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THE IMPACT OF OVER-THE-COUNTER MEDICATION USE ON ATHLETE HEALTH RISKS, PSYCHOLOGICAL FACTORS, AND PERFORMANCE IN SPORTS MEDICINE AND PHYSIOLOGY

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ABSTRACT

Over-the-counter (OTC) medication use is widespread among athletes seeking to manage pain, enhance recovery, and sustain performance. However, patterns of OTC use and their associations with psychological factors, injury risk, and performance-related physiological characteristics remain insufficiently understood. This cross-sectional study analyzed data from 30 athletes who completed a structured survey assessing demographic characteristics, training habits, psychological stress, injury history, OTC medication use, and motivations for use. Physiological performance indicators including flexibility, muscle asymmetry, and recovery time were also recorded. Descriptive statistics were computed, and inferential analyses included independent samples t-tests, chi-square tests, Pearson correlations, and binary logistic regression to examine relationships among OTC use, psychological variables, and injury risk. OTC users reported significantly lower sleep duration compared to non-users ($p = .013$), although no other performance or physiological variables differed between groups. Chi-square analysis indicated no significant association between OTC use and injury risk. Correlation analyses revealed that higher training intensity was associated with lower stress ($r = -0.35$), and reduced sleep was modestly associated with increased muscle asymmetry ($r = -0.29$). Logistic regression showed that injury history not OTC use was the strongest predictor of current injury risk. Findings suggest that OTC medication use among athletes may be linked more strongly to behavioral and recovery-related factors, particularly sleep, than to measurable physiological performance indicators. These results highlight the importance of promoting natural recovery strategies, sleep hygiene, and safe medication practices within athletic populations.

KEYWORDS: OTC Medication Use; Injury Risk; Athlete Recovery; Stress.

1. INTRODUCTION

Over-the-counter (OTC) medication use has become increasingly common among athletes seeking to manage pain, enhance recovery, and sustain performance across demanding training and competition schedules. Many athletes rely on a variety of prescription and non-prescription drugs to cope with musculoskeletal symptoms and the physical strain of sport participation (Ferry et al., 2020). This trend parallels the rising use of dietary supplements and performance-related substances among competitive athletes, including those undergoing doping controls, highlighting a broader culture of self-medication within sport (Lauritzen & Gjelstad, 2023). The normalization of pain and injury within athletic environments further reinforces such behaviors, as athletes often train and compete despite discomfort, relying on pharmaceutical aids as a coping mechanism (Waddington, 2021).

Non-steroidal anti-inflammatory drugs (NSAIDs) remain among the most frequently used OTC substances in endurance and team sports, though concerns persist regarding their potential to mask symptoms, increase injury susceptibility, and impair physiological healing (Meyer-Glitza et al., 2023). Athletes often rely on NSAIDs not only for acute pain relief but also as a preventive measure prior to training sessions or competitions, a practice that can obscure early warning signs of overuse or tissue damage and contribute to the progression of underlying injuries. Clinical guidelines emphasize cautious and evidence-based use of NSAIDs to prevent inappropriate or excessive consumption, particularly for musculoskeletal pain, noting that misuse may result in adverse gastrointestinal, renal, and cardiovascular effects, especially when combined with dehydration or high training loads (Shi et al., 2023).

In parallel, athletes frequently use nutritional supplements and recovery aids, reflecting a multifaceted approach to performance optimization and symptom management that extends beyond pharmacological strategies (Tabata et al., 2020). This reliance on supplements ranging from protein formulations and recovery drinks to vitamins, minerals, and ergogenic aids often arises from perceptions of enhanced recovery, improved energy levels, and better overall physical readiness. Together, these patterns illustrate the complex landscape of self-managed recovery practices in sport, where both medication and supplementation play central, yet sometimes insufficiently regulated, roles in athletic preparation and maintenance.

