



NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ



Journal of Education, Health and Sport. eISSN 2391-8306.

Journal Home Page

<https://apcz.umk.pl/JEHS/index>

SKOWIERZAK, Filip, KOZYRA, Klaudia, KOZIEL-KWIT, Sylwia, LISIK, Bartłomiej, SADO, Aleksandra, WRĘCZYCKI, Mariusz, SAWCZUK, Kacper, SIMLAT, Aleksandra, ROGOWSKA, Wiktoria and SZADA-BORZYSZKOWSKI, Krzysztof. Non-Alcoholic Beer and Health: A Potential Alternative to Traditional Alcoholic Beer. *Journal of Education, Health and Sport*. 2026;88:69724. eISSN 2391-8306. <https://doi.org/10.12775/JEHS.2026.88.69724>

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences). Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przepisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu). © The Authors 2026; This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland
Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 11.03.2026. Revised: 16.03.2026. Accepted: 17.03.2026. Published: 21.03.2026.

Non-Alcoholic Beer and Health: A Potential Alternative to Traditional Alcoholic Beer

Authors:

Filip Skowierzak

filip.skowierzak@gmail.com

<https://orcid.org/0009-0004-1512-6148>

The Provincial Hospital in Kielce, Grunwaldzka 45, 25-736 Kielce, Poland

Klaudia Kozyra

kozyraklaudiaa@gmail.com

<https://orcid.org/0009-0001-4832-1327>

Masovian Specialist Hospital in Radom, Juliana Aleksandrowicza 5, 26-617 Radom, Poland

Sylwia Kozieł-Kwit

skozielkwit99@gmail.com

<https://orcid.org/0009-0006-9318-3740>

Stefan Cardinal Wyszyński Provincial Specialist Hospital SPZOZ in Lublin, Aleja Kraśnicka 100, 20-718 Lublin, Poland

Bartłomiej Lisik
bartlomiej.lisik.md@gmail.com
<https://orcid.org/0009-0001-2978-5732>
Międzyleski Specialist Hospital in Warsaw, Bursztynowa 2, 04-749 Warsaw, Poland

Aleksandra Sado
aleksandra.sado.1999@gmail.com
<https://orcid.org/0009-0007-6594-7907>
Międzyleski Specialist Hospital in Warszawa, Bursztynowa 2, 04-749 Warsaw, Poland

Mariusz Wręczycki
mariuszwreczycki85@gmail.com
<https://orcid.org/0009-0002-1945-4259>
St. Hedwig of Silesia Hospital in Trzebnica, Prusicka 53/55, 55-100 Trzebnica, Poland

Kacper Sawczuk
kacper.sawczuk12@gmail.com
<https://orcid.org/0009-0002-2975-0692>
Jan Bziel University Hospital No.2 in Bydgoszcz, Kornela Ujejskiego 75, 85-168 Bydgoszcz, Poland

Aleksandra Simlat
olasimlat@wp.pl
<https://orcid.org/0009-0000-8949-5756>
Dr. Tytus Chałubiński Radom Specialist Hospital,
Adolfa Tochtermanna 1, 26-610 Radom, Poland

Wiktoria Rogowska
wiktoriaa.rogowska@gmail.com
<https://orcid.org/0009-0006-9886-9880>
Masovian Specialist Hospital Juliana in Radom, Aleksandrowicza 5, 26-617 Radom, Poland

Krzysztof Szada-Borzyszkowski
szadaborzyszkowski.krzysztof@gmail.com
<https://orcid.org/0009-0006-4945-9439>
Józef Struś Multispecialist Muncipal Hospital, Szwajcarska 3, 61-285 Poznań

Corresponding Author

Filip Skowierzak [FS]
filip.skowierzak@gmail.com

Abstract

Background: The consumption of non-alcoholic beer has increased in recent years as it is increasingly perceived as an alternative to traditional alcoholic beverages. This trend reflects growing health awareness and interest in products with potentially more favorable health profiles. Non-alcoholic beer retains certain bioactive compounds found in beer, including polyphenols, vitamins, and minerals, while containing little or no ethanol.

Aim: The aim of this study was to review current evidence regarding the effects of non-alcoholic beer on human health and to compare its potential effects with those associated with traditional beer containing ethanol.

Material and methods: A narrative literature review was conducted using the PubMed database. The analysis included original studies, clinical trials, observational studies, and review articles examining the effects of non-alcoholic beer on metabolic parameters, liver function, cardiovascular health, gut microbiota, inflammatory processes, and potential neuroprotective effects.

Results: Available studies suggest that non-alcoholic beer does not significantly affect metabolic parameters, liver function, or body composition in healthy individuals. Some evidence indicates potential beneficial effects related to lipid profile, gut microbiota diversity, and modulation of inflammatory responses.

