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Matcha versus Coffee: Comparative Effects on Cognitive Performance, Stress Response and Cardiometabolic Health in Physically Active Individuals – A Narrative Review

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Abstract

Background: Matcha and coffee are widely consumed sources of caffeine and other bioactive compounds. Caffeine-mediated effects are well established, but the distinct phytochemical profiles of these beverages contribute to different physiological responses. Direct comparisons between matcha and coffee remain limited.

Aim: We aim to compare the effects of matcha and coffee on cognitive performance, stress response, and cardiometabolic health, with emphasis on their practical relevance for physically active individuals and their potential applications before, during, and after exercise.

Material and methods: This narrative review analyzed recent publications identified through manual searches in PubMed, Scopus, and Google Scholar.

Results: Both beverages provide caffeine and may improve alertness, attention, and exercise performance, with coffee currently supported by larger evidence base for acute ergogenic effects. Matcha produce a more balanced state of alertness and may be advantageous for sustained attention under conditions of psychological and subjective arousal. Matcha-derived catechins may influence blood pressure, glucose metabolism, lipid metabolism, inflammation, and oxidative stress. Coffee consumption has been associated with favorable or neutral long-term cardiometabolic outcomes.

Conclusions: Matcha and coffee should not be viewed as competing beverages, but sources of distinct combinations of bioactive compounds with potentially complementary functional profiles. Coffee has the strongest evidence for rapid caffeine-mediated stimulation and acute

exercise performance, whereas matcha is relevant to sustained cognitive engagement and regular exposure to tea-derived polyphenols.

Keywords: matcha, coffee, caffeine, L-theanine, catechins, epigallocatechin gallate (EGCG), cognitive performance, stress response, cardiometabolic health, exercise performance, physically active individuals

1. Introduction

Coffee and tea are among the most widely consumed beverages worldwide and constitute important dietary sources of bioactive compounds. Their consumption is relevant to physically active individuals, for whom maintaining alertness, cognitive performance, exercise capacity, stress regulation, and cardiometabolic health may influence both performance and recovery. Caffeine is one of the most extensively studied ergogenic compounds and has been shown to improve several aspects of exercise performance, including aerobic endurance, muscle endurance, strength, power, and exercise speed (Grgic et al., 2020). At the same time, habitual coffee consumption has been associated with a range of favorable or neutral long-term health outcomes, including cardiovascular and metabolic outcomes, although the quality and nature of evidence vary between outcomes (Poole et al., 2017).

Coffee and matcha, however, should not be considered simply as different sources of caffeine, because they have distinct phytochemical profiles that may modify their physiological effects. Despite growing interest in matcha, direct comparisons between matcha and coffee remain limited. Previous research has predominantly investigated these beverages separately, with substantially more evidence available for coffee and caffeine than for whole matcha. The evidence gap makes it difficult to determine whether their distinct bioactive profiles translate into meaningful differences in cognitive performance, stress response, and cardiometabolic health in physically active individuals

This distinction provides the rationale for the present narrative review. Rather than comparing the beverages solely on the basis of caffeine content, the review considers their broader bioactive composition and potential effects across three interconnected domains: cognitive performance, stress response, and cardiometabolic health. Attention is given to the potential relevance of these effects for physically active individuals and to differences between acute and longer-term consumption.

The aim is to critically compare the potential effects of matcha and coffee on cognitive performance, stress response, and cardiometabolic health in physically active individuals, while examining the underlying mechanisms, practical application, limitations of the current evidence, and key gaps requiring future research. By integrating evidence concerning caffeine with research on L-theanine, catechins, chlorogenic acids, trigonelline, diterpenes, and other bioactive compounds, this review seeks to determine whether matcha and coffee may be better understood as complementary beverages suited to different physiological and behavioral contexts rather than competing sources of caffeine.

2. Research materials and methods

2.1. Literature search strategy

A literature search was conducted to identify evidence concerning the effects of matcha and coffee on cognitive performance, stress response, cardiometabolic health, and exercise-related outcomes. The search was performed using PubMed**,** Scopus, and Google Scholar databases. The search strategy was designed to identify studies investigating both beverages individually and comparatively, as well as research examining their major bioactive compounds. The search strategy combined keywords and Boolean operators related to the beverages, their bioactive constituents, and the outcomes of interest. The search terms included combinations of: *matcha, matcha tea, green tea powder, coffee, caffeine, L-theanine, catechins, EGCG, chlorogenic acids, cognitive performance, attention, memory, executive function, reaction time, mental fatigue, stress, cortisol, heart rate variability, anxiety, sleep, blood pressure, lipid profile, glucose metabolism, body weight, inflammation, oxidative stress, exercise, physical activity*, and *sports performance*. The search focused primarily on peer-reviewed studies published in English. Priority was given to randomized controlled trials, observational studies, systematic reviews, high-quality narrative reviews, and mechanistic research relevant to the review's objectives; meta-analyses were used for contextual information.

2.2. Inclusion and exclusion criteria

Studies were considered eligible when they addressed at least one of the major domains investigated in this review: cognitive performance, stress response, cardiometabolic health, or exercise-related outcomes associated with matcha, coffee, caffeine, or their major bioactive compounds. The inclusion criteria were as follows:

- studies investigating matcha, coffee, caffeine, L-theanine, catechins, EGCG, chlorogenic acids, or combinations of these compounds.
- studies evaluating at least one relevant outcome related to attention, memory, executive function, reaction time, mental fatigue, stress, cortisol, heart rate variability, anxiety, sleep, blood pressure, lipid profile, glucose metabolism, body weight, inflammation, oxidative stress, exercise performance, endurance, fatigue, or recovery.
- studies involving healthy adults, physically active individuals, athletes, or populations relevant to the cardiometabolic and cognitive effects discussed in the review.
- randomized controlled trials, controlled clinical trials, observational studies, prospective and cross-sectional studies, relevant mechanistic or experimental investigations, reviews, and meta-analyses
- studies published in English in peer-reviewed scientific journals.

Studies were excluded when they:

- did not investigate matcha, coffee, caffeine, or a relevant bioactive compound.
- did not report outcomes relevant to the objectives of the review.
- were unrelated to human health, cognitive performance, stress response, cardiometabolic health, or exercise.
- consisted solely of animal or in vitro research without clear relevance to the interpretation of human findings.
- were case reports or case series.
- were conference abstracts without sufficient methodological or outcome information.
- were non-scientific publications, commercial reports, or other sources lacking adequate scientific methodology.
- were duplicate publications.

Because this article is a narrative review, the inclusion criteria were designed to capture a broad, and multidisciplinary body of evidence rather than to restrict the review to a single study design or population.

2.3. Screening and selection process

Potentially relevant publications were identified through searches of PubMed, Scopus, and Google Scholar using combinations of predefined keywords. Search results were initially screened based on title and abstract to determine their relevance to the objectives of the review. Publications that clearly did not address the topic of interest were excluded at this stage. The full text of potentially relevant studies was subsequently assessed in detail. Studies were retained when they provided information relevant to at least one of the predefined domains, including cognitive performance, stress response, cardiometabolic health, or exercise-related outcomes. When multiple publications reported similar outcomes, priority was given to studies with stronger methodological designs, including randomized controlled trials and controlled clinical studies, as well as to studies with clearly defined interventions, standardized exposures, and objectively measured outcomes. Nevertheless, observational and mechanistic studies were also considered where randomized evidence was limited, particularly for long-term cardiometabolic outcomes and potential antioxidant or anti-inflammatory mechanisms. Reference lists of selected publications were manually screened to identify additional relevant studies. This citation-based search was used to supplement the electronic database searches and improve the comprehensiveness of the literature base. The final body of evidence was organized thematically according to the major objectives of the review: cognitive performance, stress response, cardiometabolic health, and implications for physically active individuals. Within these domains, findings were further considered according to specific outcomes, including attention, memory, executive function, reaction time, mental fatigue, cortisol, heart rate variability, perceived stress, anxiety, sleep, blood pressure, lipid profile, glucose metabolism, body weight, inflammation, and oxidative stress. Findings were critically synthesized to identify consistent patterns, potential differences between matcha and coffee, practical implications for physically active individuals, and important gaps in the current evidence base.

3. Research results

3.1 Bioactive Composition of Matcha and Coffee

Matcha and coffee are complex beverages containing multiple bioactive compounds that may contribute to their physiological effects beyond their caffeine content. Although both beverages provide caffeine, their overall phytochemical profiles differ substantially. Matcha is characterized by the presence of L-theanine and tea catechins, particularly epigallocatechin gallate (EGCG), whereas coffee contains substantial amounts of chlorogenic acids, trigonelline, diterpenes, and roasting-derived melanoidins. These differences in chemical composition provide an important basis for understanding the potentially distinct effects of matcha and coffee on cognitive performance, stress response, and cardiometabolic health. The major bioactive compounds identified in matcha, and coffee are summarized in Table 1.

Table 1. Comparison of major bioactive compounds in matcha and coffee

Bioactive Compound	**Matcha**	**Coffee**
Caffeine	+++	+++
L-theanine	+++	-
Catechins	+++	+/low
EGCG	+++	-
Chlorogenic acids	+/low	+++
Chlorophyll	+++	-
Cafestol and kahweol	-	+++*
Trigonelline	-	++
Melanoidins	+/low	+++
Vitamins and minerals	++	+/variable

Note: +++ = major/characteristic component; ++ = present in relevant amounts; + = present in lower amounts; - = not characteristic/negligible; *particularly relevant in unfiltered or incompletely filtered coffee

Matcha is a powdered form of *Camellia sinensis* leaves that are cultivated under shading conditions before harvesting and subsequently processed into a fine powder. Unlike conventional green tea, in which the leaves are infused and then discarded, matcha is consumed by ingesting the entire powdered leaf. Consequently, matcha may provide greater exposure to tea-derived compounds than conventional green tea infusions. Shading during cultivation promotes the accumulation of several bioactive constituents, including L-theanine, caffeine, chlorophyll, and catechins (Kochman et al., 2020; Phuah et al., 2023).

The composition of matcha is highly variable and depends on cultivar, geographical origin, cultivation conditions, degree and duration of shading, harvesting period, processing, storage, and preparation (Chen et al., 2022; Phuah et al., 2023). As a result, commercially available products differ considerably in their concentration of caffeine, L-theanine, and catechins (Chen et al., 2022; Phuah et al., 2023). This heterogeneity is important when interpreting clinical studies because differences in product composition and preparation may contribute to heterogeneity in physiological responses and limit direct comparisons between studies.
Coffee is similarly a chemically complex beverage whose composition is determined by both the coffee bean and its processing. Roasting induces substantial chemical transformations, including Maillard reactions, degradation of some native compounds, and formation of new compounds such as melanoidins. The physiological effects of coffee cannot be attributed exclusively to caffeine but may reflect the combined activity of several bioactive constituents. (Bonita et al., 2007; Hu et al., 2019; Moreira et al., 2012).

Coffee composition is influenced by species and cultivar, geographical and environmental conditions, processing, roast degree, grinding, and brewing technique (Bonita et al., 2007; Hu et al., 2019; Orrje et al., 2025). These factors affect both the concentration and bioavailability of individual bioactive compounds, thereby contributing to variability in physiological effects observed across different coffee preparations. Brewing method has important implications for the cardiometabolic effects of coffee because it determines the amount of diterpenes, especially cafestol and kahweol, transferred into the beverage. These compounds are present at substantially higher concentrations in unfiltered or incompletely filtered coffee, whereas paper filtration markedly reduces their transfer into the beverage (Orrje et al., 2025; Ren et al., 2019). Caffeine content also varies considerably between coffee products and preparation methods, making the serving size an imperfect indicator of actual caffeine exposure (Hu et al., 2019; Orrje et al., 2025).

3.2 Mechanism of Action

3.2.1 Caffeine: Adenosine Receptor Antagonism

Caffeine is the principal psychoactive compound present in both matcha and coffee. Its primary mechanism of action involves competitive antagonism of adenosine A1 and A2A receptors in the central nervous system, leading to increased neuronal activity and modulation of neurotransmitter signaling, including dopaminergic and noradrenergic signaling (Fredholm, 1995; Fredholm et al., 1999). Caffeine may also affect peripheral and central pathways involved in neuromuscular function and exercise-related perception, including mechanisms underlying motor unit recruitment and perceived exertion (Duncan et al., 2013; Grgic et al., 2020; Guest et al., 2021). The magnitude of caffeine-mediated responses depends on dose, habitual consumption, individual sensitivity and metabolism, and timing of ingestion (Guest et al., 2021). At higher doses, caffeine may produce greater sympathetic and central nervous system activation, which may alter the balance between its stimulatory and adverse effects.