The high physical demands of sport contribute to

elevated injury rates, making effective injury prevention and rehabilitation strategies essential (Jordan et al., 2022). Robust injury surveillance systems have improved understanding of injury patterns and risk factors, providing critical insight into athlete health and exposure over time (Costello et al., 2024). Pain perception and management remain central to this discussion, as athletes experience unique psychological and physiological challenges that influence their decisions around medication use (Alaiti & Reis, 2022). Recent systematic reviews indicate rising analgesic use in competitive sport, further underscoring the need to understand athletes' medication practices and associated health implications (Leyk et al., 2023). The physiological consequences of high training loads, including overtraining syndrome, create additional pressures that may motivate reliance on external aids such as OTC medications to maintain performance (Carrard et al., 2022). Sleep emerges as another critical factor: interventions aimed at enhancing sleep quality have demonstrated significant benefits for athletic performance, recovery, and cognitive functioning (Cunha et al., 2023). Adequate sleep plays an essential role not only in recovery but also in mitigating stress and injury risk, forming a cornerstone of athlete well-being (Charest & Grandner, 2022). Given these complex interactions between training load, recovery behaviors, and medication use, global guidelines on physical activity continue to emphasize the importance of structured, balanced activity and recovery strategies (World Health Organization, 2020).

Despite growing awareness of recovery and performance science, limited research has explored the interrelationships between OTC medication use, psychological variables, and performance-related physiological outcomes in athletes. This study aims to address this gap by examining the impact of OTC medication use on athlete health risks, psychological stress, recovery indicators, and performance metrics, contributing to a more comprehensive understanding of athlete health behaviors and their implications.

2. METHODOLOGY

2.1. Study Design

This study employed a cross-sectional quantitative research design to investigate the impact of OTC medication use on athlete health risks, psychological factors, and performance-related physiological variables. Data were analyzed to identify associations between OTC medication behaviors and key determinants of health and

performance within a sports medicine and physiology context.

2.2. Participants

A total of 30 athletes voluntarily participated in the study. Participants ranged in age from early adulthood to middle adulthood and represented a mix of genders and training backgrounds. Because the dataset contained no missing values, all 30 cases were included in the final analysis. To protect anonymity, all participant identifiers were removed, and only de-identified numerical and categorical variables were used.

2.3. Data Collection Procedure

Data for the study were collected using a structured survey comprising four major sections. The first section captured demographic and anthropometric information, including age, gender, height, weight, and body mass index (BMI). The second section focused on training and performance variables, where athletes reported their weekly training frequency, average session duration, warm-up time, training intensity measured on a 1-10 scale, sleep duration, flexibility scores, muscle asymmetry levels, and typical recovery time following training or competition. The third section addressed health and injury information, requiring participants to indicate their injury history reflecting either the number or severity of prior injuries and their current injury risk status, which was coded dichotomously as 0 for low risk and 1 for high risk. The final section examined OTC medication use and psychological factors. Athletes specified whether they used OTC medications, and if so, the type used (NSAIDs, analgesics, mixed use, or none). They also selected their primary motivation for OTC use, choosing from performance pressure, stress or anxiety, recovery needs, pain relief, or no specific motive. Additionally, participants reported their perceived stress level using a numerical rating scale.

2.4. Variables and Measures

The study incorporated several categories of variables to examine the relationships among OTC medication use, psychological factors, and athlete health and performance. Independent variables included OTC medication use, categorized as NSAIDs, analgesics, mixed use, or none; primary motivation for OTC use; psychological stress level measured as a continuous variable; and a range of training-related factors such as training frequency, session duration, training intensity, warm-up time, and sleep duration. The dependent variables

consisted of injury risk, coded as a binary outcome (0 = low risk, 1 = high risk), along with performance-related physiological indicators including flexibility scores, muscle asymmetry, and recovery time, as well as the athletes' injury history. To minimize potential confounding effects, control variables age, gender, and BMI were included in the analysis and adjusted for when examining associations between predictors and outcomes.

2.5. Data Handling and Preparation

Data were inspected for missing values, outliers, and coding inconsistencies. No missing data were identified, and all values fell within expected physiological and training-related ranges. Categorical variables were encoded for statistical analysis (e.g., gender = 0/1; injury risk = 0/1; OTC type = 1-4 coding structure).

