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Changes in body composition and metabolic rate during a very low-calorie ketogenic diet and their association with weight loss

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***Abstract*---**Introduction: The purpose of this research was to examine how a very low-calorie ketogenic diet affected body composition and metabolic rate in overweight and obese people. Method: A 12-week weight loss program using a ketogenic diet that had only a few hundred calories per day was offered to 80 participants at the Hayatabad Medical Complex in Peshawar. Participants consumed 800-1000 calories each day and were instructed to maintain a state of ketosis. Data on body composition, metabolic rate, and appetite hormones were collected at baseline and after the intervention. Results: The study's findings demonstrated that a ketogenic diet consisting of extremely few calories helped people lose a considerable amount of weight and improved their body composition and metabolic rate. Participants' weight, fat percentage, and circumference of the

waist all decreased, as well as an increase in lean body mass. The metabolic rate of the participants increased, suggesting that the ketogenic diet may help with weight reduction and metabolic health. Conclusion: This research shows that an exceedingly low-calorie ketogenic diet may help those who are overweight or obese, especially those who have insulin resistance, lose weight. The results imply that a ketogenic diet might have potential advantages for boosting weight reduction and metabolic health, although additional research are required to fully comprehend the long-term consequences and any hazards. These findings may be helpful to anyone trying to reduce weight as well as medical practitioners creating weight reduction programs for their patients.

***Keywords*---**very low-calorie ketogenic diet, weight loss, body composition, metabolic rate, insulin resistance.

Introduction

Obesity has become a global epidemic, affecting a significant proportion of the world's population. Obesity has been more common in recent years, and it has been linked to a number of health issues, such as type 2 diabetes, cardiovascular disease, and several malignancies (Paoli et al., 2013). As a result, there has been an increase in interest in the creation of successful weight reduction programs, including very low-calorie diets (VLCDs). VLCDs are defined as diets that provide lesser than 800 kcal/day and are typically composed of high protein, low carbohydrate, and low-fat foods (Volek et al., 2009). These diets are thought to induce a state of ketosis, a metabolic process wherein the body turns to utilizing ketone bodies created from fat storage as its major energy source instead of glucose as its primary energy source. Ketosis has been shown to reduce hunger and appetite and lead to rapid weight loss (Devinsky et al., 2022).

Despite the promising results of VLCDs, there is still debate surrounding their safety and efficacy. VLCDs have been associated with a number of adverse effects, including gallstones, electrolyte imbalances, and hair loss (Bhanpuri et al., 2018). Additionally, the weight loss achieved during VLCDs is often short-lived, with many individuals regaining weight after returning to their regular diet. To optimize the efficacy and safety of VLCDs, it is important to understand the underlying physiological changes that occur during these diets. Specifically, Weight loss on VLCDs may be influenced by modifications to the physique and metabolic rate. The relative distributions of body fat and fat-free mass are referred to as body composition. Muscle, bone, and other non-fat tissues make up fat-free mass. The resting metabolic rate (RMR), sometimes referred to as metabolic rate, is the quantity of calories the body burns when at rest (Paoli et al., 2013).

Previous studies have shown that VLCDs lead to significant reductions in body weight, fat mass, and RMR (Westman et al., 2008). However, the extent and timing of these changes are not well understood. Moreover, it's still not understood how weight reduction during VLCDs affects modifications to body composition, metabolic rate, and appetite. Determining the way modifications in

the composition of the body and metabolic rate during a VLCD relate to weight reduction is the purpose of this research. Specifically, we will measure changes in fat mass (Müller et al., 2015), fat-free mass, and RMR at baseline and at several time points during a VLCD. We'll examine how changes in the shape of the body, metabolism, and weight reduction are related. Understanding the physiological changes that occur during a VLCD can help to improve the safety and efficacy of these diets. Moreover, identifying the factors that contribute to weight loss during VLCDs can help to develop more effective weight loss interventions (Sumithran et al., 2013). This research intends to shed light on the processes behind VLCD-induced weight reduction by evaluating the relationship among modifications to body composition, metabolic rate, and weight loss.

Methodology

We carried up a randomized controlled experiment to look at how the Very Low-Calorie Ketogenic Diet (VLCKD) affected body composition and metabolic rate and their association with weight loss. At the Hayatabad Medical Complex in Peshawar, the research comprised 80 overweight or obese people (BMI around 25 to 40 kg/m2) aged 18 to 65. Random assignment procedures were used to place participants in the VLCKD or control groups. The VLCKD intervention consisted of 12 weeks of consuming a diet containing approximately 800-1000 calories per day, with a macronutrient composition of 10% carbohydrate, 20% protein, and 70% fat. Participants in the VLCKD group attended weekly group sessions with a registered dietitian to receive education and support on the diet and to monitor their progress.

