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## A practical guide for the use of very low calorie diets in adults with chronic kidney disease

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# A practical guide for the use of very low calorie diets in adults with chronic kidney disease

## Abstract

Obesity is increasingly common in individuals with chronic kidney disease (CKD). Being overweight or obese is associated with both the development and progression of kidney disease. Lifestyle interventions such as the use of very low-calorie diets (VLCD) are being used increasingly for patients with CKD despite warnings from manufacturers that they should be avoided or used with caution. Whilst these diets are effective and can induce rapid weight loss and suppress appetite, their use in patients with chronic and end stage kidney disease is more complex than in the general population. VLCD use in adults with kidney disease requires a more nuanced approach to prescription and closer monitoring for unintended side effects. This review describes the indications and clinical management of patients with CKD undertaking a very low-calorie diet and provides practical guidance regarding how to manage a VLCD, particularly for the latter stages of CKD.

## Disciplines

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18

19

1 **Abstract**

2 **Title:** A practical guide for the use of very low calorie diets in adults with chronic kidney  
3 disease.

4

5 Obesity is increasingly common in individuals with chronic kidney disease. Being  
6 overweight or obese is associated with both the development and progression of kidney  
7 disease. Lifestyle interventions such as the use of very low-calorie diets (VLCD) are being  
8 used increasingly for patients with CKD despite warnings from manufacturers that they  
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11 disease is more complex than in the general population. VLCD use in adults with kidney  
12 disease requires a more nuanced approach to prescription and closer monitoring for  
13 unintended side effects. This review describes the indications and clinical management of  
14 patients with CKD undertaking a very low-calorie diet and provides practical guidance  
15 regarding how to manage a VLCD, particularly for the latter stages of CKD.

16 **Keywords:** Very low-calorie diet; weight loss; chronic kidney disease; end stage kidney  
17 disease; evidence-based practice

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23 integrity of any portion of the work are appropriately investigated and resolved. KL takes  
24 responsibility that this study has been reported honestly, accurately, and transparently and  
25 that no important aspects of the study have been omitted.

## 1 **Introduction**

2 Overweight and obesity are closely linked to both the development of and progression of  
3 kidney disease <sup>1</sup>. Well controlled studies have demonstrated that weight loss can reduce  
4 proteinuria and reduce deterioration of eGFR <sup>2</sup>. For adults who have developed end stage  
5 kidney disease, the efficacy and safety of weight loss is less well established though <sup>3</sup>. In  
6 practice, although no definitive guidelines exist, individuals with end stage kidney disease  
7 who are obese are significantly less likely to be referred for kidney transplantation surgery <sup>4</sup>  
8

9 Lifestyle interventions such as the use of very low-calorie diets (VLCD) are being used  
10 increasingly for patients with chronic and end stage kidney disease. Traditionally these  
11 products (also known as very low energy diets, VLEDs) have been used to induce rapid  
12 weight loss by restricting dietary intake to less than ~800kcal (3300 kilojoules) per day <sup>5</sup>. The  
13 severe energy restriction results in ketosis and ongoing suppression of appetite occurs <sup>6</sup>. Their  
14 efficacy is well established, and when used as directed can result in weight loss of 1.5-2.5kg  
15 per week. This is considered to be the single most effective short term non-surgical weight  
16 loss intervention for obesity when used for up to 16 weeks <sup>5</sup>. VLCDs can also result in  
17 remission of Type 2 Diabetes <sup>7</sup>.

18  
19 Unfortunately, the use of VLCDs in adults with chronic and end stage kidney disease is more  
20 complex than in the general population and requires a more nuanced approach to prescription  
21 and closer monitoring for unintended side effects. Evidence for the use of VLCDs in kidney  
22 disease is limited by the small number of studies and the small numbers of participants.  
23 Therefore, the aim of this paper is to provide practical guidance to the nephrology community  
24 on the use of VLCDs in adult patients with chronic and end stage kidney disease (CKD and  
25 ESKD).

## 1 **Overview of the physiological mechanism inducing weight loss**

2 Weight loss occurs during a VLCD via the mechanism of ketosis. This is a benign metabolic  
3 state<sup>8</sup> and differs from ketoacidosis. Ketoacidosis will only occur when insulin is  
4 insufficient<sup>8</sup>. Ingestion of < 800 kcal / 3000 kilojoules per day will induce ketosis<sup>9,10</sup>. When  
5 accompanied by ongoing caloric restriction and less than 100g of carbohydrate per day,  
6 metabolism of fat stores will occur<sup>8,10</sup>. During ketosis, adipose tissue is broken down into  
7 free fatty acids and glycerol. The free fatty acids are used for energy by organs such as the  
8 liver and muscles. The ketones generated include beta-hydroxybutyrate and acetoacetate<sup>10</sup>  
9 and are used by the brain as a substrate for metabolism. The utilization of these ketone bodies  
10 has a protein sparing effect. More detailed information on this process is provided elsewhere  
11 <sup>8 10 11</sup>.

12

13 Ketogenic diets for weight loss typically result in serum ketone levels around 0.33-  
14 0.72mmol/L. By comparison, ketone levels in diabetic ketoacidosis may be as high as  
15 25mmol/L<sup>11</sup>. A diagnosis of ketoacidosis is suggested when ketone bodies are detected and  
16 glucose is >11.1 mmol/L<sup>11</sup> and significant acidosis (arterial pH < 7.3 or venous bicarbonate  
17 <15mmol/L)<sup>8</sup>.

18

## 19 **Overview of very low-calorie diet products**

20 In Australia, New Zealand, Singapore and Hong Kong, VLCDs are typically available over  
21 the counter without a prescription. The most effective form of the VLCD consists of three  
22 shakes per day (made with water) to replace all food intake. A small portion of ~2 cups of  
23 low carbohydrate vegetables may often accompany the shakes for both social reasons and to  
24 ensure adequate fibre intake. In addition, many VLCD products recommend consumption of  
25 1-2 teaspoons of oil to ensure adequate essential fatty acid intake. Some commercial versions

1 of VLCDs also provide an alternative low energy formulation to the shake in the form of a  
2 soup, bar or dessert. While VLCD products are usually supplemented with micronutrients,  
3 they are not nutritionally complete and therefore should not be used long term<sup>5</sup>. It is  
4 recommended that VLCD products are not used unless the BMI is  $> 30\text{kg/m}^2$  or the BMI is  
5  $>27\text{ kg/m}^2$  with obesity related complications<sup>12</sup>.

6

7 There are generally three phases of a VLCD program. The first phase is characterised as the  
8 intensive phase, whereby all meals and snacks are usually replaced by three VLCD products.