2.6. Statistical Analysis

Data analysis was conducted using Python-based statistical libraries, through which descriptive statistics including means, standard deviations, and frequency distributions were computed for all study variables. Several inferential statistical procedures were then applied to address the study's research questions. Independent samples t-tests were used to compare psychological and performance-related variables between athletes who used OTC medications and those who did not. Chi-square tests of association were performed to examine relationships among categorical variables such as OTC medication type, injury risk status, and motivation for OTC use. Pearson correlation coefficients were calculated to assess linear associations among continuous variables, including stress level, training load indicators, and physiological performance measures. In addition, binary logistic regression analysis was conducted to determine whether OTC medication use, psychological stress, training load, or injury history significantly predicted the likelihood of being classified as high risk for injury. Statistical significance was set at $p < 0.05$, and effect sizes were reported where appropriate to aid interpretation.

2.7. Ethical Considerations

This study used anonymized data and adhered to ethical guidelines for human subjects research. All participants provided informed consent for the use of their responses in aggregated research analysis. No personally identifiable information was collected.

3. RESULTS

3.1. Descriptive Statistics

Descriptive statistics comparing OTC medication users (n = 23) and non-users (n = 7) across physiological, psychological, and recovery-related variables are presented in Table 1. Mean differences suggest trends where non-users exhibit slightly higher sleep duration and training intensity, though most variables show comparable distributions across groups.

Table 1: Descriptive Statistics and Group Comparisons Between OTC Users and Non-Users.

Variable	Mean (Users)	SD (Users)	Mean (Non-Users)	SD (Non-Users)	t-value	p-value
Stress Level	5.30	3.02	6.14	3.39	-0.59	0.571
Training Intensity	5.49	1.84	6.23	1.35	-1.15	0.269
Sleep Hours	7.04	0.79	7.91	0.66	-2.93	0.013
Flexibility Score	60.37	10.43	60.16	10.76	0.05	0.965
Muscle Asymmetry	5.10	2.62	5.54	3.61	-0.30	0.768
Recovery Time	83.17	25.42	76.57	28.21	0.55	0.593

3.2. Group Comparisons: OTC Users vs Non-Users

Independent samples t-tests were performed to evaluate differences in stress, sleep, training intensity, flexibility, muscle asymmetry, and recovery time between OTC users and non-users.

A statistically significant difference emerged for sleep duration, where non-users (M = 7.91 h) reported significantly greater sleep than OTC users (M = 7.04 h), $t = -2.93$, $p = 0.013$ (see Figure 1). No significant differences were observed for stress level, training intensity, flexibility score, muscle asymmetry, or recovery time (Table 1). These findings suggest that insufficient sleep may be a contributing factor influencing OTC medication use in athletes.

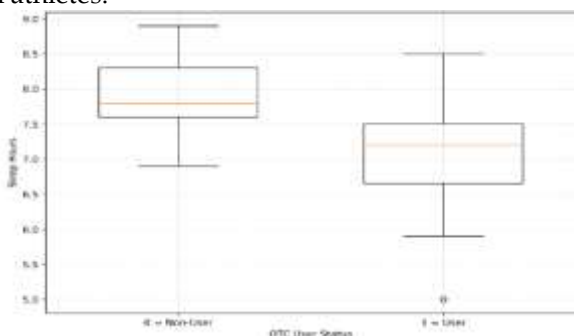


Figure 1: Sleep Hours Comparison Between OTC Users and Non-Users.

3.3. Association Between OTC Use and Injury Risk

A chi-square test evaluated whether OTC use was associated with injury risk classification. As shown in Table 2, no statistically significant association was found between OTC use (user vs. non-user) and injury risk status, $\chi^2 = 0.67$, $p = 0.41$. Although OTC users displayed a slightly higher proportion of high-risk individuals (10 of 23), this difference did not reach statistical significance.

Table 2: Contingency Table for OTC Use and Injury Risk with Chi-Square Values.

OTC User	Low Risk (0)	High Risk (1)
0 (Non-User)	4	3
1 (User)	13	10

3.4. Correlation Analysis

Correlations among the continuous physiological and psychological variables revealed several small to moderate associations (see Figure 2). Notably, training intensity demonstrated a negative relationship with stress level ($r = -0.35$), suggesting that athletes who trained at higher intensities tended to report lower levels of perceived stress. This pattern may reflect the psychological benefits of structured training or greater resilience among athletes capable of sustaining elevated workloads. Additionally, muscle asymmetry showed a modest negative correlation with sleep duration ($r = -0.29$), indicating that athletes who slept less tended to exhibit higher levels of asymmetry, potentially pointing to compromised recovery or increased muscular imbalance associated with insufficient rest. Importantly, no meaningful correlations were observed between OTC medication use and any of the continuous variables analyzed, implying that OTC use in this sample may be influenced more by behavioral or subjective factors rather than directly measurable physiological indicators.

