endocrines

Systematic Review

Effects of Beer and Wine Consumption on Metabolic and Endocrine Health Outcomes in Relation to Physical Activity: A Systematic Review

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Abstract

Background/Objectives: Physical activity is a cornerstone of preventive health, yet its practice often coexists with the consumption of alcoholic beverages like beer and wine. While these beverages contain bioactive compounds with potential health properties, alcohol itself carries significant risks. This systematic review aimed to synthesize and critically assess the evidence on physical activity and beer and wine consumption. Specifically, we examined their combined effects on metabolic syndrome components (body composition, blood pressure, lipids, glucose metabolism); inflammation and oxidative stress markers; mental health outcomes (cognitive function, mood, sleep); and physical performance, neuromuscular recovery, and fluid balance. **Methods**: Following a pre-registered protocol (PROSPERO: CRD420261281945), a systematic search of PubMed/MEDLINE, Scopus, and SPORTDiscus was conducted for studies published between 2000 and 2025. Included studies were randomized controlled trials or observational studies involving physically active adults (aged $\geq$ 18 years) who consumed beer or wine. Studies focusing solely on sedentary populations were excluded. Outcomes assessed included metabolic syndrome components, inflammation, oxidative stress, mental health, cognitive function, and physical performance. Risk of bias was evaluated using Cochrane RoB 2 for RCTs and ROBINS-I for non-randomized studies. **Results**: Eight studies were included. Moderate beer or wine consumption did not substantially negate the beneficial effects of exercise on cardiometabolic health, body composition, or cognitive function. Higher alcohol intake was associated with elevated blood pressure. Acute post-exercise consumption of alcoholic beer impaired rehydration and neuromuscular recovery, whereas non-alcoholic beer did not. **Conclusions**: Given the small number of studies and risk of bias, these findings should be interpreted with caution. In physically active populations, moderate beer or wine consumption does not clearly undermine the benefits of regular exercise on metabolic syndrome components (body composition, blood pressure, lipids, glucose metabolism). No additional benefits on inflammation or oxidative stress were observed, nor on mental health outcomes (cognitive function, mood, or sleep). However, acute post-exercise alcohol intake impairs rehydration and neuromuscular recovery, whereas non-alcoholic beer represents a safer alternative.

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Keywords: alcoholic beverages consumption; metabolic syndrome (MetS); cardiometabolic health; inflammation and oxidative stress; mental health; athletic performance; sport; nutrition

1. Introduction

Extensive research in recent decades has firmly established the vital role of regular physical activity in promoting and maintaining human health. Consistent with this evidence, global health authorities like the World Health Organization (WHO) recommend at least 150 to 300 min of moderate-intensity physical activity each week, usually broken down into daily sessions of 30 to 60 min [1,2]. The health benefits of exercise are widespread, improving physical health through better cardiovascular function, musculoskeletal integrity, metabolic control, and body composition management [3]. Additionally, its benefits extend to mental and cognitive well-being, with proven improvements in cognitive performance [4], sleep quality, and reductions in anxiety and depression symptoms [5].

While physical activity is a key part of preventive health, its practice in modern society often coincides with alcohol consumption. Current epidemiological evidence clearly identifies alcohol as a group 1 carcinogen, linking it to several cancers and other chronic diseases [6]. Moreover, for athletes, alcohol presents additional specific risks that extend beyond general health. It negatively impacts recovery, hydration, and neuro-motor function, and can increase injury risk [7,8]. Although alcohol was removed from the World Anti-Doping Agency (WADA) Prohibited List in 2018, it remains a substance of concern in sports nutrition and the broader context of athletic health and performance [9–11]. However, this clear risk profile is inconsistent with a long history of human consumption and a body of research focusing on specific alcoholic beverages, namely beer and wine. These beverages, with ancient cultural and social roots, have traditionally been at the center of ceremonies, community bonding, and moments of relaxation [12].

Beer and wine are highly complex fermented products [13]. In recent years, research interest has increasingly focused on their bioactive ingredients, aligning with the growing concept of "functional beverages"—products designed to provide health benefits beyond basic nutrition [14]. These bioactive compounds contribute to their distinctive flavors and potential health-promoting properties, including antioxidant and anti-inflammatory activities. These potential health benefits are associated with moderate consumption, which corresponds to up to one drink per day for women and up to two drinks per day for men, or approximately 14–28 g of pure alcohol [15,16]. However, the potential health benefits discussed here are associated with only moderate consumption. In fact, this has driven a rise in consumer demand for alternatives with reduced or zero alcohol content, reflecting a broader trend toward healthier lifestyles [17,18]. Among their bioactive substances, polyphenols are among the most studied and significant [19,20].

Beer contains polyphenols derived from malt and hops, which contribute to its antioxidant capacity and may help combat oxidative stress [21,22]. Specific compounds, such as xanthohumol from hops, have been studied for their potential to mitigate components of metabolic syndrome (MetS) and support cardiovascular health by helping to modulate cholesterol levels and improve vascular function [23–26].

Wine, particularly red wine, is rich in cardioprotective polyphenols such as resveratrol, flavonoids, tannins, and anthocyanins [27,28]. These compounds improve endothelial function, modulate cholesterol profiles, and exhibit antioxidant and anti-inflammatory properties [29–31].

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Despite the well-documented individual effects of physical activity and the detailed profile of alcoholic beverages like beer and wine, these two lifestyle factors are rarely studied together in scientific research. Most studies look at their effects separately, focusing either on the metabolic and performance results of exercise or on the health effects of moderate alcohol consumption. This creates a major knowledge gap: it is still unclear how engaging in physical activity and consuming these beverages—especially in their moderate or non-alcoholic forms—simultaneously or sequentially interact to affect health, performance, and recovery outcomes. Beyond this knowledge gap, a physiological rationale exists for investigating this interaction, as both exercise and moderate beer/wine consumption influence shared biological pathways, including inflammation, oxidative stress, and endothelial function, raising the question of potential synergistic or antagonistic effects.

Therefore, the primary objective of this systematic review is to synthesize and critically assess the available scientific evidence regarding the relationship between physical activity and the consumption of beer and wine, both alcoholic and non-alcoholic types. Specifically, we aim to examine their combined effects on key areas: (1) components of MetS, including body composition, blood pressure, lipids, and glucose metabolism; (2) markers of inflammation and oxidative stress, such as C-reactive protein (CRP) and uric acid; (3) mental health outcomes, including cognitive function, mood, and sleep; and (4) physical performance, neuromuscular recovery, and fluid balance. By integrating evidence from these areas, this review seeks to provide a comprehensive overview to inform public health policy and offer practical advice to individuals who include social consumption of these beverages in an active lifestyle.

2. Materials and Methods

2.1. Study Design and Registration

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [32]. The study protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) on 9 January 2026 (registration number: CRD420261281945) and is available on the PROSPERO website. The methodology for this review followed the principles outlined in the PROSPERO guidance [33].

2.2. Eligibility Criteria

The research question was structured according to the PICO framework (Population, Intervention, Comparison, Outcome). The target population (P) was physically active adults or athletes aged 18 or older. The intervention/exposure (I) was the consumption of beer or wine in any form, amount, or pattern. The comparator (C) included placebo, non-alcoholic beverages, water, or no intervention. The outcomes (O) were defined across multiple domains relevant to metabolic, endocrine, performance, and health-related measures.

Eligibility for this review was established beforehand based on study design, population, exposure, and outcomes. To thoroughly gather evidence on the relationship between beverage consumption, physical activity, and endocrine–metabolic physiology, we included both randomized controlled trials (RCTs) and non-randomized studies.

The target population included physically active adults or athletes aged 18 or older, regardless of their competitive level (recreational, amateur, or elite). Studies that focused solely on sedentary populations were excluded.

The intervention or exposure of interest was the consumption of beer or wine, in any form, amount, or pattern (including acute intake, chronic, or habitual use). Studies examining other alcoholic beverages (e.g., spirits) were considered only if they provided separately analyzable data for beer or wine. Eligible comparators were broad and included placebo, no-alcohol control groups, different beverages, or within-subject pre- and post-tests.