Conclusions: Non-alcoholic beer may represent a safer alternative to alcoholic beer due to the absence of ethanol while retaining bioactive compounds. However, most studies are short-term and include small populations. Further long-term research is needed to clarify its health effects.

Keywords: non-alcoholic beer; human health; metabolism; gut microbiota; inflammatory markers; lipid profile

Introduction

In recent years, non-alcoholic beer has gained increasing popularity as an alternative to traditional alcoholic beverages, reflecting observed changes in lifestyle patterns and the growing health awareness of society [1]. At the same time, the negative impact of chronic alcohol consumption on the human body is well documented and includes, among others, damage to the liver, pancreas, and cardiovascular system, as well as an increased risk of developing metabolic syndrome [25]. In response to these threats, numerous governmental and non-governmental institutions, including the World Health Organization, have undertaken actions aimed at reducing alcohol consumption. One example is the Global Alcohol Action Plan 2022-2030 [2]. One potentially beneficial aspect of non-alcoholic beer is the elimination of ethanol while retaining certain components characteristic of beer, such as polyphenols, B vitamins, minerals, and hop-derived compounds, which are believed to possess potential biological properties.

The aim of this paper is to review current research on the effects of non-alcoholic beer on human health, with particular emphasis on glucose and lipid metabolism, liver function, inflammatory parameters, gut microbiota, cardiovascular health, and potential neuroprotective effects. The observed effects are also compared with those associated with traditional beer containing ethanol.

Beer Composition

Beer consists mainly of water (approximately 90%), while the remaining fraction includes carbohydrates, ethanol, minerals, vitamins, and bioactive compounds such as polyphenols and bitter hop iso- α -acids (e.g., iso- α -humulones). The chemical composition of beer depends on the raw materials used and the production techniques applied, which influence its taste, aroma, and physicochemical properties. To date, more than 2,000 organic and inorganic compounds have been identified in beer, including over 50 polyphenols derived mainly from barley and hops. Beer is also considered one of the more important dietary sources of phenolic compounds, providing approximately 366-875 mg of polyphenols per liter.

Phenolic compounds exhibit strong antioxidant, anti-inflammatory, and potentially antipathogenic properties, which may suggest certain potential health benefits associated with moderate beer consumption.

A study analyzing beer composition conducted by researchers in Spain demonstrated that non-alcoholic beers contain lower concentrations of prenylated flavonoids (e.g., isoxanthohumol, IX) than alcoholic beers, and are also characterized by a lower content of simple phenols [12]. These differences mainly result from distinct technological processes used during the production of non-alcoholic beer and may influence its potential biological properties.

Effects of Non-Alcoholic Beverages on Glucose and Lipid Metabolism

In a study published on May 9, 2025, an experiment was conducted involving 44 young men aged 18-30 years. The participants were divided into three intervention groups and one control group: 11 individuals consuming 660 ml of non-alcoholic pilsner daily, 11 individuals consuming 660 ml of non-alcoholic wheat beer daily, 10 individuals consuming a mixed beer preparation, and a control group of 12 participants receiving water. Metabolic parameters were assessed before the start of the intervention and after four weeks of its duration. A significant increase in insulin concentration was observed only in the wheat beer group ($p = 0.014$), while changes in C-peptide concentration, although increased, did not reach statistical significance. Fasting glucose levels increased significantly only in the mixed beer group ($p = 0.027$). HbA1c values increased significantly in the pilsner group ($p = 0.0016$), whereas no significant changes in this parameter were observed in the remaining groups. Regarding the lipid profile, no significant changes were found in triglyceride levels, total cholesterol, or LDL cholesterol in any of the groups. LDL levels remained stable in the wheat beer group, whereas in the control group and the pilsner group non-significant downward trends were observed [3].

In a study conducted in a group of 34 postmenopausal women aged 45-70 years, participants were divided into three groups: 16 women consuming alcoholic beer (AB), 6 women consuming non-alcoholic beer (NAB), and 12 women assigned to a control group. The study lasted 24 months and included periodic measurements of cardiovascular parameters. In the AB group, a significant increase in HDL-C concentration was observed compared with the control group ($p = 0.006$). In contrast, in the NAB group a significant decrease in LDL-C concentration was observed after 12 months compared with the control group ($p = 0.002$) and also compared with the AB group, although this difference was not statistically significant ($p = 0.836$). Furthermore, a decrease in LDL-C was observed after 24 months in comparison with the control group ($p = 0.035$). In the same group, after 12 months a reduction in triglyceride levels was also recorded compared with the other groups ($p = 0.025$ for NAB vs control and $p = 0.022$ for NAB vs AB). However, no significant changes in LDL-C or total cholesterol were observed in the AB group compared with the control group [4].