9 In the healthy population, a high fluid intake of more than 2 litres of low calorie fluid or  
10 water is strongly encouraged to facilitate excretion of ketones<sup>13</sup>. This phase can last up to 12  
11 weeks. The second phase is often called a ‘controlled’ phase with 2 meals per day replaced  
12 with a VLCD product and one small low-calorie meal per day. The final phase is the  
13 maintenance phase. In this phase, individuals transition back to a pattern of healthy eating  
14 and substitute one meal per day with a VLCD product. They may have repeated periods of  
15 intensive phase use separated by periods of weight maintenance<sup>9</sup>

16

### 17 **Nutritional considerations of VLCDs for adults with kidney disease**

18 The macronutrient composition of the most popular VLCD products do not vary greatly<sup>13,14</sup>.  
19 Table 1 highlights the composition of several commonly available products. The nutrients  
20 provided when consuming the recommended amount of VLCD products are compared to the  
21 evidence-based guidelines<sup>15-17</sup> for an adult of a 90 kg male (BMI  $27\text{ kg/m}^2$ ) in Table 1. In the  
22 context of following a VLCD, it is appropriate that requirements for energy, fat and  
23 carbohydrate need not be achieved to achieve weight loss goals. As seen in Table 1, all  
24 products provide less than the recommended amount of fiber, and potassium (when additional  
25 serves of vegetables are excluded). However, meeting protein recommendations and fluid

1 requirements is far more challenging when individuals have CKD or ESKD. Importantly,  
2 evidence indicates that meeting protein targets is critical while following a VLCD so as to  
3 preserve fat free mass <sup>5</sup>. A more detailed analysis of the two main VLCD products in  
4 Australia and New Zealand are contained in Supplementary Materials.

5

## 6 **Can VLCDs be used safely in CKD and ESKD ?**

7 Initial weight loss will occur in the form of a reduction in muscle glycogen stores and  
8 diuresis that will necessitate careful monitoring of goal dry weight in patients undertaking  
9 hemodialysis (note dry weight refers to the target weight after dialysis regardless of the  
10 BMI). To prevent muscle catabolism, the use of a VLCD program should always be  
11 accompanied by a program of physical activity where possible <sup>9</sup>.

12

13 Individuals with advanced kidney disease have limited capacity to handle acid loads and will  
14 not excrete ketones readily. Evidence regarding the safety of VLCDs in those with CKD can  
15 only be derived from the small number of studies available which included individuals with  
16 CKD. One recent large randomized controlled trial using VLCDs in obese adults with type 2  
17 diabetes (the DIRECT trial) provides some important evidence that VLCDs can be used  
18 safely in people with CKD<sup>7</sup>. Results from the DIRECT trial included participants with  
19 diabetes and CKD and no adverse outcomes were reported regarding worsening of acidosis in  
20 these patients <sup>7</sup>.

21

22 Another potential side effect specific to the CKD population that is of importance to  
23 clinicians includes hyperkalemia. In a study of 22 patients on hemodialysis therapy who  
24 participated in a 12 week VLCD program, 12 of the 22 subjects had at least one episode of



1 hyperkalaemia (>6.0 mmol/L) during the 12 weeks intensive phase. Potassium dialysate  
2 concentration was also reduced in 6 patients during the study period<sup>18</sup>.

3

4 Other complications from VLCDs have been reported. This includes death. However, these  
5 deaths occurred in an era when the protein in the VLCD was not complete for essential amino  
6 acids, nor supplemented with micronutrients<sup>5</sup>. **Because these products now contain all**  
7 **essential amino acids they are now considered nutritionally complete for healthy people and**  
8 **safe for use**<sup>9</sup>. However, the VLCD product information suggests that these products should  
9 not be used or used cautiously in those with kidney disease due to altered electrolyte and  
10 fluid requirements. Individuals with CKD or ESKD and coexisting heart failure, recent  
11 myocardial infarction or unstable angina, porphyria or those that are pregnant, breast feeding  
12 or aged less than 18 year old should also avoid commencing VLCDs<sup>19</sup>.

13

14 Other medical conditions that can occur in individuals undertaking a VLCD are listed below.  
15 These side effects occur due to the rapid weight loss during a VLCD and include:

- 16 • Gall stones – which may be prevented by including 1-2 teaspoons of oil per day or  
17 use of ursodeoxycholic acid<sup>20</sup>.
- 18 • Hyponatremia and hypokalemia- consideration of cessation of diuretic therapy and  
19 of resonium if prescribed may be required
- 20 • Hypoglycemia – the very low carbohydrate intake of a VLCD will require  
21 amendment to the dose of insulin in those with diabetes and consideration of  
22 reduction in dose of sulfonylureas. A reduction in dose of sulphonylurea of 50% at  
23 commencement of the VLCD has been suggested.<sup>13</sup>.

- 1 • Hypotension – an average reduction in systolic blood pressure of 8.1% and diastolic  
2 blood pressure of 8.6% is expected <sup>21</sup> and may require dose reduction in  
3 antihypertensive medications.
- 4 • Gout – may be exacerbated by the transient increase in uric acid levels that occur in  
5 the first few weeks of a VLCD. The addition of allopurinol may be required.
- 6 • Abnormal liver function – is common in many obese patients. Elevation of Alanine  
7 Aminotransferase (ALT), gamma-glutamyl transferase (GGT) and aspartate  
8 aminotransferase (AST) and the absence of significant elevations of bilirubin or ALP  
9 or findings of acute disease may not require further investigation or changes in  
10 dietary protocol. However, isolated elevations of bilirubin and/or ALP and GGT  
11 with a progressive elevation of hepatocellular enzymes suggest concurrent hepatic  
12 disease, such as hepatitis or pancreatitis and must be investigated <sup>13</sup>.
- 13 • Medication interactions- patients on lithium may experience changes in serum  
14 lithium levels due to sodium depletion and renal retention of lithium. Lithium levels  
15 should be monitored weekly, then bimonthly. See Table 2 for more detail.
- 16 • Medications with a narrow therapeutic range – monitoring for deviations from the  
17 therapeutic ranges is recommended. This could include tacrolimus, sirolimus, and  
18 mycophenolic acid<sup>22</sup>

19

## 20 **What other side effects of VLCDs can be anticipated ?**

21 VLCDs are generally otherwise considered safe with only minor, transient side effects being  
22 observed. These side effects are a result of the rapid weight loss and ketosis and may include:  
23 sensitivity to cold, halitosis, constipation, headache, hair loss, irritability, postural  
24 hypotension, fatigue, muscle cramps and menstrual disturbances <sup>13</sup>. These side effects are  
25 generally insufficient in magnitude or duration to warrant cessation of the program but should

1 be made apparent to the patient prior to commencement. Most symptoms are observed by  
2 patients to have disappeared by days 4-6.