Finally, studies were required to report quantitative data on at least one relevant outcome within the predefined scope of this review. Outcomes of interest were categorized into four main areas: (1) parameters related to metabolic syndrome and cardiometabolic health (e.g., body composition, blood pressure, lipid profile, glucose metabolism); (2) measures of physical performance, neuromuscular function, and post-exercise recovery (e.g., exercise capacity, balance, reaction time, hydration status); (3) biomarkers of inflammation and oxidative stress (e.g., C-reactive protein, uric acid); and (4) assessments of mental health and cognitive function (e.g., quality of life scores, cognitive test performance).

2.3. Search Strategy

A systematic literature search was performed across three electronic databases—PubMed/MEDLINE (U.S. National Library of Medicine, Bethesda, MD, USA), Scopus (Elsevier B.V., Amsterdam, Netherlands), and SPORTDiscus (EBSCO Information Services, Ipswich, MA, USA). These three databases were selected for their complementary coverage: PubMed/MEDLINE provides comprehensive biomedical and clinical literature, Scopus offers broad interdisciplinary coverage of health sciences, and SPORTDiscus is the leading specialized database for exercise and sport science. This combination was considered appropriate to capture both the metabolic/endocrine outcomes and the physical activity component of our research question. The search was limited to publications from 1 January 2000, to 31 December 2025.

For PubMed, the following search string was used:

(beer[Title/Abstract] OR wine[Title/Abstract]) AND (athlete[Title/Abstract] OR athletes[Title/Abstract] OR sport[Title/Abstract] OR exercise[Title/Abstract] OR physical activity[Title/Abstract]) AND (metabolic[Title/Abstract] OR endocrine[Title/Abstract] OR hormonal[Title/Abstract]).

The search strategy was adapted for Scopus using the TITLE-ABS-KEY fields:

TITLE-ABS-KEY (beer OR wine) AND TITLE-ABS-KEY (athlete OR athletes OR sport OR exercise OR physical activity) AND TITLE-ABS-KEY (metabolic OR endocrine OR hormonal).

For SPORTDiscus, the following string was applied:

(beer OR wine) AND (athlete OR athletes OR sport OR exercise OR physical activity) AND (metabolic OR endocrine OR hormonal).

2.4. Data Collection and Analysis

All records found through database searches were compiled and imported into Zotero (version 8.0; Corporation for Digital Scholarship, Vienna, VA, USA), the reference management software, where duplicate entries were removed both electronically and manually. The study selection process was carried out independently by two reviewers (M.R. and N.M.) in two consecutive stages, following the PRISMA 2020 flow diagram.

First, titles and abstracts were screened against the eligibility criteria. Records that clearly did not meet the requirements, such as animal studies, reviews, and studies on sedentary populations, were excluded. All remaining records, including those with uncertain eligibility based on the abstract, moved on to the second stage. In this stage, the full texts of these potentially relevant articles were retrieved and carefully assessed against the predefined inclusion and exclusion criteria.

Any disagreements between the two reviewers at any stage were resolved through discussion. If consensus could not be reached, a third senior reviewer (F.M.) was consulted to make the final decision. The reasons for excluding studies at the full-text stage were documented. The entire process, including the number of records identified, screened, assessed for eligibility, and ultimately included in the review, is shown in the PRISMA 2020 flow diagram (Figure 1).

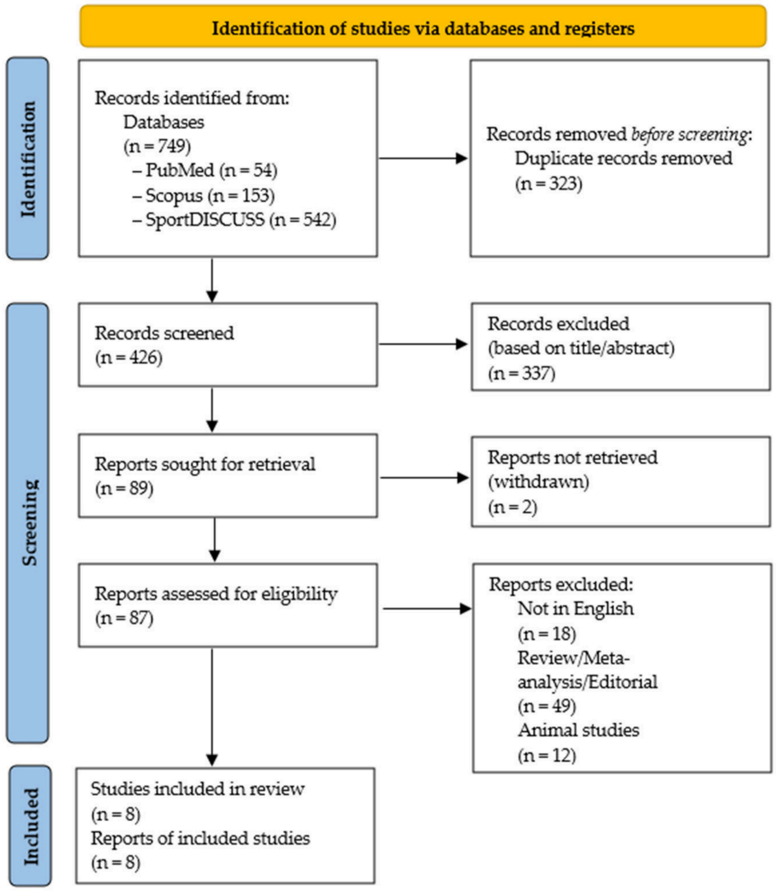

Figure 1. PRISMA 2020 flow diagram of the studies included.

2.5. Data Extraction and Management

After selecting the studies, a standardized data extraction form was created and tested. Two reviewers (M.R. and N.M.) independently extracted data from each included study. The information collected included (1) key study details (authors, publication year, country, design); (2) participant information (sample size, age, sex, detailed description and measurement of habitual physical activity level or athletic status); (3) intervention or exposure details, such as beverage type (beer or wine), dose, frequency, and duration of intake; (4) information on any related physical training protocol (type, intensity, volume, duration), when applicable; (5) details of the comparator; and (6) all relevant quantitative outcome data. For continuous outcomes, means, standard deviations, and sample sizes were collected at relevant time points (e.g., pre- and post-intervention). Any disagreements in data extraction were resolved through discussion between the two reviewers, with input from a third senior reviewer (F.M.) if needed to reach consensus.

2.6. Assessment of Risk of Bias

A dual approach to bias risk assessment was employed to accurately evaluate the methodological quality of the included studies based on their design. Two reviewers (M.R. and N.M.) independently assessed each study.

For randomized controlled trials (RCTs), the Cochrane Risk of Bias 2 (RoB 2) tool was used [34]. Each trial was evaluated across five domains: bias from the randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of the reported result. Judgments resulted in an overall rating of "low risk," "some concerns," or "high risk" of bias for each specific outcome.

For non-randomized studies, including observational cohort, cross-sectional, and quasi-experimental designs, the Risk Of Bias In Non-randomized Studies—of Interventions (ROBINS-I) tool was used [35]. This tool evaluates bias across seven domains related to confounding, participant selection, intervention classification, deviations from intended interventions, missing data, outcome measurement, and selection of reported results. Studies were then classified as having a "low," "moderate," "serious," or "critical" risk of bias.

Disagreements in assessments between the two reviewers were resolved through consensus discussion. The results of these assessments are presented narratively in the results section. Summary plots were generated using the Robvis Shiny App (University of Bristol, Bristol, UK; https://mcguinlu.shinyapps.io/robvis) [36] and are shown in dedicated figures (Figure 2 for RCTs; Figure 3 for non-randomized studies).

Reporting biases (e.g., publication bias, selective outcome reporting) were not formally assessed due to the small number of included studies (n = 8), which precluded the use of funnel plots or statistical tests.

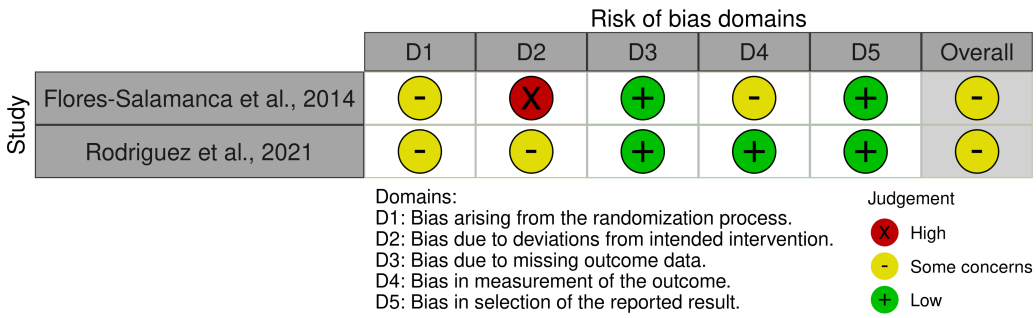

Figure 2. Risk of bias assessment for randomized controlled trials (RoB 2) for the studies by Flores-Salamanca et al. (2014) [37] and Rodriguez et al. (2021) [38].