3.2.2 L-theanine: Modulation of Neurotransmission and Alpha-wave Activity

L-theanine is a non-protein amino acid characteristic of *Camellia sinensis* and therefore represents one of the principal compounds distinguishing matcha from coffee. It can cross the blood–brain barrier and may influence several neurochemical pathways involved in excitatory and inhibitory neurotransmission. Experimental evidence suggests interactions with glutamatergic and GABAergic pathways, as well as modulation of dopaminergic and serotonergic signaling; however, much of the mechanistic evidence is derived from preclinical studies, and the precise neurobiological mechanism in humans remains incompletely understood (Unno et al., 2020; Williams et al., 2020). L-theanine has also been associated with changes in alpha-band activity, although the direction and magnitude of these effects depend on the experimental conditions (Evans et al., 2021; Gomez-Ramirez et al., 2009). The combination of L-theanine and caffeine is relevant when matcha's distinct composition. Caffeine primarily acts through antagonism at adenosine receptors, whereas L-theanine may influence cortical activity and neurotransmission through partially independent pathways. Some experimental studies investigating their combined administration suggest that these compounds may interact at the level of attentional and cortical processing (Einöther et al., 2010; Haskell et al., 2008; Kelly et al., 2008). The proposed mechanism is complementary: caffeine increases arousal and vigilance, whereas L-theanine may reduce excessive excitability and improve attentional selectivity (Einöther et al., 2010; Kelly et al., 2008)**.** However, findings obtained using isolated L-theanine or standardized caffeine–L-theanine preparations cannot automatically be extrapolated to commercially prepared matcha.

3.2.3 Catechins (EGCG): Molecular and Cellular Mechanisms

Catechins are a major group of polyphenolic compounds in *Camellia sinensis* and represent an important component distinguishing matcha from coffee. The principal tea catechins include epigallocatechin-3-gallate (EGCG), epigallocatechin (EGC), epicatechin-3-gallate (ECG), and epicatechin (EC), with EGCG considered the most abundant and extensively studied catechin. Matcha is consumed as a powdered whole-leaf product rather than as an infusion from which leaves are discarded; it may provide substantial exposure to these compounds (Cai et al., 2018; C. Liu et al., 2024). The biological activity of catechins involves multiple molecular pathways rather than a single receptor-mediated mechanism. EGCG can interact with cellular signaling pathways involved in redox regulation, including the nuclear factor erythroid 2-related factor 2 (Nrf2) pathway. Activation of Nrf2 promotes transcription of antioxidant and cytoprotective genes, including enzymes involved in cellular defense against oxidative stress. EGCG has also been reported to modulate nuclear factor kappa B (NF-κB) and mitogen-activated protein kinase (MAPK) signaling pathways, which are involved in the regulation of inflammatory and cellular stress responses (Khan & Mukhtar, 2007; Y. Wang et al., 2015). These effects provide a mechanistic basis for the potential biological activity of tea catechins beyond their direct radical-scavenging capacity. Catechins may also influence endothelial and metabolic signaling. Experimental evidence indicates that EGCG can modulate nitric oxide-related pathways and endothelial signaling, while other studies suggest interactions with AMP-activated protein kinase (AMPK) and pathways involved in glucose and lipid metabolism (Khan & Mukhtar, 2007; S. Zhang et al., 2024). However, many of these mechanisms have been demonstrated predominantly in cell and animal models, and their physiological relevance during habitual matcha consumption remains incompletely established. An important consideration is that the biological activity of catechins depends not only on their concentration in matcha but also on their absorption, metabolism, and transformation by the gut microbiota. Following ingestion, catechins undergo extensive conjugation and biotransformation, while only a relatively small proportion of intact EGCG reaches the systemic circulation (Cai et al., 2018; Yang et al., 2008). Gut microbiota can further metabolize catechins into smaller phenolic metabolites that may contribute to their biological effects (Yang et al., 2008). Consequently, the effects observed in experimental studies using purified EGCG at relatively high concentrations cannot be directly equated with those at physiologically achievable concentrations after consumption of matcha.

3.2.4 Chlorogenic Acids: Vascular, Metabolic, and Redox Signaling

Chlorogenic acids (CGAs) are major polyphenolic compounds in coffee, with 5-O-caffeoylquinic acid (5-CQA) being one of the most abundant forms. Their biological activity involves several vascular, metabolic, and redox-sensitive pathways. Following ingestion, CGAs undergo extensive metabolism, and phenolic metabolites generated during intestinal and microbial transformations may substantially contribute to their systemic biological activity. Consequently, the effects of coffee-derived CGAs cannot be attributed exclusively to the intact parent compounds (Lu et al., 2020; Nguyen et al., 2024). One proposed mechanism involves endothelial nitric oxide (NO) signaling. CGAs and their metabolites may influence endothelial nitric oxide synthase (eNOS) activity and NO bioavailability, providing a potential molecular pathway linking coffee polyphenols with vascular regulation (Lu et al., 2020; Nguyen et al., 2024). CGAs also interact with pathways involved in cellular energy metabolism**,** particularly AMP-activated protein kinase (AMPK). Experimental studies have demonstrated that chlorogenic acid can activate AMPK and increase glucose transport in skeletal muscle, partly through enhanced GLUT4 translocation. CGAs may additionally influence hepatic glucose production and lipid metabolism through AMPK-dependent signaling (Ong et al., 2012, 2013). CGAs may further modulate redox-sensitive and inflammatory signaling pathways, including Nrf2, NF-κB, and MAPK. These pathways regulate antioxidant defenses, cellular stress responses, and inflammatory mediator production (Nguyen et al., 2024; L. Wang et al., 2022). However, much of the mechanistic evidence is derived from experimental models, and the concentrations used in some studies may exceed those achieved following normal dietary coffee consumption. Therefore, these pathways should be considered potential mechanisms of action rather than established explanations for clinical effects**.** Their potential effects on blood pressure, glucose metabolism, inflammation, and oxidative stress are discussed separately in the corresponding sections of this review.

3.2.5 Trigonelline: Metabolic and Neuroprotective Signaling

Trigonelline is a niacin-related alkaloid present in coffee beans whose concentration depends on coffee species, cultivar, processing, and roasting conditions. During roasting, a proportion of trigonelline is degraded, yielding nicotinic acid and several volatile compounds as thermal degradation products. The amounts of trigonelline and its derivatives in the final beverage depend substantially on the degree of roasting and brewing conditions (Caprioli et al., 2014; Casal et al., 2000). Experimental evidence suggests that trigonelline may interact with several pathways involved in glucose and lipid metabolism, oxidative stress, and cellular signaling.

Proposed mechanisms include modulation of enzymes involved in glucose metabolism, insulin-related signaling, and cellular redox homeostasis. Trigonelline has also been investigated for potential effects on neuronal survival and neurotrophic signaling, including pathways related to oxidative stress and neuroinflammation (Liang et al., 2023). However, much of the evidence for these mechanisms comes from cell and animal studies, and the concentrations used experimentally may not reflect those achieved in habitual coffee consumption.

3.2.6 Cafestol and kahweol: Lipid Metabolism and Cellular Signaling

Cafestol and kahweol are coffee-specific diterpenes predominantly present in the lipid fraction of coffee beans. Their concentrations depend strongly on the brewing method, as paper filtration efficiently removes these lipophilic compounds, whereas unfiltered preparations such as boiled, French press, and some espresso coffee contain substantially higher amounts (Gross et al., 1997; Moeenfard & Alves, 2020; Orrje et al., 2025). The best-characterized mechanism of cafestol and kahweol involves hepatic cholesterol and bile acid metabolism. Experimental studies indicate that cafestol can suppress bile acid synthesis by downregulating key enzymes involved in cholesterol catabolism, including cholesterol 7α-hydroxylase (CYP7A1) and sterol 27-hydroxylase. This may reduce the conversion of cholesterol into bile acids and thereby contribute to increased hepatic cholesterol availability (Post et al., 1997). Cafestol has also been shown to modify hepatic lipoprotein metabolism and LDL receptor-related pathways, providing a mechanistic explanation for its cholesterol-raising properties (Rustan et al., 1997; Urgert & Katan, 1997). These effects are particularly relevant to the lipid profiles of individuals consuming substantial amounts of unfiltered coffee. Kahweol and cafestol may additionally influence cellular redox and cytoprotective signaling**.** Experimental studies indicate that kahweol can activate the nuclear factor erythroid 2-related factor 2 (Nrf2)/heme oxygenase-1 (HO-1) pathway, in part by modulating Keap1, thereby affecting cellular antioxidant defenses (van Cruchten et al., 2010).

3.2.7 Melanoidins: Redox and Maillard-Derived Signaling

Melanoidins are high-molecular-weight, nitrogen-containing compounds formed through Maillard reactions during coffee roasting. They constitute an important fraction of roasted coffee, and their concentration and structure depend on roasting conditions. Coffee melanoidins can also incorporate phenolic compounds, including chlorogenic acid derivatives, which may contribute to their biological activity (Borrelli et al., 2002; Perrone et al., 2012). The best-characterized mechanism of melanoidins involves antioxidant and redox-modulating activity. Coffee melanoidins can scavenge reactive species and inhibit lipid peroxidation, while their antioxidant properties are partly related to low-molecular-weight compounds and phenolic constituents associated with the melanoidin structure(Borrelli et al., 2002; Delgado-Andrade & Morales, 2005). They may also interact with reactive carbonyl compounds, potentially limiting their accumulation and subsequent protein glycation (H. Zhang et al., 2019). These properties provide a plausible mechanism through which coffee melanoidins could contribute to the redox-related effects of coffee. However, their precise molecular structures are highly heterogeneous, and most evidence for their biological activity remains experimental. Consequently, melanoidins should be considered a potential contributor to the antioxidant properties of coffee rather than an independently established mediator of clinical **effects** (Moreira et al., 2012).

Table 2. Comparative mechanistic profile of the major bioactive compounds in matcha and coffee

Compound	**Matcha/Coffee**	**Main mechanism**	**Potential relevance**	**Evidence**
Caffeine	Both	Adenosine A1/A2A receptor antagonism	Cognitive + exercise	Strong human evidence
L-theanine	Matcha	Neurotransmitter/ EEG modulation	Cognitive + stress	Moderate, combination-dependent
EGCG	Matcha	AMPK/Nrf2/eNOS	Cardiometabolic	Mainly experimental; limited human mechanistic evidence
CGAs	Coffee	AMPK/eNOS/Nrf2	Cardiometabolic	Experimental + some human evidence
Trigonelline	Coffee	Metabolic/redox signaling	Metabolic/neuroprotective	Mainly experimental

Cafestol/ kahweol	Coffee	Cholesterol/bile acid metabolism	Lipid profile	Strong human evidence for cholesterol effects
Melanoidins	Mainly coffee	Redox/carbonyl scavenging	Oxidative stress	Mainly experimental

3.3 Effects on cognitive performance

3.3.1 Attention

Attention is one of the cognitive domains most consistently influenced by caffeine and is therefore particularly relevant when comparing coffee with matcha. Caffeine can acutely enhance attentional performance through antagonism of central adenosine receptors, resulting in increased cortical arousal and vigilance. These effects may manifest as improved alertness, vigilance, attention, and reaction time, particularly under conditions of reduced baseline alertness or prolonged cognitive demand. A recent systematic review and meta-analysis of randomized controlled trials found that acute caffeine consumption improves attention in healthy adults, with improvements observed in both reaction time and accuracy. However, the dose–response relationship was not linear: higher doses continued to improve reaction time, whereas accuracy appeared to improve only up to a certain dose, after which further increases could be counterproductive (Kløve & Petersen, 2025). The attentional effects of matcha may reflect the combined action of caffeine and L-theanine rather than caffeine alone. Experimental studies of caffeine–L-theanine combinations have reported improvements in attention-related outcomes, including reaction time, target detection, and attentional task performance. In a randomized, placebo-controlled crossover study, caffeine and L-theanine administered together produced improvements in several measures of attention and cognitive performance compared with placebo, suggesting a potential complementary interaction between the two compounds (Haskell et al., 2008). More recent research has similarly demonstrated that L-theanine can influence neurophysiological markers of attention, although effects appear to depend on dose. In a double-blind crossover study, 400 mg of L-theanine significantly reduced P3b latency, suggesting faster attentional processing (Dassanayake et al., 2022). Evidence from studies investigating **t**ea-derived combinations also supports a potential role of L-theanine in attentional function. A randomized, double-blind, placebo-controlled study found that a combination of green tea extract and L-theanine improved selected measures of attention and memory in individuals with mild cognitive impairment after 16 weeks of supplementation (Park et al., 2011). However, these findings cannot be directly interpreted as evidence for matcha itself, as the intervention used a standardized green tea extract rather than commercially prepared matcha, and the study population differed substantially from healthy physically active individuals.

