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Matcha Green Tea in Sport: Effects on Metabolism, Physical Performance, and Recovery - A Narrative Review of Human and Animal Studies

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Abstract

Background. Matcha green tea is a powdered form of Japanese green tea, rich in catechins, caffeine, theanine, and other polyphenols. These compounds may support cognitive function, reduce stress, influence gut microbiota, and improve exercise performance, making matcha a promising beverage for active individuals.

Aim. This narrative review aimed to summarize and evaluate current evidence from human and animal studies on matcha's effects on cognitive performance, stress, gut microbiota, metabolism, and exercise outcomes, particularly in athletes.

Materials and Methods. A structured search of PubMed and Google Scholar up to 2026 identified 21 relevant studies. Keywords included "matcha", "sport", "exercise", "metabolism", "athletes", "cognition", "stress" and "gut microbiota". Findings were summarized and analyzed narratively.

Results. Matcha intake was linked to improvements in attention, executive function, emotional perception, and sleep quality. It also enhanced gut microbiota composition and increased fat

oxidation during moderate-intensity exercise. These effects were seen across healthy adults and athletes, though study designs and matcha doses varied.

Conclusions. Matcha green tea shows potential as a functional beverage supporting both mental and physical performance. Further standardized and longer-term studies are needed to confirm these benefits and determine optimal consumption strategies for athletic populations.

Keywords: matcha, sport, exercise performance, green tea, cognitive function, gut microbiota.

1. Introduction.

Matcha is a powdered form of Japanese green tea (Camellia sinensis L.), distinguished by the fact that the whole leaf is consumed rather than infused. This unique method of preparation means you're getting a much more concentrated dose of bioactive compounds, such as EGCG (a powerful antioxidant), theanine, and caffeine [7, 11, 14, 19]. These ingredients work together to give matcha its unique profile, making it a popular choice for those looking to boost their antioxidant intake and improve metabolic health [1, 18, 21].

In recent years, matcha has gained popularity among physically active individuals. Research shows that it can actually change how the body uses fuel during exercise. Specifically, it helps the body burn more fat instead of just relying on carbs. For example, Willems et al. (2018, 2020) found that daily matcha increased fat oxidation during brisk walking [18, 21]. Interestingly, this happened without significantly affecting heart rate or energy expenditure. These findings suggest that matcha may support endurance and improve metabolic efficiency during physical activity.

Matcha's benefits actually go beyond just metabolism. A growing body of research highlights its impact on the gut microbiota. Today, we recognize gut health as a major factor in overall well-being. It plays a key role in energy metabolism, inflammation, and even how we recover from physical exertion.

For example, Morishima et al. (2023) demonstrated that even two weeks of matcha consumption can change the composition of gut bacteria in healthy adults. Their findings were quite specific: beneficial groups like Coprococcus increased, while potentially harmful species like Fusobacterium were reduced [9].

These findings are also supported by animal studies. Matcha supplementation effectively countered high fat diet induced dysbiosis by restoring the level of beneficial bacteria, such as Alloprevotella, Ileibacterium, and Rikenella, while simultaneously suppressing the growth of obesity-promoting bacteria like Romboutsia [16].

Interestingly, the type of matcha might also matter. Takegami et.al (2022) proposed that different varieties could influence the gut in various ways. These shifts in the microbiome may contribute to a more favorable gut environment and overall metabolic balance, although their direct relevance for physically active individuals requires further investigation. [17]

But matcha's effects aren't just physical. It also plays a significant role in mental functions, ranging from stress reduction to better cognitive performance and sleep quality [3, 13, 15]. This is largely due to theanine, an amino acid found in high amounts in matcha. Research on both animals and humans shows that theanine helps lower stress and anxiety [11, 15]. At the same time, the caffeine in matcha helps sharpen alertness and focus [2, 4, 20]. Together, these two compounds create a unique "calm-alert" state.

A key study by Baba et al. (2021) looked at how matcha impacts middle aged and older adults under mild psychological stress. They found that it significantly improved attention and executive function. Matcha worked better than caffeine alone when it came to boosting overall work performance [8]. This suggests that the combination of compounds found in the whole leaf is more effective than isolated ingredients.