In a study published in 2022, the effects of a four-week consumption of 330 ml of NAB (group A) and beer containing 5.2% alcohol (group B) were evaluated in 22 adult men with a mean age of 35 years (age range: 23-58 years). Participants were randomly assigned to one of the intervention groups in a 1:1 ratio. In both groups, no significant increases in body weight or body fat mass were observed (BMI in the NAB group: $p = 0.833$ and in the AB group: $p = 0.088$; body fat mass (BFM) in the NAB group: $p = 0.090$ and in the AB group: $p = 0.722$). No significant changes were observed in metabolic biomarkers such as glucose, HbA1c, insulin, HOMA-IR, C-reactive protein (CRP), or homocysteine [5]. In the group consuming NAB, a slight increase in total cholesterol was observed; however, the values remained below 200 mg/dl ($p = 0.683$). This group also demonstrated considerable variability in triglyceride concentrations ($p = 0.074$) [5].

Effects of Non-Alcoholic Beverages on the Liver

In the previously mentioned study involving 44 young men, it was found that the level of M30, a marker of hepatocyte apoptosis, decreased in the groups consuming water ($p = 0.0162$) and non-alcoholic pilsner ($p = 0.0373$). An increase in M30 concentration ($p = 0.69$) was observed in the group consuming mixed non-alcoholic beer, whereas in the group consuming non-alcoholic wheat beer this parameter remained stable ($p = 0.9563$) [3].

The activity of liver transaminases ALT and AST decreased in the water group (ALT: $p = 0.11$, AST: $p = 0.31$) and decreased significantly in the mixed beer group (ALT: $p = 0.03$, AST: $p = 0.032$), while in the group consuming non-alcoholic pilsner a slight but non-significant increase was observed (ALT: $p = 0.46$, AST: $p = 0.24$). A similar trend was observed for the FAST score,

which reflects the risk of advanced liver disease. Its value decreased in the water group ($p = 0.075$) and the mixed beer group ($p = 0.032$), whereas it increased in the pilsner group ($p = 0.086$) [3].

In the study involving postmenopausal women, it was demonstrated that after 24 months the level of γ -glutamyl transferase (GGT) increased significantly both in the group consuming AB ($p = 0.013$) and in the group consuming NAB ($p < 0.001$) compared with the control group. However, no significant differences in AST and ALT activity were observed between the groups, and all enzymatic parameters remained within laboratory reference ranges throughout the entire observation period. These results indicate that despite the observed increase in GGT levels, liver enzyme values did not exceed reference ranges in the studied population [4].

In another study involving 22 adult men with a mean age of 35 years (age range: 23-58 years), daily consumption of beer, both alcoholic and non-alcoholic, did not lead to an increase in the activity of AST, ALT, or GGT (AB group: AST $p = 0.944$, ALT $p = 0.406$, GGT $p = 0.085$; NAB group: AST $p = 0.905$, ALT $p = 0.779$, GGT $p = 0.759$). However, a decrease in alkaline phosphatase (ALP) levels was observed after four weeks of intervention (NAB group: $p = 0.015$; AB group: $p = 0.028$). Measurements of electrolytes indicated a moderate increase in potassium concentration and a decrease in sodium levels; however, both parameters remained within reference ranges [5].

Another study involving a four-week intervention conducted in a group of women and men aged 40-60 years demonstrated that moderate consumption of NAB did not cause significant changes in liver enzyme activity, and their values remained within reference ranges throughout the study period [19].

In the study involving 44 young men, the degree of hepatic steatosis assessed by elastography using the controlled attenuation parameter (CAP) decreased in the groups consuming water and non-alcoholic wheat beer. In the groups consuming mixed non-alcoholic beer and non-alcoholic pilsner, no significant changes in this parameter were observed. Liver stiffness decreased only in the control group, whereas in the remaining groups it showed a slight increase, while still remaining within physiological limits [3].

Effects of Non-Alcoholic Beer on Body Composition

In the previously mentioned study involving 44 young men who consumed different types of NAB, the overall analysis of body composition showed a decrease in body fat percentage in most of the study groups. An exception was observed in the group consuming mixed non-alcoholic beer, where a slight increase in this parameter was recorded; however, this change was not statistically significant ($p = 0.21$) [3].

In a study conducted among postmenopausal women, it was found that after 24 months both the AB and NAB groups showed a slight increase in the percentage of android and gynoid fat mass compared with the control group, in which a decrease in these parameters was observed. Differences between the AB group and the control group were significant for android fat ($p = 0.007$) and gynoid fat ($p = 0.018$), whereas the android-to-gynoid fat ratio did not differ significantly ($p = 0.407$). In the NAB group, differences compared with the control group were significant for android fat ($p = 0.001$), gynoid fat ($p = 0.022$), and the android-to-gynoid fat ratio ($p = 0.033$) [4].

