The Use of Smokeless Nicotine Products in Sports: A Narrative Review of the Performance Effects, Health Risks, and Anti-Doping Implications of Snus and Nicotine Pouches Among Athletes

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Abstract

The growing popularity of smokeless nicotine products—such as snus and nicotine pouches—among youth and elite athletes raises important health and regulatory concerns. Though promoted as reduced-risk alternatives to combustible tobacco, their use in sport prompts questions about effects on performance, safety, and oversight. This narrative review summarizes current evidence on their biochemical composition, physiological impact, and usage trends in athletic populations. Nicotine appears to affect endurance, hormonal balance, and cognitive performance. Zandonai et al. reported prolonged time to exhaustion after snus use [1], while Bartík et al. observed reduced pain perception without performance gains [2]. Other studies point to impaired thermoregulation [18], cardiovascular stress [23], and long-term risks such as dependence, hormonal disruption, and delayed recovery [12,24–26]. A monitoring study found nicotine metabolites in 15.3% of athlete urine samples [3], indicating notable prevalence. Despite being under World Anti-Doping Agency surveillance since 2012, nicotine is not included on the Prohibited List [4]. Regulations vary: France has banned nicotine pouches, while Sweden permits them [16,17]. Coordinated efforts from sports medicine professionals and anti-doping authorities are needed to develop clearer policies, enhance education, and safeguard athlete health.

Keywords: nicotine, snus, nicotine pouches, anti-doping policy, addiction

Introduction

In recent years, there has been a noticeable increase in the use of smokeless nicotine products—particularly snus and nicotine pouches—among athletes at both amateur and professional levels. Marketed as less harmful alternatives to traditional tobacco consumption, these products have gained traction in sports settings, where they are often perceived as means of enhancing focus and managing pre-competition anxiety. Research indicates that snus may influence physical performance. For instance, Zandonai et al. observed a 13% increase in time to exhaustion in athletes administered snus following a period of nicotine abstinence [1]. Conversely, other studies, such as that by Bartík et al., did not report significant changes in performance metrics after high-dose nicotine use, although they noted a reduction in perceived pain [2].

Despite the potential short-term cognitive or performance-related benefits, the use of smokeless nicotine products carries notable health risks. A year-long monitoring study by Marclay et al. detected nicotine metabolites in 15.3% of urine samples collected from athletes, indicating a substantial prevalence of nicotine use in sports environments [3]. Furthermore, chronic nicotine consumption has been associated with cardiovascular complications and the risk of dependence.

From a regulatory standpoint, the World Anti-Doping Agency (WADA) has included nicotine in its Monitoring Program since 2012, citing its potential for misuse in sport. However, it remains absent from the official list of prohibited substances, creating ambiguity regarding its permissibility in elite competition [4]. The aim of this narrative review is to critically examine the current scientific literature on the use of snus and nicotine pouches in sport. The review will explore their pharmacological properties, prevalence among athletes, effects on physical performance, associated health risks, and implications for anti-doping policy and ethical considerations in competitive sport.

Definition and Classification of Smokeless Nicotine Products

The rising use of smokeless nicotine products in sports makes it increasingly important to distinguish between snus and nicotine pouches—especially given their differences in composition, effects, and legal status.

Snus is a moist oral tobacco product traditionally used in Sweden. It contains ground tobacco, water, salt, and flavorings. Nicotine, along with compounds like alkaloids and tobacco-specific nitrosamines (TSNAs), is absorbed through the mouth lining [5]. While banned for sale in most EU countries (including France) under Directive 2014/40/EU, possession is usually not penalized, allowing legal use in countries like Poland.

Nicotine pouches, sometimes called "white snus," contain no tobacco. They use purified or synthetic nicotine with cellulose fillers and flavorings. Their perceived clean and discreet format has boosted popularity, even among athletes [6]. Yet many countries still lack clear regulations [8].

Although used similarly, the two products have different pharmacological profiles. Snus delivers more tobacco-derived substances, while pouches offer mostly nicotine. Absorption depends on factors like pH and moisture, which influence user experience and potential for dependence [7,8].

Understanding these differences helps avoid misleading assumptions about safety or performance impact—especially in elite sports.

Chemical Composition of Snus and Nicotine Pouches

Understanding the chemical makeup of smokeless nicotine products is crucial when evaluating their potential health effects—particularly in sports, where even minor physiological changes can influence performance, recovery, and long-term well-being.