The available evidence suggests that coffee may provide a more predictable acute enhancement of attention due to its caffeine content, whereas matcha's cognitive effects may also reflect the interaction between caffeine and L-theanine. This combination may support attentional performance while producing a different profile of arousal than caffeine alone. Nevertheless, direct head-to-head trials comparing matcha and coffee using equivalent caffeine doses are currently lacking, making it difficult to determine whether matcha provides superior attentional benefits or simply a qualitatively different cognitive response.

3.3.2 Memory

Memory represents a more complex cognitive domain than attention, and the effects of caffeine and tea-derived compounds appear to depend on the type of memory, timing of intake, dose, and baseline arousal. Evidence for coffee's effects is largely attributable to caffeine, which may influence memory through modulation of adenosine signaling and neuronal activity. In a randomized controlled study, caffeine administered after learning enhanced long-term memory performance 24 hours later, suggesting an effect on memory consolidation rather than retrieval. However, subsequent research has questioned the magnitude and reproducibility of this effect, indicating that caffeine-related improvements in mnemonic discrimination may be small and potentially influenced by habitual caffeine consumption and withdrawal (Aust & Stahl, 2020; Borota et al., 2014). Caffeine may also be particularly beneficial when cognitive performance is challenged by suboptimal arousal or time of day. In a study of young adults, caffeine-containing coffee improved explicit, but not implicit, memory when consumed in the morning, whereas no significant memory enhancement was observed in the afternoon. These findings suggest that caffeine may partly compensate for reduced alertness and improve memory performance under conditions of lower baseline arousal rather than uniformly enhancing memory across all circumstances (Sherman et al., 2016). For matcha, direct evidence on memory is considerably more limited. Its potential cognitive effects may result from the combined action of caffeine and L-theanine, with additional contributions from catechins. A randomized, double-blind, placebo-controlled study found that a standardized green tea extract combined with L-theanine improved selected measures of memory and attention after 16 weeks in individuals with mild cognitive impairment (Park et al., 2011). However, these findings cannot be directly extrapolated to matcha because the intervention involved a standardized extract rather than commercially prepared matcha and was conducted in a clinical population. More broadly, systematic reviews of randomized trials indicate that tea, L-theanine, and caffeine–L-theanine combinations may influence aspects of cognitive function, but evidence for memory specifically remains less consistent than that for attention and alertness (Camfield et al., 2014; Payne et al., 2025).

The potential interaction between caffeine and L-theanine may nevertheless be relevant to matcha's cognitive profile. Caffeine may increase arousal and facilitate encoding or consolidation under conditions of low alertness, whereas L-theanine may modulate attentional processing and subjective arousal. This combination could theoretically support memory performance by maintaining an optimal level of cognitive arousal, although this hypothesis has not been adequately tested with whole-leaf matcha. Importantly, the current literature does not establish that matcha produces greater memory benefits than coffee at equivalent caffeine doses. Caffeine appears to have a modest, context-dependent effect on memory, with some evidence for enhanced consolidation and explicit memory, whereas evidence for matcha remains indirect and is primarily based on green tea, L-theanine, or caffeine–L-theanine preparations. The absence of well-controlled head-to-head trials comparing matcha and coffee represents an important gap in the current evidence. Further studies should compare standardized doses of matcha and coffee while controlling for caffeine content, L-theanine exposure, habitual caffeine intake, timing of administration, and baseline cognitive performance.

3.3.3 Executive function

Executive function encompasses a set of higher-order cognitive processes responsible for goal-directed behavior, including inhibitory control, cognitive flexibility, working memory, planning, and task switching. Compared with attention and vigilance, executive functions appear to be more sensitive to task complexity and baseline cognitive state, and the effects of caffeine and tea-derived compounds are therefore less consistent. Caffeine may influence executive function primarily through antagonism at adenosine receptors, particularly A_2A receptors, resulting in increased cortical arousal and modulation of dopaminergic and noradrenergic neurotransmission. Acute caffeine intake has been associated with improvements in selected executive processes, particularly inhibitory control and vigilance, although effects vary according to dose, habitual caffeine consumption, and the specific

cognitive task used (Einöther & Giesbrecht, 2013; McLellan et al., 2016). A systematic review of caffeine's effects on cognition reported relatively consistent improvements in attention and alertness, whereas evidence for higher-order executive functions was more heterogeneous (McLellan et al., 2016). The combination of caffeine and L-theanine, which is particularly relevant to matcha, may produce a distinct effect on executive functioning. In a randomized, placebo-controlled crossover study, caffeine combined with L-theanine improved aspects of attention and task switching, with effects becoming particularly apparent during demanding cognitive tasks (Haskell et al., 2008). These findings suggest that L-theanine may complement the stimulatory effects of caffeine by modulating arousal while preserving attentional efficiency. However, the evidence does not establish that the combination improves all components of executive function, and findings appear to depend on the cognitive domain examined. Evidence from studies using green tea or tea-derived compounds
provides additional support for potential effects on higher-order cognition. Chronic consumption of green tea catechins has been investigated in relation to cognitive performance, although evidence for improvements in executive function in healthy adults remains limited and inconsistent (Mancini et al., 2017).

From a comparative perspective, coffee may provide a more pronounced acute stimulatory effect on executive performance through caffeine, whereas matcha may produce a more balanced cognitive response due to the combination of caffeine and L-theanine, potentially supporting attention and task switching without excessive arousal. Nevertheless, this distinction remains hypothetical because most studies have investigated isolated caffeine, green tea extracts, or caffeine–L-theanine combinations rather than whole matcha. Direct head-to-head studies comparing standardized matcha and coffee doses on executive-function outcomes are currently lacking. The available evidence suggests that caffeine can acutely influence selected components of executive function, particularly under conditions of reduced alertness or increased cognitive demand, while the caffeine–L-theanine combination may additionally modulate attentional control and task switching. However, the evidence for a specific advantage of matcha over coffee remains insufficient, and future research should employ standardized cognitive batteries to assess inhibition, cognitive flexibility, working memory, and task switching while controlling for caffeine dose and habitual caffeine consumption.

3.3.4 Reaction time

Reaction time is an important component of cognitive performance, particularly in physically active individuals, as it reflects the speed of perceptual processing, decision-making, and motor response. Caffeine is one of the most consistently investigated dietary compounds in this context, and its acute effects are primarily attributed to antagonism of central adenosine receptors. By increasing neural arousal and vigilance, caffeine can accelerate responses to external stimuli, although the magnitude of the effect depends on dose, habitual caffeine intake, task characteristics, and baseline fatigue (Einöther & Giesbrecht, 2013; McLellan et al., 2016). A comprehensive review of caffeine's cognitive effects concluded that low-to-moderate doses generally improve reaction time and attention, whereas effects on more complex cognitive functions are less consistent (McLellan et al., 2016). Evidence from physically active populations is particularly relevant to the present review. A systematic review and meta-analysis examining caffeine and cognitive function in sport found that caffeine supplementation can improve several aspects of cognitive performance, including reaction time, particularly under conditions where fatigue or demanding exercise may impair it (Lorenzo Calvo et al., 2021). These findings suggest that the ergogenic relevance of caffeine may extend beyond peripheral physical performance by helping to maintain rapid perceptual and motor responses during prolonged or demanding activity. Similarly, caffeine has been shown to improve cognitive performance following sleep loss, with reaction time among the outcomes that may benefit from acute supplementation (Irwin et al., 2020). For matcha, the available evidence is considerably more indirect. The potential effect on reaction time may result from the combination of caffeine and L-theanine. In a randomized, placebo-controlled crossover study, the effects of L-theanine, caffeine, or their combination ware evaluated using simple and recognition visual reaction-time tasks. The combination demonstrated effects on selected measures of attention and reaction performance, suggesting that L-theanine may modify the cognitive effects of caffeine (Haskell et al., 2008). Importantly, these studies used isolated caffeine and L-theanine rather than whole-leaf matcha. Therefore, their findings provide mechanistic support for the potential cognitive effects of matcha but do not constitute direct evidence for matcha itself. The caffeine–L-theanine combination may be particularly relevant when rapid responses must be maintained under conditions of cognitive fatigue. Recent experimental evidence indicates that a combination of L-theanine and caffeine can improve reaction-time measures of selective attention in sleep-deprived young adults, although the relatively high doses used in such studies should be distinguished from the amounts typically consumed in a serving of matcha (Owen et al., 2008). This distinction is important when extrapolating findings from isolated compounds to naturally consumed beverages.

From a comparative perspective, coffee is likely to provide a more predictable acute effect on reaction time because caffeine is its principal psychoactive component and is generally consumed in higher doses than in matcha. Matcha may nevertheless produce a distinct cognitive profile because caffeine is accompanied by L-theanine and catechins. The latter combination could potentially support rapid responses while modulating excessive arousal, but this remains a hypothesis rather than an established advantage of matcha. Current evidence supports a moderate, relatively consistent acute improvement in reaction time following caffeine consumption, including in physically active and fatigued individuals. Evidence for matcha is much more limited and is largely extrapolated from studies of caffeine–L-theanine combinations or green tea preparations. Direct head-to-head trials comparing standardized matcha and coffee with equivalent caffeine doses and identical reaction-time paradigms are needed to determine whether the additional compounds in matcha meaningfully modify caffeine’s effects on response speed.

3.3.5 Mental fatigue

Mental fatigue refers to a state of reduced cognitive efficiency and increased perceived effort that develops after prolonged or demanding mental activity. It is particularly relevant to physically active individuals because sustained cognitive demands before or during exercise may impair attentional control, motivation, and the ability to maintain performance. However, the relationship between mental fatigue and physical performance is complex, and recent evidence suggests that its effects may vary depending on the type and duration of exercise and the methods used to induce fatigue (Holgado et al., 2020). Caffeine may be particularly effective in counteracting subjective and behavioral manifestations of mental fatigue. Its antagonism of central adenosine receptors increases arousal and reduces the accumulation of sleepiness and perceived cognitive effort. In a randomized crossover study, caffeine administration reduced self-reported mental fatigue and improved performance on demanding attention tasks, with the combination of caffeine and L-theanine producing improvements in several cognitive measures compared with placebo (Haskell et al., 2008). More broadly, systematic evidence indicates that caffeine can improve cognitive performance in situations characterized by fatigue, prolonged wakefulness, or demanding physical activity, with reaction time and attentional performance among the outcomes most consistently affected (Irwin et al., 2020; Lorenzo Calvo et al., 2021). The cognitive profile of matcha may be particularly relevant to mental fatigue because it provides caffeine together with L-theanine. Rather than simply increasing arousal, the caffeine–L-theanine combination may promote sustained attention with relatively controlled subjective arousal. In a placebo-controlled crossover study, 97 mg of L-theanine combined with 40 mg of caffeine improved task-switching accuracy and subjective alertness while reducing self-reported tiredness (Giesbrecht et al., 2010). Similarly, another randomized study reported improved performance on cognitively demanding switching tasks following combined administration of L-theanine and caffeine, although effects were not observed on all cognitive measures (Einöther et al., 2010). These findings provide a plausible mechanistic basis for the hypothesis that matcha could be useful during prolonged cognitive work, although they should not be interpreted as direct evidence for whole-matcha consumption. The potential relevance of this combination is also supported by studies examining selective attention under conditions of sleep deprivation,, in which L-theanine and caffeine have been shown to improve selected neurobehavioral and neurophysiological measures of attention (Nawarathna et al., 2025). Nevertheless, the doses used in such studies may exceed those from a typical serving of matcha. Furthermore, evidence from tea or isolated L-theanine–caffeine preparations cannot be automatically extrapolated to matcha, as the concentrations of caffeine and L-theanine vary substantially between products.

