GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(REVIEW ARTICLE)

Check for updates

The effect of curcumin after high-intensity exercise (HIE) on blood glucose levels

Sabila Camelia Hidayat [1,*], Sundari Indah Wiyasihati [2], Lina Lukitasari [2] and Lilik Herawati [2]

[1] *Medical Programee, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[2] *Department of Medical Physiology and Biochemistry, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*

GSC Biological and Pharmaceutical Sciences, 2024, 29(03), 022–026

Publication history: Received on 14 October 2024; revised on 03 December 2024; accepted on 06 December 2024

Article DOI: https://doi.org/10.30574/gscbps.2024.29.3.0443

Abstract

Background: After high-intensity exercise (HIE), which is widely used because it can build muscle mass more quickly, muscles use a lot of energy, leading to significant gluconeogenesis, and an increase in glucose production. Curcumin, the active compound in turmeric, is well-known as an anti-inflammatory agent that can potentially to regulate blood glucose. This review aims to determine the impact of curcumin consumption after HIE on glucose levels.

Method: This literature review use searching strategy for articles, journals, and books in research journal database. The database were taken from Pubmed and MDPI. The keyword were curcumin, HIE, and glucose. This literature review using 24 scientific articles as online data sources which were then further analyzed.

Results and Discussion: Curcumin may help lower the rise in blood sugar after high-intensity exercise by blocking NF-κB, which lowers TNF-α levels. However, curcumin did not effectively manage short-term blood sugar changes in overweight or have prediabetes or metabolic syndrome populations.

Conclusion: Curcumin potentially regulate blood glucose after HIE.

Keywords: Curcumin; Glucose; High-intensity exercise; Blood glucose; Turmeric

1. Introduction

Physical exercise has various intensities, one of which is high intensity exercise. According to the American College of Sports Medicine, high intensity exercise in 2023 is one of the most frequently performed physical exercises. This high intensity exercise is widely used because it can be done in a relatively short time with results that are no less good than physical exercise done over a longer time.

During high-intensity exercise, energy use by the muscles increases significantly. This causes the body's need for glucose to increase drastically [1]. In response to this, the body will increase glucose production through mechanisms such as gluconeogenesis in the liver.

However, a study shows that high-intensity exercise can affect insulin sensitivity and glucose use by body cells [2]. Decreased insulin sensitivity can interfere with the body's ability to properly regulate glucose levels. This will increase the risk of developing the condition into insulin resistance, even type 2 diabetes mellitus.

Curcumin, one of the active compounds found in turmeric, has attracted attention as a substance that has anti-inflammatory and antioxidant properties [3]. Several studies have shown that curcumin has beneficial effects on glucose

* Corresponding author: Sabila Camelia Hidayat

regulation and insulin sensitivity. Therefore, this study aims to better understand whether administration of curcumin after high-intensity exercise can affect glucose levels.

Apart from that, the public needs to be aware of the potential dangers and risks that arise if understanding of the potential for increasing glucose due to high-intensity exercise is still low. This makes it possible for someone not to take the necessary precautions to control the risk. As a result, the prevalence of blood glucose-related diseases, such as type 2 diabetes mellitus, may increase in society.

In this literature review, we conducted a systematic screening and compilation of the effects of curcumin administration after HIE on blood glucose levels which are closely related to muscle gluconeogenesis. Considering the need for HIE training for weight management and blood glucose regulation, this literature review has important relevance in providing information to the public about the potential dangers of increasing glucose after high-intensity exercise and the importance of using preventive strategies, such as the use of curcumin.