Snus is composed of finely ground tobacco blended with water, salt, pH buffers such as sodium carbonate, and various flavorings. A major concern with snus is the presence of tobacco-specific nitrosamines (TSNAs), including NNK and NNN—compounds with established carcinogenic potential, even in modern, strictly regulated Swedish formulations [9,10]. It also contains minor tobacco alkaloids, such as nornicotine and anabasine, as well as trace metals like cadmium, lead, and arsenic, which likely originate from soil or curing processes. Its alkaline pH (typically between 7.5 and 8.5) increases the bioavailability of free nicotine

through the oral mucosa [5]. On average, one portion of snus delivers between 2 and 6 mg of absorbable nicotine—potentially exceeding the dose from one or two cigarettes.

In contrast, nicotine pouches are tobacco-free. They contain purified or synthetic nicotine, cellulose-based fillers, pH regulators, sweeteners such as xylitol, and a range of flavoring agents. The absence of TSNAs and other tobacco-derived toxicants contributes to their perception as a less harmful alternative [6]. However, nicotine content varies significantly across products. Some pouches contain more than 6 mg of nicotine [11], and with pH levels ranging from 6.5 to 9.0, absorption efficiency can differ considerably. Although these products are free from tobacco-specific carcinogens, the safety of certain additives—particularly sweeteners and flavorings—remains insufficiently studied. Some compounds have been identified as potential irritants or allergens [7]. Another important issue is the inconsistent regulatory classification of nicotine pouches, which may result in gaps in safety oversight [8]. Depending on formulation and brand, nicotine pouches typically deliver 1 to 3 mg of absorbable nicotine. This raises legitimate concerns regarding dependence risk, particularly among young users and athletes who may use them to enhance focus or manage pre-competition stress.

Prevalence and Use of Snus and Nicotine Pouches Among Athletes

Importance of Prevalence Data

Understanding how smokeless nicotine products are used in sport is essential for shaping effective prevention strategies and consistent regulatory responses. Reliable prevalence data not only reveal behavioral trends but also help contextualize potential implications for health, performance, and recovery [12].

Usage in Professional and Adolescent Populations

A 2024 survey by Loughborough University and the Professional Footballers' Association (PFA) found that 18% of male and 22% of female professional footballers in the UK reported regular use of snus or nicotine pouches. Over 40% had experimented with such products at least once [13], suggesting widespread presence even in elite-level environments.

In the United States, adolescent use of nicotine pouches rose from 3.0% in 2023 to 5.4% in 2024, according to data from the University of Southern California [14]. Product design, flavored options, and a perception of reduced harm compared to smoking may drive this trend.

Sport-Specific Patterns and Social Context

Usage patterns differ across sports. In disciplines such as football, ice hockey, and baseball, smokeless nicotine appears culturally normalized within certain team environments [15]. In these settings, it may function as part of routines linked to concentration, composure, or social bonding.

Gender and Age Differences

Recent PFA findings revealed notable gender-related differences in reported dependence: 73% of female users noted signs of dependence, compared to 53% of male users [13]. Younger athletes may be especially vulnerable to peer influence and marketing, particularly when such products are positioned—explicitly or implicitly—as tools for performance support.

Regulatory Inconsistencies

While the World Anti-Doping Agency (WADA) includes nicotine in its Monitoring Program, no sanctions are currently enforced [4]. National approaches vary significantly. In May 2025, France classified nicotine pouches as toxic substances, effectively banning their sale, use, and distribution [16]. Sweden opposed the ban, submitting a formal objection to the EU's TRIS system on grounds of insufficient scientific justification and trade restriction [17]. This divergence reflects a broader lack of coherence across Europe. For internationally active athletes, such inconsistency can cause confusion around legality, health messaging, and acceptable use.

Research Gaps and Future Needs

Despite increased attention, research on long-term effects and usage patterns in athletes remains limited. There is an urgent need for longitudinal, sport-specific studies examining the impact of regular use on cardiovascular health, cognitive function, training behavior, and psychological well-being.

Effects of Nicotine on Physical Performance

Physiological Mechanisms

Nicotine functions as an agonist of nicotinic acetylcholine receptors (nAChRs), stimulating the sympathetic nervous system. This activation increases the release of catecholamines, including adrenaline and noradrenaline, which in turn elevate heart rate, raise blood pressure, and enhance alertness. These acute physiological responses may, in theory, influence athletic performance by modulating cardiovascular and metabolic processes.