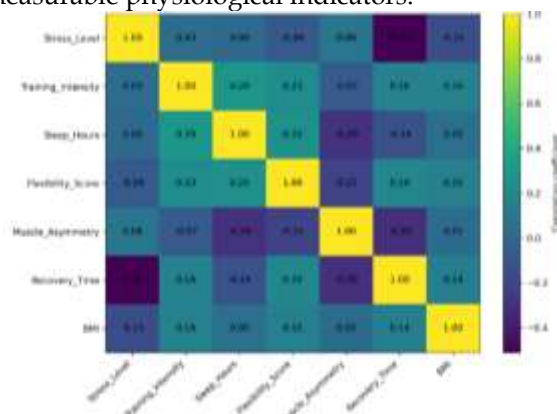


Figure 2: Correlation Matrix for Physiological and Psychological Variables.

3.5. OTC Medication Use Patterns

The distribution of OTC medication types among athletes is illustrated in Figure 3, highlighting distinct patterns of use within the sample.

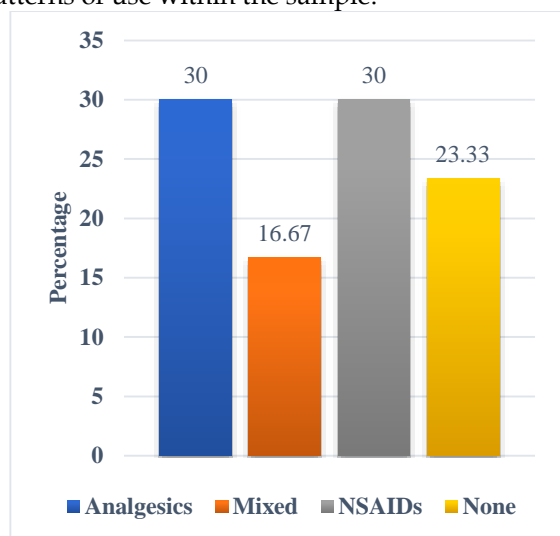


Figure 3: Distribution of OTC Medication Types Reported by Athletes.

NSAIDs and analgesics emerged as the most commonly utilized categories, each accounting for 30% of reported medication use, reflecting athletes' reliance on these agents for managing pain, inflammation, and training-related discomfort. Mixed-use, representing athletes who used more than one type of OTC medication, comprised 16.7% of the sample, suggesting a subset of individuals who may engage in broader self-management strategies or experience more complex symptom profiles. Notably, approximately 23% of athletes reported no OTC medication use, indicating that a meaningful proportion of the population manages training demands and recovery without pharmacological support. This distribution underscores the variability in athletes' approaches to pain management and recovery, highlighting the need to better understand the factors that drive these differences.

4. DISCUSSION

The present study investigated the relationships between OTC medication use, psychological and training-related factors, and health and performance indicators in athletes. The findings offer several insights into athlete behavior and wellness patterns, particularly regarding sleep, injury risk, recovery, and medication use.

A key finding was that athletes who used OTC medications reported significantly lower sleep duration compared to non-users. Sleep plays a foundational role in performance, recovery, and

hormonal regulation, and disruptions may impair physiological restoration and elevate perceived fatigue. Insufficient sleep has been shown to hinder post-exercise recovery and compromise subsequent training performance, aligning with recent discussions on optimized recovery strategies in sport settings (Naderi et al., 2025). The lower sleep duration among OTC users may suggest compensatory medication use to manage symptoms related to inadequate recovery, such as soreness or fatigue.

Although OTC use was not significantly associated with injury risk in this sample, a substantial proportion of OTC users were classified as higher risk, a trend consistent with research highlighting the physiological concerns surrounding common analgesic and NSAID use during intense or prolonged exercise. For instance, ibuprofen use during heat stress has been linked to increased renal strain and injury biomarkers, raising concerns about frequent or preventive NSAID intake among athletes (McDermott et al., 2018). Such patterns highlight the importance of athlete education on safe medication use, especially in environments of high exertional stress.