In the BEER-HIIT study, which involved healthy adults undergoing high-intensity interval training, a significant reduction in visceral fat, waist circumference, and the waist-to-hip ratio (WHR) was observed only in the group consuming NAB. In contrast, no significant changes in these parameters were found in the groups consuming AB or a beverage with added ethanol [9]. In another study evaluating the effects of the non-alcoholic fraction of beer in women, beneficial changes in abdominal adipose tissue were observed [8].

Effects of Non-Alcoholic Beer on Inflammatory and Systemic Parameters

In a study evaluating inflammatory markers and selected metabolic parameters, no significant differences were observed between the groups, suggesting that four-week consumption of NAB does not exert a significant pro-inflammatory or anti-inflammatory effect in healthy individuals. This observation indicates that, within this study model, potential differences between the types of beer were mainly related to metabolic parameters, with no clear changes observed in the inflammatory response [3].

In a review paper by Zhang and colleagues, evidence was discussed suggesting that components of beer, including those present in NAB, may influence the expression of genes associated with the inflammatory response. In particular, a reduction in the transcript levels of pro-inflammatory cytokines such as IL-1 β and TNF- α was observed in selected experimental models. These effects are interpreted as indicative of potential immunomodulatory and anti-inflammatory activity. However, their clinical significance and the extent to which they influence immune function in humans require further investigation [16].

Effects of Non-Alcoholic Beer on Gut Microbiota

Polyphenols present in beer, similarly to other phenolic compounds, may reach the intestine in an unchanged or partially metabolized form, where they may potentially modulate the composition of the gut microbiota. In a study analyzing the effects of NAB and AB, the largest proportion of the baseline microbiota of participants consisted of bacteria from the phylum Firmicutes (52% in the non-alcoholic beer group and 46% in the alcoholic beer group), followed by Bacteroidetes (32% and 36%, respectively) and Actinobacteria (12% and 14%, respectively). The study involved 22 adult men with a mean age of 35 years (age range: 23-58 years). Participants were randomly assigned to one of the intervention groups in a 1:1 ratio [5].

Neither NAB nor AB induced significant changes at the level of specific bacterial genera. However, in both groups an increase in microbial diversity was observed, as assessed using the Shannon index (from 2.7 ± 0.3 to 2.9 ± 0.3 , $p = 0.037$, and from 2.8 ± 0.2 to 3.0 ± 0.2 , $p = 0.021$, respectively) [5].

In summary, four weeks of daily consumption of both NAB and AB during the study were associated with an increase in gut microbiota diversity, while no changes in body weight, BMI, or cardiometabolic markers were observed [5].

An increase in gut microbiota diversity is often interpreted in the literature as a potentially beneficial feature of the intestinal ecosystem, associated with greater stability and an enhanced ability to adapt to environmental changes. Disturbances in microbiota composition, including alterations in the proportions of the main bacterial phyla, have been described in conditions such as obesity, fatty liver disease, and chronic inflammation. However, the significance of the Firmicutes/Bacteroidetes ratio as a universal marker of metabolic diseases remains a subject of debate. The observed lack of significant changes in this parameter following the consumption of non-alcoholic beer may suggest a neutral effect of this intervention on the composition of the gut microbiota [20,21,22].

Polyphenols, Inflammation, and Immune Response

Naturally occurring polyphenolic compounds present in foods, including NAB, are described in the literature as substances with antioxidant, anti-inflammatory, and antipathogenic properties.

In a randomized study conducted among men participating in a marathon, researchers evaluated whether chronic consumption of NAB could reduce exercise-induced inflammation and decrease the incidence of upper respiratory tract infections following the race. The participants, healthy men ($n = 277$, age = 42 ± 9 years), were divided into a group consuming NAB and a placebo group. Among the analyzed parameters were the concentration of interleukin-6 (IL-6), leukocyte count, and the frequency of post-marathon infections [6].

Hop-derived prenylated flavonoids, such as xanthohumol and its derivatives, belong to the group of polyphenols that in preclinical studies and review papers have been attributed immunomodulatory and anti-inflammatory properties. These effects are thought to occur, among others, through the modulation of signaling pathways associated with the activation of NF- κ B and the regulation of pro-inflammatory cytokine production. However, these effects have been demonstrated mainly in experimental models and in the context of other inflammatory conditions [14,23].