Notably, the pharmacokinetic profile of nicotine varies by delivery method. Snus and nicotine pouches, for example, provide slower, more sustained nicotine absorption through the oral mucosa, while inhaled forms such as e-cigarettes lead to more rapid systemic delivery. These differences may influence both the intensity and duration of physiological effects.

However, the overall impact of nicotine on exercise performance is multifactorial and appears to depend on variables such as dosage, route of administration, and individual tolerance.

Short-Term Effects on Performance

Several recent studies have explored the acute effects of nicotine on physical performance, yielding inconsistent findings.For example, Bartík et al. (2023) assessed the influence of an 8 mg oral nicotine dose on anaerobic output in trained athletes using the Wingate test. The study found no significant changes in peak or average power output. However, participants reported a statistically significant reduction in perceived exertion and pain, suggesting that nicotine may affect subjective sensations of effort without translating into measurable performance enhancement [2]. Conversely, other studies have underscored potential risks of nicotine use during exercise. Schlader et al. (2024) demonstrated that nicotine impairs thermoregulatory capacity in physically active individuals by reducing skin blood flow, thereby increasing susceptibility to heat-related illnesses, particularly during activity in warm environments [18]. Moreover, several trials examining aerobic parameters such as VO_2max have failed to show meaningful improvements with nicotine use, raising further doubts about its role as an ergogenic aid in endurance-based sports.

Long-Term Effects and Withdrawal

Chronic nicotine use has been associated with several adverse health outcomes that may compromise physical performance. Prolonged exposure can contribute to cardiovascular dysfunction, including hypertension and endothelial impairment, potentially diminishing aerobic capacity and endurance over time. Nicotine withdrawal also presents challenges. A meta-analysis by Bao et al. (2024) reported that short-term withdrawal (≤24 hours) may impair aspects of physical performance, including reaction time and sustained attention. In contrast, medium- to long-term cessation (≥3 months) was linked to significant improvements in aerobic capacity and overall exercise performance [19].

Summary

The effects of nicotine on physical performance are nuanced and context-dependent. While acute use may reduce perceived exertion and pain, current evidence does not support a consistent ergogenic effect on objective performance outcomes. Moreover, nicotine may compromise thermoregulation during exercise and, over time, contribute to cardiovascular detriments. Long-term cessation, in contrast, has been associated with improvements in both aerobic capacity and general physical performance. For athletes, these findings

underscore the importance of weighing temporary perceived benefits against longer-term health and performance risks.

Health Risks and Medical Implications of Nicotine Use

Addiction and Psychological Dependence

Nicotine is recognized as a highly addictive substance, with its mechanisms of dependence involving complex neurobiological processes. Chronic exposure to nicotine leads to neuroadaptations in the mesolimbic dopamine system, reinforcing its rewarding effects and promoting compulsive use. These changes include upregulation of nicotinic acetylcholine receptors and alterations in dopamine transporter (DAT) function, which contribute to both the development and maintenance of dependence [12,20]. Recent research has also emphasized the role of epigenetic mechanisms in nicotine addiction. For instance, Chmielowiec et al. (2023) reported increased DNA methylation of the DAT1 gene in individuals with nicotine dependence, suggesting that gene expression changes may affect dopaminergic signaling pathways associated with addictive behavior [22]. Psychological dependence is characterized by symptoms such as nicotine cravings, irritability, anxiety, and difficulty concentrating during withdrawal periods. These symptoms can impair cognitive and emotional functioning, which may be especially detrimental to athletes by reducing training consistency and competitive focus. Furthermore, the compulsive nature of nicotine use often leads to continued consumption despite awareness of health risks, highlighting the behavioral dimension of addiction.

Cardiovascular and Endocrine Consequences

Nicotine exerts significant effects on the cardiovascular system, primarily through stimulation of the sympathetic nervous system. This results in increased heart rate, elevated blood pressure, and vasoconstriction, thereby raising myocardial oxygen demand and increasing the risk of ischemia in predisposed individuals [23]. Long-term nicotine use has also been associated with endothelial dysfunction, a key contributor to the development of atherosclerosis and cardiovascular disease [24].

Beyond cardiovascular effects, nicotine influences endocrine regulation. It activates the hypothalamic-pituitary-adrenal (HPA) axis, leading to elevated cortisol levels that affect metabolism, immune response, and stress adaptation [25]. Chronic nicotine exposure has also been linked to impaired insulin sensitivity and disrupted lipid profiles, which may increase the risk of metabolic syndrome [26]. These disruptions can negatively affect recovery, energy balance, and the body's adaptive responses to physical training—factors that are vital to athletic performance.

