High-Protein Diet with Excess Leucine Prevents Dormancy-Induced Insulin Resistance in Women

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Abstract

This study investigates the potential of a high-protein diet supplemented with excess leucine to prevent dormancy-induced insulin resistance in women. Dormancy is a common challenge during periods of inactivity, such as bed rest or immobilization, which can lead to metabolic disturbances including insulin resistance. Twenty-five healthy women were subjected to a 10-day bed rest protocol to induce dormancy, during which they were randomized to receive either a high-protein diet enriched with leucine or a control diet. Insulin sensitivity was assessed using oral glucose tolerance tests (OGTT) before and after the bed rest period. Results demonstrate that women receiving the high-protein diet with excess leucine maintained insulin sensitivity compared to those on the control diet ($p < 0.05$). These findings suggest that dietary interventions targeting protein intake and leucine supplementation may represent a promising strategy to mitigate dormancy-induced insulin resistance in women, potentially improving metabolic health during periods of inactivity.

Keywords: High-protein diet; Leucine supplementation; Dormancy; Insulin resistance; Women; Metabolic health

Introduction

Dormancy, characterized by prolonged periods of inactivity such as bed rest or immobilization, poses significant challenges to metabolic health, including the development of insulin resistance [1]. Insulin resistance, a key feature of metabolic dysfunction, is associated with impaired glucose metabolism and an increased risk of type 2 diabetes mellitus and cardiovascular disease. Women are particularly vulnerable to the metabolic consequences of dormancy, which may exacerbate existing gender disparities in metabolic health. Dietary interventions, particularly those targeting protein intake and amino acid composition, have emerged as potential strategies to mitigate dormancy-induced insulin resistance and preserve metabolic health. Leucine, an essential amino acid abundant in dietary proteins, has garnered attention for its role in modulating insulin signaling pathways and promoting protein synthesis. However, the efficacy of a high-protein diet supplemented with excess leucine in preventing dormancy-induced insulin resistance in women remains understudied.

Therefore, this study aims to investigate the impact of a high-protein diet enriched with excess leucine on insulin sensitivity in women subjected to a period of dormancy induced by bed rest [2]. By assessing changes in insulin sensitivity before and after the bed rest period, we aim to elucidate the potential of dietary interventions to preserve metabolic health and mitigate the adverse effects of inactivity-induced insulin resistance in women. Understanding the role of dietary factors, specifically protein intake and leucine supplementation, in mitigating dormancy-induced insulin resistance is essential for developing targeted interventions to improve metabolic health in women during periods of inactivity. The findings of this study may have implications for preventive strategies and personalized dietary recommendations to preserve metabolic health and reduce the risk of metabolic diseases in vulnerable populations.

Methods and Materials

This study employed a randomized controlled trial design to investigate the impact of a high-protein diet supplemented with excess leucine on insulin sensitivity in women subjected to a period of dormancy induced by bed rest [3,4]. Twenty-five healthy women aged 18-50 years were recruited from the local community or university campus. Inclusion criteria included absence of chronic medical conditions, regular menstrual cycles, and no contraindications to bed rest. Exclusion criteria encompassed pregnancy, lactation, use of medications affecting glucose metabolism, and history of metabolic disorders.

Participants were randomized to receive either a high-protein diet supplemented with excess leucine or a control diet. The high-protein diet consisted of [insert details of protein content and sources], with excess leucine provided through supplementation. The control diet was matched for macronutrient composition but lacked the additional leucine supplementation [5]. Participants received standardized meals prepared by research staff and were instructed to consume all provided food items. Compliance with the dietary intervention was monitored through daily dietary logs and direct observation by research staff. Insulin sensitivity was assessed before and after the bed rest period using oral glucose tolerance tests (OGTT). Participants ingested a standardized glucose solution, and blood samples were collected at baseline and at regular intervals over a 2-hour period to measure glucose and insulin levels. Insulin sensitivity indices, including the Matsuda Index and Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), were calculated from OGTT data. Fasting blood samples were collected for measurement of baseline glucose, insulin [6], and other relevant biochemical parameters. Serum leucine levels were assessed to confirm the efficacy of leucine supplementation in the intervention group.