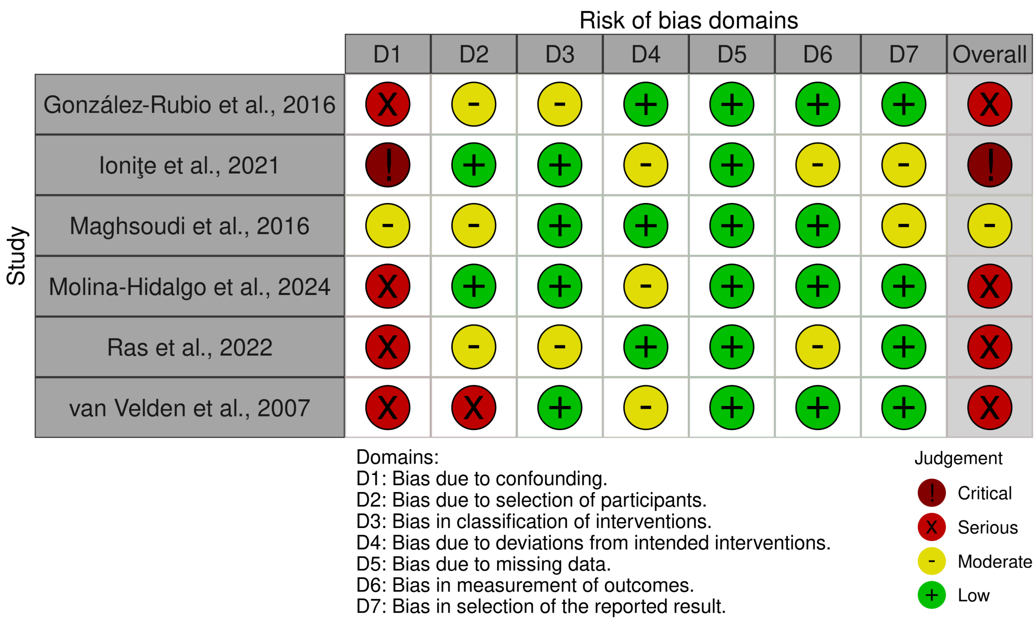

Figure 3. Risk of bias assessment for non-randomized studies of interventions (ROBINS-I) for González-Rubio et al. (2016) [39], Ioniţe et al. (2021) [40], Maghsoudi et al. (2016) [41], Molina-Hidalgo et al. (2024) [42], Ras et al. (2022) [43], and van Velden et al. (2007) [44].

2.7. Data Synthesis

Given the expected clinical and methodological diversity across studies—stemming from differences in design, population (activity level), interventions (beverage type and dose), and outcome measurements—a structured narrative synthesis was selected as the most appropriate method to summarize the evidence. Results are organized by key outcome areas (e.g., lipid metabolism, hormonal response, glycemic control) and further examined based on beverage type (beer vs. wine). In this approach, the potential influence of habitual physical activity levels will be specifically evaluated and discussed.

Given the expected clinical and methodological diversity across studies—stemming from differences in design, population, interventions, and outcome measures—a structured narrative synthesis was selected as the most appropriate method to summarize the evidence. Results were organized by key outcome areas (e.g., lipid metabolism, glycemic control) and further examined by beverage type (beer vs. wine), with specific attention to the potential influence of habitual physical activity levels.

A quantitative meta-analysis was not feasible due to the substantial heterogeneity across the eight included studies. Consequently, no pooled effect estimates, subgroup analyses, meta-regressions, or sensitivity analyses were performed. Effect measures were extracted and reported exactly as presented in the original studies, including means, standard deviations, mean differences, and odds ratios with 95% confidence intervals where available. No data preparation, conversion, or recalculations were required, and no assumptions were made regarding missing or unclear information.

No formal certainty assessment (e.g., GRADE) was undertaken. Instead, methodological limitations, imprecision, and risk of bias are discussed qualitatively for each outcome domain throughout the Discussion. This amendment has been recorded in the PROSPERO protocol.

This systematic review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [32]. The PRISMA 2020 checklist is provided as Supplementary Materials.

3. Results

The systematic search resulted in 749 records across PubMed (n = 54), Scopus (n = 153), and SPORTDiscus (n = 542). After removing 323 duplicates, 426 records were screened by title and abstract. Of these, 337 were excluded, leaving 89 reports to be retrieved. Two reports were not retrieved (withdrawn), and the remaining 87 full-text reports were assessed for eligibility. Seventy-nine reports were excluded for the following reasons: 18 were not in English, 49 were reviews or editorials, and 12 were animal studies. A total of eight studies met the inclusion criteria and were included in the systematic review. The study selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1). A complete list of studies excluded at the full-text stage, with reasons for exclusion, is available from the corresponding author upon reasonable request.

These eight studies were conducted between 2007 and 2024 across various regions, including Costa Rica [37], Spain [39,42], Romania [40], Iran [41], South Africa [43,44], and Brazil [38]. These articles show a diverse methodological landscape. The populations studied are also diverse, including young adults and athletes [37,40–42], whose endocrine responses to exercise are especially reactive, as well as middle-aged and older adults [42,45], who are more relevant for studying chronic metabolic disorders. Specific groups such as firefighters [43] and patients with metabolic syndrome [44] are also included. The detailed features of each study are summarized in Table 1.

Table 1. Characteristics of studies included.

Author, Date (Country of Study)	Study Design	Study Population	Study Groups	Physical Activity	Key Findings
Flores-Salamanca et al., 2014 [37] (Costa Rica)	RCT Crossover	Physically active college students *n* = 11 (100% male) 24.4 ± 3.7 years	All participants, in random order, received: 1. BEER: 4.6% alcohol beer. 2. NAB: non-alcoholic beer (0.5% alcohol). 3. WATER.	Post-exercise rehydration protocol: Dehydration induced by cycling to 2.1% body mass loss in a heated chamber.	Diuresis: ↑ 1218 ± 279 mL vs. ~760 mL ($p < 0.05$). Net fluid balance: worse vs. non-alcoholic beer/water Balance (VCOPx): impaired. Reaction time: slowed.
González-Rubio et al., 2016 [39] (Spain)	Observational Cross-Sectional	Community-dwelling elderly *n* = 231 (50.7% male) 55–85 years	Three groups based on habitual alcohol intake: 1. ABS: Abstainers/Occasional drinkers. 2. BEER: Moderate drinkers, ≥80% of alcohol from beer. Mean intake: 12.7 ± 8.1 g alcohol/day. 3. MIXED: Moderate drinkers of various beverages, with wine as the main source (75% of intake). Mean intake: 13.9 ± 10.2 g alcohol/day.	Leisure-time and recreational activities: Walking for pleasure, swimming, playing with kids, climbing stairs, hiking, and dancing.	BMI, sleep quality, SF-36 subscales: no significant differences vs. abstention. Vitality perception (wine): ↑ trend ($p = 0.069$). Mental health scores (moderate drinkers): ↑ trend ($p = 0.058$).
Ioniţe et al., 2021 [40] (Romania)	Quasi-experimental study	Healthy, active college students *n* = 10 (100% male) 23.5 ± 3.3 years	All participants, in random order: 1. ALC + SLE: Alcohol (1 g/kg beer) + Normal Sleep. 2. PLA + SLE: Placebo (non-alcoholic beer) + Normal Sleep. 3. ALC + SDP: Alcohol + Sleep Deprivation. 4. PLA + SDP: Placebo + Sleep Deprivation.	Structured HIIT program: 2 sessions/week for 10 weeks, performed before testing days. Sleep protocol: 8 h normal sleep vs. total sleep deprivation on test night.	Time to exhaustion: ↓ by sleep deprivation ($p < 0.05$), not by alcohol. Peak torque: unaffected. Hangover symptoms: ↑ with alcohol.
Maghsoudi et al., 2016 [41] (Iran)	Quasi-experimental study	Elite Taekwondo athletes *n* = 21 (100% male) 23 ± 2.7 years	All participants underwent a crossover of three acute post-exercise interventions: 1. Dough (fermented yogurt drink). 2. Non-alcoholic beer. 3. Chocolate milk (carbohydrate drink).	High-intensity anaerobic exercise: The Running-Based Anaerobic Sprint Test (RAST) was performed in a lab setting to induce fatigue.	Post-exercise blood glucose: ↑ by NAB ($p = 0.083$ for trend). Total cholesterol and F2-isoprostane (oxidative stress): no significant changes.