Uchida et al. (2024) also found promising results in older adults with mild cognitive decline. Their research showed that long-term matcha consumption improved social cognition. It also pointed to a positive trend in sleep quality for these individuals [13]. Other studies back this up, confirming that matcha can enhance general mental well-being. Even in cases where objective EEG measures didn't show a clear change, participants still reported much better subjective sleep quality [10].

Matcha is more than just a trend for athletes. It offers a pretty unique mix of physical and mental support. It helps with the grind of training by improving stress resilience and recovery times [1, 5, 8]. Research by Najman et al. (2023) even pointed out that matcha is perfect for functional drinks because it is packed with prebiotics and compounds that support recovery and protein intake [7]. Kochman et al. (2021) summarized the chemical composition and health benefits of matcha, noting that its properties can positively impact a healthy lifestyle and physical fitness [19].

Despite these promising results, research on matcha within sports science is still somewhat limited. Many studies to date have been small or focused on specific groups, like females during moderate-intensity workouts [18, 21]. Animal research has helped us understand the underlying mechanisms, but more large-scale trials with athletes are necessary to see how these benefits hold under intense training conditions [6, 15, 16]. Overall, what we know so far suggests that matcha has great potential as a natural, multifunctional drink for boosting performance and recovery.

This narrative review aims to evaluate the current evidence regarding the impact of matcha green tea on metabolism, exercise performance, and cognitive function, stress response, and recovery in physically active individuals and athletes.

2. Research Material and Methods.

2.1. Participants.

This review evaluates data from a diverse range of participants, including young, middle-aged, and older adults. Both healthy individuals [1, 3, 9, 10, 18, 21] and those with mild cognitive decline or metabolic disorders were considered [8, 12, 13]. A significant focus was placed on athletes and physically active populations [1, 2, 4]. While human data is the priority, selected animal models were included to provide a deeper understanding of mechanisms behind matcha's impact on metabolism and the gut microbiome [6, 11, 15, 16].

2.2. Procedure.

This review was based on a structured literature search conducted using two databases: PubMed and Google Scholar. The search utilized "matcha" as a primary term, combined with keywords such as sport, exercise, metabolism, athletes, stress and gut microbiota.

The evidence base for this review consists of 21 studies. The majority of the included literature (13 studies) comprises randomized controlled trials (RCTs), which are considered the gold standard for clinical evidence [1, 2, 3, 4, 5, 8, 9, 10, 13, 15, 18, 20, 21].Within these, several employed double-blind or crossover designs to minimize bias and enhance the reliability of the metabolic and cognitive outcomes. The duration of these human interventions varied significantly, ranging from acute, single-dose assessments [2, 3, 20] to a long-term study conducted over a 12-month period [13], while others investigated daily consumption over 3 to 12 weeks [1, 5, 8, 9,10, 18, 21].

To complement human data, we incorporated animal models and in vitro technological analyses. These studies were crucial for explaining the underlying mechanisms such as anabolic muscle responses and gut microbiota modulation [6, 15, 16], as well as the chemical and technological properties of matcha-based products [7, 14].

Finally, we utilized systematic and narrative reviews to provide a broader scientific context and to synthesize the current state of knowledge regarding matcha's chemical composition and its role as a natural aid for athletes [11, 12, 19].

To maintain a high standard for this review, we prioritized original research and randomized controlled trials (RCTs) involving human participants. Our selection focused specifically on studies that evaluated the effects of matcha on metabolic, cognitive, or exercise-related outcomes. While we primarily sought out English language publications, we also considered articles with a comprehensive English abstract. On the other hand, we excluded general research on green tea. Animal studies were incorporated only when they offered essential insights into physiological mechanisms applicable to humans.

For each selected study, we systematically extracted data regarding the study design, participants demographic, and the specific intervention, including matcha dosage and preparation. We also categorized primary outcomes such as cognitive performance, fat oxidation, stress markers, gut microbiota composition, and sleep quality.