The role of environmental and exertional stressors may further intersect with athletes' healthcare-seeking and medication behaviors. Athletic trainers and support staff often rely on emerging evidence and best-practice guidelines to manage conditions such as exertional heat illness, which requires accurate and timely information-seeking behaviors to reduce risk (Nedimyer, 2022). While the present study does not directly measure exertional illness, the intersection between training load, heat stress, and medication intake warrants continued monitoring in applied athletic settings.

Training factors also showed notable associations with psychological variables. Higher training intensity was moderately associated with lower stress levels, supporting evidence that structured, progressive resistance and endurance training may elicit favorable hormonal and psychological adaptations (Brunsden, 2023). Regular training has also been associated with improved endocrine responsiveness, potentially buffering the effects of stress and enhancing resilience during periods of high workload.

Effective recovery strategies remain essential in mitigating both physical and psychological fatigue. A broad range of established modalities from nutrition to sleep extension to active recovery has been emphasized as critical for maintaining performance across competitive schedules (Gregson

et al., 2023). The significant sleep difference observed between OTC users and non-users reinforces the importance of prioritizing natural recovery strategies over pharmacological dependence.

Training load monitoring is another critical factor, especially as excessive load or inadequate periodization increases the likelihood of overtraining, burnout, and maladaptive outcomes (McGuigan, 2022). In this context, the lack of strong associations between OTC use and physiological metrics such as muscle asymmetry or flexibility suggests that medication behaviors may be more closely related to subjective states such as sleep or psychological strain than to measurable physical imbalances.

The biochemical risks associated with NSAID use also warrant discussion. NSAIDs have well-documented molecular pathways that may induce gastrointestinal, renal, and cardiovascular side effects when used improperly or excessively (Panchal & Sabina, 2023). For athletes, these risks can be exacerbated by dehydration, intense training conditions, and insufficient recovery factors commonly present in competitive settings. Consequently, ensuring athletes adhere to recognized safe-use guidelines is essential, particularly in light of international regulatory standards, such as those outlined in the World Anti-Doping Agency's prohibited substances and methods list (World Anti-Doping Agency, 2022).

Furthermore, accurate monitoring of musculoskeletal symptoms and overuse conditions is vital, and standardized instruments such as the OSTRC questionnaire have been influential in identifying early risk markers (Conland, 2024). Although this study did not directly utilize such tools, its findings underscore the need for integrated monitoring approaches that consider both objective and subjective indicators of health.

Finally, foundational principles of exercise prescription emphasize balanced training, adequate recovery, and progressive overload as core components of athlete health and performance (Riebe et al., 2018). The subtle trends observed in this study such as relationships between sleep, stress, and medication use highlight the necessity of holistic

athlete management strategies that address both physical and psychosocial dimensions.

Overall, the findings suggest that OTC medication use among athletes may be linked more closely with behavioral and recovery-related factors particularly sleep rather than with overt physiological performance measures. Continued research with larger samples and longitudinal designs would provide deeper insights into causal relationships and long-term health implications.

5. CONCLUSION

This study examined the relationships among OTC medication use, psychological and training-related factors, and key health and performance indicators in athletes. The findings highlight that while OTC use was not directly associated with injury risk, athletes who reported using OTC medications demonstrated significantly lower sleep duration compared to non-users, suggesting that inadequate recovery may be an important factor contributing to medication use patterns. Although no significant differences were observed across physiological performance measures such as flexibility, muscle asymmetry, or recovery time, the associations between sleep, stress, and training behaviors underscore the multifaceted nature of athlete wellness. The lack of a significant statistical link between OTC use and injury risk does not diminish the importance of awareness regarding potential health risks associated with frequent analgesic or NSAID consumption, particularly in high-stress or high-load training environments. These results reinforce the need for comprehensive athlete education centered on evidence-based recovery strategies, safe medication practices, and the prioritization of sleep and natural recovery modalities. Future research with larger and more diverse athlete populations, coupled with longitudinal designs, will be essential to further clarify causal relationships and better inform sports medicine practitioners in optimizing athlete health, performance, and long-term well-being.

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