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Ashwagandha and Its Role in Stress Reduction, Hormonal Balance, and Athletic Recovery: An Evidence-Based Review

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Abstract

Introduction and Purpose: Ashwagandha (Withania somnifera) is a well-known adaptogenic herb used traditionally in Ayurvedic medicine. In recent years, it has attracted scientific interest for its potential to reduce stress, support hormonal balance, and improve recovery after physical exertion. Given the increasing use of herbal supplements among athletes and active individuals, this review aims to critically examine clinical evidence regarding the effects of ashwagandha supplementation on stress reduction, regulation of cortisol and testosterone levels, and enhancement of physical recovery.

State of Knowledge: Current clinical studies suggest that ashwagandha may effectively lower cortisol levels, thereby supporting stress resilience in both mentally and physically demanding contexts. Several randomized controlled trials have reported improvements in perceived stress and anxiety, along with significant reductions in physiological stress markers. Additionally, ashwagandha supplementation has been associated with increases in testosterone levels, particularly in physically active men, which may contribute to improved strength, recovery, and hormonal stability. Some evidence also points to enhanced muscle recovery and decreased post-exercise fatigue, although findings vary depending on dosage, extract standardization, and study duration.

Conclusion: Ashwagandha shows promising potential as a natural intervention to support psychological and physiological recovery in active populations. While findings are encouraging, further well-designed trials with larger sample sizes and standardized preparations are needed to confirm its long-term safety and efficacy.

Keywords: Ashwagandha, Withania somnifera, cortisol, testosterone, stress reduction, recovery, adaptogen, athletes

Introduction

Ashwagandha (Withania somnifera), a key herb in traditional Ayurvedic medicine, is increasingly recognized in modern health sciences for its adaptogenic properties, which may help the body resist physical and psychological stressors. It has been used for centuries to enhance vitality, balance energy, and promote resilience in the face of fatigue and chronic stress. Chronic psychological and physiological stress leads to dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis and elevated cortisol levels, which in turn may impair immune function, mood, and physical performance. Several studies have demonstrated that ashwagandha supplementation is effective in lowering serum cortisol and perceived stress. In a randomized, double-blind, placebo-controlled trial, participants receiving 300 mg of ashwagandha root extract twice daily for 60 days showed a significant reduction in serum cortisol levels compared to placebo (–27.9% vs –7.9%) [1]. In addition to reducing stress, ashwagandha has been associated with favorable hormonal effects, particularly in relation to testosterone and reproductive function. In a study involving overweight men aged 40–70, eight weeks of supplementation with standardized ashwagandha extract led to significant increases in serum testosterone and DHEA-S levels compared to placebo[2]. Emerging evidence also supports ashwagandha's role in physical recovery and performance enhancement.

A double-blind, placebo-controlled trial on healthy athletic adults found that ashwagandha root extract significantly improved VO_2 max and recovery index after eight weeks of supplementation, suggesting enhanced cardiorespiratory endurance and reduced exercise-induced fatigue[3]. Given these multidimensional effects - on stress, hormones, and physical recovery - ashwagandha presents itself as a promising natural supplement for athletes and physically active individuals. This review aims to evaluate the current clinical evidence on its effectiveness in supporting stress resilience, hormonal balance, and athletic recovery.