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Table 1. *Cont.*

Author, Date (Country of Study)	Study Design	Study Population	Study Groups	Physical Activity	Key Findings
Molina-Hidalgo et al., 2024 [42] (Spain)	RCT (Partial Randomization)	Healthy young adults n = 83 (48% male) ~22 years	Non-random allocation to: 1. HIIT group. 2. Non-training control group. Within the HIIT group, random allocation to beverage: - HIIT-Alcohol: Beer or vodka and water. - HIIT-NonAlcohol: 0.0% beer or water.	Supervised HIIT program: 2 sessions/week for 10 weeks. The control group maintained habitual activity.	Cognitive function (memory, processing speed, verbal fluency): ↑ by HIIT ($p < 0.05$), regardless of beverage type (alcoholic or non-alcoholic). Fat mass index (FMI): ↓ by HIIT ($p < 0.001$), no modifying effect of beverage type. Lean mass index (LMI): ↑ by HIIT ($p < 0.001$), no modifying effect of beverage type.
Ras et al., 2022 [43] (South Africa)	Observational Cross-Sectional	Full-time firefighters n = 124 (79.1% male) 37.5 ± 9.1 years	Single cohort analyzed by beverage preference and consumption volume: 1. Beverage Preference: Mixed drinks (40), Beer (32%), Spirits (14%), Wine (13%). 2. Volume Groups: Light (≤7 units/week, 1.7–12 g/day), Moderate (8–14 units/week, 14–24 g/day), Heavy (>14 units/week, >24 g/day) drinker.	Total weekly physical activity, including occupational duties (firefighting tasks) and leisure activities. Classified by intensity: Low, Moderate, Vigorous.	Systolic blood pressure: ↑ with higher alcohol volume ($p = 0.048$). Diastolic blood pressure: ↑ with higher alcohol volume ($p = 0.036$). Hypertension: ↑ with alcohol consumption ($p = 0.005$). BMI, cholesterol, diabetes: no significant associations.
Rodrigues et al., 2021 [38] (Brazil)	RCT Crossover	Active or retired civil servants n = 14,375 (44.7% male) 35–74 years	Cross-sectional analysis of baseline data. Groups defined by: 1. Quantity: Non-drinkers, 1–4, 4–7, 7–14, >14 drinks/week. 2. Timing: With meals, outside meals, both. 3. Beverage Type: Wine, beer, or other.	Leisure-time physical activity (LTPA): Assessed via IPAQ (MET-min/week). Analyzed as a covariate.	MetS prevalence: ↓ with higher alcohol intake (>14 drinks/week) only with meals (OR 0.76, 95% CI 0.60–0.97). Protective association: stronger with higher LTPA.
van Velden et al., 2007 [44] (South Africa)	Intervention Study	Metabolic Syndrome patients n = 12 (75% male) 32–60 years	Same participants in two sequential phases: 1. Phase 1 (4 weeks): Adherence to a Mediterranean Diet + No alcohol. 2. Phase 2 (4 weeks): Adherence to a Mediterranean Diet + Red Wine.	Prescribed mild aerobic exercise: Brisk walking (20–30 min/day) as a lifestyle recommendation alongside dietary change.	Body weight: ↓ by Mediterranean diet ($p = 0.04$), no benefit from red wine. Systolic blood pressure: ↓ by Mediterranean diet ($p = 0.045$), no benefit from red wine. HDL, LDL, TG, glucose, insulin, uric acid, hs-CRP: no benefit from red wine. ORAC: ↑ by Mediterranean diet ($p = 0.035$), no further improvement with red wine.

Abbreviations and symbols: C-reactive protein (CRP); confidence interval (CI); fat mass index (FMI); high-density lipoprotein (HDL); high-intensity interval training (HIIT); high-sensitivity C-reactive protein (hs-CRP); International Physical Activity Questionnaire (IPAQ); lean mass index (LMI); leisure-time physical activity (LTPA); low-density lipoprotein (LDL); metabolic syndrome (MetS); non-alcoholic beer (NAB); odds ratio (OR); oxygen radical absorbance capacity (ORAC); randomized controlled trial (RCT); Running-Based Anaerobic Sprint Test (RAST); triglycerides (TG); velocity of center of pressure in the anteroposterior direction (VCOPx); increase (↑); decrease (↓).

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Despite differences in designs and populations, a common endocrine–metabolic theme underpins the research. The main themes include (1) the effect of alcohol consumption on post-exercise hydro-electrolyte balance and kidney stress; (2) its influence on blood glucose, lipid levels, and oxidative stress markers after physical activity; (3) its links to blood pressure and the prevalence of metabolic syndrome; and (4) its interactions with lifestyle changes, such as the Mediterranean diet and structured high-intensity interval training (HIIT), which are known to impact the endocrine–metabolic profile.

Risk of Bias

The risk of bias for the included studies was assessed using two Cochrane tools: the RoB 2 for randomized controlled trials (RCTs) and the ROBINS-I for non-randomized studies.

As shown in Figure 2, the RCT by Flores-Salamanca et al. (2014) [37] was considered to have a low overall risk of bias. This judgment is based on proper randomization, successful implementation of the crossover design, and minimal concern about missing data. Conversely, the RCT by Rodrigues et al. (2021) [38] was considered to have a high overall risk of bias, mainly due to serious issues in the randomization process and deviations from the planned intervention.

As shown in Figure 3, the remaining six studies were assessed using the ROBINS-I tool. Although the study by Molina-Hidalgo et al. (2024) [42] was an RCT, it was evaluated with ROBINS-I because of its partial randomization design, which introduced key confounding factors similar to those in a non-randomized intervention study; it received a judgment of critical risk in the D1 (confounding) domain. The other studies assessed with this tool included González-Rubio et al. (2016) [39] (overall serious risk, mainly due to selection bias and confounding), Ioniţe et al. (2021) [40] (overall moderate risk), Maghsoudi et al. (2016) [41] (overall moderate risk), Ras et al. (2022) [43] (overall serious risk, due to confounding and participant selection), and van Velden et al. (2007) [44] (overall low risk as a well-controlled intervention study). For most studies, the main concerns were in the domains of confounding (D1) and participant selection (D2).

Consequently, only the findings from Flores-Salamanca et al. (2014) [37] and van Velden et al. (2007) [44] can be considered at low risk of bias. The remaining studies, particularly those with serious or critical risk of confounding and participant selection bias, warrant cautious interpretation. These methodological limitations are considered throughout the Section 4 and should be taken into account when evaluating the strength of the evidence presented below.

4. Discussion

The present systematic review aimed to synthesize the available evidence on the interaction between beer and wine consumption and physical activity in relation to metabolic, endocrine, and health-related outcomes. Overall, the findings suggest that, within physically active populations, moderate consumption of beer or wine does not appear to exert markedly detrimental effects on cardiometabolic health, body composition, or cognitive performance, particularly when contextualized within an active lifestyle and, in some cases, alongside healthy dietary patterns. However, the strength of these conclusions is tempered by substantial heterogeneity in study design, populations, exposures, and outcome measures, as well as by relevant methodological limitations identified in the risk of bias assessment.

Before discussing the specific findings, it is important to acknowledge the methodological limitations of the included studies. As detailed in the risk of bias assessment (Risk of Bias section), only two studies (Flores-Salamanca et al. [37] and van Velden et al. [44]) were rated as having low risk of bias. The majority of studies presented serious or critical risk, particularly in the domains of confounding and participant selection. Therefore, the following interpretations must be considered with due caution. Findings from studies with high risk of bias should be viewed as hypothesis-generating rather than conclusive, and priority is given to evidence from studies with lower risk of bias where available.