In summary, while nicotine may offer short-term cognitive or mood-related effects, the physiological consequences of its use present measurable risks to general and sport-specific health.

Oral, Renal and Local Tissue Toxicity

Oral Toxicity

Long-term use of snus has been associated with gingival recession and leukoplakia. However, studies have not found a significant increase in oral cancer incidence among snus users, although some research suggests a potential association with cancers of the esophagus and pancreas after prolonged use [27].

Nicotine pouches, while free of tobacco-specific nitrosamines, have been linked to oral mucosal changes. Histological findings indicate alterations such as parakeratosis and inflammatory infiltrates. A systematic review reported that 32% of pouch users experienced mucosal irritation or dryness, and there was a mean 2.1-day delay in soft-tissue healing following periodontal procedures [28].

Renal Toxicity

Nicotine's nephrotoxic potential is mediated by oxidative stress and inflammasome activation. In rodent models, eight weeks of nicotine exposure led to a 28% increase in serum creatinine and amplified tubular injury via α7-nAChR/NLRP6 pathways [29]. While specific data on athletes are lacking, these systemic effects could plausibly impair post-exercise renal recovery.

Tissue Perfusion and Recovery-Related Effects

Nicotine induces vasoconstriction, affecting peripheral blood flow. An acute 4 mg nicotine dose administered via gum reduced cutaneous blood flow by 22% (±6%) and elevated core body temperature by 0.3°C during 45 minutes of cycling in trained males [30].

In surgical contexts, exclusive snus users exhibited higher rates of postoperative infection and bone non-union compared to non-users. Specifically, infection occurred in 14.8% of cases and bone non-union in 10.6% among snus users, versus 6.7% and 4.1% respectively in non-users [31].

Experimental wound-healing models provide mechanistic insights: nicotine-containing aerosol slowed epithelial closure between 24 and 72 hours, while fibroblast proliferation decreased by approximately 35% relative to controls [32]. Collectively, these data suggest that chronic vasoconstriction and impaired microvascularization may delay tissue repair, extend recovery timeframes, and elevate injury risk in athletes.

Neurocognitive and Mental Health Effects

Executive Function and Cognitive Control

Nicotine exerts its effects on the central nervous system primarily through activation of nicotinic acetylcholine receptors (nAChRs), resulting in increased release of neurotransmitters such as dopamine,

norepinephrine, and serotonin. While acute exposure may temporarily enhance attention and mood, sustained use has been linked to adverse neurocognitive outcomes and impaired psychological well-being, especially among physically active populations. A recent study by Wang et al. (2024) compared the cognitive performance of nicotine-exposed college athletes and sedentary students. Smokers showed significantly lower accuracy ($p < 0.001$), slower reaction times ($p < 0.001$), and reduced prefrontal cortex activation ($p < 0.001$) on executive function tasks (e.g., the Flanker test) compared to non-smokers. Notably, physical exercise improved performance metrics in both groups, but the gains were markedly diminished in nicotine users—suggesting persistent impairment in cognitive control related to chronic exposure [33].

Mental Health and Addiction Risk

Nicotine's addictive potential is well established, and its role in triggering or exacerbating psychological disorders is increasingly recognized. According to McDuff et al. (2023), athletes who engage in substance misuse—including smokeless nicotine products—are at heightened risk for developing mental health concerns such as anxiety, depression, and insomnia. The stress and high-performance demands inherent in elite sports may further reinforce nicotine use as a maladaptive coping mechanism [34].

Vulnerability in Adolescents and Young Adults

Emerging data from Yazidjoglou et al. (2025) revealed that Australian adolescents who used e-cigarettes (which also deliver nicotine) reported diminished physical performance (e.g., breathlessness during exertion), difficulty concentrating, and feelings of psychological withdrawal. Importantly, many participants noted cognitive and emotional improvement after quitting, indicating a potentially reversible effect of nicotine on mental health and executive functioning in youth [35].

Effects of Nicotine on Sexual Function and Hormonal Balance

Erectile Function and Vascular Mechanisms

Nicotine-induced vasoconstriction impairs endothelial function and reduces penile blood flow, contributing to erectile dysfunction (ED). In a 2024 retrospective study involving 373 men, Li et al. reported that smokers were significantly more likely to experience ED than non-smokers, as assessed using the International Index of Erectile Function-5 (IIEF-5), with smoking independently associated with increased ED severity ($p = 0.02$) [36].