Materials and Methods

A systematic search of the literature was conducted in March 2025 using PubMed, Scopus, and Web of Science databases to identify clinical studies examining the effects of Withania somnifera (ashwagandha) on stress, hormonal responses, and physical recovery in healthy or physically active individuals. In the PubMed search, Medical Subject Headings (MeSH) were applied to improve the accuracy and relevance of results. The search strategy included the terms: "Withania somnifera"[MeSH Terms] OR "Ashwagandha" in combination with "Stress, Physiological"[MeSH Terms], "Cortisol"[MeSH Terms], "Testosterone"[MeSH Terms], "Hormones"[MeSH Terms], "Athletic Performance"[MeSH Terms], "Exercise"[MeSH Terms], and "Recovery of Function"[MeSH Terms], using appropriate Boolean operators. Only studies published in English between 2010 and 2025 were considered. Filters were applied to include human research, specifically randomized controlled trials and prospective clinical studies. Titles and abstracts were screened independently by two reviewers to determine eligibility based on predefined inclusion criteria. Studies were selected if they examined oral ashwagandha supplementation in adult humans and reported outcomes related to stress (including cortisol levels or subjective measures), hormonal balance (primarily testosterone), or physical recovery parameters such as VO_2 max, muscle strength, or fatigue. Studies focusing on disease populations, non-clinical reports, and animal or in vitro experiments were excluded. After initial screening, full texts of potentially relevant articles were reviewed. Disagreements between reviewers regarding study inclusion were resolved through discussion. Data extraction was performed using a standardized format, capturing key study characteristics such as sample size, participant demographics, ashwagandha dosage and duration, and primary outcomes. The quality of the included studies was assessed using the Cochrane Risk of Bias Tool 2.0 to evaluate the methodological rigor and potential sources of bias.

Results

Effects of Ashwagandha on Stress and Cortisol

Ashwagandha (Withania somnifera) has been extensively studied for its adaptogenic effects, particularly its ability to mitigate physiological and psychological stress. Chronic stress, which dysregulates the hypothalamic-pituitary-adrenal (HPA) axis, is commonly associated with elevated cortisol levels, anxiety, and fatigue. Several randomized controlled trials (RCTs) provide strong evidence that Ashwagandha supplementation can significantly reduce stress levels and serum cortisol concentrations. One of the most cited studies by Chandrasekhar et al. demonstrated a 27.9% reduction in serum cortisol levels in chronically stressed adults after 60 days of supplementation with 600 mg/day of full-spectrum Ashwagandha root extract, compared to only 7.9% in the placebo group (4).

Similarly, Salve et al. found that both 250 mg and 600 mg daily doses of Ashwagandha significantly reduced Perceived Stress Scale (PSS) scores and serum cortisol, with the higher dose showing greater efficacy (5). Lopresti et al. also reported meaningful reductions in anxiety and stress in adults taking Ashwagandha compared to placebo (6). In a more recent trial, Mishra and Kumar evaluated the effects of Ashwagandha root and leaf extract (Shoden®) in stressed but otherwise healthy individuals, observing significant reductions in cortisol and anxiety levels across both low and high-dose groups . Additional support for these findings comes from studies on specialized Ashwagandha formulations. Gopukumar et al. investigated a sustained-release Ashwagandha formulation over 90 days and found improvements in cortisol levels, psychological well-being, and sleep (7). Tiwari et al. and Verma et al. further demonstrated that Ashwagandha reduced stress markers and improved cardiorespiratory recovery in athletic populations (8). Evidence from systematic reviews confirms these effects. Pratte et al. concluded that Ashwagandha has a significant anxiolytic effect based on pooled clinical evidence (10). Studies conducted on elderly adults (7), athletes (5), and the general population (11–12) reinforce the herb's effectiveness across diverse groups. Notably, Kelgane et al. and Langade et al. observed that Ashwagandha supplementation not only reduced stress but also improved sleep quality and general well-being (10,13). While most of the evidence is positive, variations in extract type, dosing, and study duration highlight the importance of standardized protocols in future research. Collectively, these findings support the role of Ashwagandha as a safe and effective natural intervention for stress reduction and HPA axis modulation.

Hormonal Balance: Testosterone and DHEA

Ashwagandha (Withania somnifera) has been studied for its effects on male hormonal health, particularly its capacity to modulate testosterone and dehydroepiandrosterone sulfate (DHEA-S) - two key androgens associated with vitality, muscle development, and reproductive function. Research suggests that these effects may be partially mediated by ashwagandha's adaptogenic action, which influences the hypothalamic-pituitary-adrenal (HPA) axis and supports endocrine homeostasis under stress. In a placebo-controlled, crossover clinical trial by Lopresti et al. (2019), aging and overweight men (mean age ~55) received 240 mg/day of ashwagandha extract for 8 weeks. Participants exhibited statistically significant increases in serum testosterone and DHEA-S compared to placebo, along with reduced fatigue and improved psychological well-being [14]. These results suggest a dual effect: hormonal enhancement and stress reduction. A broader systematic review by Smith et al. (2021) confirmed that ashwagandha supplementation led to consistent elevations in testosterone across multiple clinical trials. The review emphasized that the greatest hormonal benefits were observed in individuals with low or borderline testosterone levels, suggesting a normalizing rather than supraphysiologic effect [15]. However, some caution has been raised regarding the generalizability of these results. A 2024 systematic review by Morgado et al. evaluated the efficacy of various "testosterone boosters," including ashwagandha. While acknowledging promising outcomes, the authors noted heterogeneity in study design, extract standardization, and outcome measures, recommending more rigorous trials to confirm ashwagandha's androgenic potential [16].

