International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
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+15878858911
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ARTICLE TITLE	PHYSICAL ACTIVITY VS. LOW-GLYCEMIC-INDEX DIET: A COMPARATIVE ANALYSIS OF THEIR EFFECTS ON INSULIN RESISTANCE TREATMENT
DOI	https://doi.org/10.31435/ijitss.3(51).2026.6684
RECEIVED	10 June 2026
ACCEPTED	10 September 2026
PUBLISHED	14 September 2026
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PHYSICAL ACTIVITY VS. LOW-GLYCEMIC-INDEX DIET: A COMPARATIVE ANALYSIS OF THEIR EFFECTS ON INSULIN RESISTANCE TREATMENT

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ABSTRACT

Introduction Insulin resistance is a complex metabolic disorder that plays a pivotal role in the pathogenesis of type 2 diabetes, metabolic syndrome, and cardiovascular diseases. Given its increasing prevalence, growing attention is being directed toward non-pharmacological interventions such as low glycemic index (LGI) diets and regular physical activity. The objective of this study was to compare the effects of an LGI diet and physical activity on the management of insulin resistance.

Current State of Knowledge A review of scientific literature published between 2020 and 2025 was conducted using PubMed, Scopus, and Google Scholar databases. Both original research articles and review papers focusing on the impact of LGI diets and physical activity on insulin resistance were included. The findings indicate that both LGI diets and regular physical activity positively influence glycemic parameters by enhancing tissue sensitivity to insulin and reducing blood glucose and insulin concentrations. The combination of these interventions yields superior therapeutic outcomes compared to each intervention alone. The effectiveness of combined strategies also appears to be influenced by the timing and type of physical exercise.

Conclusions A multifaceted approach integrating an LGI diet with physical activity constitutes an effective strategy for managing insulin resistance. Given the multifactorial nature of insulin resistance, treatment should be individually tailored and monitored by healthcare professionals. Further research is warranted to account for variables such as sex, age, and duration of the intervention.

KEYWORDS

Low Glycemic Index Diet, Physical Activity, Insulin Resistance, Lifestyle Modification

CITATION

Ostrowicz, K., Bartosik, K., Furtek, D., Ciesielska, J., Marchewka, K., Oczkowska, W., Pelczar, A., Malinowski, A., Brzuchacz, D., & Borkowska, J. (2026). Physical activity vs. low-glycemic-index diet: A comparative analysis of their effects on insulin resistance treatment. *International Journal of Innovative Technologies in Social Science*, 3(51). https://doi.org/10.31435/ijitss.3(51).2026.6684

Introduction and Objective

Insulin resistance (IR) is a complex metabolic disorder characterized by the body's impaired response to insulin-a hormone secreted by pancreatic β-cells, responsible for maintaining glucose homeostasis. In peripheral IR, a marked reduction in insulin receptor sensitivity is observed, particularly in skeletal muscle, adipose tissue, and the liver, resulting in disturbances in glucose transport and metabolism [1]. IR is a key contributor to the development of metabolic syndrome, type 2 diabetes mellitus (T2DM), and cardiovascular diseases [1,2].

The increasing prevalence of insulin resistance in the general population is strongly associated with a sedentary lifestyle, high-calorie diets, overweight, and excessive intake of highly processed carbohydrates. IR is recognized as a major risk factor for chronic diseases, and its management plays a crucial role in the prevention of metabolic disorders [1].

Current clinical guidelines emphasize lifestyle modification as the cornerstone of IR therapy, particularly dietary intervention and the adoption of regular physical activity. A low glycemic index (LGI) diet, by promoting a gradual release of glucose into the bloodstream, mitigates postprandial glycemic spikes and enhances insulin sensitivity [3]. The intake of complex carbohydrates and dietary fiber, typical of this dietary model, supports weight reduction, decreases fasting glucose and insulin levels, lowers triglyceride concentrations, and favorably influences blood pressure regulation [1,3].

Regular physical activity promotes increased fatty acid oxidation and muscle mass gain, reducing intramyocellular lipid accumulation especially in skeletal muscles and subsequently improving insulin sensitivity [4]. Physical exercise improves glycemic control, even in the absence of weight loss, by decreasing adiposity and enhancing the metabolic response to insulin. Both aerobic and resistance training have demonstrated high efficacy in improving insulin sensitivity and glycemic parameters [4,5].