From a comparative perspective, coffee may provide a stronger and more predictable acute countermeasure to mental fatigue because it commonly delivers a higher dose of caffeine, whereas matcha may offer a potentially more balanced combination of stimulation and attentional control due to the simultaneous presence of L-theanine. This distinction could be particularly relevant during prolonged periods of studying, work, or cognitively demanding activity. However, direct comparisons between matcha and coffee under standardized mental-fatigue conditions are currently lacking. Evidence supports caffeine's ability to reduce subjective fatigue and maintain aspects of cognitive performance under demanding or fatiguing conditions. The caffeine–L-theanine combination may additionally influence perceived tiredness, task switching, and sustained attentional performance, providing a plausible explanation for a potentially distinct cognitive profile of matcha. However, because most evidence comes from isolated caffeine, tea extracts, or purified L-theanine–caffeine combinations rather than whole-leaf matcha, to reduce subjective fatigue and maintain aspects of cognitive performance under demanding or fatiguing conditions.

Table 3. **Comparative cognitive effects and current evidence gaps for matcha and coffee**

Cognitive domain	Main finding	Matcha vs coffee	Key evidence gap
Attention	Caffeine reliably improves attention and vigilance; caffeine–L-theanine may additionally improve attentional switching and selected measures of sustained attention (Giesbrecht et al., 2010; Haskell et al., 2008; McLellan et al., 2016)	Matcha may provide a more balanced attentional response, whereas coffee provides more predictable stimulation (Giesbrecht et al., 2010; Haskell et al., 2008; McLellan et al., 2016)	Few/no standardized head-to-head trials.
Memory	Caffeine may modestly enhance selected memory processes, particularly consolidation (Camfield et al., 2014; Sherman et al., 2016)	Evidence favors coffee/caffeine; evidence for matcha remains indirect and its largely based on green tea extract or caffeine-L-theanine preparations (Camfield et al., 2014; Mancini et al., 2017; Park et al., 2011)	Lack of trials using whole matcha and equivalent caffeine doses
Executive function	Caffeine may improve selected executive processes; caffeine–L-theanine may influence selected executive processes,	Matcha may potentially support cognitive control with less excessive arousal (Einöther et	Effects on individual executive domains remain inconsistent.

	particularly attention control and task switching (Einöther et al., 2010; Haskell et al., 2008; McLellan et al., 2016)	al., 2010; Haskell et al., 2008)	
Reaction time	Caffeine generally improves response speed and psychomotor performance, particularly under conditions of fatigue, sleep loss, or demanding activity (Irwin et al., 2020; Lorenzo Calvo et al., 2021; McLellan et al., 2016)	Coffee is likely to provide a more predictable acute effect (Giesbrecht et al., 2010; Haskell et al., 2008)	Direct matcha vs coffee comparisons are lacking.
Mental fatigue	Caffeine reduces subjective fatigue and helps maintain cognitive performance under demanding conditions (Irwin et al., 2020; Lorenzo Calvo et al., 2021; McLellan et al., 2016); caffeine-L-theanine combinations may additionally influence subjective tiredness, task switching, and	Coffee may provide a stronger and more predictable acute countermeasure to mental fatigue; matcha may provide sustained stimulation with potentially lower subjective overstimulation (Einöther et al., 2010; Giesbrecht et al., 2010)	Whole-matcha studies during experimentally induced mental fatigue are scarce.

	sustained attention (Einöther et al., 2010; Giesbrecht et al., 2010)		

3.4 Effects on Stress Response

3.4.1 Cortisol

Cortisol is one of the principal biomarkers of hypothalamic–pituitary–adrenal (HPA) axis activity and is commonly used to assess physiological responses to acute stress. Its secretion follows a pronounced circadian rhythm and is influenced by psychological stress, physical exercise, sleep, nutritional status, and habitual caffeine consumption. Consequently, changes in cortisol following coffee or matcha consumption should be interpreted in relation to the timing of intake and the type and intensity of the stressor**.** Caffeine may potentiate the cortisol response to acute stress**.** Experimental evidence indicates that caffeine can increase cortisol secretion independently of, and in combination with, psychological or physical stress. In a randomized, double-blind, placebo-controlled crossover study, repeated caffeine administration increased cortisol concentrations, while subsequent exposure to mental stress or exercise further influenced the cortisol response (Lovallo et al., 2006). These findings suggest that coffee, particularly when consumed in relatively high caffeine doses, may enhance HPA-axis activation during stressful conditions. However, the magnitude of this response depends on dose, habitual caffeine intake, sex, timing, and the individual's previous exposure to caffeine. The potential stress-response profile of matcha may differ because caffeine is consumed together with L-theanine and catechins. L-theanine has been investigated as a potential modulator of the physiological response to stress. In a randomized, placebo-controlled crossover trial, an L-theanine-containing intervention reduced the salivary cortisol response to a standardized cognitive stressor three hours after administration and simultaneously reduced subjective stress (White et al., 2016). Similarly, earlier experimental work demonstrated that L-theanine administration attenuated both psychological and physiological responses to an acute stressor, including cortisol-related responses (Kimura et al., 2007). These findings provide a plausible mechanism by which the L-theanine component of matcha could partially counterbalance the stimulatory effects of caffeine on the stress response. However, the available evidence does not demonstrate that consumption of whole matcha reduces cortisol compared with coffee**.** Most studies investigating cortisol have used purified L-theanine or caffeine rather than matcha and coffee as complete beverages. Moreover, the dose of L-theanine used experimentally may differ substantially from the amount present in a typical serving of matcha. A randomized controlled trial of four weeks of L-theanine supplementation demonstrated improvements in several stress-related outcomes, but it did not establish that these effects are reproduced by dietary consumption of matcha (Hidese et al., 2019).

From a comparative perspective, coffee may therefore be associated with greater acute HPA-axis stimulation, particularly when relatively high amounts of caffeine are consumed, whereas matcha may provide a potentially more moderated stress response because of the concurrent presence of L-theanine. This distinction is biologically plausible but remains insufficiently demonstrated in direct beverage comparisons. Importantly, caffeine and L-theanine may interact rather than exert completely independent effects; therefore, the overall cortisol response to matcha cannot be predicted simply from its caffeine content. Current evidence suggests that caffeine can enhance cortisol responses to acute stress, whereas L-theanine may attenuate stress-related cortisol elevations**.** This opposing pharmacological profile provides a plausible mechanistic basis for a potentially different stress response to coffee and matcha. Nevertheless, direct randomized trials comparing standardized matcha and coffee, preferably matched for caffeine content and performed under controlled psychological or exercise stress conditions, are needed to determine whether the L-theanine content of matcha translates into a clinically meaningful reduction in cortisol response.

3.4.2 Heart Rate Variability

Heart rate variability (HRV) is a non-invasive marker of cardiac autonomic regulation that reflects fluctuations in successive cardiac cycle intervals. Parameters such as the root mean square of successive differences (RMSSD) and high-frequency (HF) power are commonly used as indicators of vagal modulation, whereas standard deviation of normal-to-normal intervals (SDNN) reflects overall variability across the recording period. Because psychological stress and exercise can alter autonomic balance, HRV has been increasingly used to evaluate physiological stress and recovery in physically active individuals.

Caffeine may acutely influence autonomic regulation through antagonism of adenosine receptor and increased sympathetic activity. However, evidence regarding its effects on HRV is inconsistent and appears to depend on the experimental context. Importantly for the present review, a systematic review of caffeine administration before exercise in healthy active adults found no significant effect on post-exercise HRV recovery, including RMSSD and HF indices. The meta-analysis included 12 studies, with caffeine doses ranging from 100–400 mg or 2–6 mg/kg (Benjamim et al., 2020; Porto et al., 2022). A more recent systematic review and meta-analysis similarly found no significant differences between caffeine and placebo in post-exercise RMSSD or HF, and no dose–response relationship between caffeine intake and HRV recovery (Almeida et al., 2024). These findings suggest that although caffeine may increase subjective and cardiovascular arousal, this does not necessarily translate into a measurable impairment of vagal recovery following exercise.

The available literature on matcha has primarily focused on psychological stress, attention, cortisol, and subjective outcomes rather than HRV as a primary endpoint. Therefore, it is currently difficult to determine whether the combination of caffeine, L-theanine, and catechins in matcha produces a different autonomic response from caffeine delivered through coffee. This represents an important gap because L-theanine may theoretically counterbalance excessive stimulant-related arousal, while tea catechins may influence vascular and metabolic pathways. However, such mechanisms should not be interpreted as evidence of a clinically meaningful improvement in HRV in humans.

From a comparative perspective, coffee may produce greater acute sympathetic stimulation when a relatively high caffeine dose is consumed, whereas matcha may provide a more moderate pattern of stimulation due to differences in caffeine dose and the presence of L-theanine. Nevertheless, current evidence does not support the conclusion that matcha consistently improves HRV or provides superior autonomic stress regulation compared with coffee. In physically active individuals, the available evidence instead indicates that caffeine consumed before exercise does not significantly impair post-exercise HRV recovery. The current evidence is insufficient to establish a clear advantage of either matcha or coffee for cardiac autonomic regulation, and direct caffeine-matched trials comparing the two beverages are needed. Future studies should incorporate standardized measurements of RMSSD, SDNN, and HF along with cortisol, perceived stress, anxiety, and sleep, to evaluate the autonomic effects of matcha and coffee within a broader stress-response framework.

3.4.3 Perceived stress

Perceived stress refers to the subjective assessment of the extent to which an individual perceives everyday demands as unpredictable, uncontrollable, or overwhelming. Unlike cortisol or heart rate variability, it represents subjective psychological response and may therefore provide complementary information when evaluating the effects of matcha and coffee on stress. Coffee may exert a more complex influence on perceived stress due to its caffeine content. Acute caffeine intake increases alertness and can improve cognitive performance, but higher doses may also increase physiological arousal and anxiety in susceptible individuals (Kaplan et al., 1997; Pané-Farré et al., 2015). Consequently, the effects of coffee on perceived stress are likely to depend on caffeine dose, habitual consumption, individual sensitivity, and the presence of an external stressor. This may be particularly relevant in individuals exposed to prolonged cognitive demands or high psychological stress. L-theanine has demonstrated potential stress-reducing effects. In a randomized controlled crossover study, L-theanine administration attenuated subjective and physiological responses to an acute mental stressor, supporting its potential role in stress regulation (Kimura et al., 2007). A subsequent randomized, double-blind crossover trial reported a significant reduction in subjective stress following an L-theanine-containing intervention compared with placebo, together with a reduction in salivary cortisol after the stressor (White et al., 2016). Evidence from longer-term supplementation studies is also suggestive. Four weeks of L-theanine administration (200 mg/day) reduced several stress-related symptoms, including trait anxiety and sleep-related disturbances, in healthy adults (Hidese et al., 2019). A systematic review of randomized controlled trials concluded that L-theanine supplementation may help reduce stress and anxiety, particularly in individuals exposed to stressful conditions, although the authors emphasized heterogeneity between studies and the need for further research (Williams et al., 2020). Importantly, there is also direct evidence involving matcha rather than isolated L-theanine. A randomized, placebo-controlled study examining daily matcha consumption found effects on cognitive function under conditions of mild acute psychological stress, providing preliminary evidence that matcha may influence stress response. However, the study population and intervention design limit the extent to which these findings can be generalized to physically active individuals or interpreted as evidence that matcha is superior to coffee (Baba, Inagaki, et al., 2021).

From a comparative perspective, matcha may have a potential advantage in situations characterized by prolonged psychological stress, as its combination of caffeine and L-theanine could provide cognitive stimulation while moderating excessive subjective arousal. Coffee, particularly at higher caffeine doses, may produce stronger stimulation and could increase perceived tension or anxiety in caffeine-sensitive individuals. Nevertheless, this proposed difference should be interpreted with caution because most evidence for the stress-modulating effects of L-theanine comes from isolated supplementation rather than standardized matcha, and direct matcha-versus-coffee trials remain scarce. Current evidence suggests that L-theanine may reduce subjective stress responses, whereas caffeine may have bidirectional effects depending on dose and individual sensitivity. Matcha therefore represents a potentially interesting alternative to coffee during periods of prolonged mental work or psychological stress, but there is currently insufficient evidence to conclude that it consistently reduces perceived stress compared with coffee.