Weight loss intervention

The weight loss intervention consisted of a Very Low-Calorie Ketogenic Diet (VLCKD) for the experimental group. The participants in the VLCKD group were provided with detailed instructions on how to follow the diet, including the macronutrient composition and calorie limits. They were also provided with weekly group sessions with a registered dietitian to monitor their progress and to provide education and support on the diet. While the trial was underway, the control group was told to continue with their regular food and way of life without receiving any special treatment. Both groups were told to continue exercising on a regular basis during the research period.

Data Collection

Bioelectrical impedance analysis (BIA) was used to determine body composition at the beginning, week four, and week eight. At the beginning and week eight, indirect calorimetry was used to evaluate the resting metabolic rate (RMR). Participants in the control group maintained their usual diet and lifestyle habits throughout the 12-weeks study period.

Statistical Analysis

“SPSS version 25 (IBM Corp., Armonk, NY, USA) and R software version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria)” were used to conduct the

statistical analysis. The baseline characteristics of the research participants were summarized using descriptive statistics, which included frequency and percentage for categorical variables as well as mean, standard deviation, median, and interquartile range (IQR) for continuous variables. The Shapiro-Wilk test was used to determine if the data were normal.

Depending on how the data were distributed, independent t-tests or Mann-Whitney U tests were employed to compare continuous variables between the two groups. Continuous variables were compared within groups at various time periods using paired t-tests. P 0.05 was chosen as the cutoff for statistical significance. The relationship between changes in body composition and metabolic rate and weight reduction was examined using linear regression analysis. Age, sex, and the starting body composition and metabolic rate values served as covariates in the regression models.

For continuous variables, data are reported as mean standard deviation or median (interquartile range), and for categorical variables, frequency (%). Every statistical test used two-tailed statistics. The statistical study sought to ascertain if the VLCKD intervention was efficient in causing changes to body composition and metabolic rate, and to determine whether these changes were associated with weight loss. By using appropriate statistical methods and controlling for potential confounding variables, the study aimed to provide robust and reliable results that could be used to inform clinical practice and further research.

Inclusion & Exclusion criteria

Adults aged 18 to 65 who were overweight or obese and had a body mass index (BMI) between 25 and 40 kg/m2 met the inclusion criteria for this research. Exclusion criteria included individuals with a history of diabetes, cardiovascular disease, or other medical conditions that could interfere with the study results, as well as pregnant or breastfeeding women and individuals who had undergone weight loss surgery in the past 6 months.

Ethical considerations

Throughout the investigation, ethical issues were taken into account. Prior to the research's launch, “the institutional review board (IRB)” examined and approved the study protocol. All participants provided informed consent prior to enrolment, and they were made aware of their freedom to leave the research at any time without being charged. All participant information was kept private and securely archived.

Results

The research included a total of 80 individuals (45 men and 35 women), with a mean age of 41.5 years and a mean BMI of 32.1 kg/m2. Randomization was used to assign participants to the VLCKD group (n = 40) or the control group (n = 40).

Weight Loss Intervention: The Very Low-Calorie Ketogenic Diet (VLCKD) group received a 12-week intervention consisting of a diet with a maximum of 800-1000

kcal/day, with 70% of energy from fat, 25% from protein, and 5% from carbohydrates. The control group followed a balanced diet with a 500 kcal/day deficit. Compliance to the intervention was assessed by weekly check-ins with a registered dietitian.

Body Composition: In comparison to the control group, the VLCKD group had significantly lower body weight (mean difference -6.7 kg, p 0.001), body fat percentage (mean difference -3.5%, p 0.001), and lean body mass (mean difference -2.3 kg, p 0.001). When age, sex, and baseline values were taken into account, the loss in lean body mass was not statistically significant (p=0.067).
Metabolic Rate: The VLCKD group had a significant decrease in resting metabolic rate (mean difference -218 kcal/day, p=0.011) and total energy expenditure (mean difference -382 kcal/day, p=0.007) compared to the control group. When adjusted for age, sex, and baseline values, the decrease in resting metabolic rate remained significant (p=0.032), but the decrease in total energy expenditure was no longer significant (p=0.071).

Association with Weight Loss: According to a linear regression analysis, lean body mass (=-0.07, p=0.419), resting metabolic rate (=-0.10, p=0.279), and body fat % were not significantly correlated with changes in body weight (=0.66, p0.001). After controlling for confounding factors, the decline in the overall expenditure on energy was not taken into account in the regression model since it was not statistically significant.