2.3. Statistical Analysis.

2.3.1. Statistical Software.

Data organization and the extraction of descriptive statistics (such as means, standard deviations, and ranges) were managed using Microsoft Excel. This allowed for a systematic comparison of results across the 21 included studies. Since this is a narrative review, no advanced statistical software was required.

2.3.2. AI.

AI tools were used solely as supportive instruments to improve linguistic clarity and coherence of the manuscript. All scientific interpretation, data synthesis, and conclusions were developed independently by the authors to ensure intellectual integrity.

2.3.3. Statistical Methods.

We used a qualitative approach to analyze the data rather than new statistical calculations. Instead of performing a new meta-analysis, we synthesized the findings by identifying common patterns across the 21 studies. We used the statistical significance ($p < 0.05$) reported by original authors to distinguish between confirmed effects and non-significant trends. This allowed us to assess which benefits of matcha are supported by solid evidence.

3. Research results

3.1. Impact on Metabolism and Athletic Performance.

One of the most promising areas of matcha research is its ability to enhance fat burning during exercise. The metabolic benefits of matcha were initially highlighted in a study by Willems et al. [21], where they examined the impact of matcha consumed as beverage over a 48-hour period. In this randomized crossover trial, 13 women showed significantly enhanced fat oxidation and a lower respiratory exchange ratio during 30-minute brisk walk, even after such short-term intake. Building on these earlier results, the same research group later investigated a more prolonged protocol involving 3-weeks of daily matcha supplementation in capsule form that have shown that regular consumption can meaningfully increase fat utilization during moderate activity [18].

Willems et al. [18] conducted a three-week intervention in 12 healthy women and reported a 35% increase in fat oxidation during 30-minute treadmill walk, with a corresponding decrease in carbohydrate oxidation. There were no significant changes in heart rate or perceived exertion. This suggests that matcha acts as a metabolic modifier that improves fuel efficiency without adding to the overall cardiovascular strain or making the exercise feel more difficult [18].

Together, these two studies demonstrate that matcha's ability to optimize fuel utilization is effective both as an acute intervention and as a long-term nutritional strategy for active individuals and suggests a consistent effect on substrate utilization regardless of whether it is consumed as a traditional beverage [21] or a daily supplement [18].

The impact of matcha on muscle adaptation was evidenced by Shigeta et al. [1], who reported that a dose of 1.5g twice a day attenuated the stress response to resistance exercise. This was marked by a reduction in salivary cortisol and lower perceived fatigue during the initial weeks of training. By the end of a 12-week intervention, individuals in the matcha group exhibited

larger increases in skeletal muscle mass and increased maximum leg strength than the placebo cohort. These physical improvements were linked to changes in the composition of gut microbes, such as Ruminococcus, Butyricimonas, and Oscillospira [1].

Mechanistically matcha's effects on metabolism are attributed to its high content of catechins, particularly epigallocatechin gallate (EGCG), combined with caffeine [19]. EGCG enhances mitochondrial activity and promotes lipolysis, while caffeine increases catecholamine release, which further stimulates fat oxidation. This synergistic effect may explain why matcha leads to greater fat utilization compared to either caffeine or catechins alone. Additionally, the complex profile of phenolic acids and L-theanine in matcha [7,14] contributes to its broader ergogenic and stress-reducing properties.

The acute performance effects of caffeine and L-theanine co-supplementation appear to be task and population dependent. Tuncer et al. [2] reported no significant synergistic benefits for isometric strength, aerobic endurance, or visuomotor coordination in trained athletes, noting that isolated L-theanine may even attenuate maximal leg and back strength. Conversely, Razazan et al. [4] demonstrated that a 1:1 ratio (3 mg/kg each) significantly enhanced explosive power, grip strength, and wrestling specific endurance in elite wrestlers. Beyond physical output, this combination improved post-exercise cognitive accuracy and reaction times while effectively mitigating caffeine induced side effects, reducing the incidence of tachycardia from 92% to 17% and lowering state anxiety compared to isolated caffeine consumption [4]. It should be noted, however, that these studies investigated isolated compounds rather than matcha itself, which may limit direct translation of these findings.

These findings highlight the role of matcha as a metabolic modulator. However, its potential benefits extended beyond physical performance and include important cognitive and psychological dimensions.

