Coffee Consumption and Insulin Resistance and Sensitivity

Subjects: Agriculture, Dairy & Animal Science
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Definition

Long-term coffee consumption has a nonsignificant effect on insulin resistance and sensitivity.

1. Introduction

Coffee has become one of the most famous drinks today and is increasingly consumed globally. Coffee contains various bioactive ingredients that can positively or negatively affect the human body [1][2]. Coffee consumption is inversely associated with total mortality [3][4][5], endometrial cancer [6], colon cancer [7], hepatic cancer [8], prostate cancer [9], and chronic liver disease [10].

Diabetes mellitus is a rapidly growing global problem with large social, health, and economic consequences [11]. Many cohort and nested case-control studies have been conducted on the association between coffee consumption and type 2 diabetes. A meta-analysis of 30 epidemiologic studies found that drinking a cup of coffee daily reduces the risk of diabetes by 6% (relative risk (RR) = 0.94; 95% confidence interval (CI), 0.93–0.95) [12]. The effect size between caffeinated coffee and decaffeinated coffee consumption did not differ significantly (RR = 0.93; 95% CI = 0.90–0.96 vs. RR = 0.94; 95% CI = 0.90–0.98) [12]. The association between coffee consumption and diabetes has been shown only in epidemiologic studies; randomized clinical trials (RCTs) directly verifying this association are limited. Instead, RCTs have studied the effects of coffee consumption on glucose and insulin levels. In a recent meta-analysis, coffee and decaffeinated coffee consumption did not significantly affect fasting blood glucose concentration (mean difference (MD) = 1.34 mg/dL; 95% CI = −0.52–3.20 mg/dL and MD = 5.28 mg/dL; 95% CI = −5.34–15.91 mg/dL, respectively) [13]. Moreover, the effects of coffee and decaffeinated coffee at 2-h post-75-g glucose load plasma glucose concentration were not significant (MD = −23.99 mg/dL; 95% CI = −63.78–15.81 mg/dL and MD = 12.27 mg/dL ; 95% CI = −8.52–33.07 mg/dL) [13]. Coffee significantly altered fasting insulin concentration (MD = 1.1 μIU/mL; 95% CI = 0.17–2.03 μIU/mL) [13]. However, measurements of these concentrations have limitations in evaluating insulin sensitivity and resistance.

The hyperinsulinemic-euglycemic clamp is the gold standard for assessing insulin sensitivity in humans [14]. However, this method is not suitable for use in clinical practice because it is a time-consuming, labor-intensive, and expensive method, and requires skilled examiners. Several surrogate indices (e.g., homeostasis model assessment (HOMA), quantitative insulin sensitivity check index (QUICKI), Matsuda, McAuley, Belfiore, Cederholm, Avignon, and Stumvoll indexes) have been developed as alternative measures of insulin resistance or sensitivity [15][16].

Few studies have assessed the effects of coffee consumption on insulin sensitivity/resistance indices. Until 2017, only two studies were included in meta-analysis and systematic reviews [13][17]. Newer studies have been conducted since then, which makes it essential to evaluate the influence of coffee consumption on insulin resistance or sensitivity through a meta-analysis.

2. Coffee Consumption and Insulin Resistance and Sensitivity

Herein evaluated the effects of coffee consumption on HOMA-IR and Matsuda index by analyzing four RCTs. HOMA-IR is used in many studies as a tool for evaluating insulin resistance and mainly reflects liver insulin resistance [18][19]. This index was more reliable to assess insulin resistance than the fasting glucose/insulin ratio and was an independent predictor of cardiovascular disease [20][21]. Matsuda index is a simple index of whole-body insulin sensitivity including liver and muscle [19][22]. Other surrogate indices,

except for HOMA-IR and Matsuda, were rarely used in coffee studies. Although not included in the search terms, insulin resistance indices using C-peptide levels (e.g., clamp-like index (CLIX), C-peptide immunoreactivity insulin resistance (CPR-IR)) exist [23][24]. However, these indices have not been used previously to assess the effects of coffee.

A previous meta-analysis reported no significant effect of coffee consumption on HOMA-IR relative to the control by analyzing two RCTs [13]. Herein showed that coffee consumption significantly decreased HOMA-IR. However, the robustness of the result was not warranted. The significance of our result was driven by one significant result from a large-weighted study. The weight of the crossover design is generally larger than that of parallel design in a meta-analysis [25]. The characteristics of the group showing significant results were different from those of other studies. They were young adults (aged 18–45 years), had a normal weight (BMI < 25 kg/m^2), and did not have any metabolic syndrome including hypercholesterolemia. In such a population, the possibility of coffee consumption lowering insulin resistance cannot be ruled out. However, it is difficult to conclude that coffee consumption reduces insulin resistance from one study. Moreover, coffee consumption did not significantly affect the Matsuda index.

Although not included in this meta-analysis, in one non-RCT, HOMA-IR was 3.93, 4.10, and 4.22 in subgroups that consumed zero, four, and eight cups of coffee daily, respectively [26]. The difference was not significant, and other markers of glucose metabolism also were not significantly different [26]. Some studies reported HOMA for β-cell function (HOMA-B) as an indicator of insulin resistance. There was no significant difference in HOMA-B between the coffee consumption and placebo groups in a study by Alperet et al. [27]. Mansour et al. conducted an RCT that administered two main coffee components, caffeine and chlorogenic acid, to patients with non-alcoholic fatty liver disease and type 2 diabetes [28]. HOMA-IR between chlorogenic acid plus caffeine, chlorogenic acid, caffeine, and placebo did not differ significantly [28].

Previous studies showed that caffeine can lower insulin sensitivity and increase insulin resistance and glucose concentration [29][30][31]. MacKenzie et al. conducted a randomized crossover trial and found that 400 mg of caffeine (equivalent to two cups of coffee) per day decreases insulin sensitivity in young adults [31]. The mechanism of caffeine’s effects on glucose metabolism has not been fully revealed, but several have been suggested. Caffeine inhibits glucose uptake and glycogen synthase activity in the skeletal muscle by competitively blocking adenosine receptors [32]. Other mechanisms include increased levels of epinephrine and free fatty acids that can increase insulin resistance after caffeine intake [31][32]. However, the nonsignificant effects of coffee on insulin resistance and sensitivity in the present meta-analysis might be due to other ingredients in coffee that may negate the effects of caffeine on insulin resistance and sensitivity [33]. Chlorogenic acid reduced glucose concentrations, and its metabolite, quinides, increased insulin sensitivity in rats [34]. Chlorogenic acid may competitively inhibit glucose absorption in the intestine and reduce hepatic glucose output through glucose-6-phosphatase inhibition [34].

3. Conclusions

Long-term caffeinated or decaffeinated coffee consumption does not negatively affect insulin resistance or sensitivity. There is no need to restrict coffee intake in non-diabetic, prediabetic, and diabetic individuals for fear of insulin resistance. In addition, more studies evaluating the effects of coffee consumption in healthy, young, and normal-weight individuals are needed.

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Keywords

coffee;insulin resistance;insulin sensitivity