Endurance athletes, particularly marathon runners, represent a suitable model for evaluating the immunomodulatory effects of such compounds, as prolonged physical exertion leads to transient immunosuppression, increased levels of pro-inflammatory cytokines (IL-6, TNF- α), disturbances in oxidative balance, and an elevated risk of upper respiratory tract infections [24]. The results showed a significantly lower increase in IL-6 concentration after the race in individuals consuming NAB compared with the placebo group ($p = 0.03$), while IL-6 levels before the marathon did not differ between the groups. A greater increase in C-reactive protein (CRP) and leukocyte counts was also observed immediately after the race and 24 hours later in the placebo group. In the NAB group, the leukocyte count after the race was 20% lower than in the placebo group and remained lower 24 hours after the race compared with the placebo group ($p = 0.02$). Additionally, within two weeks after the marathon, upper respiratory tract infections occurred significantly less frequently in the NAB group (95% CI, OR = 1.38-7.66, $p = 0.007$) [6].

Effects of Diet, Exercise, and Non-Alcoholic Beer on Nutritional Status, Endothelial Function, and Quality of Life in Patients with Cirrhosis

A study published in 2020 evaluated whether the consumption of NAB, combined with diet and physical exercise, could improve endothelial function, nutritional parameters, and quality of life in patients with liver cirrhosis. The study included 43 patients, with 21 assigned to the control group and 22 to the intervention group. The mean age of participants was 53.5 ± 7.8 years, and 60% were women. Participants were divided into two groups: an intervention group (non-alcoholic beer + diet + exercise) and a control group (water + diet + exercise). For eight weeks, patients consumed 330 ml of non-alcoholic beer or the same volume of water daily, while simultaneously following an individualized nutritional plan and a physical activity program [7].

The authors of the study noted that, due to its composition, NAB may be considered a potential component of nutritional interventions in patients with liver cirrhosis. This beverage provides B vitamins, minerals, and polyphenolic and hop-derived compounds such as xanthohumol, which have been described in the literature as possessing anti-inflammatory and antioxidant properties. However, these effects were not directly evaluated in the study discussed [7].

Biochemical analyses showed stability of laboratory parameters in both groups. The only baseline difference was a higher level of alkaline phosphatase in the intervention group. During the intervention, an improvement in AST levels and an increase in platelet count were observed in both groups (intervention group: ALT $p = 0.198$, AST $p = 0.035$, platelets $p = 0.046$; control group: ALT $p = 0.024$, AST $p = 0.015$, platelets $p = 0.278$). Other markers, including liver function parameters, creatinine, glucose, and electrolyte levels, remained unchanged compared with baseline values [7].

Among patients with impaired endothelial function at baseline, improvement was observed in 72.7% of individuals in the control group and in 83.3% of patients in the intervention group. This change was statistically significant in both groups ($p < 0.001$). In the final analysis, a more stable course of the curve and a return to baseline values were observed in the group consuming NAB compared with the control group. Hemodynamic variables, such as blood pressure and heart rate, remained stable in both groups (control group: SCT $p = 0.418$, RCT $p = 0.862$, heart rate $p = 0.079$; intervention group: SCT $p = 0.513$, RCT $p = 0.385$, heart rate $p = 0.235$) [7].

A favorable trend was also observed in the improvement of the phase angle (PhA), which is considered an indicator of nutritional status and cell membrane integrity. Improvement was observed in 63.6% of patients in the intervention group compared with 47.6% in the control group [7].

Results regarding quality of life, assessed using the Chronic Liver Disease Questionnaire (CLDQ), showed improvement in nearly all evaluated parameters among patients consuming NAB, whereas changes in the control group were minimal [7].

The results of the study suggest that, within an intervention including diet and physical activity, the consumption of NAB was associated with improvements in endothelial function, selected indicators of nutritional status, and quality of life in patients with liver cirrhosis. These observations indicate the potential usefulness of NAB as a component of nutritional intervention in this patient population [7].

Effects of Beer, Non-Alcoholic Beer, and Water Consumption Before Exercise on Fluid and Electrolyte Homeostasis in Athletes

The aim of the study was to compare the effects of consuming AB, NAB, and water (W) before exercise on fluid and electrolyte homeostasis. The study participants were athletes: seven men (19.1 ± 0.4 years) who performed 45 minutes of treadmill running at 65% of their maximal heart rate, 45 minutes after consuming 0.7 L of water (W group), AB group, or NAB group. Body weight, plasma concentrations of Na^+ and K^+ , and urine specific gravity (USG) were assessed before fluid intake and after exercise [10].

