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Ketogenic Diet Versus a Standard Low-Calorie Diet to Treat Mildly Obese Patients in an Outpatient Clinic: An Observational Retrospective Study

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Abstract

Purpose: The aim of this study is to evaluate the effectiveness of a Very Low-Calorie Ketogenic Diet (VLCKD) compared to a Low-Calorie Diet (LCD) in the treatment of mildly obese patients. We aimed to highlight the difference in weight loss, compliance, physical activity levels and drop-out rates between the VLCKD group and the standard LCD one.

Methods: In this retrospective observational study, data from 154 patients were analysed, 87 of whom were on a very low-calorie ketogenic diet and 67 on a standard low-calorie diet. Dropout rate at 6 months was 46% in the ketogenic diet group and 68% for the low calories group.

Results: After 6 months, the LCD patients experienced a mean weight loss of 7 kg compared to the significantly higher average of 12 kg lost by the VLCKD patients ($p<0,0031$). Moreover, the VLCKD group had a lower drop-out rate than the standard LCD one.

Conclusions: Our conclusion therefore is that the ketogenic diet is a more effective dietetic intervention than a standard low-calorie diet in the treatment of obesity due to a greater weight loss in the medium term and better patient compliance.

Keywords: Obesity; Ketogenic Diet; Physical Activity; Low-Calorie Diet; Very Low-Calorie Ketogenic Diet

Introduction

Obesity is defined as an abnormal or excessive fat accumulation which represents a risk to health; it is considered a risk factor for several chronic diseases including diabetes, cardiovascular diseases and cancer. It was once considered a problem only in high-income countries, but nowadays overweight and obesity are dramatically on the rise in low- and middle-income countries too, especially in urban settings [1]. Challenging obesity represents one of the major public health challenges of the 21st century.

According to WHO, obesity is an excessive fat accumulation that presents a risk to health. The body mass index (BMI) is a common method to measure it: a person with a BMI equal to or more than 25 kg/m^2 is considered overweight, while values equal to or higher than 30 kg/m^2 are diagnosed as obesity. A BMI between 30 and 34.9 kg/m^2 is classified as first-class obesity, between 35 and 39.9 kg/m^2 as second class and over 40 kg/m^2 as third-class obesity [2].

In 1998 the NIH defined as "therapeutic success" a weight loss of 10% of body weight achieved in a period of six months with a weight re-gain of maximum 3 kg in two years. This would still be adequate to improve the morbid component due to excessive fat accumulation [3].

Therapeutic interventions in obese patients are many and range from a dietetic consultation to bariatric surgery.

The aim of this study is to compare the use of a ketogenic diet and a low-calorie one in the treatment of mild/moderate obesity, by evaluating weight loss, compliance with the assigned dietetic plan, compliance to physical exercise recommendations, and the drop-out rate of patients in the short term. It also aims to highlight whether a ketogenic diet could be effective in the treatment of mild obesity and whether it could be more effective than a standard hypocaloric scheme [4].

Material and Methods

In this retrospective observational study, 154 patients were selected from the weight control clinic in Humanitas Gradenigo Hospital in Turin. These patients received a dietetic treatment aimed at weight loss and maintenance. Patients started either a VLCKD ketogenic diet or a standard LCD low-calorie diet. The VLCKD group consists of 87 patients, while the LCD group is composed of 67 patients. This study was not submitted to the ethics committee because our institution's guidelines do not consider it to be needed for retrospective observational studies.

Inclusion and exclusion criteria

Inclusion criteria:

- Both men and women between 18 and 65 years old;
- BMI between 30 and 39.9 kg/m^2 (obesity class I and II).

Exclusion criteria:

- Patients treated with anorectic drugs;
- Patients with severely dysfunctional, emotional or compensatory changes in eating behaviour (observed from dietetic history);
- Presence of severe comorbidity such as cancer, diabetes, recent major surgery, recent heart attack, severe mobility issues, diverticulitis, pancreatitis, IBD.

Dietetic treatment

The two therapeutic interventions were not set up through randomized criteria but based on a team decision. The team was composed of endocrinologists, dieticians and psychologists. They took into consideration:

- dietetic history and previous dietetic interventions,
- eating patterns including timings, food choices and patient's self-management skills,
- general approach towards food and predisposition to following a very strict diet rather than a more balanced and freer one,
- patient's need of reaching short-term results for motivational or clinical reasons (i.e. chronic pain, respiratory issues);

Both groups received the same advice on physical exercise and the same psychological support.