3

#### 4 **How effective are VLCDs in those with CKD or ESKD ?**

5 There are limited studies providing clinical evidence on the effectiveness of VLCDs in those  
6 with CKD. This may be in part due to the reservations held by clinicians previously regarding  
7 the side effects and dangers of severe energy restriction in this population <sup>19</sup>. Despite the  
8 paucity of data some case series and case reports do exist, which report successful weight  
9 reduction and minimal reported adverse effects. Lassemillante et al <sup>23</sup> were able to  
10 demonstrate a median weight loss of 7% (range 5.2-11.4%) in one year with the use of a  
11 modified VLCD protocol in a small cohort of chronic haemodialysis patients with no  
12 significant side effects reported. Phosphate binders were continued as prescribed for all but  
13 for one patients in which binders were temporarily ceased for a medical procedure. There  
14 was no report of use of potassium binding resins but adjustment to potassium dialysate  
15 concentration was reported for one patient. Similarly, Friedman et al <sup>24</sup> were able to achieve  
16 an average weight loss of 14.2 kg in five patients with advanced diabetes nephropathy with  
17 the use of VLCD for a period of 12 weeks. They observed a statistically significant  
18 approximate reduction of 12% in serum creatinine and cystatin C and a 36% non-statistically  
19 significant reductions in albuminuria and a non-significant increase in albumin. In addition,  
20 improvements in glycaemia, hyperinsulinaemia and insulin resistance were noted. The only  
21 adverse side effect in this case series were a transient elevation in blood urea nitrogen and  
22 creatinine early in the diet that resolved after reducing anti- hypertensives. In a recent study  
23 of 22 HD patients following a VLCD diet for 12 weeks, pre dialysis weight declined by an  
24 average of 0.91kg per week whilst mean waist circumference reduced by 10.5cm at 12 weeks  
25 compared to baseline. Nine out of the 22 patients achieved a goal weight required to be

1 actively listed for kidney transplantation<sup>18</sup>. In another case report on the use of a VLCD in  
2 a haemodialysis patient, weight loss in the order of 72kg in 77 days was reported<sup>25</sup>.

3

#### 4 **What patient groups with CKD may benefit from a VLCD regimen ?**

5 Select groups of patients with CKD are likely to benefit from weight loss<sup>26</sup>. This includes:

- 6 • Patients with CKD stage 1-3 and a BMI > 30kg/m<sup>2</sup> especially those with type 2  
7 diabetes
- 8 • Those with CKD and a BMI > 30kg/m<sup>2</sup> or an increased waist circumference that are  
9 potential candidates for kidney transplantation
- 10 • Those with CKD and a BMI > 30kg/m<sup>2</sup> or an increased waist circumference that are  
11 using weight loss as a strategy to delay progression of renal failure.
- 12 • Patients with CKD stage 5 and a BMI > 30kg/m<sup>2</sup> undertaking dialysis that are  
13 potential candidates for kidney transplantation
- 14 • Patients with CKD stage 5 and a BMI > 30kg/m<sup>2</sup> undertaking dialysis that may  
15 benefit from weight loss for other reasons e.g. improved mobility, reduced joint pain.

16

17 As a general guide, Nephrologists should give serious consideration to any individuals who  
18 display poor motivation; poor adherence to their insulin regimen and / or dialysis  
19 prescription; those with financial restrictions and those who lack social support. These  
20 factors place them at high risk of side effects, inadequate weight loss and a low likelihood of  
21 success. The Nephrologist should balance the benefits of weight loss with the risks that may  
22 be associated with embarking on a strict VLCD.

23

#### 24 **What VLCD prescription is recommended ?**

1 Recent guidance from a panel of clinical experts suggests that despite the paucity of scientific  
2 evidence, VLCDs are safe and efficacious in those with CKD but require close monitoring to  
3 prevent complications<sup>27</sup>. It should be emphasized that due to differing nutrient requirements  
4 at each stage of CKD, there is no single VLCD prescription recommended. As a result, Table  
5 3 outlines three suggested VLCD prescriptions for those with CKD stage 1-2<sup>13</sup>. The standard  
6 protocol of 3 VLCD shakes per day with 2 cups of low carbohydrate vegetables and 1-2  
7 teaspoons of oil is sufficient. In addition, liberal water intake (or intake of low-calorie  
8 beverages to minimise taste fatigue) is encouraged. In motivated individuals, this program  
9 can be continued for up to 12 weeks. It can also be repeated numerous times following  
10 review with the health care team.

11

12 For those with Stage 3-5 CKD a modified program is required. Protein intake using the  
13 standard approach for Stage 1- 2 CKD is compromised and additional modifications are  
14 required to meet the varying protein needs of individuals with stage 3-5 CKD. Lasse Millante  
15 et al<sup>23</sup> prescribed a modified low calorie diet for a small cohort of haemodialysis patients.  
16 The diet was implemented using a standardised protocol utilising meal replacements, aiming  
17 at the following prescription (i) protein 1.1<sup>28</sup> to 1.2g/kg per day<sup>16</sup>, (ii) potassium 1mmol/kg  
18 per day, (iii) phosphate 800-1000mg/day, and (iv) meet any fluid restrictions. On average,  
19 the protocol prescription was ~1000 kcal / 4000 kJ and 100g protein per day. This comprised  
20 of meal replacement shakes (Optifast) (x2 per day) and bars (x1 per day); 150g meat per day;  
21 1 cup low calorie vegetables; 1 serve of 15g carbohydrate food; 2 serves of low potassium  
22 fruits. Established fluid restrictions were maintained. The median study length in this study  
23 was 364 days. The most dramatic weight loss was noted in the first 8-12 weeks. In contrast,  
24 Friedman et al<sup>24</sup>, used an adapted VLCD for weight loss in patients with advanced diabetic  
25 nephropathy for a period of 12 weeks. Participants were advised to include 4 VLCD

1 products per day and one lean meal consisting of 2 serves of vegetables and 1 serve of protein  
2 and a daily multivitamin supplement. The diet was composed of 75g protein and 800kcal/  
3 3360KJ per day with all essential vitamins and minerals provided. Carbohydrate content was  
4 restricted to less than 50g per day to induce ketosis and suppress appetite. Based on these  
5 limited studies, a modified protocol is suggested as shown in Table 3. Low potassium  
6 vegetables and fruit can be included if required.