3.4.4 Anxiety

Anxiety is an emotional state characterized by feelings of tension, worry, and increased arousal in response to perceived threats or challenging situations. Unlike stress, which refers to the physiological and psychological response to external demands, anxiety reflects an individual's subjective emotional experience. The effects of caffeine on anxiety appear to be dose- and individual-dependent. In a randomized crossover study, 500 mg of caffeine produced greater tension, nervousness, anxiety, excitement, irritability, and restlessness than 250 mg, suggesting that higher caffeine exposure may increase subjective psychological arousal (Kaplan et al., 1997). Individual sensitivity may further modify this response. Experimental evidence indicates that people with greater sensitivity to anxiety-related physiological sensations may show stronger responses to caffeine, supporting the importance of individual variability when interpreting the effects of coffee on anxiety. More recent controlled evidence indicates that acute caffeine administration can influence subjective and physiological components of anxiety, although responses differ between individuals and populations (Hoppe et al., 2025; Pané-Farré et al., 2015). L-theanine may exert anxiolytic and stress-modulating effects. A randomized controlled trial found that four weeks of L-theanine supplementation (200 mg/day) reduced trait anxiety and other stress-related symptoms in healthy adults (Hidese et al., 2019). Acute administration of L-theanine has also been shown to attenuate psychological and physiological responses to an acute stressor, suggesting a potential mechanism by which L-theanine could modify the effects of caffeine (Kimura et al., 2007). However, evidence for an anxiolytic effect of whole matcha remains limited. Studies involving matcha have primarily examined cognitive performance following psychological stress rather than anxiety as the primary outcome.

Current evidence suggests that caffeine may increase anxiety-related symptoms in a dose- and sensitivity-dependent manner, whereas L-theanine may attenuate subjective stress and anxiety. Nevertheless, this proposed advantage should be interpreted cautiously, as most evidence for the anxiolytic properties of L-theanine derives from isolated supplementation rather than whole-matcha consumption. This provides a plausible basis for a potentially more favorable anxiety profile of matcha compared with coffee, direct head-to-head trials assessing validated anxiety measures are required before such a difference can be considered established.

3.4.5 Sleep

Sleep is an important component of the stress response. Insufficient or disrupted sleep can increase psychological stress, impair cognitive performance, and alter autonomic and endocrine regulation. Caffeine consumption, particularly later in the day, can negatively affect subsequent sleep**.** A systematic review and meta-analysis demonstrated that caffeine reduces total sleep time and sleep efficiency, increases sleep latency, and increases nighttime wakefulness (Gardiner et al., 2023). Importantly, a controlled study showed that 400 mg of caffeine consumed even 6 hours before bedtime significantly disrupted sleep, indicating that the effects of caffeine may persist well beyond the period of perceived stimulation (Drake et al., 2013). The potential sleep profile of matcha may differ from coffee because of its L-theanine content. L-theanine has been investigated for its potential effects on sleep quality, and a randomized controlled trial reported improvements in sleep-related measures after 4 weeks of L-theanine supplementation (Hidese et al., 2019). More importantly for the present comparison, a recent controlled study demonstrated that theanine attenuated caffeine-induced increases in wakefulness after sleep onset and helped maintain sleep quality in healthy young women (Baba et al., 2023). This finding provides experimental support for the hypothesis that L-theanine may partially counteract the sleep-disrupting effects of caffeine. Evidence specifically involving whole matcha remains limited but is particularly relevant. In a randomized placebo-controlled trial, four weeks of daily matcha consumption did not significantly alter objectively measured total sleep time, sleep latency, wake after sleep onset, or sleep efficiency, despite the beverage providing approximately 71.5 mg of caffeine and 50.3 mg of L-theanine per daily dose (Baba et al., 2024). Thus, matcha did not appear to produce the degree of sleep disruption that might be expected solely from its caffeine content, although these findings cannot establish that matcha is superior to coffee. However, this advantage remains hypothetical, as direct head-to-head trials comparing standardized matcha and coffee with equivalent caffeine exposure are lacking.

Current evidence supports a clear sleep-disrupting effect of caffeine, particularly when consumed later in the day, whereas L-theanine may partially attenuate caffeine-related sleep disturbances. Whether the combination of caffeine and L-theanine in matcha translates into better sleep outcomes than coffee remains uncertain and warrants further controlled investigation.

Table 4. Comparative effects of matcha and coffee on stress-related outcomes

Outcome	**Matcha**	**Coffee**	**Potential comparative advantage**	**Current evidence/limitations**
Cortisol	L-theanine may attenuate the psychological stress, including the cortisol response; whole-matcha studies suggests potential stress-modulating effects, although cortisol is not consistently assessed (Baba, Kaneko, et al., 2021; Kimura et al., 2007; Williams et al., 2020)	Caffeine may increase physiological arousal and can influence the neuroendocrine stress response, particularly at higher doses or in caffeine-sensitive individuals (Kaplan et al., 1997; McLellan et al., 2016)	Potential advantage of matcha due to the presence of L-theanine, which may partially counteract caffeine-related HPA-axis activation.	Evidence for L-theanine is stronger than evidence for whole matcha. Direct matcha vs coffee comparisons are lacking.

Heart rate variability (HRV)	L-theanine has been shown to attenuate sympathetic activation during acute psychological stress, suggesting a potential beneficial effect on autonomic balance (Kimura et al., 2007); direct evidence for whole matcha and HRV remains limited	Caffeine may influence autonomic cardiac regulation, but systematic reviews and meta-analyses indicate heterogenous effects on HRV, with no consistent impairment of post-exercise vagal recovery (Almeida et al., 2024; Koenig et al., 2013; Porto et al., 2022)	Potential advantage of matcha, but currently hypothetical.	Limited, indirect evidence for matcha; most available evidence concerns isolated L-theanine caffeine. Direct caffeine-matched matcha vs coffee trials are lacking
Perceived stress	L-theanine may reduce subjective stress and improve responses to acute psychological stress. Controlled studies of matcha also	Acute caffeine may increase subjective arousal and tension, particularly at higher doses or in caffeine-sensitive individuals (Kaplan et al., 1997;	Matcha may be preferable during prolonged psychological stress because of the combination of caffeine and L-theanine.	Evidence for L-theanine is relatively consistent, but evidence for whole matcha remains limited and heterogenous.

	suggest potential benefits under mild psychological stress (Baba, Kaneko, et al., 2021; Kimura et al., 2007; White et al., 2016)	McLellan et al., 2016)		
Anxiety	L-theanine may reduce subjective psychological tension and anxiety-related responses (Kimura et al., 2007; White et al., 2016); preliminary studies of matcha suggest possible stress- and anxiety-related benefits (Baba,	Higher caffeine doses may increase anxiety, nervousness and tension, responses are strongly dependent on dose, habitual intake, and individual sensitivity (Hoppe et al., 2025; Kaplan et al., 1997; McLellan et al., 2016)	Potential advantage of matcha, especially in individuals sensitive to caffeine-induced anxiety	Effects depend strongly on caffeine dose, habitual consumption and individual sensitivity. Direct head-to-head evidence is insufficient.

	Kaneko, et al., 2021)			
Sleep	A recent randomized trial found that 4 week of moderate matcha consumption did not significantly alter objective sleep parameters, including total sleep time, sleep latency, or sleep efficiency (Baba et al., 2024).	Caffeine can increase sleep latency, reduce total sleep time and sleep efficiency, with effects depending strongly on dose and timing of consumption (Clark & Landolt, 2017; Drake et al., 2013)	Potential advantage of matcha, when consumed earlier in the day and in moderate amounts, although this should not be interpreted as evidence that matcha is sleep promoting	Direct matcha vs coffee trials are scarce; caffeine dose and timing remain the major determinants of sleep effects.

3.5 Cardiometabolic Effects

3.5.1 Blood pressure

Blood pressure is an important cardiometabolic outcome when comparing matcha and coffee because both beverages contain caffeine, which can produce acute cardiovascular stimulation, while matcha additionally provides catechins and L-theanine that may influence vascular function. The effects of coffee and matcha should therefore be considered separately for acute blood pressure responses and longer-term habitual consumption. Acute caffeine intake can transiently increase blood pressure, particularly in individuals who are not habitual caffeine consumers. This effect is attributed primarily to adenosine receptor antagonism, increased sympathetic activity, and transient changes in vascular resistance. However, the response tends to attenuate with regular caffeine exposure. A meta-analysis of randomized controlled trials found that chronic consumption of coffee or caffeine led to relatively modest increases in blood pressure, although the magnitude varied between studies and populations (Noordzij et al., 2005). Importantly, long-term observational evidence does not necessarily support the assumption that habitual coffee consumption increases the risk of hypertension. A systematic review and meta-analysis found no clear evidence that coffee consumption was associated with an increased risk of developing hypertension, despite the possibility of transient increases in blood pressure following acute caffeine exposure (Steffen et al., 2012). Thus, acute blood-pressure responses should not be equated with long-term cardiovascular risk. In contrast, evidence concerning green tea and its catechins suggests a potential modest blood-pressure-lowering effect with regular consumption. Meta-analyses of randomized controlled trials have reported small reductions in both systolic and diastolic blood pressure following green tea or catechin supplementation (Khalesi et al., 2014; Peng et al., 2014; Xu, Yang, Ding, et al., 2020). These effects have been attributed partly to catechins, particularly EGCG, which may improve endothelial function and nitric oxide bioavailability, thereby promoting vasodilation. The potential vascular effects of matcha are therefore particularly relevant because, unlike conventional tea infusions, matcha involves consumption of the entire powdered leaf and consequently provides substantial amounts of catechins. Nevertheless, evidence specifically examining whole matcha and blood pressure remains considerably more limited than the evidence for green tea generally. It would therefore be inappropriate to assume that the blood-pressure effects demonstrated for green tea extracts or standardized catechin preparations necessarily translate directly to commercially prepared matcha.

Current evidence suggests that caffeine may transiently increase blood pressure, whereas regular consumption of green tea and its catechins may produce modest reductions in blood pressure. Matcha could theoretically combine these opposing effects because it provides both caffeine and catechins, but direct evidence comparing standardized matcha with coffee is insufficient. Future head-to-head trials should control for caffeine dose, catechin content, habitual caffeine consumption, baseline blood pressure, measurement timing.

3.5.2 Lipid profile

Lipid metabolism represents an important component of cardiometabolic health when comparing matcha and coffee. The effects of these beverages may differ because matcha is rich in catechins, particularly epigallocatechin-3-gallate (EGCG), whereas coffee contains diterpenes such as cafestol and kahweol, whose effects on circulating lipids depend strongly on the brewing method. Evidence from randomized controlled trials suggests green tea catechins may modestly improve the lipid profile, particularly by reducing total and LDL cholesterol. Meta-analyses have reported small but significant reductions in total cholesterol and LDL cholesterol following green tea or catechin consumption, while effects on HDL cholesterol and triglycerides have generally been less consistent (Kim et al., 2011; Xu, Yang, Li, et al., 2020; Zheng et al., 2011). These effects have been attributed in part to catechin-mediated modulation of hepatic lipid metabolism, including inhibition of cholesterol synthesis and absorption and activation of AMP-activated protein kinase (AMPK). However, most clinical evidence concerns green tea or standardized catechin preparations rather than whole matcha; therefore, the findings cannot be directly extrapolated to all matcha products. In contrast, the effect of coffee on lipid parameters depends substantially on its diterpene content and preparation method. Cafestol and kahweol are concentrated in the lipid fraction of coffee and can increase serum total and LDL cholesterol, particularly when coffee is prepared without effective filtration. Cafestol has been described as one of the most potent dietary cholesterol-raising compounds, with effects on hepatic pathways involved in cholesterol and bile-acid metabolism (Ricketts et al., 2007; Urgert & Katan, 1997). Clinical evidence supports this distinction. A meta-analysis of randomized controlled trials found that coffee consumption can adversely affect lipid parameters, although the magnitude of the effect varies according to coffee type and preparation (Du et al., 2020). Thus, coffee should not be considered a homogeneous exposure when evaluating lipid outcomes. Filtered coffee, which contains considerably fewer diterpenes, is likely to have a different lipid effect from unfiltered coffee.

Current evidence suggests that catechin-rich tea consumption may modestly reduce total and LDL cholesterol levels, whereas diterpene-rich coffee may increase circulating cholesterol concentrations Whether whole matcha consistently yields a more favorable lipid profile than commonly consumed coffee remains uncertain, as direct head-to-head trials are lacking. Future studies should standardize the caffeine dose, matcha catechin content, coffee brewing method, and exposure duration when comparing their effects on LDL-C, HDL-C, triglycerides, and other lipid-related cardiometabolic outcomes.