A consistent observation across the included studies is the primary role of physical activity in improving a wide spectrum of health and performance metrics, irrespective of concurrent beverage consumption. The evaluated interventions—ranging from structured high-intensity training to habitual leisure-time activity—consistently demonstrated beneficial effects on body composition, cognitive function, aerobic capacity, and cardiovascular parameters. This central finding robustly reinforces the well-established principle that regular exercise is a cornerstone of health promotion and disease prevention [45–48].

Furthermore, the reviewed evidence highlights the powerful synergy between physical activity and healthful nutrition, a paradigm central to lifestyle medicine. The study by van Velden et al. (2007) [44], for instance, demonstrated that the combination of a Mediterranean diet and physical activity yielded significant cardiometabolic improvements, with the addition of red wine providing no incremental benefit. This aligns with a robust body of literature underscoring the superior efficacy of combined dietary and exercise interventions for metabolic health, weight management, and chronic disease prevention compared to either approach alone [49,50]. The Mediterranean dietary pattern, in particular, is well documented to synergize with exercise to enhance overall well-being and cardiometabolic risk profiles [51]. Within this established context, where exercise and diet form the foundational therapeutic platform, the consumption of beer or wine emerges as a potential secondary modulator of health outcomes. Its impact appears contingent on specific factors such as quantity and its integration within an otherwise active and health-conscious lifestyle.

The relationship between moderate alcohol consumption and MetS in the general population is complex, with some epidemiological studies suggesting a protective association. For example, in a general population sample, medium–high alcohol consumption has been associated with lower odds of MetS compared to low consumption [52]. Similarly, in a Mediterranean cohort, moderate alcohol intake was linked to a lower prevalence of MetS and certain cardiovascular diseases compared to abstinence [53]. However, when examining this relationship specifically within physically active populations, the evidence from the present review presents a more nuanced picture, suggesting that moderate beer or wine consumption does not significantly alter the metabolic effects of physical activity.

Body composition and adiposity were primarily improved by exercise, with no modifying effect from beverage type. For instance, in the study by Molina-Hidalgo et al. (2024) [42], a HIIT program significantly reduced fat mass regardless of whether participants consumed alcoholic or non-alcoholic beer. Similarly, in the large observational study by Rodrigues et al. (2021) [38], the association between higher alcohol intake and a lower prevalence of MetS was only significant when consumption occurred with meals, highlighting the importance of behavioral context.

Conversely, a negative dose–response relationship with blood pressure was observed. In the active cohort of firefighters studied by Ras et al. (2022) [43], higher alcohol volume was a significant predictor of elevated systolic and diastolic blood pressure, indicating that the pressor effect of ethanol can persist even with regular physical activity.

Data on lipid profile and glucose metabolism remain inconclusive. As seen in the study by Maghsoudi et al. (2016) [41], only marginal, non-significant changes in triglycerides and blood glucose were reported following post-exercise consumption of non-alcoholic beer. Furthermore, van Velden et al. (2007) [44] found that adding red wine to a Mediterranean diet and exercise regimen provided no further improvement to lipids or insulin sensitivity.

Beyond the core components of MetS, the modulation of chronic, low-grade inflammation and oxidative stress represents another potential pathway through which dietary components might influence long-term health. While the polyphenol content of beer and wine is often highlighted for its potential antioxidant and anti-inflammatory properties in vitro [54–58], the evidence from intervention studies in active populations does not strongly support a significant beneficial impact from moderate consumption within an exercise context.

The study by van Velden et al. (2007) [44] provides the most direct test of this hypothesis. In patients with metabolic syndrome following a Mediterranean diet and mild exercise protocol, the addition of moderate daily red wine for four weeks did not yield any further improvement in the inflammatory marker high-sensitivity C-reactive protein (hs-CRP) compared to the diet-and-exercise phase without alcohol. Similarly, Maghsoudi et al. (2016) [41] found no significant changes in the oxidative stress marker F2-isoprostane in elite athletes following the acute post-exercise consumption of non-alcoholic beer, compared to other recovery beverages. These findings suggest that moderate beer or wine consumption provided no additional anti-inflammatory or antioxidant benefits beyond those of physical activity and a healthy dietary pattern alone.

The influence of lifestyle factors on health operates not only through physiological pathways like inflammation but also through their direct effects on the central nervous system. Moderate alcohol consumption has been linked in some general population studies to certain positive mental health outcomes and social well-being, although the evidence is complex and influenced by lifestyle factors [59,60]. Therefore, the interaction between beer or wine consumption and physical activity deserves specific examination concerning mental well-being, sleep, and cognitive and neuromotor performance within an active lifestyle setting.

Observational studies in active populations suggest a neutral to potentially nuanced positive association with subjective well-being. In a cohort of active elderly individuals, González-Rubio et al. (2016) [39] found no significant differences in most quality-of-life domains, including sleep quality, between abstainers and moderate drinkers of beer or other beverages. However, trends indicated a marginally higher perception of vitality among those with a mixed (predominantly wine) intake and better mental health scores among moderate drinkers, though these did not reach conventional statistical significance.

In contrast, intervention studies highlight clear acute impairments when alcohol is consumed in proximity to exercise, extending to sleep architecture. Ioniţe et al. (2021) [40] reported that alcohol ingestion (from beer) led to increased hangover symptoms, and while sleep deprivation independently reduced exercise performance, it did not significantly worsen the hangover state. More directly, Flores-Salamanca et al. (2014) [37] demonstrated that consuming beer after exercise-induced dehydration significantly impaired postural balance and slowed reaction time compared to non-alcoholic beer or water, indicating acute neurocognitive deficits. Notably, the study by Molina-Hidalgo et al. (2024) [42] found that a 10-week HIIT program improved cognitive performance independently of concurrent moderate beer or non-alcoholic beverage consumption, suggesting that the cognitive benefits of sustained exercise are robust and not modified by this dietary factor.

Thus, while habitual moderate consumption does not appear detrimental to self-reported mental health or sleep quality, acute alcohol intake can negatively impact neuromotor control, cognitive performance, and sleep recovery.

While the previous sections addressed health outcomes, the direct impact of beverage consumption on the acute capabilities and recovery of the physically active individual is of paramount practical importance. The ergogenic or ergolytic potential of beer and wine, particularly regarding hydration and neuromuscular function, has been a point of interest in sports nutrition. While some studies have suggested potential recovery benefits [61–64], controlled interventions present a more cautionary tale.

The most consistent finding across the reviewed studies is the deleterious effect of alcoholic beer on post-exercise rehydration and fluid balance. Flores-Salamanca et al. (2014) [37] clearly demonstrated that, compared with water or non-alcoholic beer, alcoholic beer consumption after exercise-induced dehydration led to significantly higher diuresis and a poorer net fluid balance, leaving participants in a state of net fluid loss. From a physiological standpoint, this diuretic effect is primarily mediated by alcohol-induced suppression of arginine-vasopressin (also known as antidiuretic hormone, ADH), which reduces water reabsorption in the renal collecting ducts and increases urine output [65]. This diuretic effect directly counteracts a primary goal of post-exercise recovery.

Furthermore, alcohol intake showed a clear negative impact on metrics of neuromuscular performance and recovery. The same study by Flores-Salamanca et al. (2014) [37] reported impaired postural balance and slowed reaction time following beer consumption. Ioniţe et al. (2021) [40] found that sleep deprivation significantly reduced time to exhaustion in an aerobic test, and while alcohol alone did not reduce peak muscle torque, its consumption was associated with increased hangover symptoms, which could indirectly affect training readiness and perceived recovery.

In contrast, the consumption of non-alcoholic beer appears to be a neutral or context-dependent alternative. Throughout this review, "non-alcoholic beer" refers to products with an alcohol content below 0.5% vol., in line with the European scientific literature [66]. Maghsoudi et al. (2016) [41] found no significant negative impact on anaerobic performance markers compared to other post-exercise beverages. Critically, the rehydration study by Flores-Salamanca et al. (2014) [37] showed that non-alcoholic beer performed similarly to water in restoring fluid balance, without the detrimental diuretic and neuromotor effects of its alcoholic counterpart.

In summary, the evidence strongly indicates that consuming alcoholic beer in the acute post-exercise period is counterproductive, impairing rehydration and key aspects of neuromuscular function that are crucial for safety and subsequent performance. Non-alcoholic beer does not share these acute drawbacks and may represent a more suitable choice within a recovery context. When considering wine, the evidence is more limited and derives exclusively from observational studies on chronic consumption. Two studies suggested potential associations between moderate wine intake and higher physical activity levels or better mental health scores, but these findings were not statistically significant and were subject to confounding. No study directly compared beer and wine within the same experimental design, and no firm conclusions can be drawn regarding wine-specific effects. These findings underscore that the acute physiological demands of recovery from exercise often conflict with the biological effects of alcohol.