7

### 8 **What monitoring is required ?**

9 Standard VLCD protocols recommend regular, ideally fortnightly follow up <sup>13</sup>, with  
10 additional medical monitoring for patients classified as high risk. Patients are classified at  
11 high risk if they have a BMI > 27 kg/m<sup>2</sup> with co-morbidities; have a BMI>35 kg/m<sup>2</sup> and are  
12 taking prescribed medications during the VLCD; or are aged greater than 65years <sup>13</sup>. Based  
13 on these criteria, almost all patients with ESKD are likely to be classified at high risk.  
14 However, follow up at this level is often not practical <sup>24</sup>. Utilising telehealth to provide  
15 ongoing motivation and monitoring in addition to regular blood testing seems a pragmatic  
16 compromise in an already unwell population. Regular case discussion and review such as  
17 with a team that includes the Nephrologist, dietitian, renal nurse, GP or Endocrinologist may  
18 also be useful. For patients undertaking dialysis, frequent review of goal dry weight for  
19 dialysis should be completed to avoid fluid overload. For patients with diabetes, additional  
20 blood glucose monitoring should occur after commencement to monitor for hypoglycemic  
21 events. Monitoring of waist circumference can be unreliable and inaccurate in very obese  
22 patients so it is recommended to be used with caution. Recommendations regarding the  
23 frequency and type of monitoring are adapted from clinical treatment protocol literature <sup>13</sup>  
24 and are shown in Table 4. Liaison with the medical team is required to determine the

1 frequency of monitoring pathology such as uric acid, bicarbonate, vitamin D, and full blood  
2 counts.

3

#### 4 **What other factors require consideration when using VLCDs in CKD and ESKD ?**

- 5 • **Motivation and adherence level.** Adherence to VLCDs can be incredibly  
6 challenging. This is not just because eating is a social activity but also is a pleasurable  
7 one. VLCDs should only be recommended to highly motivated patients with adequate  
8 family and social support <sup>23</sup>. Recent qualitative research suggests that strategies such  
9 as structured reviews and support, early evidence of rapid weight loss, and knowledge  
10 of strategies about how to distract from temptations will enhance adherence <sup>29</sup>.  
11 Anecdotal reports from patients indicate the intensive phase may actually be easier to  
12 adhere due to ketotic suppression of appetite rather than during later phases when  
13 ketosis is mild or not present at all. Suggestions to overcome common barriers to  
14 adherence are provided in Supplementary Materials.
- 15 • **Weight goals for dialysis.** Due to the rapid weight loss associated with use of a  
16 VLCD, patients should be monitored closely. It is important to regularly reassess dry  
17 weight for individuals undertaking dialysis so as to avoid the risk of fluid overload.
- 18 • **Protein needs.** Will vary in patients with kidney disease depending on stage of CKD  
19 and dialysis method, Patients undertaking dialysis require protein in the order of more  
20 than 1.1g/ kg of adjusted body weight/ per day. An adjusted body weight refers to the  
21 nutrient requirements for an obese individual using a BMI of 26 kg/m<sup>2</sup>, which is the  
22 upper end of the healthy BMI range for an adult patient undertaking hemodialysis.
- 23 • There is a lack of evidence about how to meet these additional protein requirements  
24 while following VLCDs. Some clinicians may choose to include an additional shake  
25 or a serve of protein rich foods (although this does add extra kilojoules). Other

1 suggestions include adding protein powders such as Beneprotein™ (Nestle Nutrition,  
2 25 kcal / 105 kJ per scoop and 6 g protein). A new product on the Australian market  
3 called BodieZ Protein water™ may also be a useful addition by providing 30g protein  
4 in 500ml of fluid with negligible potassium, sodium and phosphate however will need  
5 to be included as part of the fluid allowance for fluid restricted patients.

- 6 • **Fluid requirements.** Patients with ESKD are required to limit their fluid intake. The  
7 VLCD prescription will need to be factored into the fluid allowance and patients  
8 should be advised that they need to maintain their fluid allowance whilst on the  
9 VLCD program. Use of bars rather than shakes may facilitate compliance with the  
10 fluid restriction.
- 11 • **Binder.** Phosphate binders may still be necessary for patients following the intensive  
12 phase of a VLCD. Monitoring of serum levels of phosphate for those at CKD stages  
13 3B-5D is important and should be accompanied by advice on adjustment of binders  
14 when required.
- 15 • **Dialysate bath strength.** May require adjustment and ongoing monitoring for those  
16 undertaking hemodialysis due to the alterations in dietary sodium, potassium and acid  
17 load likely to be experienced. Monitoring by the dialysis team is required.
- 18 • **Financial burden.** VLCDs are not available on prescription and will impose a  
19 financial burden in the order of ~\$50 AUD per week to maintain. Whilst this replaces  
20 all meals, for many patients this may prohibit commencement of a VLCD and  
21 potentially impact adherence.
- 22 • **Taste fatigue.** This is a common complaint for many patients undertaking a VLCD. It  
23 is strongly recommended that patients be encouraged to consume the appropriate  
24 quantity and amount of low carbohydrate vegetables to support adherence. Examples  
25 of the nutritional composition of these foods are shown in [Supplementary materials](#).



1 Fluids such as tea, herbal tea, coffee, soda water, low kilojoule mineral water, low  
2 kilojoule cordial, low kilojoule non-cola soft drinks, and low kilojoule jelly are all  
3 appropriate alternatives to water within the individual patient set fluid allowance.

4 Chewing of artificially sweetened lollies and chewing gum may also assist with taste  
5 fatigue and the temporary effects of halitosis. However, these may have a laxative  
6 effect if consumed in excessive amounts and can cause abdominal discomfort and  
7 diarrhea

- 8 • **Resumption of eating.** Whilst the focus of VLCD is on rapid weight loss, it is  
9 just as important to identify behaviors and strategies that will facilitate successful  
10 resumption of eating and long-term weight maintenance. Ongoing frequent  
11 contact with health professionals and a skilled multidisciplinary team led by a  
12 dietitian is associated with better results and should be encouraged.

#### 13 14 **Case study: a tale of two patients.**

15 The following table (Table 5) describes two patients with CKD who have been referred for  
16 VLCD. The first step in the assessment of these individuals would be to ascertain their  
17 motivation and readiness to change. Given that cognitive impairment<sup>30</sup> and low health  
18 literacy<sup>31</sup> are also common in end stage kidney disease it would be important to ascertain  
19 how well each patient understands what is being recommended and what the implications of  
20 the VLCD prescription will be. Given Patient 1 has a history of noncompliance it would be  
21 pertinent to explore what the challenges to compliance may be. If these patients were to agree  
22 to trial the intense VLCD prescription with three shakes per day then adjustments to insulin  
23 will be required in patient 1, and to antihypertensives and diuretics in Patient 2. Frequent  
24 review of dry body weight for dialysis will be required. Discussion about side effects such as  
25 hypoglycemia and dizziness would be required. Strategies to prevent constipation by

1 ensuring adequate intake of low carbohydrate vegetables, fruits, and salad items or via the  
2 use of a suitable fiber supplement would also be prudent. In the case of Patient 1, additional  
3 discussion would be required to determine how to obtain an adequate protein intake on a  
4 VLCD while undertaking haemodialysis. Options to meet protein targets could include the  
5 use of a VLCD protein supplement bar, which offers the additional benefit of extra protein  
6 while limiting fluid intake compared to using additional VLCD shakes, desserts or soups.