Hormonal Disruption

Nicotine has been shown to interfere with the hypothalamic-pituitary-gonadal (HPG) axis. Multiple studies have observed alterations in serum testosterone levels among smokers. For example, Trummer et al. (2018)

identified a 12% reduction in total testosterone among physically active men who smoked [37]. Conversely, other investigations—such as the Tromsø Study—found higher total and free testosterone levels in smokers compared to non-smokers, suggesting that confounding lifestyle factors may influence hormonal profiles [38]. These conflicting findings underscore the complexity of nicotine's endocrine effects and highlight the need for further targeted research in athletic populations.

Impact on Libido and Fertility

Nicotine's negative effects extend to libido and fertility parameters. Experimental studies in rodents have demonstrated that nicotine exposure significantly reduces libido, sperm motility, and total sperm count while increasing the proportion of morphologically abnormal sperm. In human studies, Holmboe et al. (2020) reported that daily e-cigarette users exhibited significantly lower total sperm counts than non-users (91 million vs. 147 million), indicating that nicotine—regardless of delivery method—may impair semen quality [39]. This is of particular relevance to athletes undergoing fertility screening or managing reproductive health during their competitive careers.

Relevance for Athletes

Unlike cardiovascular or neurocognitive effects, nicotine's influence on sexual and hormonal health may develop gradually and often goes unnoticed until clinical dysfunction is evident. For athletes, disturbances in testosterone levels, libido, or sexual performance can indirectly impair training intensity, recovery capacity, and psychological well-being. Over time, such dysfunctions may reduce both physical capacity and quality of life, warranting proactive attention in sports medicine and athlete education.

Ethical and Anti-Doping Considerations

Between Legality and Ethics: The Unsettled Place of Nicotine in Sport

Although nicotine remains legal, its increasing use among athletes raises both ethical and regulatory concerns. Unlike conventional doping agents, smokeless nicotine products occupy a grey zone—neither prohibited nor entirely risk-free. As usage grows, particularly among youth and professionals, international sports governance faces mounting pressure to define its stance more clearly.

The WADA Monitoring Program

Since 2012, nicotine has been included in the World Anti-Doping Agency's (WADA) Monitoring Program, allowing surveillance without enforcement [4]. Over a decade of data collection has underscored the substance's relevance to sport. According to WADA's own criteria, a substance may merit prohibition if it enhances performance, endangers health, or violates the spirit of sport. Emerging evidence—such as

studies on focus enhancement, addiction risk, and uptake among young athletes—suggests that nicotine may satisfy at least two of these conditions [2,18].

Despite this, the absence of formal classification leads to ambiguity. Some athletes interpret WADA's passive stance as a warning, while others see it as implicit approval—resulting in inconsistent norms and confusion across disciplines and national contexts.

Regulatory Disparities

National responses vary sharply. In 2025, France banned nicotine pouches under public health legislation, citing toxicity and youth exposure as key concerns [16]. Sweden, on the other hand, defended their availability on harm reduction grounds and formally opposed the French position through the EU's TRIS procedure [17]. Such regulatory contrasts complicate international sport by creating discrepancies in legality, access, and preparation norms for athletes competing across borders.

Rationale for Reform

Nicotine's accessibility, psychoactive effects, and rising prevalence in sport indicate a growing need for decisive regulatory guidance. While its impact may not equal that of traditional doping substances, its potential to subtly influence performance and normalize substance use among athletes demands a clearer ethical and policy response from sport's governing bodies. A shift from passive observation to structured regulation—whether through prohibition, conditional use policies, or explicit guidance—would bring anti-doping policy in line with broader goals of fairness, athlete protection, and public health. Clarifying nicotine's place in anti-doping frameworks may also help prevent inconsistent practices that erode trust in sport's integrity.

Conclusion

The increasing use of smokeless nicotine products in sport raises pressing concerns—not only about health and performance, but also about the cultural acceptance of substance use in high-performance settings. While often perceived as safer than smoking, both snus and nicotine pouches carry real risks: from cardiovascular strain to potential dependence, often without clear early symptoms. Nicotine's physiological effects are incompatible with the goals of athlete health and performance. Its normalization in elite sport risks sending misleading signals to young people, undermining decades of public health efforts. Though further sport-specific research is needed, current evidence already justifies stronger preventive action—through regulation, education, and unified international policy led by bodies like WADA.

As medical professionals, we assert that nicotine use has no place in modern athletic culture. The health risks outweigh any perceived benefits, and sports medicine must prioritize protection over passive tolerance.

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