Diet composition

The ketogenic diet was divided into 3 phases: a therapeutic one, a transitioning one and a maintenance one. During the therapeutic phase, which lasted 60 days, patients consumed 800 kcal/day of which <30 g/day of carbohydrates, 1.3-1.5 g/ideal body weight/day of proteins and 10-30 g/day of fats. During this phase, patients were advised to use 2 meal replacements a day. The meal replacements are "NewPenta" products (New Penta, Castelletto Stura, Italy) in single portions of 15-20 g of protein, derived from eggs, dairies and vegetable sources (proteins from milk, eggs, soy, lupine, wheat). The meals are enriched with prebiotic fibres as well. A multivitamin and multi mineral supplement (Pentacal Plus by New Penta, Castelletto Stura, Italy) was prescribed too.

During the transitioning phase, which lasted 4 weeks, patients gradually reintroduced slow-release carbohydrates at a rate of increase of 30 g/week (respectively 60 g, 90 g, 120 g and finally 150 g on the 4th week). During this phase they gradually left the ketosis state.

All patients were proved to be in ketosis as they were tested after 1 month with the test KETOSTIX, Ascensia Diabetes Care, Basel, Switzerland.

During the maintenance phase, all foods are gradually reintroduced and patients restart a balanced diet. Their calorific intake in this phase is calculated based on the patient's requirements which, in turn, is based on their ideal weight.

The LCD was a diet scheme ranging between 1200 and 1600 kcal/day which included metered food portions. The intake was calculated on 15-20 kcal/kg of weight which 55-60% were carbohydrates, 15-20% were proteins and 25-30% were fats. Some education about food quality and labelling of nutritional information was provided too.

Measurements

To compare the two dietary patterns in the treatment of obesity class I and II, changes in anthropometric measures were evaluated (weight and BMI) as well as compliance with the dietetic plan and exercise activity in each group. Diet recall and diet history were also investigated by the dietician. Weight and height were measured with scale and stadiometer SECA GmbH & Co, Hamburg, Germany, model 711. Height was measured in cm and weight to the nearest 0.1 kg.

Variations of these parameters were checked at each nutritional control Tables 1 and 2.

VLCKD	BMI		WEIGHT (kg)	
	Median	Range	Median	Range
T0	33,9	(30- 40)	90,8	(65,5-130)
T1	31,5	(26,7-38,9)	84,1	(64-124,5)
T2	30,2	(24,6-36,5)	80,3	(62,7-110,8)
T3	29,4	(24,2-38,1)	78,5	(61,7-105,2)
T4	29	(22,9-38,3)	73	(61,6-103,5)
T5	29,4	(22,1-37,5)	77,3	(60-98,6)

Table 1: Weight and BMI measured during follow-up appointments in the VLCKD group

LCD	BMI		WEIGHT (kg)	
	Median	Range	Median	Range
T0	33,9	(30- 40)	89,5	(65-126,8)
T1	33,2	(28,1- 41,8)	88,7	(68-121)
T2	31,5	(25,8- 38,9)	86	(62,5-124)
T3	30,5	(24,5-36,4)	83,1	(64,5-114)
T4	30,7	(25-37)	70,6	(64-99,5)
T5	30,6	(25,5-36,1)	83,5	(64-101)

Table 2: Weight and BMI measured during follow-up appointments in the LCD group

At each point in time the following parameters were measured: weight, BMI, percentage change in weight. Diet was also monitored (intakes of carbohydrates (maximum 30 g/day), proteins, fats, fibre, and fluids) and other factors such as bowel movements, level of appetite (suppressed/non-suppressed), and sense of wellbeing (energy levels) were recorded.

Physical activity

WHO global recommendations on physical activity were given to both groups of patients (4). The compliance to these was scored as follows:

- <150 minutes/week of aerobic physical activity at moderate intensity was scored as 0
- 150 minutes/week of aerobic physical activity at moderate intensity or 75 minutes/week of aerobic physical activity at vigorous intensity was scored as 1
- >300 minutes/week of aerobic physical activity at moderate intensity or >150 minutes/week of aerobic physical activity at vigorous intensity was scored as 2

The scores were assessed for each patient at each visit.