Despite the acknowledged effectiveness of both interventions, debate continues regarding which offers superior therapeutic outcomes in managing IR.

The aim of this review is to compare the effects of a low glycemic index diet and physical activity in the treatment of insulin resistance.

Materials and Methods

This review is a non-systematic literature review focused on the impact of physical activity, low glycemic index diet, and the combination of both therapeutic strategies in the management of insulin resistance. Literature was searched through PubMed, Scopus, and Google Scholar databases. The analysis included publications from 2020 to 2025.

Articles were selected based on the review of titles, abstracts, and full texts, using the following keywords: “low glycemic index diet,” “physical activity,” and “insulin resistance.” Original studies (including randomized controlled trials and observational studies) and review articles were included, provided they directly addressed the effects of LGI diets and physical activity on insulin resistance. Only full-text articles published in English were included.

Excluded were publications without full text (e.g., conference abstracts, letters to the editor), studies not directly related to the topic, and non-peer-reviewed sources (e.g., blogs or popular science articles). Potential limitations include heterogeneity of study populations (age, sex, physical activity levels), challenges in ensuring adherence to dietary and exercise protocols, short intervention durations, and varied methods of assessing insulin resistance. Moreover, IR is a multifactorial condition, complicating the attribution of outcomes to a single intervention.

Current State of Knowledge

Effect of Physical Activity on Insulin Resistance

While pharmacological strategies to improve metabolic control and prevent IR-related diseases are under development, numerous studies have demonstrated that increased physical activity and sustained weight loss significantly reduce the risk of metabolic syndrome and can prevent or delay T2DM onset. Therefore, lifestyle interventions involving regular physical activity- with or without dietary changes- play a central role in the effective treatment of insulin resistance [6].

According to the American Diabetes Association, “to improve glycemic control, assist with weight maintenance, and reduce the risk of cardiovascular disease, it is recommended to engage in at least 150 minutes per week of moderate-intensity aerobic physical activity and/or at least 90 minutes per week of vigorous aerobic activity, distributed over at least 3 days/week with no more than 2 consecutive days without activity” [7].

In a 12-week randomized controlled trial examining aerobic and resistance exercise in women, both exercise types yielded benefits, but their combination provided the greatest improvements in fasting plasma glucose, insulin levels, and HOMA-IR index. Visceral fat reduction strongly correlated with IR modulation [8].

Visceral adipose tissue secretes pro-inflammatory cytokines and adipokines that contribute to IR and inflammation. Physical exercise induces lipolysis and elevates adiponectin levels, enhancing tissue insulin sensitivity [9,10]. Concurrently, it lowers circulating free fatty acid (FFA) concentrations, reducing ectopic lipid deposition in muscle and liver and limiting lipotoxic disruption of insulin signaling.

Aerobic and combined exercise activate AMP-activated protein kinase (AMPK), which increases expression and translocation of glucose transporter type 4 (GLUT-4) to the cell membrane, enhances fatty acid oxidation, and suppresses lipogenesis [8,9]. Consequently, glucose uptake improves independently of insulin, and plasma glucose and insulin concentrations decrease.

Resistance training increases muscle mass, thereby enhancing whole-body glucose storage capacity and upregulating insulin receptor density. Regular exercise also promotes mitochondrial biogenesis and function in skeletal muscle, increases oxidative enzyme activity (e.g., CPT-1, HK2, GS), improves electron transport chain efficiency, reduces reactive oxygen species (ROS), and supports non-oxidative glucose metabolism and glycogen synthesis [8,9,10].

Similar findings were reported in a randomized trial comparing the effects of aerobic, resistance, and combined exercise on hemoglobin A1c (HbA1c) levels. HbA1c was reduced by - 0.51% in the aerobic group

and −0.38% in the resistance group. The combined group experienced additional reductions of −0.46% versus aerobic and −0.59% versus resistance-only interventions [11].

Even a single hour of aerobic exercise can improve insulin sensitivity by approximately 20%, an effect comparable to some pharmacological agents. This enhanced sensitivity may persist for up to 48 hours post-exercise [12].

Effect of a Low Glycemic Index Diet on Insulin Resistance

Lifestyle modification and dietary intervention are foundational in the management of IR and prediabetes. A crossover RCT involving 26 overweight or obese adults demonstrated that a LGI diet significantly reduced the area under the curve for both glucose and insulin compared to a high GI diet. Reducing dietary GI or carbohydrate content led to decreased postprandial glycemia and insulin response, with effects sustained throughout the day [13].

