Australian and international guidelines for heart-healthy eating favor diets low in total fat, especially saturated fat; however, studies investigating the effects of low-fat diets such as the DASH diet or Mediterranean diet in heart failure revealed conflicting results.[10]

There has been a growing interest for the therapeutic use of diets restricting dietary carbohydrate. Referred to as a low-carbohydrate diet (LCD), this dietary pattern is generally defined by restricting total carbohydrate to less than 130 g per day. If less than 50 g of dietary carbohydrate is consumed, the LCD is classified as ketogenic.[11] Low-carbohydrate, including ketogenic, diets prioritize the intake of green leafy vegetables and a variety of proteins including red meat and fish as well as the use of natural fats (butter, avocado, nuts).[11] Initially advocated in the management of intractable epilepsy in children, LCDs have since been shown to be an efficacious dietary option for patients with neurodegenerative disease, cancer, and type 2 diabetes mellitus.[12,13] In addition, increasing evidence suggests LCDs may be an effective adjunct to the medical management of patients with DMCM.[14–16] The LCD approach for DMCM originates from the hypothesis that insulin resistance is the most significant factor in the evolution of the disease. Low-carbohydrate diets have been shown to improve glycemic control and insulin sensitivity.[17] By reversing the underlying cause of DMCM, it is presumed that cardiac function and therefore heart failure symptoms will improve.[14]

Regardless of the dietary pattern adopted, implementing permanent behavioral and/or lifestyle change may prove difficult for some patients.[18] Furthermore, unhealthy food habits are influenced by a multitude of psychological and environmental factors, hence can be challenging to break.[18] Although there is some quantitative research on the effect of LCDs in patients with DMCM,[19] qualitative data in this field are lacking. By gaining insight into the perceptions, experiences, and motivations of patients with DMCM on certain diets, healthcare workers may be able to guide patients with DMCM toward long-lasting dietary change.

Aim

This study explores the personal experience of patients with DMCM who followed an LCD for 16 weeks, as part of a registered clinical trial. The main objective was to understand what enables patients with DMCM to adhere to an LCD longer term, as well as the barriers they face. Finally, this project explores DMCM patients' perceptions of dietary education and support received in their treatment journey.

Methodology

Study Design

Reflexive thematic analysis was used for this work. This assisted the qualitative researcher to meaningfully convey their understanding and appreciation of certain participants' experiences, perceptions, and accounts of their thinking.[20] Focus group interviews (FGIs) as well as semistructured, one-on-one interviews were conducted to answer the objectives of this study. In addition to the thematic analysis framework by Braun and Clarke,[21] the Consolidated Criteria for Reporting Qualitative Research guidelines[22] have been used to report this qualitative study.

Participants and Study Setting

Participants were part of a randomized controlled trial comparing the effects of an LCD with usual care in

TABLE 1 Participant Demographics

Participant/Respondent	Gender	Age, y	Type of Interview
1	Male	43	FGI
2	Male	60	FGI
3	Male	65	FGI
4	Male	51	FGI
5	Male	42	FGI
6	Male	81	I
7	Female	64	I
8	Female	63	I
9	Female	46	I

Abbreviations: FGI, focus group interview; I, semistructured one-on-one interview.

patients with DMCM.[23] At the completion of the 16-week trial, participants randomized to the LCD group were invited to take part in an interview. Participants were given the choice between FGIs or one-on-one interviews. As data for the randomized controlled trial and the interviews were collected mostly during the COVID-19 pandemic, all interviews were conducted online or, where participants did not have access to a personal computer, via telephone.

Data Collection

All interviews were undertaken between June 2022 and January 2023 by the first author. Interviews lasted between 20 and 64 minutes in duration and were recorded with the help of an online video-recording platform or the QuickTime player application. Both FGIs and semistructured interviews were guided by the interview discussion guide comprising 12 questions (Table 1). Because of the preceding clinical trial, the rapport between the female interviewer, who was a critical care nurse with an interest in low-carbohydrate nutrition, and participants was well established. Before commencing the interview, participants were informed of the anticipated length, purpose of the interview, that interviews were recorded, and terms of confidentiality. Interview questions were developed with coauthor input and a review of the literature. Emphasis was placed on asking open-ended questions and probing to allow for open participant engagement.[24] Interview recordings were transcribed intelligent verbatim.