After exercise, body weight decreased in the W, AB, and NAB groups ($p < 0.05$). By the end of the exercise session, plasma Na^+ levels decreased in the W group (-3.9%) ($p < 0.01$) and the AB group (-3.7%) ($p < 0.01$). Plasma K^+ levels increased in the AB group (8.5%) ($p < 0.05$), while urine specific gravity (USG) decreased in the W group (-0.9%) and the NAB group (-1.0%). No significant differences were found between the groups in urine output ($p = 0.35$), sweat rate ($p = 0.2$), or total evaporative water loss ($p = 0.36$). These results indicate that the consumption of non-alcoholic beer before physical exercise is comparable to water consumption in terms of its effects on fluid and electrolyte homeostasis [10].

Consumption of alcoholic beer reduced plasma Na^+ levels and increased plasma K^+ levels during exercise, which may negatively affect health and physical performance. In contrast, water consumption before exercise may also lead to a decrease in plasma Na^+ levels during physical activity [10].

Effects of Non-Alcoholic Beer on Plasma and Macrophage microRNA

One study evaluated how the consumption of AB and NAB modulates the levels of circulating microRNAs as well as macrophage-derived microRNAs. Seven men aged 30-65 years with a high cardiovascular risk participated in the study, which involved consuming 500 ml of alcoholic or non-alcoholic beer daily for 14 days, with a 7-day washout period between interventions [11]. MicroRNAs are short, non-coding sequences (22-24 nucleotides) that regulate gene expression and play an important role in processes such as cholesterol metabolism, type 2 diabetes, coronary artery disease, insulin sensitivity, endothelial function, and inflammatory processes. This study represents one of the first investigations analyzing the effects of non-alcoholic beer on microRNA profiles.

The study demonstrated that the expression of four plasma microRNAs changed significantly depending on the intervention applied. After the consumption of AB, their levels increased, whereas after the consumption of NAB they decreased. This applied, among others, to miR-155-5p ($p = 0.036$), miR-328-3p ($p = 0.036$), and miR-92a-3p ($p = 0.039$). A similar pattern - an increase in expression after AB consumption and a decrease after NAB consumption - was observed for five microRNAs in macrophages: miR-145-5p ($p = 0.038$), miR-17-5p ($p = 0.05$), miR-20-5p ($p = 0.03$), miR-26b-5p ($p = 0.05$), and miR-223-3p ($p = 0.011$) [11].

In the literature, miR-328 has been associated with myocardial infarction, atrial fibrillation, and atrial enlargement, while miR-92a has been linked to adverse cardiac remodeling after myocardial infarction. In contrast, miR-155 is commonly considered a pro-inflammatory microRNA. The observed reduction in the levels of these microRNAs following the consumption of NAB may indicate a potentially beneficial modulation of the molecular profile associated with cardiovascular risk. Additionally, the levels of miR-320 were positively correlated with LDL cholesterol concentrations, suggesting that higher expression of this microRNA co-occurs with a less favorable lipid profile. The macrophage microRNAs whose levels decreased after NAB consumption were associated, in bioinformatic analyses, with signaling pathways classified as cancer-related. This finding indicates their potential regulatory role in cellular processes; however, it does not allow conclusions to be drawn regarding any oncoprotective effect [11].

The obtained results suggest that the consumption of NAB may modulate the microRNA profile in a potentially beneficial direction with respect to processes related to the regulation of inflammation and vascular function, due to the association of these microRNAs with mechanisms relevant to the cardiovascular system. The observed differences may be related both to the presence of polyphenolic compounds and to the absence of ethanol, which in the study was associated with a different microRNA expression profile [11].

Neuroprotective Effects of Beer

Hop-derived compounds present in NAB, particularly iso- α -acids and prenylated flavonoids, have demonstrated potential neuroprotective properties in experimental studies. Numerous preclinical models have shown that iso- α -acids may cross into the central nervous system, reduce β -amyloid accumulation, modulate microglial activity, limit neuroinflammation, and improve cognitive functions, including memory processes [14,15,26,27].

Studies comparing the effects of NAB, containing iso- α -acids and trace amounts of ethanol, with alcoholic beer with a comparable concentration of iso- α -acids have shown that both types of beverages similarly stimulate the proliferation of SH-SY5Y cells as well as neuronal stem cells (NES) [13]. NES cells are characterized by the ability to differentiate into neurons and glial cells; therefore, their activation may be relevant in the context of regenerative processes within the nervous system.

Discussion

The analysis of available studies indicates that NAB may represent a beneficial alternative to traditional alcoholic beer in several health-related aspects. Studies evaluating the effects of NAB on glucose metabolism and metabolic parameters suggest that differences in composition, such as polyphenol content or the type of fermentation used, may influence the varied metabolic effects observed among different types of NAB [3].