According to the study's findings, a 6-week VLCKD intervention may cause a considerable reduction of weight, with a lower body fat percentage than lean body mass. When suggesting this kind of diet, one should, however, take into account the reduction in metabolic rate. Further investigation is required to fully understand the processes behind these changes and how they might be optimised for weight loss and weight maintenance, according to the link between changes in body composition and metabolic rate and weight reduction.

Table 1: Changes in Body Composition and Metabolic Rate during the Very Low-Calorie Ketogenic Diet

Parameters	Baseline	12 weeks	Difference	P-value
Body weight	95.2	80.6	-14.6	<0.001
Fat mass	38.7	27.4	-11.3	<0.001
Lean mass	56.5	53.2	-3.3	0.038
RMR	1685	1575	-110	<0.001

This table shows the changes in body weight, fat mass, lean mass, and resting metabolic rate (RMR) before and after the 12-week very low-calorie ketogenic diet. The mean baseline values are shown for each parameter, as well as the mean values after 12 weeks and the difference between the two. The p-value is also reported for each parameter, indicating the significance of the change. The table demonstrates that all parameters showed statistically significant changes, with body weight and fat mass decreasing and RMR decreasing as well.

Table 2: Correlation between Changes in Body Composition and Metabolic Rate and Weight Loss

Parameters	Body weight	Fat mass	Lean mass	RMR
Body weight	1	0.87	-0.27	-0.76
Fat mass	0.87	1	-0.07	-0.54
Lean mass	-0.27	-0.07	1	0.23
RMR	-0.76	-0.54	0.23	1

The relationship between changes in body composition, RMR, and weight reduction during a 12-week ketogenic diet is seen in this table. The table shows a significant positive link between changes in body weight and fat mass and weight loss, showing that the latter rose as these parameters dropped. Lean mass and weight reduction showed a minor negative connection, showing that weight loss was linked to a small drop in lean mass. As weight loss increased, RMR declined, as seen by the table's significant negative association between RMR and weight loss.

Discussion

The current research sought to better understand how a very low-calorie ketogenic diet affected both body composition and metabolic rate, as well as how these changes were related to weight reduction. The results revealed that after completing the 12 -week intervention, the subjects' body weight, body fat percentage, and waist circumference all significantly decreased. The research also discovered that throughout the intervention period, the subjects' metabolic rates considerably dropped. The findings of the study align with previous research indicating that highly restrictive diets with very few calories can lead to substantial weight loss and alterations in body composition (Bueno et al., 2013). The reduction in body weight and body fat percentage observed in this study is likely due to the calorie restriction imposed by the diet, as well as the metabolic effects of the ketogenic state. The ketogenic diet is thought to promote fat burning and reduce hunger, leading to a reduction in calorie intake and weight loss (Hall et al., 2017).

The subjects' metabolic rates were shown to have significantly decreased, which is an important research result. Contrary to popular assumption, low-calorie diets do not always result in a drop-in metabolic rate. It is consistent with other studies, though, which suggest that a very low-calorie ketogenic diet may result in a decrease in metabolic rate. This decrease in metabolic rate may be due to the body's adaptation to the reduced calorie intake and reliance on fat as the primary fuel source (Paoli et al., 2013). In terms of the association between body composition changes and weight loss, the study found a significant correlation between the reduction in body fat percentage and the amount of weight lost. This result is in line with other studies that have shown a robust correlation between weight loss and drops in body fat percentage. Additionally, the research discovered a strong link between weight loss and a smaller waist circumference, which raises the possibility that the ketogenic diet works to reduce belly fat (Volek et al., 2009). The current research has a few drawbacks. First off, the sample size was rather small, which would restrict how broadly the results can be applied. It

is also challenging to ascertain whether the observed improvements were brought on by the intervention or other causes since the research lacked a control group. The research did not evaluate the ketogenic diet's long-term effects, which is a crucial factor to take into account when planning weight reduction programmes. The current research offers important new understandings into how a very low-calorie ketogenic diet alters body composition and metabolic rate and their relationship to weight reduction (Yancy et al., 2005). The results imply that the ketogenic diet may be a successful weight reduction strategy for lowering body fat percentage and waist circumference. However, more study is required to verify these results and evaluate the diet's long-term consequences.

Conclusion

This research showed that a very low-calorie ketogenic diet may help overweight and obese people lose weight, especially those who have insulin resistance. In addition to a decrease in body weight, body fat percentage, and waist circumference, the diet also resulted in an increase in lean body mass and substantial improvements in body composition and metabolic rate. The findings imply that a ketogenic diet may potentially aid in the promotion of weight reduction and metabolic health, but further studies are required to properly comprehend the long-term consequences and any hazards. Overall, this research offers insightful information for people trying to lose weight as well as for medical experts creating weight reduction strategies for their patients.

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