7

### 8 **Conclusion**

9

10 The use of VLCDs in patients with CKD provides additional challenges to the health care  
11 team. However, with modifications to the protocol and careful monitoring and selection of  
12 the patient this can be a potentially successful alternative weight loss option for patients who  
13 wish to improve their health outcomes.

14

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21 *Contributions:* Research idea and study design: KL, MR. Each author contributed important  
22 intellectual content during manuscript drafting or revision and accepts accountability for the  
23 overall work by ensuring that questions pertaining to the accuracy or integrity of any portion  
24 of the work are appropriately investigated and resolved. KL takes responsibility that this  
25 manuscript has been reported honestly, accurately, and transparently and that no important

1 aspects of the study have been omitted; and that any discrepancies from the study as planned

2 (and, if relevant) have been explained.

3

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Table 1. Comparison of nutritional composition of common VLCD products (when used as three shakes per day)

	Optifast	Optislim	Cambridge Weight Plan	EBG recommendation Stage 3-4 CKD	EBG recommendation Stage 5 dialysis
Calories / day Kilojoules / day	600 / 2517	582 2447	472 1986	2500-2920 10 500-12 264	2500 10 500
Carbohydrate (g/day)	59	59	53	295	295
Protein (g/day)	54	59	38	63-84	92
Fiber (g/day)	10.3	1.4	11.0	25-30g	25-30g
Fat (g/day)	14	15	10.0	57	57
Fluid recommendation (ml/day)	2100-2600			<1500ml *	<1000ml *
Sodium (mmol/day)	51	56	45	<100 mmol	<100 mmol
Potassium (mmol/kg)	58	44	54	<84 mmol *	<84 mmol
Phosphorus (mg/day)	1140	1001	882	<1000mg	<1000mg

Legend: EBG: evidenced based guideline.; \*indicates may be different depending on symptoms and/or biochemistry results. Table 1 adapted from information from Gibson et al <sup>6</sup>. Energy requirements are adjusted and based on BMI 26 kg/m<sup>2</sup> (84kg). Requirements for carbohydrate and fat are based on recommendations to consume a minimum of 45% of kilojoules from carbohydrate; less than 30% of kilojoules from fat <sup>14</sup>. Protein intake for stage 3-4 CKD is based on 0.75-1g/kg adjusted body weight <sup>12</sup>; for stage 5 CKD protein intake is calculated using 1.1g/kg <sup>24</sup> for an adjusted body weight of 84kg. Adjusted body weight refers to nutrient requirements for an individual with a BMI of 26 kg/m<sup>2</sup>, which is the upper end of the healthy BMI range for an adult patient undertaking hemodialysis.

Table 2: Medications and recommended adjustments in CKD for VLCD program

<b>Medication type</b>	<b>Suggested adjustment</b>
Hypoglycaemic agents	<p>Sulphonylureas and insulin need to be reduced at the start of the program. Recommend review with GP/Endocrinologist before starting VLCD.</p> <p>Recommend blood glucose monitoring q.i.d per day. Start VLCD on a weekend</p>
Insulin	<p>Insulin requirements will require adjustment.</p> <p>For patients aware of their carbohydrate to insulin ratio, a suitable dose adjustment to their basal insulin should be made. A reduction in the basal should be considered due to a reduction in hepatic glucose production. On the intensive phase, a 50% reduction dose is suggested a starting point. However, patients should not withhold or significantly reduce the basal insulin dose without discussion with their diabetes specialist. Basal insulin should never be completely ceased to avoid the risk of ketoacidosis.</p> <p>Patients on twice daily mixed insulin are usually best managed by changing the dose of insulin to a basal insulin at half the previous total dose.</p>
Antihypertensive agents	<p>Blood pressure decreases with weight loss. VLCDs have a diuretic effect and adjustment of diuretics at commencement of VLCD may be required.</p>
Lipid lowering drugs	<p>Monitor and decrease unless familial hyperlipidemia</p>
Warfarin	<p>Monitor INR for deviations from the therapeutic range as intake of Vitamin K will alter compared to usual intake</p>
Digoxin	<p>Monitor for deviations from the therapeutic range</p>
Lithium	<p>Monitor level and thyroid function. Ensure adequate fluid intake</p>

Table 3. Suggested VLCD prescription and suitability according to stage of CKD

	Intensive phase	Controlled phase	Maintenance phase
<p>CKD Stage 1-2</p> <p>Suitable for standard VLCD program</p>	<p>3 shakes per day, 2 cups low carbohydrate vegetables, liberal fluid intake &amp; 1-2 teaspoon oil daily</p> <p>Provides: ~2970 kJ / 710 kcal, 65g protein, 18 g fiber, 31 mmol Na, 92 mmol K, 986 mg Ca, 1171 mg P.</p> <p>Monitor for constipation</p>	<p>2 shakes per day, 1 light meal<sup>1</sup>, 1 serve dairy (~400 kJ /100 Kcal or 150ml reduced fat milk), 1 serve fruit (300 kJ/70Kcal) &amp; liberal fluid intake</p> <p>Provides: ~ 3962 kJ/ 947 Kcal, 72g protein, 19g fibre, 26 mmol Na, 84 mmol K, 1202 mg Ca, 1193 mg P</p> <p>Monitor for constipation</p>	<p>1 shake per day, 2 light meals<sup>1</sup>, 2 serves dairy (~400 kJ /100 Kcal each or 300ml reduced fat milk), 2 serves fruit (~300kJ / 70 Kcal each) &amp; liberal fluid intake</p> <p>Provides: ~ 5475 kJ /1308kcal, 84g protein, 31g fibre, 24mmol Na+, 96mmol K+, 1148mg Ca, 1314mg P</p> <p>Monitor for constipation</p>
<p>CKD Stage 3-4</p> <p>Stage 3 – suitable for standard VLCD program with close monitoring of renal function and electrolytes initially</p> <p>Stage 4 – contact nephrologist to discuss suitability. If suitable close monitoring of renal function, electrolytes and fluid status is recommended.</p>	<p>3 shakes per day, 2 cups low carbohydrate vegetables<sup>2</sup>, fluid intake as per medical team &amp; 1-2 teaspoon oil daily</p> <p>Provides: : ~2970 kJ / 710 Kcal, 65g protein, 18 g fiber, 31 mmol Na, 92 mmol K, 986 mg Ca, 1171 mg P.</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is recommended.</p>	<p>2 shakes per day, 1 light meal<sup>1, 2</sup>, 1 serve dairy (~400kJ / 100 Kcal or 150ml reduced fat milk),1 serve fruit* (300 kJ/70 Kcal) &amp; fluid as per medical team</p> <p>Provides: ~3962 kJ / 947 Kcal, 72g protein, 19g fiber, 26 mmol Na, 84 mmol K, 1202 mg Ca, 1193 mg P</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is recommended.</p>	<p>1 shake per day, 2 light meals<sup>1, 2</sup>, 2 serves dairy (~400 kJ /100 Kcal each or 400ml reduced fat milk ), 2 serves fruit<sup>2</sup>, (~300 kJ / 70 Kcal each) &amp; fluid as per medical team</p> <p>Provides: 5475 kJ /1308 Kcal, 84g protein, 31g fiber, 24mmol Na+, 96mmol K+, 1148mg Ca, 1314mg P</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is</p>