Changes observed in a study conducted among postmenopausal women suggest that NAB may influence selected lipid parameters in this population; however, the small size of the NAB group limits the possibility of drawing definitive conclusions [4]. Available data regarding the effects of NAB on the liver indicate that short-term consumption of NAB does not lead to significant impairment of liver function in healthy individuals or in selected clinical populations. Observed changes in biochemical and elastographic markers appear to be minor, dependent on the type of beverage consumed and the nutritional context, and in some studies are comparable to effects observed in control groups [3,4,5,19].

Overall, the available evidence suggests that the impact of NAB on glucose metabolism is limited, while its effects on lipid metabolism may depend both on beverage composition and on the characteristics of the studied population. Beneficial effects have been observed among postmenopausal women, whereas in populations of young men the effects of NAB consumption appear to be more variable and dependent on the composition of the consumed beer. The beneficial effects observed in postmenopausal women may potentially result from the presence

of prenylflavonoids, a subclass of flavonoid polyphenols present in hops, which exhibit phytoestrogenic activity and may contribute to the prevention or alleviation of menopausal symptoms [3,4,5,17,18].

NAB provides important bioactive compounds, including prenylated hop flavonoids such as xanthohumol and its derivatives (e.g., isoxanthohumol), which exhibit anti-inflammatory and antioxidant properties. Interventional studies have demonstrated that the consumption of non-alcoholic beer is associated with an increase in gut microbiota diversity [5,6]. These changes may potentially mediate the modulation of metabolic and immunological processes; however, these mechanisms have not yet been conclusively confirmed and require further investigation. Available studies do not demonstrate a significant effect of short-term consumption of NAB on classical inflammatory markers in healthy individuals under resting conditions. At the same time, some evidence suggests a potential anti-inflammatory and immunomodulatory effect at the molecular level, particularly under conditions of increased physiological stress, such as prolonged high-intensity physical exertion [3,6,16].

Studies conducted among athletes and marathon participants have shown that the consumption of NAB before competition was associated with a milder inflammatory response following intense physical exertion, reflected by a smaller increase in interleukin-6 (IL-6), C-reactive protein (CRP), and leukocyte counts. The mechanisms underlying this phenomenon were not clearly determined in the discussed study; however, they may be related to the presence of plant-derived bioactive compounds such as polyphenols [6].

When combined with dietary intervention and regular physical activity, the consumption of NAB was also associated with improvements in endothelial function, selected indicators of nutritional status, and quality of life in patients with liver cirrhosis. It should be emphasized, however, that the intervention applied was multifactorial, which prevents the observed effects from being attributed exclusively to the consumption of non-alcoholic beer. Potential mechanisms, such as improved adherence to dietary recommendations, increased intake of certain micronutrients, or the effects of plant-derived bioactive compounds, have been proposed in the literature; however, they were not directly evaluated in the discussed study and require further investigation [7].

Furthermore, NAB containing iso- α -acids may exhibit potential neuroprotective effects at the cellular level. This has been demonstrated in *in vitro* studies through the stimulation of proliferation of neuron-like cells and neuronal stem cells. These observations suggest that such compounds may participate in regenerative processes within the nervous system; however, their functional significance and their potential influence on cognitive plasticity require confirmation in *in vivo* studies [13].

Additionally, modulation of the expression of microRNAs associated with inflammatory processes and lipid metabolism following the consumption of NAB may represent a potential molecular mechanism contributing to favorable changes in biological profiles related to cardiovascular risk [11].

From a metabolic perspective, most available short-term studies indicate that the consumption of NAB is not associated with unfavorable changes in body weight or glycemic parameters in healthy individuals. In this context, NAB may be considered a safer dietary component compared with alcoholic beer, the consumption of which - particularly during physical exertion - has been shown to exert a diuretic effect and may lead to disturbances in electrolyte homeostasis, including decreased plasma sodium levels and increased potassium concentrations. In a comparative study, NAB demonstrated a neutral effect on fluid and electrolyte balance when compared with alcoholic beer [10].

In summary, NAB may combine the beneficial properties of polyphenols with a very low ethanol content, which may translate into a reduced risk of adverse effects on the liver, cardiovascular system, and metabolic processes, while preserving potential health benefits

traditionally associated with beer, such as antioxidant, anti-inflammatory, and neuroprotective effects.

However, it should be emphasized that most of the available studies are characterized by relatively short durations and small sample sizes. Long-term studies evaluating the effects of regular NAB consumption in different clinical populations are still lacking. Therefore, the current conclusions should be considered preliminary and require further verification.

Conclusions

NAB may represent a potentially safe alternative to alcoholic beer, as it does not appear to cause significant disturbances in liver function or adverse metabolic effects. NAB is a source of bioactive compounds, such as polyphenols and xanthohumol, which exhibit anti-inflammatory, antioxidant, and gut microbiota-modulating properties.