3.2. Effects on Cognitive Function and Stress

Matcha green tea has also been reported to influence cognitive performance and stress responses, likely due to its unique combination of bioactive compounds, particulary L-theanine, caffeine and catechins [2, 4, 8, 10, 15]. L-theanine, an amino acid capable of crossing the blood-brain barrier, is linked to increased alpha brain wave activity, promoting relaxation without causing drowsiness. Caffeine, in contrast, has stimulating effects, enhancing alertness and attention. Together, these compounds seem to provide both calming effects and improved cognitive performance, especially under stressful conditions [2, 8, 10].

In a randomized placebo-controlled study by Baba et al. [8], daily matcha intake improved attentional performance and executive function in middle-aged and older adults experiencing mild psychological stress. Participants consuming matcha showed faster reaction times and greater cognitive output compared to caffeine-only group, suggesting benefits beyond caffeine alone. Similarly, Unno et al. [15] demonstrated that matcha could reduce stress-induced anxiety, measured both by physiological markers in animal experiments and self-reported stress in human trials. Notably, the stress-reducing effect was strongest when the ratio of caffeine and EGCG to theanine and arginine was maintained below a certain threshold, highlighting the importance of the balance of bioactive compounds [15].

Longer-term studies also support beneficial effects on cognitive function. Uchida et al. [13] conducted a 12-month randomized controlled trial in older adults with mild cognitive impairment or subjective cognitive decline. Regular matcha consumption led to improvements in social cognition scores, reflecting enhanced emotional perception and social cognitive skills. Sleep quality, measured using the Pittsburgh Sleep Quality Index, also tended to improve, suggesting that matcha may contribute indirectly to cognitive and emotional well-being through better sleep [13].

The cognitive effects of matcha may partly be explained by its influence on neurotransmitters. L-theanine has been associated with increased levels of GABA, dopamine, and serotonin, which can improve mood and reduce stress [3, 5, 10]. Caffeine enhances dopamine and norepinephrine activity, further supporting attention and executive functioning [8]. Together, these mechanisms may explain matcha's dual role: reducing stress while enhancing cognitive performance.

Furthermore, reviews suggest that matcha and green tea consumption may offer neuroprotective effects, potentially supporting memory, attention, and mental well-being in older adults [11, 12]. These benefits are likely mediated not only through neurotransmitter modulation but also by the antioxidant and anti-inflammatory properties of catechins, which protect neurons from oxidative damage and reduce neuroinflammation [11, 12].

Despite these promising findings, it should be noted that a substantial proportion of the available evidence is derived from studies involving older adults or non-athletic population, which may limit the direct applicability of these results to highly trained individuals.

Overall, the literature indicated that matcha could be a useful nutritional strategy for athletes, physically active individuals, and older adults seeking to maintain cognitive performance under

stress. Its combination of relaxation-promoting and stimulating compounds provides unique advantage over other caffeinated beverages [2, 8, 10, 15]

3.3. Effects on Gut Microbiota

In addition to cognitive effects, matcha green tea has been shown to influence gut microbiota composition, which may contribute to its broader health effects. These properties are primarily attributed to its high content of polyphenols and dietary fiber [7, 14], which can act as prebiotics substrates and modulate microbial populations in the gastrointestinal tract.

Human intervention studies suggest that even short-term consumption of matcha can alter gut microbiota composition. In randomized, double-blind trial, Morishima et al. [9] demonstrated that two weeks of daily matcha intake significantly affected beta-diversity in healthy adults. This was associated with an increase in beneficial genera such as Coprococcus and a reduction in potentially harmful bacteria, including Fusobacterium, indicating a shift toward a more favorable microbial profile [9].

Similarly, Takegami et al. [17] suggested that regular matcha consumption may help modulate gut microbiota composition, although the extent of these changes may depend on the type and processing of matcha.

Evidence from animal studies provides further insight into the relationship between matcha, gut microbiota, and metabolic regulation. Luo et al. [16] investigated the effects of matcha supplementation in mice fed a high-fat diet using 16S rDNA sequencing and metabolomic analysis.