Collectively, current evidence supports the role of ashwagandha in promoting hormonal balance - especially testosterone and DHEA - in stressed or aging populations. Its adaptogenic properties may further amplify these endocrine effects by attenuating cortisol-related hormonal suppression.

The Effect of Ashwagandha on Glucose Metabolism and Insulin Sensitivity in Athletes

Ashwagandha (Withania somnifera) is a well-established adaptogen traditionally used in Ayurvedic medicine. Recently, it has attracted growing scientific attention for its potential to improve glucose metabolism and insulin sensitivity - factors essential to athletic performance and recovery. Several clinical trials have demonstrated that Ashwagandha supplementation can significantly lower fasting blood glucose and insulin levels. For instance, Singh et al. (2024) reported statistically significant reductions in both markers following eight weeks of supplementation with 600 mg/day of standardized Ashwagandha root extract in healthy adults [17]. The underlying mechanism may involve a reduction in oxidative stress and modulation of the hypothalamic–pituitary–adrenal (HPA) axis, which helps maintain glucose homeostasis [18,19]. For athletes, efficient glucose uptake by skeletal muscle is critical for sustaining energy levels during exercise and promoting muscle glycogen resynthesis afterward. Improved insulin sensitivity can translate to faster post-exercise recovery and enhanced energy utilization. In a placebo-controlled trial by Patel et al. (2023), physically active individuals supplementing with Ashwagandha for 30 days showed notable improvements in glycemic control without any adverse effects [20]. Additionally, Ashwagandha's adaptogenic properties may reduce the catabolic effects of chronic physical stress on glucose metabolism, further supporting its potential as a metabolic aid for athletes [19]. While these findings are promising, further research specifically targeting athletic populations is needed to establish optimal dosages, timing, and long-term safety in the context of sports performance.

Ashwagandha's Role in Modulating Thyroid Hormones and Its Implications for Athletic Performance

Ashwagandha also shows potential in modulating thyroid hormone levels, which may hold important implications for sports performance. Thyroid hormones such as triiodothyronine (T3) and thyroxine (T4) are crucial regulators of basal metabolic rate, protein synthesis, and mitochondrial function [21]. A clinical trial by Sharma et al. (2018) found that 600 mg/day of Ashwagandha root extract administered to patients with subclinical hypothyroidism for eight weeks resulted in significant increases in serum T3 and T4 levels, along with a corresponding reduction in thyroid-stimulating hormone (TSH) [22]. These effects suggest that Ashwagandha may support thyroid hormone biosynthesis or improve peripheral conversion of T4 to T3. Similar thyroid-supportive effects have been observed in animal models as well [23]. In the context of sports, optimal thyroid function is essential for maintaining metabolic efficiency, muscle function, and adaptive responses to training. Athletes experiencing stress-related suppression of thyroid activity may benefit from Ashwagandha's regulatory influence on the HPA axis and thyroid homeostasis [18,19]. Nonetheless, overstimulation of thyroid activity can pose health risks, particularly for individuals predisposed to hyperthyroidism.

A 2023 review by Zahedi et al. emphasized that while Ashwagandha holds therapeutic potential in thyroid dysfunction, its use should be personalized and monitored, especially in populations with existing endocrine conditions [24]

Physical Recovery and Performance

Ashwagandha (Withania somnifera) has garnered attention in sports science for its potential to enhance physical performance and accelerate recovery. Clinical studies have evaluated its effects on maximal oxygen uptake (VO_2 max), muscle strength, body composition, Total Quality Recovery (TQR), and biomarkers of physiological restoration. Its adaptogenic and anti-inflammatory properties make it particularly relevant for athletes under physical stress.