Dietetic counselling

Dietetic counselling was performed by a registered dietician. During the first visit, all motivational aspects and expectations of the patients were assessed. Psychological help was provided by the team when needed. Critical issues in compliance were discussed and the discussion of such issues was useful to establish a good rapport between dietician and patient. Realistic goals were agreed and possible strategy changes were arranged during the months of treatment.

Statistical Methods

The continuous variables were processed into median and range, the categorical variables were processed into absolute frequency and percentages. To calculate the changes at different points in time within the same group or across different groups, we used the T-student test and Wilcoxon test. Data are represented in column graphs. Statistical significance was established at $p \leq 0.05$. All statistical analyses were performed using the program MedCalc Statistical Software 18.9 Ostend, Belgium.

Results

Weight and BMI

As far as weight and BMI are concerned, both groups reported a decrease in these measures.

The VLCKD group, after 6 months, achieved a relevant weight loss and subsequent decrease in BMI. The VLCKD group was characterized by a mean initial weight of 90.8 kg (65.5-130 kg) and the ketogenic dietetic plan led to a reduction to a mean weight of 78.5 kg (61.7-105.2 kg); a mean weight loss of almost 12 kg. This group had an initial mean BMI of 33.9 kg/m^2 (30-40 kg/m^2). The use of VLCKD diet made the subjects fall into the overweight range limits after 6 months: mean BMI 29.3 kg/m^2 (24.2-38.1 kg/m^2). The mean BMI value decreased from 33.9 to 29.3 kg/m^2; a reduction of more than 4.5 kg/m^2.

The LCD group showed a lesser but still significant improvement in anthropometric measures after 6 months. LCD patients' weight had a preintervention mean value of 89.5 kg (65-126.8 kg) and low-calorie dietary treatment led, after 6 months, to a mean value of 83.1 kg (64.5-114 kg). The initial BMI of 33.3 kg/m^2 (30-40 kg/m^2) (medium class obesity), after 6 months of dietetic standard treatment underwent a reduction of more than 2.5 kg/m^2 settling on a BMI of 30.5 kg/m^2 (24.5-25.6 kg/m^2).

Comparing the two dietary treatments at 6 months, greater improvements were obtained through the ketogenic diet compared to the standard low-calorie one. The mean weight loss was 12 kg for VLCKD patients and 6.4 kg for LCD patients, showing a remarkable statistical difference at 6 months ($p<0.00031$). The difference in the reduction of the BMI value is 4 kg/m^2 for VLCKD group and 2.5 kg/m^2 for LCD group ($p<0.0012$).

Figure 1 describes the BMI trend at different times of the programme for both groups. As evidenced by the graphic, the drop in weight and BMI in the VLCKD group was sharper at 6 months (T3, $p <0.0012$) while the weight of LCD patients dropped more during the first 3 months (T2) and then they maintained the same weight up to 12 months without any significant difference between T2 and T5 ($p<0.069$). By contrast, VLCKD patients continued to lose weight in the first 6 months and then maintain it to 12 months. Moreover, the weight loss of these patients at 12 months is statistically significant compared to T2 ($p<0.046$).