Data Analysis

To highlight the true essence of participant experience and allow for themes to develop naturally, we adopted a sematic, inductive approach. Audio recordings and transcripts were analyzed using the following 6-step model for reflexive thematic analysis as proposed by Braun and Clarke.[25,26] (1) The author who conducted the interviews immersed themselves in the data set. This familiarization involved repeated reading of the transcripts to explore initial ideas. (2) Meaningful aspects of the data were identified using codes. (3) With the assistance of a thematic map, first themes emerged. (4) Initial themes were refined by collapsing similar themes and separating others to reflect the meaning of the data set as a whole. To ensure quality and trustworthiness, codes and themes were rechecked by a different member of the research team (B.R.). (5) Themes were refined to grasp the essence within. Once data saturation was achieved, (6) a report was generated.[26]

Findings

A total of n = 9 participants consented to be interviewed. Five participants agreed to participate in an FGI, whereas 4 participants consented for one-on-one interviews (Table 2). Four core themes and 15 codes (Figure) were identified. Main themes included (1) *nutrition literacy*, (2) *disease-related health benefits*, (3) *balancing commitments*, and (4) *availability of resources and support*.

Theme 1: Nutrition Literacy

Most participants reported an improvement in their ability to understand nutrition information, often citing it in context of wanting to continue with the LCD. The phrases "Looking at ingredients more," "reading

TABLE 2 Interview Discussion Guide

- ⇒ What do you know about low-carbohydrate (LC) diets?
  - ⇒ Can you tell me, what has changed for you since you have started the LC diet?
    - ▪ Was there anything regarding your health that has changed for the better?
    - ▪ Was there anything regarding your health that has changed for the worse?
  - ⇒ Think back to the start of the intervention.
    - ▪ Can you tell me what the easiest part of the diet was?
    - ▪ Can you tell me what the most difficult part of the diet was?
  - ⇒ Can you tell me what has helped you to adhere to the LC diet?
  - ⇒ Can you think of reasons to continue/discontinue with the LC diet?
  - ⇒ Have I missed anything regarding the LC diet that you would like to share?
  - ⇒ Can you think of additional resources/education that would have helped with adherence to the diet?
  - ⇒ Do you think the LC diet is beneficial for patients with heart failure?
  - ⇒ Do you think patients with heart failure receive enough education regarding diet and healthy nutrition?
  - ⇒ Who do you think should educate heart failure patients regarding diet and nutrition?
  - ⇒ Can you think of anything else that would help to improve your heart failure symptoms?

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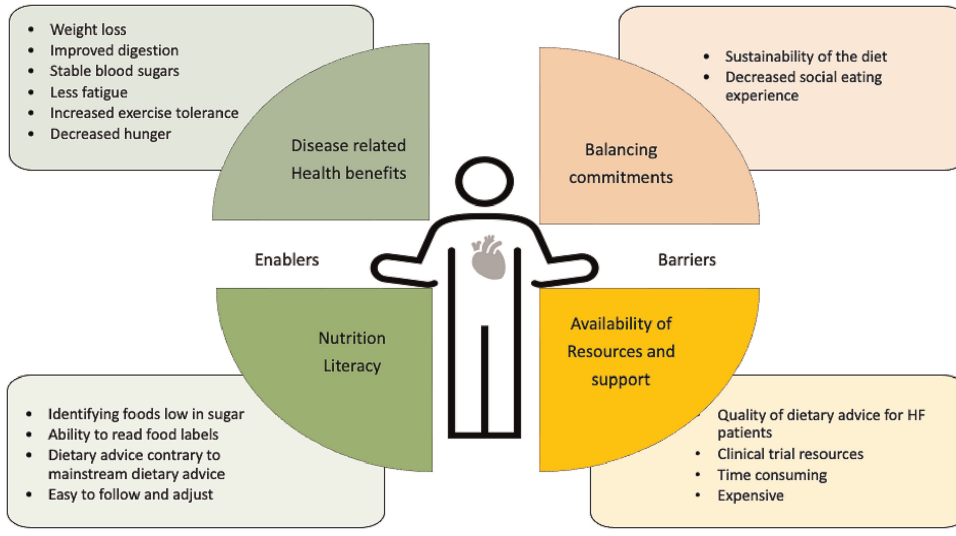

FIGURE. *Codes and themes.*

the labels on packets," and "cutting out crap" were frequently used. Sugar content in food was often described as "frightening."