Limitations and Future Perspectives

This systematic review has several important limitations that shape its conclusions. The main constraint is the small number of primary studies that meet the inclusion criteria, which highlights the lack of research specifically focused on the interaction between physical activity and beer or wine consumption. This leads to a limited and diverse evidence base, including various study designs, populations, and outcome measures, preventing a quantitative meta-analysis and requiring a narrative synthesis.

A major methodological concern, as identified in the risk of bias assessment, is the widespread issue of confounding in observational and quasi-experimental studies. The significant risk of bias in this area indicates that unmeasured lifestyle, dietary, or genetic factors could greatly affect the reported associations, reducing the strength of causal inference. Additionally, the generalizability of the findings is limited by the demographic focus of the existing literature, which mainly involves young, healthy, and often male participants, with fewer insights into women, older adults, or individuals with chronic metabolic conditions, and by the geographic restriction of the available studies to specific regions (Costa Rica, Spain, Romania, Iran, South Africa, and Brazil), each with distinct drinking patterns, dietary contexts, and genetic backgrounds.

A further limitation is the heterogeneity in the definition of moderate alcohol consumption across the included studies. Studies used varying units (grams per day, milliliters per day, units per week, drinks per week) and, in some cases, did not specify the exact dose. Nevertheless, most studies with habitual consumption reported intakes that approximate the 14–28 g/day range adopted in this review. This variability should be considered when comparing findings across studies.

This review also has process-related limitations. The literature search was restricted to three databases and English-language articles. This may have introduced both publication bias and language bias, potentially excluding relevant studies published in other languages or in less specialized databases. Furthermore, the small number of studies precluded formal assessments of publication bias and certainty of evidence (e.g., GRADE), as acknowledged in the methods.

These limitations define clear priorities for future research. There is a strong need for prospective studies and randomized controlled trials specifically designed and adequately powered to examine the interaction effect. Such research should emphasize methodological rigor to control confounding factors, include more diverse demographic groups, and explore the long-term health effects. Special focus should be given to studying non-alcoholic and low-alcohol beer and wine variants, which help isolate the effects of bioactive compounds from those of ethanol. Addressing these issues is essential for producing solid, actionable evidence to inform lifestyle choices for active individuals.

5. Conclusions

This systematic review synthesized available evidence on the interplay among beer and wine consumption, physical activity, and related health outcomes. Given the small number of included studies and the methodological concerns identified in the risk-of-bias assessment, the following conclusions should be interpreted with caution.

Based on the available evidence, within physically active populations, moderate consumption of beer or wine does not clearly undermine the benefits of regular exercise on cardiometabolic health and body composition. Physical activity itself remained the primary driver of improved metabolic parameters, with no consistent additive or synergistic effects from beverage consumption.

Regarding inflammation and oxidative stress, the reviewed studies did not provide consistent evidence that moderate beer or wine consumption offers measurable additional benefits when combined with exercise, suggesting that the anti-inflammatory effects of physical activity may eclipse any modest contribution from beverage-derived polyphenols.

For mental health and cognitive function, the evidence indicates that regular exercise improves cognitive performance independently of concurrent moderate alcohol consumption, while acute alcohol intake may impair neuromotor function and reaction time.

Concerning physical performance and recovery, a clear finding emerges: alcoholic beer consumed acutely after exercise impairs rehydration and neuromuscular recovery, whereas non-alcoholic beer does not share these drawbacks and represents a safer alternative for active individuals.

In summary, moderate beer or wine consumption integrated into an active lifestyle is unlikely to negate the primary benefits of regular exercise. However, moderation is essential, timing matters, and non-alcoholic alternatives should be preferred in the post-exercise recovery context. Given the overall low quality of evidence in this area, further well-designed studies are needed to confirm these findings.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/endocrines7020024/s1: Supplementary File S1: Completed PRISMA 2020 checklist.

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References

1. Bull, F.C.; Al-Ansari, S.S.; Biddle, S.; Borodulin, K.; Buman, M.P.; Cardon, G.; Carty, C.; Chaput, J.-P.; Chastin, S.; Chou, R.; et al. World Health Organization 2020 Guidelines on Physical Activity and Sedentary Behaviour. *Br. J. Sports Med.* **2020**, *54*, 1451–1462. [CrossRef] [PubMed]
2. Yang, Y.J. An Overview of Current Physical Activity Recommendations in Primary Care. *Korean J. Fam. Med.* **2019**, *40*, 135–142. [CrossRef]
3. Kapoor, G.; Chauhan, P.; Singh, G.; Malhotra, N.; Chahal, A. Physical Activity for Health and Fitness: Past, Present and Future. *J. Lifestyle Med.* **2022**, *12*, 9–14. [CrossRef]
4. Adelirad, F.; Javadivala, Z.; Dianat, I.; Amrahi Tabieh, A.; Chattu, V.K. Physical and Cognitive-Based Training in Healthy Older Adults: Evidence from a Systematic Review and Meta-Analysis. *Biosoc. Health J.* **2024**, *1*, 14–25. [CrossRef]
5. Stanton, R.; To, Q.G.; Khalesi, S.; Williams, S.L.; Alley, S.J.; Thwaite, T.L.; Fenning, A.S.; Vandelanotte, C. Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4065. [CrossRef]
6. Anderson, B.O.; Berdzuli, N.; Ilbawi, A.; Kestel, D.; Kluge, H.P.; Krech, R.; Mikkelsen, B.; Neufeld, M.; Poznyak, V.; Rekve, D.; et al. Health and Cancer Risks Associated with Low Levels of Alcohol Consumption. *Lancet Public Health* **2023**, *8*, e6–e7. [CrossRef]
7. Jones, J.A. Risk Factors for Alcohol Abuse Among College Athletes. *J. Clin. Sport Psychol.* **2015**, *9*, 76–96. [CrossRef]
8. Caceres-Ayala, C.; Pautassi, R.M.; Acuña, M.J.; Cerpa, W.; Rebolledo, D.L. The Functional and Molecular Effects of Problematic Alcohol Consumption on Skeletal Muscle: A Focus on Athletic Performance. *Am. J. Drug Alcohol Abus.* **2022**, *48*, 133–147. [CrossRef]
9. WADA—Prohibited List 2018. Available online: https://www.wada-ama.org/sites/default/files/prohibited_list_2018_en.pdf (accessed on 25 May 2026).
10. Mazzeo, F.; Altavilla, G.; D'Elia, F.; Raiola, G. Development of Doping in Sports: Overview and Analysis. *J. Phys. Educ. Sport* **2018**, *18*, 1669–1677. [CrossRef]
11. Ruggiero, M.; Santamaria, S.; Montesano, P.; Ferrante, L.; Russo, Y.; Mazzeo, F. Pain Management in Italian Elite Athletes: Trends in the Use of Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), Glucocorticoids, and Narcotics in Anti-Doping Reports (2013–2023). *Pharmaceuticals* **2026**, *19*, 298. [CrossRef]
12. Sudhinaraset, M.; Wigglesworth, C.; Takeuchi, D.T. Social and Cultural Contexts of Alcohol Use: Influences in a Social-Ecological Framework. *Alcohol Res.* **2016**, *38*, 35–45. [CrossRef]
13. Radonjić, S.; Maraš, V.; Raičević, J.; Košmerl, T. Wine or Beer? Comparison, Changes and Improvement of Polyphenolic Compounds during Technological Phases. *Molecules* **2020**, *25*, 4960. [CrossRef] [PubMed]
14. Carvalho, F.; Lahlou, R.A.; Pires, P.; Salgado, M.; Silva, L.R. Natural Functional Beverages as an Approach to Manage Diabetes. *Int. J. Mol. Sci.* **2023**, *24*, 16977. [CrossRef]