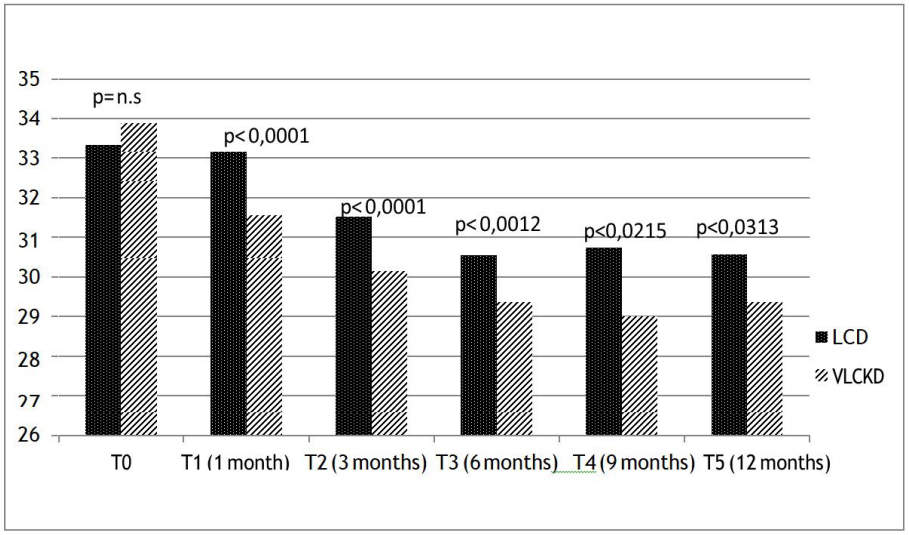

Figure 1: Trend of the BMI from T0 to the last follow-up

This trend underlines how VLCKD performs better, not only as an effective means for initial weight loss, but also for continued weight loss, in the treatment of mild obesity.

Drop out and compliance

A consistent reduction in the number of patients was recorded at every control point. VLCKD patients, who were supposed to have a stricter and more difficult diet to be maintained over time have a, surprisingly, lower percentage of dropouts. There were no dropouts due to clinical reasons or side effects.

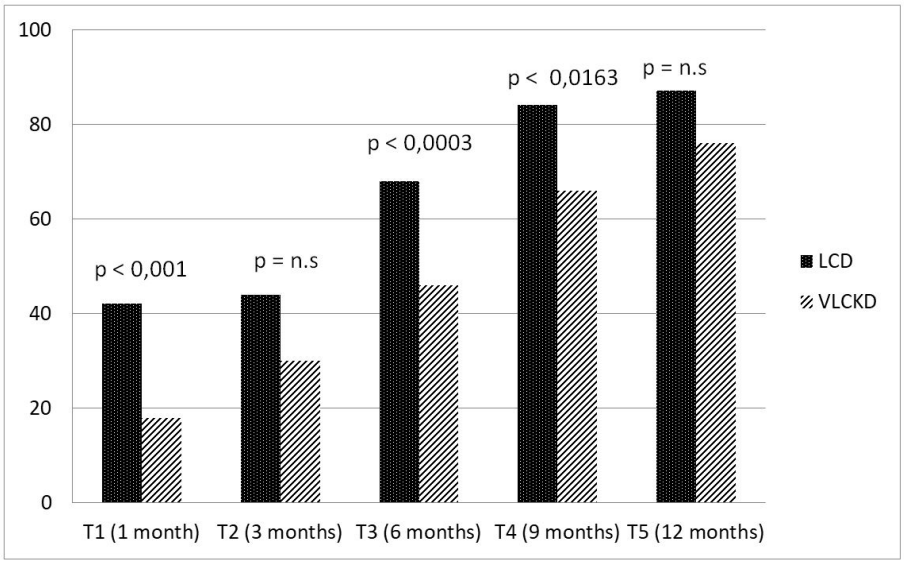

Figure 2: Trend of the percentage weight loss from the first visit to the 12 months

After one month from the beginning of the intervention, the VLCKD group had a dropout rate of 18% while the LCD group of 42%, with a statistically significant difference ($p<0.001$). Both groups, after 6 months of dieting, had a high rate of dropouts: 46% from the VLCKD group and 68% from the LCD (Figure 2). Such a difference in dropouts is statistically significant ($p<0.00003$). After 9 months the dropout rate was 66% in the VLCKD group and 84% in the LCD group, with a significant difference between groups ($p<0.0163$).

In addition to a minor dropout, VLCKD patients had a better compliance to the dietetic scheme and a high adherence to the exercise recommendations compared to LCD patients. The compliance to the diet was measured with a Ketur Test at each visit. In addition to this test, patients completed a short questionnaire investigating their sense of hunger, fatigue and general wellbeing.

Patients' compliance to the diet was measured after 1 month: 88.9% of VLCKD patients and 69.2% of LCD patients were adhering to the dietetic scheme, the difference between groups is statistically significant ($p<0.013$). After 3 months, 91% of VLCKD patients and 56.4% LCD patients were compliant, this difference is again statistically significant ($p<0.001$). From the 6th month on, the difference in compliance is not significant anymore (Figure 3).