> It [the trial] has made me very conscious of foods I should try and avoid you know, things like cake and white bread. I used to eat lollies and chocolate and other nasty things like ice cream. I never cared but I don't buy most of that now, so it has really turned my whole diet around. I'm going to try and continue them [LCD foods] and continue the healthy habits. (Respondent 6, interview)

> Just turning it [food packet] over, looking at those nutritional facts. And there's the decision made for you. (Respondent 3, FGI)

During the interviews, we noticed participants had moments of sudden insight and/or discovery. This was frequently related to the low-carbohydrate dietary advice received during the 16-week trial and contrasted with nutrition information participants had received in the past.

> It is really a revelation to me because I have always based my diet around grains and fruit. Lots of vegetables and very little lean meat—it's a flip really. (Respondent 7, interview)

> You can basically eat protein and fat. There's nothing wrong with a steak covered in Camembert cheese. [In the past] you were taught that that's wrong. (Respondent 3, FGI)

Theme 2: Disease-Related Health Benefits

One of the biggest enablers to resume the dietary regimen was the perceived improvement in health on the LCD. Although weight loss was seen as a reason to continue, it was of secondary importance to most participants. Improvements in health factors related to DMCM were rated higher and varied among participants. According to respondent 1 (FGI), "Obviously, my blood sugar levels have stabilized a lot further down than I could with a normal diet." Respondent 4 remarked, "I think, mobility for me has improved…. The difference [I see with], just simple things like putting on your shoes."

Respondent 8 (Interview) commented: "I also can run now—more a shuffle [laughs] but I wasn't able to do this before."

Other participants observed similar improvements in energy levels and exercise tolerance.

> Earlier at the start, you'd go for a little bit of a walk, and you'd be huffing and puffing but just after a number of months doing the same sort of thing [the LCD] I don't feel that. (Respondent 1, FGI)

In addition, participants reported "unexpected health benefits," which are often related to long-standing physical discomfort such as difficulty sleeping, "Best sleep I had in a long time. I don't feel tired" (respondent 7, interview), and indigestion, "I feel my gut has improved. I needed the toilet urgently on my old diet, so that has improved" (respondent 8, interview).

In this context, many participants also spoke of being "less hungry," which seemed to happen over time. This newfound awareness resulted in feelings of contentment and a natural change in eating behavior.

> …my diet was pretty average, and you tend to always crave certain foods—you're always hungry! I find now that I eat almost less and don't feel that hunger, like I can easily only have a lunch or dinner and be fine. (Respondent 5, FGI)

> I didn't have any hunger [during the trial]. [The LCD] was easy to follow and adjust, even if I had to wait for a more appropriate meal. It was ok…it didn't seem to bother me—the hunger wasn't there. (respondent 3, FGI)

Theme 3: Balancing Commitments

Most participants found the diet was easy to sustain and to be "straightforward," whereas a different respondent described the LCD as "painting by numbers." Most participants experienced a "balancing act" between continuing the LCD long term and returning to their usual

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way of eating. Generally, commitment to the diet was balanced against the enjoyment of eating out and the pleasure in eating with family.