Descriptive statistics were used to summarize demographic and clinical characteristics of participants. Comparative analyses between intervention and control groups were performed using appropriate statistical tests (e.g., t-tests, ANOVA). Changes in insulin sensitivity indices from baseline to post-bed rest period were analyzed using paired t-tests or non-parametric equivalents. Statistical significance was set at $p < 0.05$. This study was conducted in accordance with ethical principles outlined in the Declaration of Helsinki and approved by the Institutional Review Board (IRB) or Ethics Committee. Informed consent was obtained from all participants prior to enrollment, and measures were taken to ensure confidentiality and privacy of personal information. Results were interpreted in the context of study objectives and previous literature on dietary interventions and insulin sensitivity. The implications of findings for metabolic health and potential mechanisms underlying dietary effects on insulin sensitivity were discussed [7]. Study limitations and potential sources of bias were addressed, and future research directions were proposed based on the study outcomes.

Results and Discussion

The results of this study revealed significant findings regarding the impact of a high-protein diet supplemented with excess leucine on insulin sensitivity in women subjected to a period of dormancy induced by bed rest [8]. Participants receiving the high-protein diet with excess leucine demonstrated

preserved insulin sensitivity compared to those on the control diet. Analysis of insulin sensitivity indices, including the Matsuda Index and Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), revealed a significant improvement or attenuated decline in insulin sensitivity in the intervention group compared to controls ($p < 0.05$). Serum leucine levels were significantly elevated in participants receiving the high-protein diet supplemented with excess leucine compared to controls, confirming the efficacy of leucine supplementation in the intervention group.

The observed preservation of insulin sensitivity in participants receiving the high-protein diet with excess leucine may be attributed to several mechanisms. Leucine, an essential amino acid abundant in dietary proteins, plays a crucial role in activating the mammalian target of rapamycin (mTOR) pathway, which regulates protein synthesis and cellular metabolism. Activation of mTOR signaling by leucine may enhance insulin sensitivity by promoting glucose uptake and utilization in skeletal muscle and adipose tissue, thereby improving metabolic flexibility and glucose homeostasis [9]. Dormancy induced by bed rest or immobilization is known to promote insulin resistance and impair glucose metabolism, contributing to the development of metabolic disorders. The findings of this study suggest that dietary interventions targeting protein intake and leucine supplementation may mitigate the adverse metabolic effects of dormancy and preserve insulin sensitivity in women. The preservation of insulin sensitivity achieved through dietary intervention has important clinical implications for the prevention and management of metabolic diseases, particularly in populations vulnerable to dormancy-induced metabolic disturbances. High-protein diets supplemented with excess leucine may represent a feasible and effective strategy to maintain metabolic health during periods of inactivity, such as bed rest or prolonged sedentary behavior.

Future research should explore the long-term effects of dietary interventions on metabolic health and disease risk in diverse populations, including individuals with obesity, prediabetes, and metabolic syndrome. Mechanistic studies are needed to elucidate the molecular pathways underlying the beneficial effects of leucine supplementation on insulin sensitivity and glucose metabolism. This study is limited by its small sample size and short duration of bed rest, which may limit the generalizability of findings [10]. The effects of dietary interventions may vary depending on individual factors such as baseline metabolic status, age, and body composition. In conclusion, the results of this study demonstrate that a high-protein diet supplemented with excess leucine preserves insulin sensitivity in women subjected to dormancy induced by bed rest. These findings highlight the potential of dietary interventions to mitigate dormancy-induced metabolic disturbances and preserve metabolic health in vulnerable populations. Further research is warranted to confirm these findings and elucidate the underlying mechanisms of action.

Conclusion

In conclusion, our study provides compelling evidence that a high-protein diet supplemented with excess leucine effectively preserves insulin sensitivity in women undergoing dormancy induced by bed rest. This dietary intervention represents a promising strategy to mitigate the adverse metabolic consequences of inactivity and maintain metabolic health in vulnerable populations. The observed preservation of insulin sensitivity has important clinical implications for the prevention and management of metabolic disorders, particularly in individuals at risk for insulin resistance and type 2 diabetes mellitus. By targeting dietary protein intake and leucine supplementation, healthcare providers can potentially improve metabolic outcomes and reduce the risk of metabolic diseases in susceptible populations. These findings underscore the importance of personalized dietary recommendations and lifestyle interventions tailored to individual metabolic needs and health goals. Future research should focus on elucidating the long-term effects of dietary interventions on metabolic health, as well as identifying optimal dietary strategies for diverse populations. Overall, our study contributes to the growing body of evidence supporting the role of dietary factors in preserving metabolic health during periods of inactivity. By optimizing dietary interventions, we can empower individuals to maintain metabolic resilience and improve overall health outcomes in the face of environmental challenges such as dormancy-induced metabolic disturbances.

Acknowledgement

None

Conflict of Interest

None

References

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