2. Material and Methods

In order to compile a literature review examining the effects of high-intensity exercise (HIE) and curcumin consumption on glucose levels, a systematic search and organization of relevant articles, journals, and books was conducted. This process was facilitated through Google Chrome, utilizing databases such as PMC and MDPI. The literature review focused on specific thematic search terms, including "curcumin," "HIE," and "glucose." Additionally, a thorough evaluation was performed regarding the administration of curcumin following high-intensity exercise and its impact on blood glucose levels, with particular attention paid to the structural and chemical properties of curcumin. The search encompassed various studies on high-intensity exercise and the associated benefits for blood glucose management. The results of this literature review yielded a range of findings; some articles included all relevant thematic keywords, while others were focused specifically on curcumin and blood glucose, exercise and curcumin, or solely on curcumin. Among the numerous articles found in the search results, the initial screening is conducted by examining the title and abstract of each article. Ultimately, 24 relevant scientific articles were identified for further analysis. By synthesizing these pertinent studies, this literature review aims to provide a comprehensive overview of the implications of curcumin supplementation and exercise on blood glucose levels, thereby highlighting potential management strategies.

3. Results and Discussion

3.1. The potential benefits of exercise

High-intensity exercise can increase skeletal muscle cellular metabolism producing responses in specific muscle fibers, in this case predominantly type II fibers with a higher recruitment threshold are fully active during high-intensity exercise. This exercise-induced enhanced mitochondrial biogenesis is mediated by AMPK, PGC-1α, SIRT1 and ROS pathways as well as by modulation of Ca2+ homeostasis. The adaptive response to high-intensity exercise is achieved more quickly than the time required for MICT, so high-intensity exercise is preferred [4]. As exercise intensity increases, so do metabolic demands and the production of reactive oxygen species (ROS) [5,6].

3.2. The potential benefits of curcumin

Curcumin, the primary bioactive compound found in turmeric (*Curcuma longa*), is responsible for the plant's yellow pigment [7]. Curcumin is known for several benefits, for example as an anti-inflammatory and antioxidant. To get these benefits, curcumin needs to be absorbed into cells. Curcumin can be absorbed in cells through passive diffusion and active transport mechanisms. Curcumin is absorbed by the intestine through the intestinal P-gp transporter protein [8].

Curcumin has anti-inflammatory benefits through several processes. Some of them, namely reducing the activity of cyclooxygenase-2 (COX-2), lipoxygenase, and the enzyme inducible nitric oxide synthase (NOS), inhibiting the production of inflammatory cytokines, tumor necrosis factor-alpha (TNF-α), interleukin (IL)-1, -2, -6, -8, and -12, migration inhibitor proteins, down-regulates mitogen-activated, and monocyte chemoattractant protein (MCP) [9].

3.3. The effect high intensity exercise on blood glucose regulation

Elevated blood glucose levels can result from various factors, including reduced insulin secretion by the pancreas, impaired glucose uptake, or a combination of both [10]. The blood glucose regulation process is a combination of various processes, such as gluconeogenesis from the liver, glucose circulation in the bloodstream, glucose uptake by muscles. When doing physical exercise, the energy source is obtained from the muscle glycolysis process which will be uptaken

for energy for muscle contractions. Physical exercise can positively influence glucose metabolism by enhancing glucose transport, which can occur independently of insulin's role in muscle cell biology [11–13]. This physical exercise will affect glucose metabolism, such as increasing glucose transport, which in this case does not depend on the role of insulin and affects the biology of insulin in muscle cells [12].

3.4. The effect curcumin on blood glucose regulation

Studies regarding the relationship of curcumin to glucose have often been carried out in vitro, in vivo, and in humans. In vitro studies carried out on skeletal muscle cells showed positive effects on potential antidiabetic properties. Curcumin exerts these positive effects through increasing GLUT-4 translocation, increasing AKT phosphorylation, and decreasing proinflammatory cytokines [14].

The antidiabetic properties of curcumin in in vivo and human studies also show positive results. In vivo studies show curcumin's ability to regulate glucose and lipid levels, improve insulin sensitivity and pancreatic beta cell function, and reduce inflammation and oxidative stress. On the other hand, human studies related to curcumin show a decrease in hepatic glucose production through various pathways, one of which is by suppressing the NF-κB pathway [14].