15. Committee on Review of Evidence on Alcohol and Health; Food and Nutrition Board; Health and Medicine Division; National Academies of Sciences, Engineering, and Medicine. *Review of Evidence on Alcohol and Health*; Calonge, B.N., Stone, K.B., Eds.; National Academies Press: Washington, DC, USA, 2025; p. 28582.
16. Phillips, J.A. Dietary Guidelines for Americans, 2020–2025. *Workplace Health Saf.* **2021**, *69*, 395. [CrossRef]
17. Ruggiero, M.; Mercurio, N.; Ferrante, L.; Scudiero, O.; Mazzeo, F. Craft Non-Alcoholic and Low-Alcohol Beer (NABLAB): Perceived Role as Functional Foods Among Italian Consumers and a Focus on Benefits for Well-Being and Physical Activity. *Nutrients* **2026**, *18*, 33. [CrossRef] [PubMed]
18. Silva, P. Low-Alcohol and Nonalcoholic Wines: From Production to Cardiovascular Health, along with Their Economic Effects. *Beverages* **2024**, *10*, 49. [CrossRef]
19. Postigo, V.; García, M.; Crespo, J.; Canonico, L.; Comitini, F.; Ciani, M. Bioactive Properties of Fermented Beverages: Wine and Beer. *Fermentation* **2025**, *11*, 234. [CrossRef]
20. Hans, S.; Zabetakis, I.; Lordan, R. The Potential Cardioprotective Bioactive Compounds in Fermented Alcoholic Beverages: Mechanisms, Challenges, and Opportunities in Beer and Wine. *Nutr. Res.* **2025**, *133*, 108–126. [CrossRef]
21. Breda, C.; Barros, A.I.; Gouvinhas, I. Characterization of Bioactive Compounds and Antioxidant Capacity of Portuguese Craft Beers. *Int. J. Gastron. Food Sci.* **2022**, *27*, 100473. [CrossRef]
22. Tirado-Kulieva, V.A.; Hernández-Martínez, E.; Minchán-Velayarce, H.H.; Pasapera-Campos, S.E.; Luque-Vilca, O.M. A Comprehensive Review of the Benefits of Drinking Craft Beer: Role of Phenolic Content in Health and Possible Potential of the Alcoholic Fraction. *Curr. Res. Food Sci.* **2023**, *6*, 100477. [CrossRef]
23. Oliveira Neto, J.R.; De Oliveira, T.S.; Ghedini, P.C.; Vaz, B.G.; Gil, E.D.S. Antioxidant and Vasodilatory Activity of Commercial Beers. *J. Funct. Foods* **2017**, *34*, 130–138. [CrossRef]
24. Chiva-Blanch, G.; Magraner, E.; Condines, X.; Valderas-Martínez, P.; Roth, I.; Arranz, S.; Casas, R.; Navarro, M.; Hervas, A.; Sisó, A.; et al. Effects of Alcohol and Polyphenols from Beer on Atherosclerotic Biomarkers in High Cardiovascular Risk Men: A Randomized Feeding Trial. *Nutr. Metab. Cardiovasc. Dis.* **2015**, *25*, 36–45. [CrossRef]
25. Paiva, R.A.M.; Mutz, Y.S.; Conte-Junior, C.A. A Review on the Obtaining of Functional Beers by Addition of Non-Cereal Adjuncts Rich in Antioxidant Compounds. *Antioxidants* **2021**, *10*, 1332. [CrossRef]
26. Salanță, L.C.; Coldea, T.E.; Ignat, M.V.; Pop, C.R.; Tofană, M.; Mudura, E.; Borșa, A.; Pasqualone, A.; Anjos, O.; Zhao, H. Functionality of Special Beer Processes and Potential Health Benefits. *Processes* **2020**, *8*, 1613. [CrossRef]
27. El Rayess, Y.; Nehme, N.; Azzi-Achkouty, S.; Julien, S.G. Wine Phenolic Compounds: Chemistry, Functionality and Health Benefits. *Antioxidants* **2024**, *13*, 1312. [CrossRef]
28. Wang, P.; Wang, J.; Li, D.; Ke, W.; Chen, F.; Hu, X. Targeting the Gut Microbiota with Resveratrol: A Demonstration of Novel Evidence for the Management of Hepatic Steatosis. *J. Nutr. Biochem.* **2020**, *81*, 108363. [CrossRef]
29. Ruggiero, M.; Motti, M.L.; Meccariello, R.; Mazzeo, F. Resveratrol and Physical Activity: A Successful Combination for the Maintenance of Health and Wellbeing? *Nutrients* **2025**, *17*, 837. [CrossRef]
30. Zortea, K.; Franco, V.C.; Francesconi, L.P.; Cereser, K.M.M.; Lobato, M.I.R.; Belmonte-de-Abreu, P.S. Resveratrol Supplementation in Schizophrenia Patients: A Randomized Clinical Trial Evaluating Serum Glucose and Cardiovascular Risk Factors. *Nutrients* **2016**, *8*, 73. [CrossRef] [PubMed]
31. Malhotra, A.; Bath, S.; Elbarbry, F. An Organ System Approach to Explore the Antioxidative, Anti-Inflammatory, and Cytoprotective Actions of Resveratrol. *Oxidative Med. Cell. Longev.* **2015**, *2015*, 803971. [CrossRef] [PubMed]
32. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ* **2021**, *372*, n71. [CrossRef] [PubMed]
33. Booth, A.; Clarke, M.; Dooley, G.; Ghersi, D.; Moher, D.; Petticrew, M.; Stewart, L. The Nuts and Bolts of PROSPERO: An International Prospective Register of Systematic Reviews. *Syst. Rev.* **2012**, *1*, 2. [CrossRef]
34. Sterne, J.A.C.; Savović, J.; Page, M.J.; Elbers, R.G.; Blencowe, N.S.; Boutron, I.; Cates, C.J.; Cheng, H.-Y.; Corbett, M.S.; Eldridge, S.M.; et al. RoB 2: A Revised Tool for Assessing Risk of Bias in Randomised Trials. *BMJ* **2019**, *366*, l4898. [CrossRef]
35. Sterne, J.A.; Hernán, M.A.; Reeves, B.C.; Savović, J.; Berkman, N.D.; Viswanathan, M.; Henry, D.; Altman, D.G.; Ansari, M.T.; Boutron, I.; et al. ROBINS-I: A Tool for Assessing Risk of Bias in Non-Randomised Studies of Interventions. *BMJ* **2016**, *355*, i4919. [CrossRef] [PubMed]
36. McGuinness, L.A.; Higgins, J.P.T. Risk-of-bias VISualization (Robvis): An R Package and Shiny Web App for Visualizing Risk-of-bias Assessments. *Res. Synth. Methods* **2021**, *12*, 55–61. [CrossRef]
37. Flores-Salamanca, R.; Aragón-Vargas, L.F. Postexercise Rehydration with Beer Impairs Fluid Retention, Reaction Time, and Balance. *Appl. Physiol. Nutr. Metab.* **2014**, *39*, 1175–1181. [CrossRef] [PubMed]