> In terms of splitting my cooking away from the others [the family], I didn't actually find that [that] difficult, because if you're still feeding them pasta, it's a matter of you make the sauce and prepare something else [for myself]. I take the sauce out for me and use the rest for them [the family]. (Respondent 3, FGI)

> My Italian friend, she keeps giving me things with pasta. I suppose the most difficult part is to avoid certain foods…. Overall it wasn't too difficult following the whole plan, except that I had [carbs] here and there which was a bit unavoidable. (Respondent 5, interview)

> When I've been going out [while on the LCD] I have not been having chips but [ate] vegetables. I don't order chips anymore. Lots of pubs, if you want vegetables, they charge you more money for vegetables. It's an expensive meal if they charge extra for vegetables. (Respondent 9, interview)

Upon reflection, some participant described a change in their personal commitment to the diet, which seemed to have happened over time. In 1 case, the participant experienced the need to do it on their own and in their own time.

> When I first spoke to you about it [the clinical trial] I was thinking, I wouldn't mind being in the control group, then I don't have to do anything. You know, I can stay in the status quo. But [now] I think it's been really great moving on to the diet. And for the most part, I'm still sticking to it. (Respondent 4, FGI)

> You know If I hadn't been living on a diet of McDonald's and pizza I would have done a lot better—I worked that out for myself. My journey is going to be longer and slower. I would like another appointment in 3 months. See what I can do by myself—this is more my personality. (Respondent 7, interview).

Theme 4: Availability of Resources and Support

Access and availability of resources were critical factors not only in context of transitioning to the LCD but also to enable behavior change. Many participants felt the LCD was "expensive" and found this to be a barrier to convert to low-carbohydrate foods. Expense was a barrier when going out to eat but especially when budgeting for family meals was discussed. One respondent remarked:

> It's quite difficult because you're increasing your protein, which means you're increasing your meat and that's an expensive component. Always using almond flour to make muffins or scones is expensive. That's 25 bucks for a kilo—in comparison [more expensive] than bread…you know five kids on a tight budget. (Respondent 3, FGI)

> It was expensive. I always buy the specials in the shops. [I am] still buying full cream milk and butter so that will stay, I guess. (Respondent 8, interview)

In addition, participants perceived "time" to be a key factor when preparing LCD meals/snacks. Specifically, participants were of the opinion the LCD involved a lot more cooking than their usual diet.

> [Bread or fruit] It's convenient, it doesn't require cooking and you can just throw it in your bag. It is just convenient—a sandwich for work. (Respondent 7, interview)

Most participants wished for "something with recipes in it" in addition to the material received at the beginning of the trial.[23] Participants felt the recipe book would have been something to "get them started" or "help them out." All participants received links to online platform discussing recipes and/or cooking methods; however, very few used this service. According to a respondent:

> Maybe because I'm a bit old school. Probably because older people are not on the Internet. If there is stuff on a piece of paper—there it is! That would have probably made it easier for people. (Respondent 9, interview)

Regarding the support they received throughout the trial, participants felt it significantly increased their ability of changing habits using phrases such as "it kept me in line." Participants frequently expressed their gratitude.

> Your support [was important]. The idea that you were prepared to ring us and talk to us and check up on us and follow through…. (Respondent 2, FGI)

When exploring participants' feelings and/or opinions in regard to professional dietary guidance received in hospital, responses were surprisingly negative. Whereas some participants found they were given information but could not "absorb" it, others expressed that dietary advice was "overwhelming" at times or contrary to nutrition advice given to them by a different health professional in the same setting. Patients expressed that they were "treated" but not "heard" and that health professionals should continue to offer help, even after patients are discharged from hospital. All participants thought dietary advice should come from a dietitian as opposed to a doctor or nurse, because "it is their field of expertise."

> They [hospital staff] are trying to keep you alive. They spent a lot of money [to keep me alive] and put in a pacemaker. It kind of seems a bit of a waste, if I was just going to go off [home] and died due to poor diet. It [dietary advice] seems to be a low investment for a high return. I guess just being able to speak to someone could have steered me in the right direction—as you have done during the study. (Respondent 4, FGI)

> [They said] that I could lose more weight if I simply started to exercise. There wasn't a lot of information coming from the hospital level—someone saying try and stay away from these foods. If you are going to keep me alive, give me the tools to keep me alive. (Respondent 3, FGI)

> [At] my initial hospital stay, I was introduced [to the heart failure nurse] while I was getting checked out. I had a quick chat to her and she said: Hey take this booklet with you and read through the booklet. Keep taking your medicine. We'll be in contact. The booklet did touch on some diet stuff but maybe one or two pages out of 53. (Respondent 4, FGI)