3.5.3 Glucose metabolism and insulin sensitivity

Glucose metabolism is an important component of cardiometabolic health when comparing matcha and coffee. Both beverages contain caffeine, which may acutely affect glucose homeostasis, while matcha also provides catechins, particularly EGCG, which have been proposed to modulate insulin signaling and glucose uptake. Evidence from randomized controlled trials suggests that green tea and catechin consumption may exert modest beneficial effects on glucose metabolism and insulin sensitivity. A meta-analysis of 17 randomized controlled trials found that green tea consumption was associated with improvements in fasting blood glucose and insulin sensitivity, although the magnitude of the effects was relatively small and heterogeneous between studies (K. Liu et al., 2013). Other meta-analyses have similarly reported potential improvements in insulin resistance and glycemic control, particularly in individuals at increased metabolic risk (X. Wang et al., 2014; Yu et al., 2017). These effects have been attributed partly to catechin-mediated modulation of insulin signaling, glucose uptake, AMPK activity, and hepatic glucose metabolism. However, most clinical evidence concerns green tea, or green tea extracts rather than whole matcha, and therefore these findings cannot be directly extrapolated to all matcha products. The effects of coffee on glucose metabolism are more complex and appear to depend on the duration of exposure. Acute consumption of caffeinated coffee may transiently impair glucose tolerance or increase postprandial glucose responses, potentially because of caffeine-induced increases in catecholamine activity and reduced insulin-mediated glucose disposal. In contrast, observational evidence consistently associates habitual coffee consumption with a lower risk of developing type 2 diabetes, suggesting that long-term metabolic effects may differ from the acute response. Clinical trials have produced mixed results, with some indicating improvements in glucose metabolism after prolonged consumption, while others show no significant changes in insulin sensitivity (Moon et al., 2021; Reis et al., 2019). A meta-analysis evaluating coffee consumption and insulin resistance found no consistent overall effect on insulin sensitivity or resistance, highlighting the heterogeneity of coffee interventions and the importance of distinguishing acute from chronic effects (Moon et al., 2021). Consequently, the potential long-term protective association between coffee consumption and type 2 diabetes cannot be interpreted as evidence that coffee acutely improves insulin sensitivity. For physically active individuals, these distinctions may be particularly relevant. Acute caffeine-induced changes in glucose and insulin responses may interact with exercise-induced increases in glucose uptake and insulin sensitivity. However, there is currently insufficient evidence to determine whether consuming matcha rather than coffee provides a meaningful metabolic advantage before or after exercise.

Current evidence suggests that catechin-rich tea may modestly improve insulin sensitivity and glycemic control, whereas coffee shows a complex pattern, with potentially unfavorable acute effects but favorable associations with long-term type 2 diabetes risk. Direct studies comparing standardized matcha and coffee, with equivalent caffeine exposure and assessment of glucose, insulin, and insulin sensitivity over both acute and chronic periods, are needed.

3.5.4 Body weight

Body weight and body composition are relevant cardiometabolic outcomes when comparing matcha and coffee, as both beverages contain caffeine, and matcha additionally provides catechins that may influence energy expenditure and lipid oxidation. However, the available evidence does not support the use of either beverage as a standalone weight-loss intervention. Caffeine may transiently increase energy expenditure and fat oxidation, providing a plausible mechanism for a modest effect on body weight. A systematic review and dose–response meta-analysis of randomized controlled trials found that caffeine intake was associated with small reductions in body weight, BMI, and fat mass, although the magnitude of the effect varied according to dose and study characteristics (Tabrizi et al., 2019). These effects may be particularly relevant in physically active individuals because caffeine can further enhance exercise performance and fat oxidation. However, acute increases in fat oxidation do not necessarily translate into clinically meaningful long-term reductions in body weight. Evidence for green tea catechins, particularly when combined with caffeine, suggests a similarly modest effect. Meta-analyses of randomized controlled trials have reported small reductions in body weight and BMI following green tea or catechin consumption (Hursel et al., 2009; Phung et al., 2010). More recent evidence suggests that green tea catechins may modestly enhance the effects of exercise training on body weight and body composition in overweight and obese individuals, although the available studies remain heterogeneous (Gholami et al., 2024). The potential effects of matcha may therefore result from the combined actions of caffeine and catechins, which may increase energy expenditure and fat oxidation and influence AMPK-related metabolic pathways. Nevertheless, an important limitation is that most clinical evidence concerns green tea extracts, standardized catechin preparations, or conventional green tea rather than whole matcha. Therefore, the observed effects cannot be directly attributed to matcha itself.

From a comparative perspective, both matcha and coffee may have modest effects on body weight primarily through their caffeine content, while matcha provides an additional potential contribution from catechins. However, the available evidence does not establish a clear superiority of matcha over coffee for weight management. Importantly, the calorie content of the final beverage and added sugar, milk, or other ingredients may substantially influence the overall effect on energy balance. Caffeine and green tea catechins may contribute to small reductions in body weight or fat mass, but these effects are unlikely to be large enough to have major clinical significance in isolation. Direct head-to-head studies comparing standardized matcha and coffee, particularly in physically active individuals, are needed to determine whether their distinct bioactive profiles translate into meaningful differences in body weight or body composition.

3.5.5 Inflammation

Low-grade systemic inflammation is an important component of cardiometabolic dysfunction and may contribute to the development of insulin resistance, endothelial dysfunction, obesity-related metabolic abnormalities, and cardiovascular disease. The catechins present in matcha may exert anti-inflammatory effects by modulating several signaling pathways, including inhibition of NF-κB activation and reduction of pro-inflammatory cytokine signaling. However, clinical evidence regarding systemic inflammatory biomarkers is less consistent than experimental evidence. A systematic review and meta-analysis of randomized controlled trials found no significant overall reduction in circulating C-reactive protein (CRP) following green tea catechin supplementation, despite evidence suggesting potential anti-inflammatory effects in experimental models (Serban et al., 2015). This suggests that the biological plausibility of catechin-mediated anti-inflammatory activity does not necessarily translate into a measurable reduction in systemic inflammation in healthy populations. Coffee also contains several compounds with potential anti-inflammatory properties. Chlorogenic acids and other polyphenols may influence inflammatory signaling and oxidative stress, while coffee-derived compounds generated during roasting may contribute to its biological activity. A systematic review of clinical trials concluded that coffee consumption appeared to have a predominantly anti-inflammatory effect although responses to caffeine itself were more heterogeneous. In particular, coffee consumption did not consistently alter CRP, whereas some studies reported changes in IL-6 and adiponectin (Paiva et al., 2019). Evidence from observational studies is somewhat more supportive of an anti-inflammatory association for coffee. A meta-analysis of observational studies reported that coffee consumption was associated with lower circulating CRP concentrations, although the authors emphasized the observational nature of the evidence and the possibility of residual confounding (Y. Zhang & Zhang, 2018). More recent evidence continues to investigate this relationship, with a 2024 systematic review and meta-analysis specifically evaluating coffee consumption and CRP concentrations (Choi & Je, 2024). These findings suggest that the long-term inflammatory profile associated with habitual coffee consumption may differ from the transient physiological effects of caffeine.

From a comparative perspective, both matcha and coffee contain compounds with potential anti-inflammatory activity, but the evidence does not currently demonstrate a clear superiority of either beverage. Matcha has a stronger mechanistic rationale based on to catechins and EGCG, whereas coffee offers a broader array of polyphenols and roasting-derived compounds that may also influence inflammatory pathways. Importantly, most clinical evidence for matcha-related effects is extrapolated from studies of green tea or isolated catechins rather than standardized whole-matcha preparations. Similarly, the inflammatory response to coffee may vary with coffee type, roast level, brewing method, caffeine content, and individual characteristics. Overall, both matcha and coffee may exert anti-inflammatory effects, but current clinical evidence remains heterogeneous. The potential anti-inflammatory activity of matcha is biologically plausible because of its high catechin content, whereas evidence for coffee suggests that its effects cannot be attributed to caffeine alone. Importantly, the lack of consistent changes in CRP after green tea catechin supplementation indicates that mechanistic anti-inflammatory activity should not automatically be interpreted as a clinically significant reduction in systemic inflammation. Direct head-to-head studies of matcha and coffee are needed to establish whether their distinct phytochemical profiles translate into meaningful differences in inflammatory status.

3.5.6 Oxidative stress

Oxidative stress results from an imbalance between the generation of reactive oxygen species (ROS) and the capacity of endogenous antioxidant systems to neutralize them. In physically active individuals, exercise-induced increases in oxygen consumption and mitochondrial activity can transiently enhance ROS production. Although moderate oxidative stress is involved in physiological signaling and training adaptation, excessive or prolonged oxidative stress may contribute to lipid peroxidation, inflammation, endothelial dysfunction, and impaired recovery. Therefore, the antioxidant properties of matcha and coffee may be relevant to their cardiometabolic effects. Matcha may have particularly strong antioxidant potential due to its high concentration of catechins, especially EGCG. However, it is important to distinguish mechanistic evidence from clinical outcomes. Most human evidence concerning oxidative stress has been obtained with green tea or standardized catechin preparations rather than whole matcha. This distinction is particularly relevant in physically active individuals. A systematic review of human studies found regular, but not acute, green tea supplementation increased total antioxidant status and reduced markers of exercise-induced oxidative stress (Rojano-Ortega, 2021). Similarly, a randomized controlled study in healthy humans demonstrated that green tea catechin supplementation influenced oxidative stress metabolites both at rest and during exercise (Sugita et al., 2016). These findings suggest that repeated exposure to tea catechins may enhance antioxidant capacity and potentially attenuate excessive exercise-related oxidative stress. Nevertheless, they should not be interpreted as evidence that consuming matcha immediately before exercise provides the same effect. Coffee also contains numerous compounds with antioxidant properties, including chlorogenic acids, trigonelline, caffeine, and melanoidins generated during roasting. Importantly, coffee consumption does not appear to simply increase oxidative stress despite the presence of caffeine. A review of human intervention studies concluded that coffee consumption may improve several biomarkers of oxidative stress, although results varied according to the marker investigated, coffee composition, and study design (Martini et al., 2016). More recent evidence from randomized controlled trials similarly suggests that coffee consumption can reduce or favorably modify selected biomarkers of oxidative stress and inflammation in healthy individuals and those at increased cardiovascular risk (Dludla et al., 2023).

From a comparative perspective, both beverages may contribute to antioxidant defense, but through partially different phytochemical profiles. Matcha is particularly rich in catechins and therefore has a strong mechanistic rationale for reducing oxidative stress. Coffee, in contrast, contains a broader mixture of polyphenols and roasting-derived compounds that may also exert antioxidant activity. Consequently, it would be inaccurate to characterize coffee simply as pro-oxidant because of its caffeine content. For physically active individuals, the potential effects of both beverages should also be interpreted in relation to the timing and magnitude of exercise-induced oxidative stress. Some ROS production is necessary for cellular signaling, mitochondrial adaptation, and training responses; therefore, complete suppression of exercise-induced oxidative stress is not necessarily desirable. The available evidence suggests that regular green tea consumption may attenuate excessive oxidative stress without necessarily eliminating the physiological redox signaling associated with exercise (Rojano-Ortega, 2021). However, direct evidence for matcha consumed before, during, or after exercise remains limited. matcha and coffee contain bioactive compounds that can modulate oxidative stress, but the available evidence does not establish a clear superiority of either beverage. Importantly, most available human evidence concerns green tea rather than matcha specifically, while coffee studies vary considerably in beverage composition and preparation. Direct head-to-head trials comparing standardized matcha and coffee, particularly in physically active individuals and across different exercise phases, are therefore needed.