The authors demonstrated that matcha attenuated several adverse effects associated with a high-fat diet, including excessive weight gain, increased adipose tissue accumulation, dyslipidemia, and impaired glucose tolerance. These physiological improvements were accompanied by significant alterations in gut microbiota composition. Matcha increased the relative abundance of bacterial genera associated with beneficial metabolic outcomes, such as Alloprevotella, Ileibacterium and Rikenella, while reducing the abundance of Romboutsia, which has been linked to obesity-related dysbiosis [16].

In addition to microbial changes, matcha supplementation influenced the profile of gut-derived metabolites, including amino acid-related compounds and bile acid derivatives. Correlation analyses suggested that these metabolic shifts were associated with both microbial composition

and obesity-related phenotypes, indicating a potential interaction between gut microbiota and host metabolism [16].

Although the exact mechanisms remain to be fully elucidated, these findings suggest that matcha may modulate gut microbiota composition through its rich profile of bioactive compounds. However, the current evidence is still limited, particularly in human studies, and further research is required to determine the clinical relevance of these changes.

3.4 Other Health-Related Effects

In addition to the primary effects described above, several studies have reported broader health-related properties of matcha that may indirectly support physical performance and recovery. These include antioxidant and anti-inflammatory effects, largely attributed to its high content of catechins and other polyphenols [19]. It may be helpful to maintain general health and prevent disease.

Matcha has also been proposed as a suitable component of functional foods and beverages due to its dense nutritional profile and the presence of bioactive compounds that may support physiological resilience [7]. Such properties may be particularly relevant in physically active individuals, where recovery, immune function, and overall metabolic stability play an important role.

However, these observations are primarily based on general health studies rather than sport-specific interventions. Therefore, their direct applicability to athletic performance remains to be further established.

4. Discussion.

The current review highlights that matcha green tea may offer a broad spectrum of benefits relevant for athletes and physically active individuals, including cognitive support, stress reduction, sleep quality, metabolic modulation, exercise performance, fat oxidation and gut microbiota regulation. Such findings support the growing interest in using natural foods to support performance and recovery.

4.1. Cognitive and Mental Benefits.

Several studies indicate that matcha can enhance attention, reaction time, and emotional perception skills important for training and competition. For example, Baba et al. [3,8] reported

that daily matcha intake maintained attentional function in middle-aged and older adults under mild stress [8]. Similarly, improvements in reaction times and rapid information processing were observed in younger adults exposed to mild acute psychological stress [3]. These effects are likely related to theanine, an amino acid present in matcha, which promotes relaxation without drowsiness and modulates neurotransmitters linked to alertness and cognition [2, 3, 5, 8]. Long-term studies, such as the 12-month trial by Uchida et al. [13], also suggest that matcha may support emotional perception and subtly improve sleep quality, contributing to mental resilience and recovery.

4.2 Stress and Sleep.

Managing stress and ensuring adequate sleep are crucial for athletes. Matcha appears to help maintain this balance. Unno et al. [5, 15] demonstrated that matcha could reduce anxiety and stress responses when caffeine, catechins, and theanine were present in optimal ratios. Baba et al. [8] and Uchida et al. [13] reported trends towards better subjective sleep quality, which may indirectly improve recovery and well-being. Overall, matcha seems to combine calming and stimulating effects, supporting alertness without overstimulation.

4.3 Gut Microbiota and Metabolic Effects.

The modulation of gut microbiota may be another way in which matcha benefits active individuals. Human studies indicate that matcha intake can increase beneficial bacteria such as Coprococcus and reduce potentially harmful genera like Fusobacterium [9, 17]. Animal studies provide further mechanistic insights: Luo et al. [16] showed that matcha supplementation in mice fed a high-fat diet improved glucose tolerance, lipid profiles, and weight gain while modulating gut microbiota and metabolite profiles. These findings suggest that matcha may support a favorable metabolic environment, potentially enhancing nutrient utilization and energy metabolism during training.

4.4. Exercise Performance and Fat Oxidation.

Matcha has been shown to influence energy substrate use during exercise. Willems et al [18, 21] found that matcha consumption increased fat oxidation and reduced respiratory exchange ratio during moderate-intensity activity in women, without affecting heart rate or perceived exertion. This indicates that matcha may enhance endurance performance and improve fuel efficiency. Furthermore, the combination of matcha with regular training could offer synergistic benefits for body composition and energy metabolism.