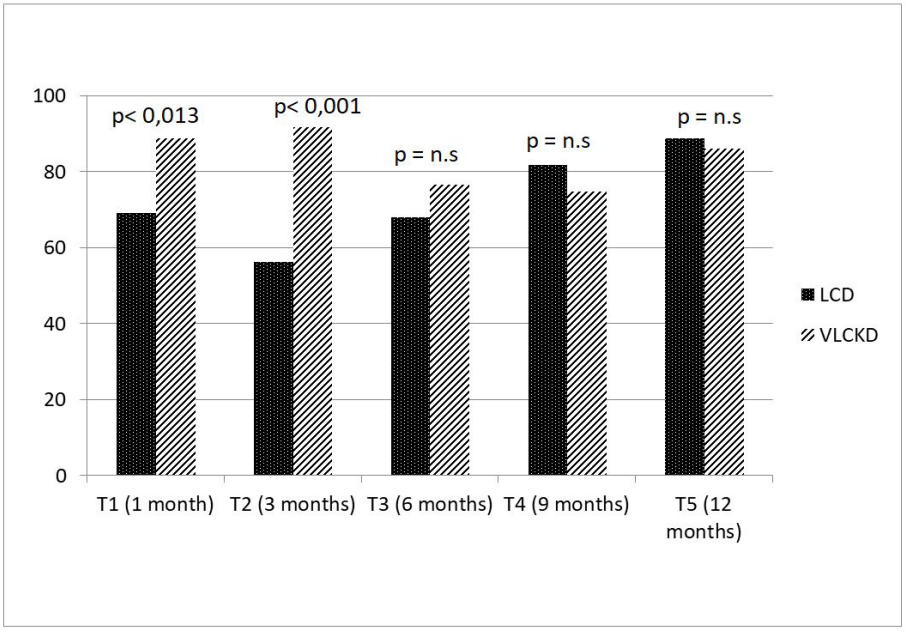

Figure 3: Trend of the compliance to the dietetic plan from the first visit to the 12 months

Physical activity

As far as physical activity is concerned, patients gradually and steadily increased it without any significant differences between the two groups. As shown in Figure 4, the intensity of physical activity performed by the two groups at T_0 and T_3 is not significantly different between groups and therefore the difference in weight loss appears to be due to the diet only.

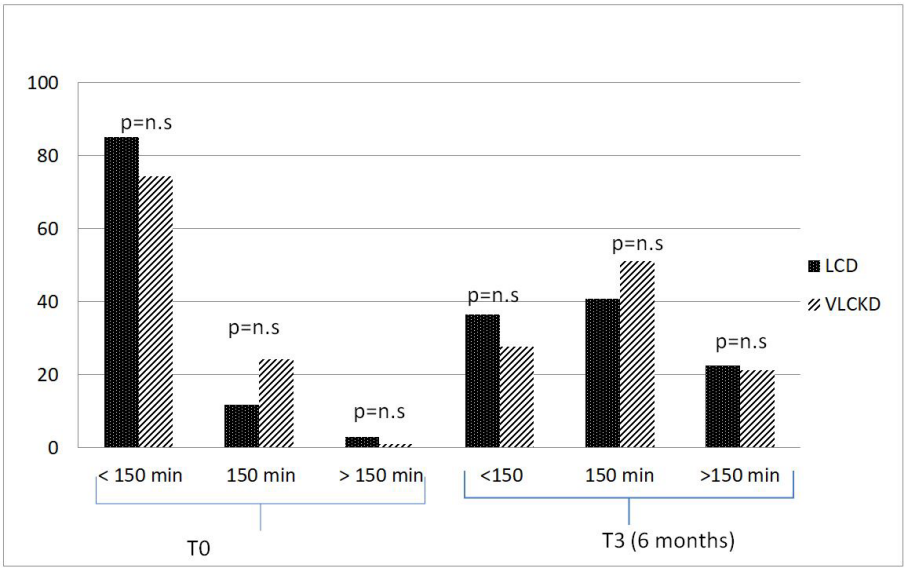

Figure 4: Variation of physical activity of the two groups from T0 to 6 months

Discussion

Traditional dietetic therapies have proven to be ineffective in treating overweight in the long run. According to the literature, it has not yet been possible to establish the best treatment for moderate obesity.