	Monitor for constipation	Monitor for constipation.	recommended. Monitor for constipation
<p>CKD Stage 5D</p> <p>Contact nephrologist to discuss suitability. Those not suitable may include those with poor motivation, poor adherence to their insulin regimen and /or dialysis prescription, those with financial restrictions and those who lack social support. If suitable for commencement, close monitoring of electrolytes, fluid status, ideal dry weight is recommended</p>	<p>4 shakes per day, 1 cup low carbohydrate vegetables <sup>2</sup>, fluid intake as per allowance &amp; 1 tsp oil daily.</p> <p>Alternatively, the patient could also use 3 shakes per day and a dietitian prescribed portion of appropriate protein powder or protein water or high protein food. This may be preferable is a potassium restriction is required</p> <p>Provides (based on for shakes per day): ~ 3810KJ/912Kcal, 85g protein, 22g fiber, 40mmol Na+, 116mmol K+, 1405mg Ca, 1531mg P</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is recommended. Monitor for constipation</p>	<p>2 shakes per day, fluid intake as per allowance, 1 light meal <sup>2,3</sup>, 1 serve dairy (~400 kJ /100 Kcal or 150ml reduced fat milk), 1 serve of fruit <sup>2</sup> (~300 kJ/70kcal).</p> <p>Provides: ~ 4235KJ/1012Kcal, 82g protein, 19g fiber, 27mmol Na+, 87 mmol K+, 1207mg Ca, 1289 mg P</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is recommended. Monitor for constipation</p>	<p>1 shake per day , fluid intake as per allowance, 2 light meals <sup>2,3</sup>, 1 serve dairy (~400kJ /100 kcal or 150ml reduced fat milk), &amp; 2 serves of fruit <sup>2</sup> (~300 kJ each).</p> <p>Provides: ~ 6022KJ,1439 Kcal, 104g protein, 31 g fiber, 25mmol Na+, 102mmol K+, 1157mg Ca, 1506mg P</p> <p>Binders are recommended if phosphate level is outside the reference range. Monitoring of serum potassium is recommended. Monitor for constipation</p>

Note:

Nutrient analysis based on Optifast use. Estimate of nutritional composition will vary depending on the type of food selected in the meal plan.

1. Meal composed of 1-2 slice bread or up ½ cup rice or 1 cup pasta and 65g meat or chicken /or 130g fish and 2 cups low carbohydrate vegetables and 1-2 teaspoons of oil. This would provide ~ 1500 kJ/357 Kcal
2. At later stages of CKD the low carbohydrate vegetables and fruit may need to be low potassium choices.
3. Meal composed of 1-2 slice bread or up ½ cup rice or 1 cup pasta and 100g meat or chicken /or 130g fish and 2 cups low carbohydrate vegetables and 1-2 teaspoons of oil. This would provide ~ 1700 kJ/405 Kcal

Table 4. Suggested monitoring during VLCD for patients with CKD

<b>Variable</b>	<b>Baseline measurement</b>	<b>Monitoring frequency after commencement of VLCD</b>
<i>Anthropometry</i>		
Weight* and BMI	✓	Every 2 weeks
Waist circumference	✓	Every 2 weeks
<i>Clinical measures</i>		
Blood pressure	✓	Every 2 weeks
<i>Biochemistry</i>		
Electrolytes/urea/creatinine	✓	Every 2-6 weeks depending on CKD stage
Serum bicarbonate	✓	Every week in at risk patients (patients with diabetes requiring insulin).
Calcium / Magnesium / Phosphate	✓	Every 2-6 weeks depending on CKD stage
Liver function tests	✓	Every 6 weeks
Post prandial blood glucose level	✓	Every 2 weeks or more frequently if hypoglycemia occurs
Fasting glucose in those with diabetes	✓	Every 2 weeks
Cholesterol/Triglycerides/HDL	✓	Every 6 weeks
Uric acid	✓	At discretion of medical team
Full blood count	✓	At discretion of medical team
Iron studies	✓	At discretion of medical team
C Reactive protein	✓	At discretion of medical team

<b>Variable</b>	<b>Baseline measurement</b>	<b>Monitoring frequency after commencement of VLCD</b>
1,25 hydroxy Vitamin D	✓	At discretion of medical team
Thyroid stimulating hormone	✓	At discretion of medical team

\*Ideal dry weight may need frequent re-assessment to avoid fluid overload whilst on VLCD

Table 5. Case study of two patients referred for VLCD prescriptions

Patient 1, 51-year-old male undertaking haemodialysis	Patient 2, 47-year-old female, Stage 3B CKD
Referred for VLCD to be eligible for kidney transplant	Referred for VLCD to reduce progression of CKD
BMI 37 kg/m <sup>2</sup> (weight 122kg)	BMI of 31kg/m <sup>2</sup> (weight 87 kg)
T2DM on insulin, retinopathy, gout, hyperlipidemia, cholecystectomy	Hypertension, Glomerulonephritis
Poor compliance with 1000ml fluid restriction and interdialytic weight gain more than 3L regularly. Does not test blood glucose levels regularly	Many attempts at weight loss previously but unsuccessful
Medications include Sevelemer 1 bd, 25 units Insulin glargine (Lantus), insulin aspart (Novorapid) 5 units tds, Rosuvastatin, Darbepoetin alfa, calcium carbonate 1 tds, calcitriol, Ergocalciferol	Medications include Metoprolol, Rosuvastatin, Ramipril, Clopidogrel, fish oil, Ergocalciferol, Spironolactone, vitamin B12
<u>Calculated requirements</u> (Based on an adjusted weight of 92kg) Protein = 101g/day (1.1g/kg) Fluid=1000ml/day Potassium=92mmol/day (1mmol/kg) Phosphate=800-1000mg	<u>Calculated requirements</u> (Based on an adjusted weight of 75kg) Protein = 56-75g/day (0.75-1.0g/kg) Fluid=2615-3360ml/day (in absence of a fluid restriction) Potassium=75mmol/day (1mmol/kg) Phosphate= RDI recommended

Supplementary Materials Table 1. Nutrition Profile of major VLCD products in Australia and New Zealand.