On the other hand, a meta-analysis found that turmeric and curcumin were ineffective in managing short-term glucose fluctuations in individuals with subclinical metabolic disturbances, such as those who are overweight, have prediabetes, or are diagnosed with metabolic syndrome [17].

3.5. The effect of curcumin after high intensity exercise on blood glucose levels

The increase in glucose after physical exercise is due to the body's homeostasis to meet increased energy needs. In previous research, it was found that glucose levels decreased more during moderate intensity physical exercise than after high intensity exercise. In addition, various proinflammatory agents will be secreted due to the action of skeletal muscles. This proinflammatory agent is secreted via TNF-α and regulates blood glucose. Furthermore, there will be damage to glucose uptake [15]. The increase in blood glucose which is assumed to be one of the effects after high intensity exercise is believed to be inhibited by curcumin. In this process, curcumin intervenes at the NF-κB activation stage. If curcumin inhibits NF-κB activation, TNF-α activation by NF-κB will also decrease. This decrease will also be followed by glucose levels in the blood which will also decrease [16]**.**

The effectiveness of curcumin in regulating blood glucose levels is influenced by the dosage administered [17–20]. The recommended effective dose of curcumin for reducing TNF-α levels is 400 mg per day [21]. A study reported that curcumin, when administered for at least four weeks, can reduce blood glucose levels in mice with type 1 diabetes mellitus [22]. The prolonged duration of treatment in these studies may enhance the efficacy of combining curcumin supplementation with physical exercise, making this combination more effective in lowering blood glucose than either curcumin supplementation or exercise alone [23,24].

4. Conclusion

Based on the literature review on the effect of curcumin consumption after high-intensity exercise on blood glucose levels, curcumin has the potential to regulate blood glucose after HIE. Blood glucose regulation after high-intensity exercise with curcumin should be investigate further to assess its effectiveness and to determine the appropriate dosage required for optimal results.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Dela F, Ingersen A, Andersen NB, Nielsen MB, Petersen HHH, Hansen CN, et al. Effects of one-legged high-intensity interval training on insulin-mediated skeletal muscle glucose homeostasis in patients with type 2 diabetes. Acta Physiol. 2019 Jun;226(2):e13245.

[2] Bracken RM, Edavalath M, Morton R, West D, Fielding A, Luzio S, et al. Exercise-induced hyperglycaemia in the absence of diabetes. Diabet Med. 2010;27(6):723–4.

[3] Hewlings SJ, Kalman DS. Curcumin: A review of its effects on human health. Foods. 2017;6(10):1–11.

[4] Torma F, Gombos Z, Jokai M, Takeda M, Mimura T, Radak Z. High intensity interval training and molecular adaptive response of skeletal muscle. Sport Med Heal Sci. 2019;1(1):24–32.

[5] Gloire G, Legrand-Poels S, Piette J. NF-κB activation by reactive oxygen species: fifteen years later. Biochem Pharmacol. 2006;72(11):1493–505.

[6] Ayubi N, Kusnanik NW, Herawati L, Komaini A, Cholik T. Effects of Curcumin on Inflammatory Response During Exercise-Induced Muscle Damage (Literature Review). Inflammation. 2022;27:30.

[7] Zebib B, Mouloungui Z, Noirot V. Stabilization of curcumin by complexation with divalent cations in glycerol/water system. Bioinorg Chem Appl. 2010;2010.

[8] Xue M, Cheng Y, Xu L, Zhang L. Study of the Intestinal Absorption Characteristics of Curcumin In Vivo and In Vitro. J Appl Pharm. 2017 Jan;09.

[9] Afriyana R, Junando M, Nurmasuri. Potensial Ekstrak Herbal Temulawak (Curcuma zanthorrhiza) Sebagai Anti Bakteri dan Anti Inflamasi Agromedicine |. Agromedicine. 2023;10(1):128–32.

[10] Mouri Mi, Badireddy M. Hyperglycemia. In: StatPearls [Internet]. StatPearls Publishing; 2023.