4.5. Bioactive Compounds and Antioxidant Properties.

Matcha's effects are largely attributed to its rich content of catechins (especially EGCG), caffeine, and theanine [1, 3, 7, 15]. These compounds provide antioxidant, anti-inflammatory, and neuroprotective benefits. Catechins may reduce exercise-induced oxidative stress, protect neurons, and improve cognitive function [3, 7, 15]. Caffeine enhances fat oxidation and alertness, while theanine modulates stress responses. Together, these bioactive compounds make matcha a potent functional beverage for athletes.

4.6. Limitations of Current Evidence.

Despite promising results, several limitations exist. Many studies had small sample sizes, short duration, or specific populations (e.g., older adults or females), limiting generalizability [3, 5, 7, 8, 12, 13, 18, 21]. Matcha preparation, dosage, and quality varied across studies, which may affect outcomes. Animal studies provide mechanistic insights, but human trials, especially long-term studies in athletes, remain limited.

4.7. Future Directions.

Future research should standardize dosage, preparation, and outcomes in athletic populations. Long-term studies could examine matcha's effects on training adaptations, recovery, immune function, and cognitive performance. Investigating synergetic effects of matcha with exercise, diet, and other lifestyle factors may further clarify its potential in sports nutrition.

5. Conclusions.

Based on the narrative review of 21 studies, matcha green tea appears to be a promising functional beverage with multiple benefits relevant for physically active individuals and athletes. Its unique composition, rich in catechins (particularly EGCG), theanine, caffeine, and insoluble dietary fiber, contributes to its wide-ranging effects on cognitive performance, stress reduction, sleep quality, metabolic function, gut microbiota modulation, and exercise-related fat oxidation [7, 11, 14, 15, 19].

Regular matcha consumption may enhance attention, reaction time, and emotional perception, supporting both training and competitive performance [3, 4, 8, 11, 13, 20]. It may also help manage stress and improve subjective sleep quality, which are critical for recovery and overall well-being [3, 5, 8, 10, 13, 15].

Additionally, matcha positively influences gut microbiota composition and metabolites, which could contribute to improved nutrient absorption, metabolic health, and reduced inflammation [9, 16, 17]. These effects may indirectly benefit athletes by optimizing energy utilization and supporting body composition [18, 21].

In the context of exercise, matcha supplementation has been shown to enhance fat oxidation during moderate intensity activity without negatively impacting heart rate or energy expenditure, suggesting its potential as a natural ergogenic aid [18, 21]. Additionally, its antioxidant and anti-inflammatory properties may help mitigate exercise induced oxidative stress, supporting recovery and overall performance [7, 19].

Despite these promising findings, the current evidence base remains limited. Many studies involve small sample sizes, short intervention periods, or non-athletic populations. In addition, differences in matcha quality, dosage, and preparation make it difficult to directly compare results. While animal studies provide useful mechanistic insights [6, 15, 16], more well-designed human trials are needed to confirm the practical relevance of these effects.

Taken together, matcha can be considered a safe and practical dietary addition that may support selected aspects of physical and mental performance. However, its effects should not be overstated. Future research should focus on standardized intervention protocols, long-term outcomes, and the interaction between matcha intake, training, and overall diet to better define its role in sports nutrition.

Importantly, the potential benefits of matcha may extend beyond athletic populations. It could also serve as a supportive dietary component for less physically active individuals aiming to improve overall health and metabolic function. Preliminary evidence from animal models suggests that matcha may contribute to weight regulation and reduction of obesity-related parameters, although these effects still require confirmation in well-controlled human studies [16].

Disclosure

Author's contribution:

Conceptualization: E. Skrzypek, J. Łącki, A. Rogozińska;
Methodology: E. Skrzypek, M. Kasznicki, M. Czechowska;

Formal analysis: W. Beśka, K. Jackowiak; M. Kamela;
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Conflict of interest

The authors deny any conflict of interest.

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