<b>Item</b>	<b>Serve Size</b>	<b>Cals</b>	<b>kJ</b>	<b>Protein (g)</b>	<b>CHO (g)</b>	<b>Fat (g)</b>	<b>Fibre (g)</b>	<b>Na (mmol)</b>	<b>K (mmol)</b>	<b>P04 (mg)</b>
Optifast VLCD Shake (all flavours average)	53g	201	840	20	18.2	4.5	3.6	9.3	25	360
Optifast VLCD Bar (Berry Crunch)	60g	238	1000	17.1	22.8	7.8	4.1	15.9	18	560
Optifast VLCD Bar (cappuccino)	60g	235	990	17.1	22.2	7.7	4.2	15.9	18.5	570
Optifast VLCD Bar (Cereal)	65g	201	890	18.2	22.1	5.2	2	17.6	17.6	550
Optifast VLCD Bar (chocolate)	70g	228	950	17.8	17.8	7.6	8.4	10.9	22	525
Optifast VLCD Soup (vegetable)	54g	201	840	20	18.2	4.5	3.6	33	25	360
Optifast VLCD Soup (chicken)	48g	201	840	20	18.2	3.6	3.6	28.7	25	360
Optifast VLCD Soup (tomato)	54g	201	840	20	18.2	3.6	3.6	31.5	20	360
Optifast VLCD Dessert (all flavours)	46g	201	840	20	18.2	4.5	3.6	23.7	25	580

Nutrition Profile Optifast® VLCD™ Product Range (adapted from reference 9)

Nutrition Profile of Optislim® VLCD Product Range (adapted from reference 11)

<b>Item</b>	<b>Serve Size</b>	<b>Cals</b>	<b>kJ</b>	<b>Protein (g)</b>	<b>CHO (g)</b>	<b>Fat (g)</b>	<b>Fibre (g)</b>	<b>Na (mmol)</b>	<b>K (mmol)</b>	<b>P04 (mg)</b>
Optifast VLCD Shake (all flavours average)	40	150	628.4	14.1	16.94	2	N/A	16.5	17.5	264.96
Optislim VLCD Bars (cookies and cream)	60	214	896	19	17.6	7.4	0.7	16.1	14.3	476
Optislim VLCD Bar (choc fudge)	60	215	900	18.5	17.2	7.6	1.1	16	16.8	508
Optifast VLCD Bar (caramel crunch)	60	214	894	19.4	17.3	7.3	0.7	16.5	15	493
Optifast VLCD Bar (berry crunch)	60	214	896	18.1	18.4	7.5	0.8	20.7	14.6	568
Optislim Life Soup (creamy chicken)	50	206	860	15.4	20.2	7.2	N/A	27.5	13.6	250
Optislim Life Soup (pumpkin)	50	205	856	14.3	21.7	3.6	N/A	27.5	13.6	250
Optislim Life Soup (tomato)	50	206	862	15.3	21.4	2.1	N/A	19.4	13.6	250

Legend: Cals: Calories; kJ: kilojoules; CHO: carbohydrate; Na: sodium; K: potassium Po4: phosphate

Supplementary Materials Table 2. Suggestions for managing adherence to a VLCD.

Issue	Suggestions for patients
<b>“Finding it difficult to prepare the VLCD diet at work”</b>	<ul style="list-style-type: none"> <li>• Use a wide brim water bottle to mix up VLCD shakes</li> <li>• Try VLCD bars instead</li> </ul>
<b>“I am used to having a snack between meals”</b>	<ul style="list-style-type: none"> <li>• Halve a VLCD Bar and consume half at morning tea, the other half at afternoon tea and eat a salad or cooked vegetables at lunch</li> <li>• Include other snack items in between meals such as diet jelly, or low-carbohydrate, low potassium (where needed) vegetables</li> <li>• If you are undertaking the controlled or maintenance phase, include 1-2 pieces of fruit (use low potassium choices if needed); or a low-fat yoghurt (~150g) as a snack between meals</li> <li>• Drink adequate fluid within fluid restriction levels (where needed) and obtain an adequate sleep each night to make sure hunger signals are not signals of thirst or tiredness</li> </ul>
<b>“I am just too hungry, it is too restrictive”</b>	<ul style="list-style-type: none"> <li>• If the VLCD program is followed correctly, most people find appetite is controlled after the first week of the intensive phase</li> <li>• If additional carbohydrates are avoided, you should enter a state of ketosis and this will further reduce appetite</li> <li>• If struggling to stick to the program, a small portion of lean meat or fish can be included in the first week prior to the onset of ketosis to help manage hunger levels</li> <li>• Ensure hunger signals are not mistaken for cues to eat due to boredom or stress</li> </ul>
<b>“I seem to have hit a plateau and my weight is not decreasing ”</b>	<ul style="list-style-type: none"> <li>• Consider increasing exercise intensity to burn more calories or alternatively look at ways to increase daily activity levels. A pedometer is a useful tool to measure this</li> <li>• Individuals should try aiming for 8,000-12,000 steps per day, increasing up to this amount gradually from your current level of activity</li> </ul>
<b>“I have too many social outings involving eating out and I don’t want to miss out on these”</b>	<ul style="list-style-type: none"> <li>• Focus on the other aspects of socialising such as the people they are with and the location rather than focusing solely on the food and drink</li> <li>• Try having VLCD product prior to going out to reduce appetite and then choose low starch salad or vegetables (low potassium if needed)</li> <li>• Try stir-fry vegetables, or a garden salad with the dressing on the side (no creamy sauces). If possible, skip the</li> </ul>