[11] Richter EA, Derave W, Wojtaszewski JFP. Glucose, exercise and insulin: emerging concepts. J Physiol. 2001;535(2):313–22.

[12] Febriyanti. Perbandingan Kadar Asam Laktat dan Kadar Glukosa Darah pada Wanita Berpakaian Olahraga Tertutup dengan Berpakaian Olahraga Terbuka Setelah Aktivitas Fisik Submaksimal. Repos Univ Airlangga. 2010;

[13] Abdelrazek HMA, Kilany OE, Muhammad MAA, Tag HM, Abdelazim AM. Black seed thymoquinone improved insulin secretion, hepatic glycogen storage, and oxidative stress in streptozotocin-induced diabetic male Wistar rats. Oxid Med Cell Longev. 2018;2018.

[14] Servida S, Panzeri E, Tomaino L, Marfia G, Garzia E, Ciniglio Appiani G, et al. Overview of Curcumin and Piperine Effects on Glucose Metabolism: The Case of an Insulinoma Patient's Loss of Consciousness. Int J Mol Sci. 2023;24(7).

[15] Steensberg A, Fischer CP, Keller C, Møller K, Pedersen BK. IL-6 enhances plasma IL-1ra, IL-10, and cortisol in humans. Am J Physiol Metab. 2003;285(2):E433–7.

[16] Nanavati K, Rutherfurd-Markwick K, Lee SJ, Bishop NC, Ali A. Effect of curcumin supplementation on exercise-induced muscle damage: a narrative review. Eur J Nutr. 2022;61(8):3835–55.

[17] Musazadeh V, Golandam F, Faghfouri AH, Shadbad MA, Keramati M, Moridpour AH, et al. Curcumin upplementation contributes to relieving anthropometric and glycemic indices, as an adjunct therapy: a meta-research review of meta-analyses. J Funct Foods. 2022;99:105357.

[18] Poolsup N, Suksomboon N, Kurnianta PDM, Deawjaroen K. Effects of curcumin on glycemic control and lipid profile in prediabetes and type 2 diabetes mellitus: a systematic review and meta-analysis. PLoS One. 2019;14(4):e0215840.

[19] Baziar N, Parohan M. The effects of curcumin supplementation on body mass index, body weight, and waist circumference in patients with nonalcoholic fatty liver disease: a systematic review and dose–response meta-analysis of randomized controlled trials. Phyther Res. 2020;34(3):464–74.

[20] Dehzad MJ, Ghalandari H, Nouri M, Askarpour M. Effects of curcumin/turmeric supplementation on glycemic indices in adults: A grade-assessed systematic review and dose–response meta-analysis of randomized controlled trials. Diabetes Metab Syndr Clin Res Rev. 2023;17(10):102855.

[21] McFarlin BK, Venable AS, Henning AL, Sampson JNB, Pennel K, Vingren JL, et al. Reduced inflammatory and muscle damage biomarkers following oral supplementation with bioavailable curcumin. BBA Clin. 2016;5:72–8.

[22] Zhang D wei, Fu M, Gao SH, Liu JL. Curcumin and diabetes: a systematic review. Evidence-Based Complement Altern Med. 2013;2013.

[23] Dolati S, Namiranian K, Amerian R, Mansouri S, Arshadi S, Azarbayjani MA. The effect of curcumin supplementation and aerobic training on anthropometric indices, serum lipid profiles, C-reactive protein and insulin resistance in overweight women: a randomized, double-blind, placebo-controlled trial. J Obes Metab Syndr. 2020;29(1):47.

[24] Naghizadeh H, Heydari F, Jadidi JP. The effect of 12 weeks of high-intensity interval training and curcumin consumption on glycemic index, adiponectin and lipid profile in obese men with type2 diabetes hyperlipidemia. J Appl Heal Stud Sport Physiol Spring/Summer. 2023;10:50–66.