VO_2 Max and Cardiorespiratory Endurance

VO_2 max is a key metric of aerobic capacity. In a randomized controlled trial (RCT), participants who took 300 mg of ashwagandha twice daily for 8 weeks showed statistically significant improvements in VO_2 max compared to the placebo group ($p = 0.0074$) [25]. Another study confirmed these findings, with 600 mg/day of ashwagandha improving VO_2 max in healthy adults undergoing resistance training over 8 weeks [26]. Similar outcomes were reported in a study on elite Indian cyclists, where VO_2 max and cardiorespiratory endurance increased after 8 weeks of supplementation [27]. A systematic review and meta-analysis concluded that ashwagandha supplementation consistently improves VO_2 max in both trained and untrained individuals, likely via enhanced oxygen utilization and reduced fatigue [28].

Muscle Strength and Body Composition

Ashwagandha has also been linked to improvements in muscular strength and body composition. In a well-controlled RCT, young men undergoing resistance training who received 600 mg/day of ashwagandha showed significantly greater gains in bench press and leg extension strength, muscle size (arm and chest circumference), and fat reduction than the placebo group [29]. Another study found that 500 mg/day of aqueous ashwagandha extract over 12 weeks improved upper and lower body strength while supporting favorable changes in lean body mass [26]. Additionally, improvements in body composition were seen in female athletes, suggesting benefits across sexes and training levels [30].

Recovery and Biomarkers

Ashwagandha appears to accelerate recovery through modulation of muscle damage and inflammation. Participants in strength-training programs who supplemented with ashwagandha showed reduced serum creatine kinase levels - an indicator of muscle damage - and reported lower perceived fatigue and improved recovery scores [31,32]. Furthermore, a recent trial with female athletes showed that 28 days of supplementation (600 mg/day) improved TQR scores and perceived sleep quality [33]. These findings align with traditional adaptogen profiles, indicating improved HPA axis regulation and reduced cortisol levels during recovery [34,35].

Delayed Onset Muscle Soreness (DOMS) and Muscle Recovery

Delayed Onset Muscle Soreness (DOMS) is a common phenomenon that occurs following intense or unfamiliar physical exertion. It is typically characterized by muscle pain, stiffness, and a temporary reduction in strength, peaking 24–72 hours post-exercise. DOMS results from microtrauma to muscle fibers and the associated inflammatory and oxidative stress responses. Ashwagandha (Withania somnifera), a well-known adaptogenic and anti-inflammatory medicinal herb, has been investigated for its potential to reduce DOMS and accelerate post-exercise recovery. In a randomized, double-blind, placebo-controlled study, Ziegenfuss et al. evaluated the effects of ashwagandha root extract on strength development and recovery in healthy male participants engaged in resistance training. Over eight weeks, participants who received ashwagandha supplementation experienced significantly greater improvements in muscle strength and faster recovery compared to the placebo group. Notably, they also exhibited reduced levels of creatine kinase (CK), indicating less exercise-induced muscle damage [36]. Similarly, Sandhu et al. examined the effects of ashwagandha supplementation on physical performance and recovery in young adults. After 12 weeks, the ashwagandha group showed improvements in aerobic capacity and faster recovery, which were attributed to the adaptogenic effects of the plant [37]. The mechanisms by which ashwagandha may alleviate DOMS include its ability to modulate inflammatory responses and reduce oxidative stress. Bioactive compounds such as withaferin A are believed to exert anti-inflammatory effects through inhibition of pro-inflammatory transcription factors [38]. In summary, current clinical evidence suggests that ashwagandha supplementation may reduce the severity of DOMS and support faster recovery following strenuous exercise. However, more robust, well-controlled trials are needed to validate these findings and define optimal dosing strategies.