38. Rodrigues, R.; de Azevedo Franke, R.; Teixeira, B.C.; Macedo, R.C.O.; Lopes, A.L.; Diefenthaeler, F.; Reischak-Oliveira, Á.; Baroni, B.M.; Vaz, M.A. Combined and Isolated Effects of Alcohol Consumption and Sleep Deprivation on Maximal Strength, Muscle Endurance and Aerobic Exercise Performance in Healthy Men: A Cross-over Randomized Controlled Trial. *Sleep Biol. Rhythm.* **2021**, *19*, 433–441. [CrossRef]
39. González-Rubio, E.; San Mauro, I.; López-Ruíz, C.; Díaz-Prieto, L.E.; Marcos, A.; Nova, E. Relationship of Moderate Alcohol Intake and Type of Beverage with Health Behaviors and Quality of Life in Elderly Subjects. *Qual. Life Res.* **2016**, *25*, 1931–1942. [CrossRef] [PubMed]
40. Ioniţe, C.; Turnea, M.; Ilea, M.; Rotariu, M. Statistical Study of Changes in Motor Quality (Speed) Following a Moderate Beer Consumption. *J. Men's Health* **2021**, *17*, 111–120. [CrossRef]
41. Maghsoudi, Z.; Shiranian, A.; Askai, G.; Ghaisvand, R. Effect of Various Kinds of Beverages on Stress Oxidative, F 2 Isoprostane, Serum Lipid and Blood Glucose of Elite Taekwondo Players. *Iran. J. Nurs. Midwifery Res.* **2016**, *21*, 470–474. [CrossRef]
42. Molina Hidalgo, C. Effects of Moderate Alcohol Consumption in Response to a High-Intensity Interval Training in Healthy Adults. The BEER-HIIT Study 2024. Doctoral Dissertation, Universidad de Granada, Granada, Spain, 2021.
43. Ras, J.; Leach, L. Alcohol Consumption, Physical Activity, and CAD Risk Factors in Firefighters. *Open Public Health J.* **2022**, *15*, e187494452210311. [CrossRef]
44. van Velden, D.P.; van der Merwe, S.; Fourie, E.; Kidd, M.; Blackhurst, D.M.; Kotze, M.J.; Mansvelt, E.P.G. The Short-Term Influence of a Mediterranean-Type Diet and Mild Exercise with and without Red Wine on Patients with the Metabolic Syndrome. *S. Afr. J. Enol. Vitic.* **2007**, *28*, 44–49. [CrossRef]
45. Dhuli, K.; Naureen, Z.; Medori, M.C.; Fioretti, F.; Caruso, P.; Perrone, M.A.; Nodari, S.; Manganotti, P.; Xhufi, S.; Bushati, M.; et al. Physical Activity for Health. *J. Prev. Med. Hyg.* **2022**, *63*, E150–E159. [CrossRef]
46. Franklin, B.A.; Eijsvogels, T.M.H.; Pandey, A.; Quindry, J.; Toth, P.P. Physical Activity, Cardiorespiratory Fitness, and Cardiovascular Health: A Clinical Practice Statement of the ASPC Part I: Bioenergetics, Contemporary Physical Activity Recommendations, Benefits, Risks, Extreme Exercise Regimens, Potential Maladaptations. *Am. J. Prev. Cardiol.* **2022**, *12*, 100424. [CrossRef] [PubMed]
47. Ruggiero, M.; Montesano, P.; Ferrante, L.; Mennitti, C.; Scudiero, O.; Mazzeo, F. Unified Sports for Inclusive Education: Assessing Basketball's Role in Supporting Students with Special Educational Needs—A Pilot Study. *Disabilities* **2025**, *5*, 102. [CrossRef]
48. Ruggiero, M.; Vicidomini, A.; Tafuri, D.; Mazzeo, F.; Meccariello, R. Energy Homeostasis and Kisspeptin System, Roles of Exercise and Outcomes with a Focus on Male Reproductive Health. *Endocrines* **2025**, *6*, 43. [CrossRef]
49. Nitschke, E.; Gottesman, K.; Hamlett, P.; Mattar, L.; Robinson, J.; Tovar, A.; Rozga, M. Impact of Nutrition and Physical Activity Interventions Provided by Nutrition and Exercise Practitioners for the Adult General Population: A Systematic Review and Meta-Analysis. *Nutrients* **2022**, *14*, 1729. [CrossRef]
50. Santos, L. The Impact of Nutrition and Lifestyle Modification on Health. *Eur. J. Intern. Med.* **2022**, *97*, 18–25. [CrossRef]
51. Bonofiglio, D. Mediterranean Diet and Physical Activity as Healthy Lifestyles for Human Health. *Nutrients* **2022**, *14*, 2514. [CrossRef] [PubMed]
52. Skultecka, A.; Nyberg, F.; Lissner, L.; Rosvall, M.; Thelle, D.S.; Olin, A.-C.; Torén, K.; Björck, L.; Rosengren, A.; Mehlig, K. Comparison of Associations between Alcohol Consumption and Metabolic Syndrome According to Three Definitions: The Swedish INTERGENE Study. *Metab. Open* **2024**, *23*, 100292. [CrossRef] [PubMed]
53. Athyros, V.G.; Liberopoulos, E.N.; Mikhailidis, D.P.; Papageorgiou, A.A.; Ganotakis, E.S.; Tziomalos, K.; Kakafika, A.I.; Karagiannis, A.; Lambropoulos, S.; Elisaf, M. Association of Drinking Pattern and Alcohol Beverage Type with the Prevalence of Metabolic Syndrome, Diabetes, Coronary Heart Disease, Stroke, and Peripheral Arterial Disease in a Mediterranean Cohort. *Angiology* **2007**, *58*, 689–697. [CrossRef]
54. Fariña, E.; Daghero, H.; Bollati-Fogolín, M.; Boido, E.; Cantero, J.; Moncada-Basualto, M.; Olea-Azar, C.; Polticelli, F.; Paulino, M. Antioxidant Capacity and NF-kB-Mediated Anti-Inflammatory Activity of Six Red Uruguayan Grape Pomaces. *Molecules* **2023**, *28*, 3909. [CrossRef]
55. Ciliberti, M.G.; Francavilla, M.; Albenzio, M.; Inghese, C.; Santillo, A.; Sevi, A.; Caroprese, M. Green Extraction of Bioactive Compounds from Wine Lees and Their Bio-Responses on Immune Modulation Using in Vitro Sheep Model. *J. Dairy Sci.* **2022**, *105*, 4335–4353. [CrossRef]
56. Pereira, M.J.; Santos, D.; Cruz, A.; Jesus, Â.; Martins, J.P.; Moreira, F.; Santos, M.; Pinho, C.; Oliveira, A.I. Exploring Alternative Potentialities of Portuguese and Spanish Craft Beers: Antioxidant and Photoprotective Activities. *Beverages* **2025**, *11*, 11. [CrossRef]
57. Tsoupras, A.; Panagopoulou, E.A.; Kyzas, G.Z. Anti-Inflammatory, Antithrombotic and Anti-Oxidant Bioactives of Beer and Brewery by-Products, as Ingredients of Bio-Functional Foods, Nutraceuticals, Cosmetics, Cosmeceuticals and Pharmaceuticals with Health Promoting Properties. *AIMS Agric. Food* **2024**, *9*, 568–606. [CrossRef]
58. Schenone, S.; Bruno, O.; Ranise, A.; Brullo, C.; Bondavalli, F.; Filippelli, W.; Mazzeo, F.; Capuano, A.; Falcone, G. 2-Aryl-3-Phenylamino-4,5-Dihydro-2h-Benz[g]Indazoles with Analgesic Activity. *Il Farm.* **2003**, *58*, 845–849. [CrossRef]
59. Moreno-Llamas, A.; De La Cruz-Sánchez, E. Moderate Beer Consumption Is Associated with Good Physical and Mental Health Status and Increased Social Support. *Nutrients* **2023**, *15*, 1519. [CrossRef] [PubMed]

60. Tommasi, M.; Arnò, S.; Di Marcantonio, C.; Picconi, L.; Sergi, M.R.; Saggino, A. Tasting through the Lens of the Mind: The Impact of Personality and Mental Health on Wine Sensory and Psychoactive Effects. *Curr. Res. Food Sci.* **2025**, *10*, 101033. [CrossRef]
61. Castro-Sepulveda, M.; Johannsen, N.; Astudillo, S.; Jorquera, C.; Álvarez, C.; Zbinden-Foncea, H.; Ramírez-Campillo, R. Effects of Beer, Non-Alcoholic Beer and Water Consumption before Exercise on Fluid and Electrolyte Homeostasis in Athletes. *Nutrients* **2016**, *8*, 345. [CrossRef] [PubMed]
62. Wynne, J.L.; Wilson, P.B. Got Beer? A Systematic Review of Beer and Exercise. *Int. J. Sport Nutr. Exerc. Metab.* **2021**, *31*, 438–450. [CrossRef] [PubMed]
63. Lafay, S.; Jan, C.; Nardon, K.; Lemaire, B.; Ibarra, A.; Roller, M.; Houvenaeghel, M.; Juhel, C.; Cara, L. Grape Extract Improves Antioxidant Status and Physical Performance in Elite Male Athletes. *J. Sports Sci. Med.* **2009**, *8*, 468–480.
64. Montesano, P.; Mazzeo, F. Improvement in Soccer Learning and Methodology for Young Athletes. *J. Phys. Educ. Sport* **2019**, *19*, 795–801. [CrossRef]
65. Evans, G.H.; James, L.J.; Shirreffs, S.M.; Maughan, R.J. Optimizing the Restoration and Maintenance of Fluid Balance after Exercise-Induced Dehydration. *J. Appl. Physiol. (1985)* **2017**, *122*, 945–951. [CrossRef] [PubMed]
66. Okaru, A.O.; Lachenmeier, D.W. Defining No and Low (NoLo) Alcohol Products. *Nutrients* **2022**, *14*, 3873. [CrossRef] [PubMed]

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