Discussion

To our knowledge, this is the first qualitative study to explore the personal experiences of patients with DMCM during an LCD trial. The main aim was to find enablers

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What's New and Important

- Patients with DMCM experience improvements in disease-related symptoms when engaging in an LCD.
- Time needed to prepare a low-carbohydrate meal, expense, and a decrease in social eating experience were strong barriers to the diet.
- Nutritional strategies should be integrated in the multidisciplinary management for patients with DMCM.
- Dietary advice should continue after patients are discharged from hospital.

and barriers to longer term LCD adherence. We were also interested in how patients perceived dietary advice and support given to them by healthcare professionals.

Our findings suggest that patients with DMCM experienced improvements in disease-related symptoms on an LCD. Cardiovascular health benefits such as weight loss were of secondary importance to study participants, whereas factors related to quality of life, such as being able to tie shoelaces, the feeling of improved gut health, being or able to "run instead of walk," were motivations to continue with the LCD. This is not surprising because previous studies investigating heart failure patients' preferences in regard to longevity or quality of life using a time trade-off approach identified that over half of patients with heart failure considered quality of life even more precious than a long life.[27]

Poor nutrition literacy is associated with negative health outcomes in patients with heart failure.[28] Most participants reported a good understanding of the LCD by the end of the 16-week trial. Participants were able to create simple recipes without relying on resources. Improved self-efficacy is an important factor in a person's ability to change and may be predictive of long-lasting behavior transformation.[29] Most participants reported a reduction in hunger. Because of the diet's unique ability to reduce hunger, the LCD may be particularly well suited for long-term success in patients with metabolic diseases such as DMCM.[13,30]

Although the priority group, that is, patients with DMCM, was exposed to this longer term (4 months) evaluation, our participants stayed highly motivated. This reflective motivation was enabled through continuous support such as one-on-one dietary advice sessions and perceived disease-related health benefits. Because of the impact of health behaviors on the progress of disease in DMCM, multiple lifestyle changes are usually recommended at the time of diagnosis.[6] The patient who is often very unwell at this stage may be overwhelmed with information relating to this complex disease.[31] Our participants spoke of being given information in hospital but not being able to "hear" it. In addition to this, participants reported receiving mixed messages regarding which diet was best for them. These findings support the results of a study by Ivynian et al.[31] The authors who investigated the experiences with patient-provider communication in patients with heart failure found that even patients with sound health literacy may not be able to understand and/or retain information in times of distress.[31] A different study by Beeken et al,[32] which explored the views on diet of cancer survivors, also mirrors our findings. The authors suggest that patients may be overburdened in the hospital setting and simply "forget" the information given to them.[32] It is therefore vital that information passed on during this time is nontechnical and easy to understand but, most importantly, ongoing.[31]

Most of our patients were dissatisfied with the nutritional guidance received in hospital and expressed the wish to receive dietary education even after being discharged home. Dietitian input is crucial in the multidisciplinary management of heart failure and should be used throughout all stages of the patient journey.

Limitations

Our study has several limitations. All study participants were recruited from a single heart function clinic in Victoria, Australia. The findings of this study may therefore not be generalizable to other populations. Because of the COVID-19 pandemic, our clinical trial as well as all interviews were conducted entirely online. The experience of participants in LCD trials conducted face-to-face may therefore be different to ours. Finally, our relatively small sample necessitates further investigations into the experience of patients with DMCM on an LCD in order for the present results to be generalizable.

Conclusion

This qualitative study aims to explore the personal experiences of patients with DMCM who followed an LCD for 16 weeks. Behavior change is a slow process especially in patients with increased symptom burden such as DMCM. Enablers such as improvement in health-related symptoms have impact on diet adherence. Patients have both heart failure and type 2 diabetes mellitus continue to benefit from a multidisciplinary management approach. To remove barriers to dietary behavior change, patient information needs to be simple and ongoing. More research exploring the experience of patients with DMCM on an LCD are warranted.

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