The results of this study confirm that patients treated with a ketogenic diet have at 6 months about twice the weight loss of the LCD group. This significant difference may have several causes, one being that the ketogenic diet has a lower caloric intake compared to the standard low-calorie treatment (with a deficit of about 400-600 kcal/die) and therefore, being the energy intake lower, the weight loss is higher. Furthermore, as underlined in other studies [5-7], VLCKD are characterized by different weight loss mechanisms: there is a reduction in appetite due to the filling effect of the large protein intake and due to the hormones responsible for controlling the sense of hunger, in addition to the possible direct anorectic effect of the ketones [8]. These mechanisms facilitate the reduction of lipogenesis and the increase of lipolysis, improving the metabolic use of lipids through gluconeogenesis as fats are used to produce ketones. Another important mechanism that could be used to explain the weight loss is protein saving and the maintenance of the lean body mass obtained with VLCKD. Preservation of a good muscle mass maintains the basal metabolism and consequently increases the total energy expenditure (TEE) as the lean mass is metabolically more active. Preservation of muscle mass can also help weight maintenance in the long term.

As previously stated, weight loss of the VLCKD group after 12 months is significantly higher compared to that obtained at 3 months. This study demonstrated a weight loss in the VLCKD patients up to 6 months and then the maintenance of the weight while the LCD patients show a weight loss up to 3 months only and then maintenance. Therefore, a ketogenic diet appears to be more effective than a standard one in the medium term. Similar results were obtained in randomized intervention studies [9,10]. These studies show that weight loss achieved with the ketogenic diet in the first 6 months of treatment correlates positively with long-term weight maintenance if consistent with lifestyle changes [11]. Further validations are given by the study published by Castro *et al.* [12], which emphasizes how rapid and relevant weight loss induced by VLCKD is also associated with a good compliance to the dietary pattern and, consequently, improvement of psychological well-being which could therefore contribute to long-term success of this specific nutritional intervention.

A relevant point to be considered is that this study, as others before [13-15], has a high percentage of dropouts. Nevertheless, there are significant differences depending on whether the patients were from the VLCKD or the LCD group. It appears evident that identifying a correct dietetic plan for each patient is fundamental for a positive outcome and that staff competence is of the greatest importance to carry out correct nutritional counselling by investigating the patient's motivations, expectations and other psychological factors. A suboptimal management of all these factors can therefore induce a dropout that in this and other studies has proved to be around 40-50% percent [16-19]. The lower dropout rate in the ketogenic diet group is mainly due to the reduced caloric intake, which induces a fast weight loss which is motivating for the patient, as is the reduced sense of hunger. It can be hypothesized that the ketogenic diet is perceived as a personalized medical therapy and hence compliance is better. The use of meal replacements also can be perceived as a medical prescription.

In regards to compliance and physical activity, the significant difference between the two groups at T1 and T3 suggests that the ketogenic diet can engage patients more effectively during the first 3 months. We notice an increase in the frequency of physical activity from the first visit in both groups of patients at each time considered. This increase confirms that exercise, together with diet, is useful and accepted by patients as an addition to the dietetic treatment [20].

It is not possible to rule out that the most motivated patients were selected for VLKD therefore there could have been a bias on the effectiveness of the diet or in the dropout rate. Another weakness of this study is it being retrospective and not interventional, therefore we could not compare the 2 groups' personal data in detail.

Conclusion

Literature counts many studies comparing different approaches to weight loss. Analysing the data of this retrospective observational study we can state that the prescription of a ketogenic diet is useful and effective to reduce weight and BMI of I and II class obesity patients compared to a standard low-calorie diet at 6 and 12 months. Patients following a ketogenic regime maintained their weight up to 12 months, potentially making it possible to maintain weight not only in the medium term but also in the long term [21]. This is an interesting data as literature indicates VLCKD as effective in III class obesity and in bariatric pre-surgical patients only [22-24].

There is increasing evidence that weight loss leads to a reduced risk of several chronic diseases. To achieve relevant weight loss, it is necessary to correctly manage the patient and include physical exercise in the intervention [25,26]. It could be hypothesized that physical activity encouraged the participants of this study towards a series of positive aspects such as greater awareness of holistic wellbeing factors, better preservation of muscle mass leading to an ability to perform more exercise and higher compliance to the diet itself.

Declarations

Funding

The authors have not received funding

Conflicts of interest/Competing interests

The authors declare no conflict of interest

Availability of data and material

Not applicable

Code availability

Not applicable

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