A meta-analysis of 14 clinical trials concluded that LGI diets produce modest but clinically relevant improvements in mid-term glycemic control among diabetic individuals [14]. Nutritional interventions and lifestyle changes should be regarded as therapeutically equivalent to pharmacotherapy in diabetes prevention and management. LGI dietary strategies can lead to glycemic control improvements comparable to, or exceeding, those achieved with modern insulin analogs [15].

Additionally, a mean HbA1c reduction of approximately 0.15% was observed with LGI diets. Improved HbA1c may reflect enhanced insulin sensitivity- an important therapeutic target in nutritional interventions.

Effect of a Behavioral Strategy- Combining LGI Diet and Physical Activity

The most effective approach to treating IR is multifactorial and incorporates dietary modifications, increased physical activity, and behavioral support. A foundational component of intervention is an energy deficit of 500–750 kcal/day, typically achieved through a low-fat, LGI diet, with standard caloric intake of 1200–1500 kcal/day for women and 1500–1800 kcal/day for men [16–18].

Regarding physical activity, guidelines recommend 150–180 minutes per week of moderate-intensity aerobic exercise, such as walking or cycling. For time-constrained individuals, short daily sessions (e.g., 10 minutes) and increased incidental activity (e.g., stair climbing) are advised [16,17].

Evidence clearly supports the synergistic effect of combining LGI diets with physical activity on weight reduction and metabolic control, thereby enhancing IR treatment outcomes. This combined approach simultaneously reduces caloric intake and increases expenditure, achieving energy deficits more effectively than either strategy alone [19,20].

While LGI diets alone improve insulin sensitivity through weight loss, the addition of physical activity promotes enhanced fatty acid oxidation in the fasting state and improves mitochondrial function [16,21]. Regular exercise increases the ability of skeletal muscle to utilize fatty acids during both exercise and rest, indicating improved metabolic flexibility. This reduces the accumulation of harmful lipid intermediates, further enhancing insulin responsiveness.

Furthermore, one study showed that the timing of exercise may influence glycemic outcomes individuals exercising in the afternoon exhibited better glucose control compared to morning exercisers. Thus, time-of-day considerations should be incorporated into exercise prescriptions for IR [22].

Another systematic review highlighted the benefit of performing exercise after meals versus before, with postprandial activity yielding significantly greater improvements in glycemic control [23].

One meta-analysis emphasized the superiority of behavioral therapy- specifically combining LGI diets with physical activity—over pharmacological interventions for IR treatment. Lifestyle-based interventions were shown to be up to four times more effective in achieving metabolic syndrome remission than pharmacological therapies [24].

Conclusions

Insulin resistance represents a significant public health concern, closely linked to lifestyle factors primarily unhealthy diet and physical inactivity. This literature review demonstrates that both a low glycemic index diet and regular physical activity independently exert beneficial effects on insulin sensitivity, glycemic and insulinemic control, and type 2 diabetes risk reduction.

An LGI diet effectively manages IR by reducing postprandial hyperglycemia and facilitating weight loss. Meanwhile, physical activity both aerobic and resistance enhances glucose metabolism through increased glucose utilization, mitochondrial function, and modulation of key metabolic proteins.

The greatest therapeutic benefits are achieved through a combined intervention. The synergistic application of a LGI diet and regular physical activity yields greater weight loss, improved metabolic parameters, and superior insulin sensitivity often outperforming pharmacological treatment. Incorporating behavioral strategies, such as optimizing exercise timing and tailoring dietary plans, further enhances intervention efficacy.

Thus, effective management of insulin resistance should be grounded in comprehensive, multifaceted lifestyle modification, rather than symptom based pharmacological treatment alone.

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All authors have read and agreed with the published version of the manuscript.
Funding Statement: The study did not receive special funding.
Data Availability Statement: The authors confirm that the data supporting the findings of this study are available within the article's bibliography.
Conflict of Interest Statement: The authors declare no conflicts of interest.
Declaration of Generative AI and AI-Assisted Technologies: The authors used ChatGPT to improve language and readability, after which the content was reviewed and edited. The authors accept full responsibility for the substantive content of the publication.

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