Effectiveness Across Athletic Levels

Notably, these effects have been observed in both recreational and elite athletes. In a comparative study, elite cyclists and healthy adults alike experienced improvements in performance, endurance, and subjective recovery when using ashwagandha [25,27]. Additional studies have confirmed that these benefits are reproducible across different training intensities and durations [34,35].

Effective Dosage of Ashwagandha for Enhancing Physical Performance

The effectiveness of ashwagandha (Withania somnifera) in improving physical performance is dose-dependent and can vary based on the extract type, study population, duration of supplementation, and specific performance outcomes. Most clinical trials use standardized root extracts, such as KSM-66® or Sensoril®, with varying withanolide content. Across multiple randomized controlled trials, daily doses ranging from 300 mg to 1000 mg of standardized extract, typically divided into two doses, have shown significant improvements in strength, endurance, testosterone levels, and recovery markers. For instance, doses of 600 mg/day of KSM-66® have consistently demonstrated benefits in muscle strength, aerobic capacity, and muscle recovery in both trained and untrained individuals [39,40]. Higher doses, such as 750–1000 mg/day, were often used in trials focused on hormonal balance and stress reduction, showing additional benefits in cortisol modulation and mood stabilization, which may indirectly enhance athletic performance [41,42].

Importantly, the majority of trials that reported significant ergogenic effects lasted at least 8 weeks, suggesting that chronic supplementation may be more effective than acute dosing. Furthermore, studies using aqueous root extracts appear more consistent in outcomes compared to those using full-plant or leaf extracts, due to differing phytochemical compositions. Although ashwagandha is generally well tolerated, individual responses and the risk of gastrointestinal side effects at higher doses warrant consideration. Thus, based on current evidence, an effective dosage for physical performance enhancement appears to be:

- 300–600 mg/day for general improvement in strength and endurance,
- 600–1000 mg/day for combined hormonal and anti-stress benefits.

Interpretation of Results and Population Variability

Clinical trials investigating the effects of ashwagandha (Withania somnifera) supplementation on physical performance have yielded promising yet variable results. This variability can be attributed to differences in study populations, including factors such as age, sex, training status, and baseline hormonal profiles. In young, healthy males engaged in resistance training, ashwagandha supplementation has been associated with significant improvements in muscle strength and size. For instance, Wankhede et al. reported greater increases in bench-press and leg-extension strength, as well as muscle size, in the ashwagandha group compared to placebo over an 8-week period [43]. Similarly, Ziegenfuss et al. found that ashwagandha supplementation enhanced strength training adaptations and recovery [44]. Studies involving female athletes are more limited, but available data suggest potential benefits. Verma et al. demonstrated that ashwagandha supplementation improved strength, recovery, and VO_2 max in resistance-trained adults, including females [45]. However, due to the paucity of data in female populations, further investigation is warranted. Age-related differences may also influence the efficacy of ashwagandha. Lopresti and Drummond observed increases in testosterone levels and improved vitality in aging, overweight males supplemented with ashwagandha [46], suggesting a possible benefit in age-associated decline of physical function. Baseline hormonal status appears to modulate the response. Ambiye et al. found significant improvements in testosterone levels and sperm parameters in oligospermic males [47]. This indicates that individuals with hormonal deficiencies might derive more pronounced effects from supplementation. Training status plays a significant role as well. Tiwari et al. reported improvements in VO_2 max and endurance in untrained athletic adults [48], while Sandhu et al. demonstrated increased cardiorespiratory performance in healthy young men [49]. The ergogenic effects of ashwagandha may be more evident in novice exercisers than in highly trained individuals. Cognitive and psychomotor enhancements related to physical output have also been observed. Choudhary et al. showed that ashwagandha improved psychomotor performance and executive function, potentially supporting exercise efficiency [50]. Individual tolerability and metabolic response also vary. A tolerability trial by Raut et al. found high individual variation in adaptogenic outcomes among healthy volunteers [51]. This may reflect genetic and metabolic diversity affecting response magnitude. The bioavailability and form of ashwagandha extract matter greatly. KSM-66®, a high-concentration full-spectrum extract, was shown to reduce stress and improve well-being in a clinical trial [52], possibly enabling better training recovery.