Table 5. Comparative effects of matcha and coffee on cardiometabolic health

Cardiometabolic outcome	**Matcha**	**Coffee**	**Comparative interpretation**	**Main limitation**
Blood pressure	Catechins may support endothelial function and vasodilation; regular green tea/catechins consumption has been associated with small reductions in systolic and diastolic BP (Khalesi et al., 2014; Peng et al., 2014; Xu, Yang, Ding, et al., 2020).	Caffeine and coffee may cause a transient increase in BP, particularly in non-habitual consumers; however, the response may attenuate with regular exposure, and habitual coffee consumption has not been associated with increase long-term hypertension risk (Noordzij et al., 2005; Steffen et al., 2012)	Potential advantage: matcha**,** particularly for vascular effects, although this remain hypothetical, direct evidence for whole matcha is limited	Most evidence for matcha is extrapolated from green tea/catechin studies; acute and chronic effects differ

Lipid profile	Catechins, particularly EGCG, may modestly reduce total and LDL cholesterol and influence hepatic lipid metabolism (Kim et al., 2011; Xu, Yang, Li, et al., 2020; Zheng et al., 2011)	Effects depend strongly on diterpene content and brewing method; cafestol and kahweol may increase total and LDL-cholesterol, especially in unfiltered coffee(Du et al., 2020; Ricketts et al., 2007; Urgert & Katan, 1997)	Potential advantage: matcha vs unfiltered coffee; the difference may be smaller with filtered coffee.	Limited studies of whole matcha; coffee effects are highly preparation dependent
Glucose metabolism & insulin sensitivity	Catechins may influence insulin signaling, glucose uptake and glycemic control; meta-analyses of green tea randomized control trials suggests modest improvements in fasting glucose, HbA1c, and, in some, insulin sensitivity (K.	Acute caffeine may impair glucose tolerance, whereas habitual coffee consumption is consistently associated with lower long-term risk of T2DM; intervention studies of insulin sensitivity	No clear winner; matcha may have a favorable acute metabolic profile, whereas coffee has strong evidence for favorable long-term associations with T2DM risk	Acute vs chronic effects differ; very limited head-to-head matcha–coffee studies

	Liu et al., 2013; X. Wang et al., 2014; Yu et al., 2017)	remain heterogenous (Moon et al., 2021; Reis et al., 2019)		
Body weight	Caffeine and catechins may modestly increase energy expenditure and fat oxidation and may contribute to small reductions in body weight or BMI (Hursel et al., 2009; Tabrizi et al., 2019)	Caffeine and catechins may modestly increase energy expenditure and fat oxidation, and is associated with small reductions in body weight, BMI and fat mass (Tabrizi et al., 2019)	Potentially comparable effects**;** no evidence that matcha produces clinically superior weight management	Effects are small; most matcha evidence comes from green tea/catechin preparations rather than whole matcha
Inflammation	Catechins may inhibit inflammatory signaling and modulate cytokine production; however, clinical evidence is inconsistent, with no significant overall reduction in CRP	Coffee contains chlorogenic acids and other compounds with potential anti-inflammatory activity; clinical studies show heterogenous effects on inflammatory biomarkers,	Both potentially beneficial**;** neither can currently be considered superior. Matcha has a strong mechanistic rationale, whereas coffee has broader	Inconsistent clinical biomarker findings; matcha-specific human evidence is particularly limited

	demonstrated in meta-analysis of green tea catechin RCTs (Serban et al., 2015)	while observational evidence suggests possible associations with lower CRP (Paiva et al., 2019; Y. Zhang & Zhang, 2018)	evidence base but heterogenous clinical findings	
Oxidative stress	High catechin/EGCG content provides strong antioxidant potential; regular green tea supplementation, rather than acute intake, may increase antioxidant status and attenuate exercise-induced oxidative stress (Rojano-Ortega, 2021; Sugita et al., 2016)	Chlorogenic acids, trigonelline, caffeine and roasting-derived melanoidins contribute to coffee’s antioxidant activity. Human intervention studies suggest potential improvements in selected oxidative-stress markers, although findings are heterogeneous (Martini et al., 2016)	Potential mechanistic advantage: matcha, but both beverages may favorably influence oxidative balance through different bioactive compounds	Much of the matcha evidence derives from green tea rather than whole matcha; effects depend on dose, timing, and exercise context

3.6 Implications for Physically Active Individuals: Pre-, During-, and Post-Exercise Considerations

Before Exercise: Alertness and Reaction Time

The pre-exercise period represents the most established practical application of caffeine. Acute caffeine ingestion before exercise can improve endurance performance and increase the capacity to sustain prolonged exercise. A systematic review and meta-analysis demonstrated a significant ergogenic effect of acute caffeine ingestion on endurance performance, with benefits observed across different exercise modalities (Southward et al., 2018). More recent evidence also supports a dose-dependent relationship between caffeine intake and aerobic exercise performance (Martins et al., 2026). Caffeine may improve performance through several complementary mechanisms, including adenosine receptor antagonism, increased central nervous system arousal, reduced perception of effort, and modulation of neuromuscular function. These effects are particularly relevant when rapid alertness and sustained vigilance are required before competition or high-intensity training. Accordingly**,** coffee may represent the more predictable pre-exercise option, particularly because its caffeine content is generally higher and more easily standardized than that of commercially prepared matcha. Matcha's combination of caffeine and L-theanine could provide stimulation while limiting excessive subjective tension or overstimulation. Evidence from studies investigating caffeine–theanine combinations suggests potential benefits for cognitive and physical performance, although these findings cannot be directly equated with consumption of whole matcha. A recent randomized crossover study in competitive athletes specifically examined isolated and combined caffeine and theanine and provides additional support for investigating this combination in athletic populations (Tuncer et al., 2025). Thus, alertness, reaction time, and immediate ergogenic stimulation, coffee currently has the stronger evidence base, whereas matcha may be attractive for individuals who prefer a potentially less intense subjective stimulation. The distinction is particularly relevant for athletes who are sensitive to caffeine-induced anxiety or excessive arousal.

During Exercise: Endurance and Fatigue

During prolonged exercise, caffeine may help maintain performance by reducing perceived exertion and delaying the perception of fatigue. Evidence from endurance studies indicates that caffeine can improve time-trial performance and prolong exercise capacity (Southward et al., 2018; Z. Wang et al., 2022). These effects are particularly relevant during prolonged endurance exercise and competition, where maintaining effort in the later stages of exercise is critical. For this reason, coffee or caffeine-containing products may be more practical than matcha during competition, particularly when a clearly defined caffeine dose is required. However, coffee itself may not always be the most convenient beverage during exercise due to its volume, gastrointestinal tolerance, and variability in caffeine concentration. In practice, caffeine-containing sports products may therefore be preferable to coffee when precise dosing is required. The potential role of matcha during exercise is less well established. Although its caffeine content may theoretically support endurance and reduce perceived fatigue, there is currently insufficient evidence that consuming matcha during exercise provides an additional performance advantage attributable to catechins or L-theanine. Furthermore, catechins should not automatically be considered acute ergogenic agents. Evidence concerning green tea suggests that antioxidant effects may require regular consumption rather than a single acute dose (Rojano-Ortega, 2021). Therefore, during prolonged exercise**,** the caffeine component is likely to be the principal determinant of any acute ergogenic effect, rather than the specific beverage from which the caffeine is obtained. Matcha may nevertheless be useful when a lower or more moderate caffeine exposure is desired.

After Exercise: Recovery, Oxidative Stress, and Inflammation

The post-exercise period presents a different set of considerations because the primary objectives shift from acute performance enhancement toward recovery, restoration of physiological homeostasis, and adaptation to training. Exercise induces a transient increase in reactive oxygen species and inflammatory signaling. These responses are not necessarily detrimental, as they participate in cellular signaling and physiological adaptation; however, excessive oxidative stress may contribute to fatigue and impaired recovery. Evidence from green tea studies suggests regular catechin consumption, rather than a single acute dose, may increase total antioxidant status and attenuate exercise-induced oxidative stress (Rojano-Ortega, 2021). In a systematic review, green tea supplementation for more than one week, particularly at catechin doses of approximately 400–800 mg/day, was associated with improved antioxidant status and reduced exercise-induced oxidative stress, whereas acute ingestion did not demonstrate the same effect. This finding provides a potential rationale for regular matcha consumption in the broader recovery and training context, because matcha contains substantial amounts of catechins. However, evidence specifically involving matcha is insufficient to conclude that it improves post-exercise recovery more effectively than coffee. Coffee may also influence recovery by affecting perceived fatigue and exercise performance, potentially facilitating subsequent training sessions. Nevertheless, caffeine consumed later in the day may interfere with sleep, which is one of the most important determinants of recovery. Therefore, the timing of coffee or matcha consumption after evening exercise should be considered carefully. The potential recovery-related benefits of caffeine should not outweigh the negative consequences of sleep disruption. From a practical perspective, matcha may therefore be more after exercise when the primary objective is regular dietary exposure to catechins and antioxidant compounds, whereas coffee may be more useful when the goal is to maintain alertness or combat post-exercise fatigue. However, neither beverage should be considered a substitute for established recovery strategies such as adequate carbohydrate and protein intake, hydration, and sufficient sleep.

Taken together, the available evidence suggests that coffee has a clearer practical role as an acute pre- and during-exercise ergogenic aid, largely because of its caffeine content and the extensive evidence supporting caffeine supplementation in sport. Meta-analyses consistently demonstrate improvements in endurance performance following acute caffeine ingestion. Matcha may instead offer broader but less well-established physiological profile. The combination of caffeine and L-theanine may be relevant for achieving alertness without excessive subjective stimulation, while catechins may contribute to antioxidant and cardiometabolic effects during regular consumption. However, these potential advantages should not be overstated, as most evidence regarding catechins and exercise comes from green tea or isolated catechin preparations rather than standardized matcha. The systematic review of green tea and exercise-induced oxidative stress, for example, found benefits primarily with regular supplementation rather than acute ingestion. Consequently, the choice between matcha and coffee should be individualized based on the exercise phase, desired stimulation intensity, caffeine sensitivity, exercise timing, and tolerance. Coffee may be preferable when rapid and predictable caffeine-mediated ergogenic effects are the primary objective, particularly before or during competition. Matcha may be more attractive when a moderate stimulant effect is combined with regular dietary exposure to L-theanine and catechins, particularly outside the immediate performance window. Importantly, there is currently no sufficient evidence to recommend matcha over coffee as a superior sports beverage. The major knowledge gap is the lack of randomized, head-to-head trials comparing standardized matcha and coffee with equivalent caffeine doses in trained individuals. Future studies should evaluate not only performance outcomes but also perceived exertion, anxiety, HRV, cortisol, sleep, oxidative stress, inflammation, and recovery across the pre-, during-, and post-exercise periods.

3.7 Practical Applications

The choice between matcha and coffee may be guided primarily by the intended purpose of consumption, timing, and individual response to caffeine. Coffee currently has the strongest evidence for acute performance enhancement, particularly when consumed before or during endurance exercise. Its main advantage is the well-established ergogenic effect of caffeine, including reductions in perceived exertion and improvements in endurance performance and exercise capacity (Grgic et al., 2020; Guest et al., 2021; Southward et al., 2018). Accordingly, coffee may be particularly useful before training and competition, especially when rapid increases in alertness, psychomotor readiness, and exercise performance are desired. Caffeine is commonly consumed approximately 30–60 minutes before exercise, although the optimal timing may vary according to the individual and the form of caffeine administration. Coffee may also be used during prolonged exercise or competition when maintaining alertness and reducing perceived fatigue are important. However, in these situations, standardized caffeine-containing products may provide more predictable dosing than coffee, as coffee's caffeine content varies considerably between preparations. Coffee may also be used after exercise when maintaining alertness or preparing for a subsequent training session is relevant. Nevertheless, post-exercise caffeine intake should be considered in relation to the timing of the next sleep period. Caffeine consumed several hours before bedtime can impair sleep duration and sleep quality, even when individuals do not always perceive substantial changes in their sleep (Drake et al., 2013). Because adequate sleep is essential for recovery, frequent consumption of coffee later in the day may be counterproductive, particularly in individuals who are sensitive to caffeine or who train in the evening.

In contrast, matcha may be relevant in situations requiring prolonged cognitive engagement and sustained attention, such as studying, academic work, or extended periods of mentally demanding activity. Its combination of caffeine and L-theanine provides a plausible basis for a different subjective profile of stimulation compared with coffee, with caffeine promoting alertness while L-theanine may contribute to attentional control and a state of relaxed alertness. Experimental studies of caffeine–L-theanine combinations and limited randomized trials of whole matcha suggest that these interventions may support attention and selected aspects of cognitive performance, particularly under conditions of acute psychological stress (Baba, Inagaki, et al., 2021; Baba, Kaneko, et al., 2021; Haskell et al., 2008). However, these findings should be interpreted with caution because many studies have examined isolated caffeine and L-theanine rather than standardized matcha preparations. Matcha may therefore be a suitable alternative for individuals seeking sustained alertness, but who experience excessive nervousness or subjective stimulation after higher caffeine doses. This consideration may be particularly relevant during prolonged cognitive work or situations associated with elevated psychological stress. However, it should not be interpreted as evidence that matcha has anxiolytic or stress-reducing effects superior to those of coffee. Rather, the lower, potentially more moderate, caffeine exposure from a typical serving of matcha, together with the presence of L-theanine, may provide a different balance between stimulation and subjective arousal. The potential role of matcha may also extend to long-term dietary patterns supporting recovery and cardiometabolic health. Matcha contains catechins, including EGCG, which have been associated with antioxidant and cardiometabolic effects in experimental and green tea studies. Regular green tea catechin consumption has been associated with increased antioxidant capacity and attenuation of exercise-induced oxidative stress, with evidence suggesting that these effects are more apparent following repeated rather than acute consumption (Rojano-Ortega, 2021). Most available evidence concerns green tea or standardized catechin preparations rather than whole matcha; it remains uncertain whether regular matcha consumption produces comparable effects in physically active individuals. Importantly, there is currently insufficient evidence to conclude that matcha directly accelerates muscle recovery or improves subsequent exercise performance.