	<p>carbohydrate foods on offer and have a small or no serve of protein.</p> <ul style="list-style-type: none"> <li>• Try omitting that VLCD shake or meal and opt for a small portion of protein such as 100g meat or chicken, some fish or eggs</li> <li>• Avoid alcohol - have a sparkling mineral water with a wedge of lemon or lime in it or a diet soft drink served in a champagne or wine glass</li> <li>• For patients undertaking the controlled or maintenance phases, choose grilled meat, chicken or fish with a side salad or cooked low starch vegetables</li> <li>• Always ask for the sauce / dressing to be omitted or placed on the side to control the amount that is put on the meal</li> <li>• Always choose your own meal, and if possible avoid banquets and sharing meals</li> <li>• If possible, get a copy of the menu prior to going out so you can take your time to review the menu options</li> </ul>
<p><b>“I don’t want to consume shakes and salads in the cold weather ”</b></p>	<ul style="list-style-type: none"> <li>• Try making Shakes with warm water (not boiling) or can try the VLCD Soups</li> <li>• Consume cooked vegetables instead of salad (low potassium if needed)</li> <li>• Make your own low-calorie soup from the allowed vegetables (use low potassium if needed)</li> </ul>
<p><b>“I am getting constipated”</b></p>	<ul style="list-style-type: none"> <li>• Ensure all of the fluid allowed is consumed (within fluid restriction if needed)</li> <li>• Try to consume the recommended 2 cups of low starch vegetables per day</li> <li>• Exercise daily to help keep bowels healthy and regular</li> <li>• Consider using a fibre supplement such as Benefibre or laxative such as Movicol / Osmolax</li> </ul>
<p><b>“Everyone around me is concerned that the diet is too strict”</b></p>	<ul style="list-style-type: none"> <li>• Reassure your supporters that this program is supervised and effective.</li> <li>• Ask them to help exercise with you to facilitate weight loss</li> <li>• Consider if desired, moving between phases as your individual goals or lifestyle changes over time</li> </ul>
<p><b>“It is too boring”</b></p>	<ul style="list-style-type: none"> <li>• Vary the type of products used. Try shakes of all flavours, soups, bars and desserts with the serves of low carbohydrate vegetables and fruit.</li> <li>• Vary flavours for salads and vegetables by adding fresh or dried herbs and spices, and trying different types of low carbohydrate vegetables (use low potassium if needed)</li> <li>• Add different colours to the plate to help make the meal look</li> </ul>

	appealing
<b>“I don’t seem to have enough energy”</b>	<ul style="list-style-type: none"> <li>• High intensity exercise uses predominantly carbohydrates. During the intensive phase minimal amounts of carbohydrates are consumed; therefore, lower intensity exercise and weights may be easier for the individual.</li> <li>• Vary the time of day you exercise</li> <li>• Choose an exercise that you enjoy or exercise with a friend to improve motivation levels</li> <li>• Even if exercise intensity and duration is slightly reduced, some exercise is still better than none as it improves metabolism and helps preserve metabolic muscle tissue</li> <li>• Drinking sufficient fluids (within fluid restriction levels if needed) and getting adequate sleep will also help improve energy and motivation to exercise</li> </ul>
<b>“I keep getting headaches”</b>	<ul style="list-style-type: none"> <li>• This is normal in the first few days of the intensive phase and indicates the transition into ketosis.</li> <li>• Consider trialling an alternative phase eg controlled phase if unable to persist.</li> </ul>
<b>“I’m not losing any weight”</b>	<ul style="list-style-type: none"> <li>• This is very unlikely to occur during the intensive phase if followed correctly.</li> <li>• Consider adjusting ideal body weight for dialysis patients as this may suggest fluid overload if the individual is not losing weight and they are compliant with the prescription.</li> <li>• If the individual has not included regular exercise, then consider introducing gentle low intensity exercise. The combined effects of exercise plus a VLCD have been shown to increase the retention of lean muscle mass and reduce fat mass.</li> </ul>

Supplementary materials: Table 3. Recommended low carbohydrate, low potassium vegetables for consumption during a VLCD

<b>Item</b>	<b>Serving Size (g)</b>	<b>Energy (calories)</b>	<b>Energy (kilojoules)</b>	<b>Protein (g)</b>	<b>Carbohydrate (g)</b>	<b>Sodium (mmol)</b>	<b>Potassium (mmol)</b>	<b>Phosphate (mg)</b>
Sprout, alfalfa, raw	100g	22	91	3.2	0.5	1.7	1.5	65
Asparagus	50g	11	45	1.25	0.7	0.04	4	24.5
Spout, bean, raw	100g	20	84	2.7	1.4	0.04	3.3	36
Cabbage, bok choy, raw	50g	10	41	1.3	0.3	1.3	5	14
Brussels sprout, fresh,	50g	18	75	1.9	1.05	0.65	5	Not listed
Cabbage, white, raw	50g	13	54.5	0.8	1.7	0.33	3.7	20
Capsicum, red, raw	100g	25	106	1.5	3.5	0.09	4.5	28
Carrot, mature, peeled	50g	16	66	0.4	2.5	0.87	3.6	18
Cauliflower, raw	50g	12	49.5	1.05	0.95	0.67	3.8	25
Celery	50g	7.6	32	0.3	1.15	2.11	3.4	14.5
Cucumber, Lebenese,	100g	12	51	0.4	1.9	0.83	3.4	44
Eggplant, raw	100g	21	89	1	2.4	0.22	4	28
Fennel, raw	50g	11	46	0.5	1.65	0.83	4	Not listed
Garlic, peeled, raw	25g	31	131	1.5	2.55	0.09	3	Not listed
Bean, green, fresh, raw	50g	15	61	1.2	1.35	0.04	2.8	21
Konjac noodles	100g	10.5	44	0.1	<0.5	0.02	Not listed	Not listed
Lettuce, iceberg, raw	50g	4.8	20	0.5	0.2	0.57	2.6	12.5
Mushroom, common	50g	12	52	1.65	0.7	0.17	4	55
Onion, brown	100g	30	127	1.7	4.6	0.48	4	39
Radish, red skinned	100g	15	62	0.8	1.9	0.87	4.6	20
Shallot, peeled, raw	50g	12	52	0.8	1.6	1.17	2.9	17.5
Silverbeet, raw	50g	8	35	0.8	0.55	4.6	3.6	17
Snowpea, raw	50g	18	76	1.45	2.25	0.02	5	21
Squash, button, raw	100g	26	110	2.7	3.2	0.04	3.6	Not listed
Tomatoes, common,	50g	9	37	0.5	1.2	0.17	2.7	13

Tomatoes, cherry, raw	50g	7.7	33	0.25	1.1	0.22	3	Not listed
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Nutrient composition data obtained from Food Standards Australia and New Zealand located at

<http://www.foodstandards.gov.au/science/monitoringnutrients/afcd/Pages/foodsearch.aspx>