Cognitive-enhancing effects may also support athletic performance indirectly. Pingali et al. found significant improvements in working memory and mental tracking [53], potentially aiding in complex sports tasks requiring strategy and focus. Finally, stress and recovery improvements have downstream effects on physical performance. Two separate trials demonstrated that standardized ashwagandha extract effectively reduces anxiety and improves sleep, which are crucial for recovery [54,55]. Studies with elite athletes have demonstrated mixed outcomes, suggesting a potential ceiling effect in trained populations , while less-trained individuals may benefit more [56].

Discussion

The clinical evidence reviewed suggests that Withania somnifera (ashwagandha) demonstrates substantial promise as an adaptogenic agent supporting stress reduction, hormonal regulation, and physical performance. Across multiple randomized controlled trials, ashwagandha has consistently shown the ability to reduce serum cortisol levels and improve subjective measures of stress and anxiety. For example, Chandrasekhar et al. reported a 27.9% reduction in cortisol after 60 days of supplementation compared to 7.9% in the placebo group, confirming its efficacy in HPA axis modulation [4]. These effects on stress may have downstream benefits for hormonal balance. Several studies found that ashwagandha increases serum testosterone, particularly in males with suboptimal baseline levels. Lopresti et al. documented significant elevations in both testosterone and DHEA-S among aging, overweight men, suggesting potential benefits for both reproductive health and muscle development [14]. Importantly, this hormonal regulation appears to be synergistically linked to ashwagandha's stress-mitigating effects. Ashwagandha's role in improving physical recovery and athletic performance is also noteworthy. Enhanced VO_2 max, reduced post-exercise fatigue, and improvements in muscle strength and composition have been reported in both recreational and trained athletes. For example, Wankhede et al. observed that supplementation led to significantly greater gains in strength and muscle size in resistance-trained young men compared to placebo [29]. These benefits are likely mediated by both endocrine effects and the plant's anti-inflammatory properties, such as reductions in creatine kinase levels indicative of reduced muscle damage [36]. Additionally, emerging data point to positive effects on glucose metabolism and thyroid function. Improved insulin sensitivity may support athletic recovery, and a trial by Sharma et al. found that ashwagandha increased T3 and T4 levels in patients with subclinical hypothyroidism [22]. These findings suggest broader metabolic regulatory potential, which could be especially valuable in athletic populations experiencing stress-induced dysregulation. Despite these encouraging results, several limitations should be acknowledged. Heterogeneity in extract formulations, dosages, and study populations complicates direct comparison across trials. As noted by Morgado et al., variability in study design and outcome measures necessitates more standardized research to validate the androgenic claims of ashwagandha supplementation [16]. Furthermore, while studies in male populations are robust, data on female and elite athletic populations remain limited, calling for sex-specific and sport-specific investigations. In conclusion, while the current body of evidence strongly supports ashwagandha's adaptogenic properties and its potential for enhancing both physiological and psychological resilience, long-term safety, optimal dosing strategies, and broader population applicability require further investigation.

Conclusion

Ashwagandha (Withania somnifera) emerges from current clinical evidence as a potent adaptogen with multifaceted benefits for stress resilience, hormonal balance, and athletic recovery. Its efficacy in reducing cortisol levels and improving perceived stress has been confirmed across several randomized controlled trials [4, 5, 6], while positive effects on testosterone and DHEA-S indicate its value in hormonal modulation, particularly among aging or stressed populations . In athletic contexts, ashwagandha has demonstrated improvements in VO_2 max, muscle strength, and recovery markers such as creatine kinase, highlighting its potential to enhance both performance and post-exercise restoration . Supplementation also appears to support metabolic health, including insulin sensitivity and thyroid hormone regulation, which may further contribute to physical readiness and adaptation . However, heterogeneity in dosing, extract standardization, and population demographics underlines the need for more rigorously designed, large-scale trials. Furthermore, limited data on female and elite athlete populations warrant focused research in these groups . In summary, ashwagandha represents a promising natural intervention with a strong safety profile and wide-ranging applications in stress management and athletic performance. Continued exploration through high-quality clinical research will be essential to refine its therapeutic use and optimize its effectiveness across diverse populations.

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