These practical distinctions should not be interpreted as evidence that matcha or coffee is universally superior. The effects of both beverages depend on caffeine dose, habitual caffeine consumption, individual sensitivity, timing of intake, sleep status, and the specific cognitive or physical demands of the activity. Therefore, the most appropriate beverage may depend on the desired balance between stimulation, cognitive endurance, stress regulation, and physical performance. The choice between matcha and coffee should therefore be individualized rather than based on the assumption that one beverage is universally superior.

Table 6. Potentially preferable option between matcha and coffee depend on practical situation

Practical situation	Potentially preferable option	Rationale
Before studying	Matcha	Caffeine + L-theanine may support attention while potentially limiting excessive stimulation
Prolonged mental work	Matcha	Potential combination of sustained alertness and a less pronounced subjective stimulant effect
High psychological stress	Matcha	L-theanine may partially counteract excessive caffeine-related arousal
Before training	Coffee	Strong evidence for caffeine-mediated ergogenic effects
Before competition	Coffee/caffeine	Rapid and relatively predictable stimulant and performance effects
During prolonged exercise	Coffee/caffeine	Caffeine may reduce perceived exertion and delay fatigue
Regular recovery-oriented consumption	Matcha	Catechins may support antioxidant defenses; evidence remains indirect
Late-day exercise	Matcha or low-caffeine option	Avoiding high caffeine exposure may reduce the risk of sleep disruption

4. Discussion

The main contribution of this narrative review is the integration of the cognitive, stress-related, cardiometabolic, and exercise-specific effects of matcha and coffee within a single comparative framework. Rather than evaluating these beverages solely by their caffeine content, the present review considers their broader phytochemical profiles and potential interactions among their major bioactive constituents. Matcha provides caffeine together with L-theanine, catechins, and other tea-derived compounds, whereas the physiological effects of coffee are strongly influenced by caffeine and chlorogenic acids, among other bioactive constituents. These differences provide a plausible basis for partially distinct physiological profiles, although direct evidence comparing whole matcha and coffee remains limited. The extensive literature on coffee generally supports its safety and potential benefits when consumed at usual levels, whereas evidence concerning matcha is substantially less developed and is frequently extrapolated from studies of green tea or isolated catechins (Grosso et al., 2017; Poole et al., 2017).

An additional consideration is the context and timing of consumption. Before exercise, coffee currently has stronger evidence base for acute alertness and caffeine-mediated ergogenic effects. Caffeine supplementation has been consistently associated with improvements in several aspects of exercise performance, including endurance, muscle endurance, strength, and power, while coffee represents a practical dietary source of caffeine (Grgic et al., 2020; Higgins et al., 2016).

During prolonged physical or cognitively demanding activity, caffeine may support endurance, reduce perceived exertion, and attenuate fatigue, while the potential contribution of matcha to sustained cognitive performance remains less well established. By comparison, the potential contribution of matcha to sustained cognitive performance during exercise remains insufficiently investigated. The difference in the strength of evidence is important when translating the findings of the present review into practical recommendations: the evidence supporting caffeine-mediated ergogenic effects should not be conflated with evidence demonstrating an ergogenic effect of whole coffee or matcha (Grgic et al., 2020; Higgins et al., 2016).

Following exercise, caffeine may be relevant to recovery in specific circumstances, particularly when rapid glycogen restoration is required. Experimental studies have shown that high-dose caffeine co-ingestion with carbohydrate can accelerate muscle glycogen resynthesis; however, these findings were obtained using relatively high caffeine doses and should not be interpreted as evidence that routine post-exercise coffee consumption improves recovery (Pedersen et al., 2008). Other controlled studies have reported no impairment of glycogen resynthesis with caffeine, further emphasizing the context- and dose-dependence of this response. Matcha's catechins provides a basis for antioxidant ad anti-inflammatory effects. Evidence from green tea supplementation suggest that regular rather than acute consumption may increase total antioxidant status and attenuate exercise-induced oxidative stress (Rojano-Ortega, 2021).

However, direct evidence supporting matcha's superior recovery effects is currently insufficient.

Table 7. Potential context-dependent roles of coffee and matcha in physically active individuals

Context	Coffee	Matcha	Interpretation
Before exercise	Stronger evidence for acute alertness and ergogenic effects of caffeine (Grgic et al., 2020; Higgins et al., 2016)	Potential cognitive benefits from caffeine + L-theanine; evidence is more limited (Baba, Kaneko, et al., 2021; Foxe et al., 2012)	Coffee currently has stronger evidence
During prolonged activity	Caffeine may reduce perceived exertion and fatigue and support endurance performance (Grgic et al., 2020)	Potential support for sustained attention; direct evidence during exercise is limited	Coffee has stronger performance evidence
After exercise	May support recovery in specific circumstances, particularly when rapid glycogen restoration is required(Pedersen et al., 2008)	Catechins provide a plausible basis for antioxidant/anti-inflammatory effects, but direct recovery evidence is limited (Rojano-Ortega, 2021)	Neither can currently be considered superior

An important unresolved question is whether potentially different effects of matcha and coffee are attributable primarily to their distinct phytochemical profiles or to differences in caffeine exposure. This distinction is particularly important because many studies compare interventions using different caffeine doses, while others investigate isolated caffeine rather than whole beverages. Consequently, apparent differences between matcha and coffee cannot always be attributed to the presence of L-theanine, catechins, chlorogenic acids, or other compounds. Well-controlled head-to-head trials using standardized whole-matcha and coffee preparations with equivalent caffeine exposure are therefore required to determine whether their effects differ independently of caffeine dose.

The cardiometabolic literature further illustrates this problem. Green tea catechins have been associated with modest improvements in blood pressure and lipid parameters in randomized trials, although findings for glucose metabolism and insulin sensitivity have been less consistent (Khalesi et al., 2014; Kim et al., 2011; X. Wang et al., 2014). Coffee has been investigated extensively in observational and interventional research, with evidence generally suggesting that habitual moderate consumption is compatible with favorable or neutral long-term health outcomes (Grosso et al., 2017; Poole et al., 2017).

The context-dependent perspective also highlights that the most appropriate beverage may depend on the specific physiological or behavioral objective rather than on an overall ranking of the two beverages. Coffee currently has stronger evidence for rapid stimulation and exercise-related performance benefits, while matcha is a promising but less extensively investigated alternative that may offer a different combination of cognitive and stress-related effects. Importantly, the available evidence does not support the claim that matcha is universally superior to coffee. Rather, the potential value of each beverage may depend on interactions among caffeine dose, accompanying bioactive compounds, timing of consumption, exercise demands, and individual characteristics.

Sleep represents an additional factor that should be considered when applying these findings in physically active populations. Because caffeine can prolong sleep latency and reduce total sleep time and sleep efficiency, late-day consumption may counteract potential performance or recovery benefits, particularly in caffeine-sensitive individuals (Clark & Landolt, 2017). Thus, beverage selection should consider not only the desired acute effect but also the potential consequences for subsequent sleep and recovery.

Future research should therefore move beyond determining simply whether matcha or coffee improves a given outcome. Studies should establish whether whole-matcha and coffee beverages produce different effects when caffeine exposure is standardized, whether these differences persist under conditions of physical and mental fatigue, and whether acute effects on cognition, stress, or exercise performance translate into meaningful effects on recovery and longer-term adaptation. Such research would help determine whether the distinctive phytochemical composition of matcha provides functional advantages beyond those attributable to caffeine alone. Until such evidence becomes available, coffee and matcha should be viewed as complementary beverages.

5. Limitations of Current Evidence

Despite growing interest in matcha and coffee as sources of bioactive compounds with potential cognitive, stress-related, and cardiometabolic effects, the current evidence has several important limitations. Previous literature has largely examined these beverages separately, whereas their potentially distinct profiles justify a direct comparison regarding cognitive function, stress response, and cardiometabolic health in physically active individuals. Although a substantial body of research has examined caffeine, green tea extracts, individual catechins, or caffeine–L-theanine combinations, findings from these studies cannot necessarily be extrapolated to whole-matcha consumption, as matcha is a complex matrix of multiple bioactive compounds. Few studies investigating matcha include relatively small sample sizes, reducing statistical power and increasing uncertainty around effect estimates. The interpretation of the literature is further complicated by substantial differences in caffeine doses and in the concentrations of bioactive compounds. Studies investigating coffee or caffeine often use standardized caffeine doses, whereas studies involving matcha may differ considerably in the amount of powder consumed, caffeine concentration, catechin content, preparation method, and frequency of consumption. A related issue is the considerable variability in matcha's chemical composition. The concentrations of caffeine, catechins, L-theanine, and other bioactive compounds can vary with tea cultivar, geographical origin, cultivation conditions, shading practices, harvesting time, processing methods, storage, and preparation. This heterogeneity makes it difficult to define a standardized dose of matcha and limits the reproducibility and comparability of results across studies.

Furthermore, one of the most important gaps in the current literature is the paucity of well-controlled head-to-head trials directly comparing standardized matcha and coffee. Most available studies examine coffee, caffeine, matcha, green tea, or individual compounds in isolation. Although caffeine is one of the most extensively studied ergogenic substances, much of the available evidence concerns isolated caffeine rather than coffee or matcha as whole beverages. Consequently, findings obtained with isolated caffeine may not fully capture the effects of coffee or matcha, in which caffeine interacts with other bioactive constituents. The evidence is particularly limited in physically active individuals and athletes. Evidence regarding the antioxidant, anti-inflammatory, and metabolic effects of catechins is often derived from general adult populations rather than physically active or athletic populations. Findings obtained in sedentary or generally healthy adults cannot be automatically extrapolated to physically active individuals due to variations in training status, habitual caffeine consumption, energy expenditure, nutritional intake, body composition, and exercise-induced psychological stress.

Another limitation is the heterogeneity of outcome measures and study protocols. Studies differ substantially in the methods used to assess cognitive, psychological, autonomic, inflammatory, and metabolic outcomes. For example, cognitive studies may use various attention or reaction-time tasks, while stress studies may assess cortisol, HRV, perceived stress, or anxiety using different protocols and time points. Likewise, oxidative stress may be assessed using different biomarkers, including lipid peroxidation products, antioxidant capacity, or markers of DNA oxidation. This methodological heterogeneity makes quantitative comparison difficult and may explain some apparently inconsistent findings.

Furthermore, many studies evaluate acute responses following a single exposure, whereas relatively little is known about the effects of long-term matcha consumption in physically active populations. Acute improvements in alertness or reaction time do not necessarily translate into sustained improvements in cognitive performance, exercise performance, or long-term cardiometabolic outcomes. Conversely, potential antioxidant, anti-inflammatory, and metabolic effects may require repeated or long-term consumption and therefore cannot be adequately evaluated using acute study designs.

The relatively small number of available trials and frequent use of small samples also limit the ability to assess publication bias and the robustness of reported effects.

6. Conclusion

Matcha and coffee should not necessarily be considered competing beverages, but rather as sources of bioactive compounds with potentially distinct functional profiles. Coffee currently has stronger evidence of rapid stimulation and acute exercise-related effects, whereas matcha may offer benefits for attention, stress-related responses, and polyphenol exposure. However, the limited number of direct head-to-head trials, variability in matcha composition and caffeine doses, small study populations, and limited research in physically active individuals prevent definitive conclusions regarding the superiority of either beverage. Future research should prioritize well-designed randomized controlled trials that directly compare standardized whole-matcha and coffee preparations at equivalent caffeine doses in physically active populations.

Disclosure

All authors have read and approved the final version of the manuscript for publication

Author Contributions

Conceptualization: AW, SB
Methodology: AW, MS, MI
Investigation: WZ
Resources: DS
Data curation: AAM, SB
Writhing-rough preparation: KKC, MI
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The authors declare no conflicts of interest.

Declaration of the Use of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT for the purpose of language editing and grammar correction of the English text to improve readability and linguistic accuracy. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the substantive content of the publication.

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