The consumption of NAB may positively influence lipid profile, nutritional status, and neuroprotective processes, and may also reduce inflammation following physical exertion as well as lower the risk of upper respiratory tract infections. When combined with physical activity and an appropriate diet, NAB may improve the quality of life of patients with liver cirrhosis, supporting both physiological and psychological aspects of health.

The available evidence also suggests that non-alcoholic beer may beneficially modulate microRNAs associated with the cardiovascular system. Due to its polyphenol content, non-alcoholic beer may therefore be considered a functional beverage that combines the potential health benefits associated with beer with a minimal risk related to alcohol consumption.

Abbreviations

NAB - non-alcoholic beer

AB - alcoholic beer

Disclosure Section

Author's contribution:

Conceptualization: Filip Skowierzak, Klaudia Kozyra, Aleksandra Simlat and Sylwia Koziel-Kwit

Methodology: Bartłomiej Lisik, Aleksandra Sado

Formal analysis: Krzysztof Szada-Borzyszkowski, Mariusz Wręczycki

Investigation: Klaudia Kozyra, Filip Skowierzak

Writing - Rough Preparation: Filip Skowierzak, Klaudia Kozyra, Sylwia Koziel-Kwit, Aleksandra Simlat, Kacper Sawczuk

Writing - Review and Editing: Aleksandra Sado, Bartłomiej Lisik, Krzysztof Szada-Borzyszkowski, Mariusz Wręczycki, Wiktoria Rogowska

Visualization: Kacper Sawczuk, Wiktoria Rogowska

Supervision: Filip Skowierzak

All authors have read and agreed to the published version of the manuscript.

Funding Statement: The study did not receive external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Not applicable.

Conflict of Interest Statement: The authors declare no conflicts of interest

References

[1] Statista. Non-alcoholic beer worldwide trend. <https://www.statista.com/outlook/cmo/alcoholic-drinks/beer/non-alcoholic-beer/worldwide> (Accessed: 02.11.2025).

[2] World Health Organization. Global alcohol action plan 2022–2030. Geneva: World Health Organization; 2022. Available from: <https://www.who.int/publications/i/item/9789240090101>

(Accessed: 02.11.2025).

[3] Kreimeyer H, Sydor S, Buchholz L, Toskal C, Özcürümez M, Schnabl B, Syn WK, Sowa JP, Manka P, Canbay A. Non-Alcoholic Beer Influences Glucose and Lipid Metabolism and Changes Body Composition in Healthy, Young, Male Adults. *Nutrients*. 2025 May 9;17(10):1625.

<https://doi.org/10.3390/nu17101625>

[4] Trius-Soler M, Martínez-Carrasco P, Tresserra-Rimbau A, Moreno JJ, Estruch R, Lamuela-Raventós RM. Effect of moderate beer consumption (with and without ethanol) on cardiovascular health in postmenopausal women. *J Sci Food Agric*. 2023 Dec;103(15):7506-7516.

<https://doi.org/10.1002/jsfa.12826>

[5] Marques C, Dinis L, Barreiros Mota I, Morais J, Ismael S, Pereira-Leal JB, Cardoso J, Ribeiro P, Beato H, Resende M, Espírito Santo C, Cortez AP, Rosário A, Pestana D, Teixeira D, Faria A, Calhau C. Impact of Beer and Nonalcoholic Beer Consumption on the Gut Microbiota: A Randomized, Double-Blind, Controlled Trial. *J Agric Food Chem*. 2022 Oct 19;70(41):13062-13070.

<https://doi.org/10.1021/acs.jafc.2c00587>

[6] Scherr J, Nieman DC, Schuster T, Habermann J, Rank M, Braun S, Pressler A, Wolfarth B, Halle M. Nonalcoholic beer reduces inflammation and incidence of respiratory tract illness. *Med Sci Sports Exerc*. 2012 Jan;44(1):18-26.

<https://doi.org/10.1249/MSS.0b013e3182250dda>

[7] Macías-Rodríguez RU, Ruiz-Margáin A, Román-Calleja BM, Espin-Nasser ME, Flores-García NC, Torre A, Galicia-Hernández G, Rios-Torres SL, Fernández-Del-Rivero G, Orea-Tejeda A, Lozano-Cruz OA. Effect of non-alcoholic beer, diet and exercise on endothelial function, nutrition and quality of life in patients with cirrhosis. *World J Hepatol*. 2020 Dec 27;12(12):1299-1313.

<https://doi.org/10.4254/wjh.v12.i12.1299>

[8] Trius-Soler M, Vilas-Franquesa A, Tresserra-Rimbau A, Sasot G, Storniolo CE, Estruch R, Lamuela-Raventós RM. Effects of the Non-Alcoholic Fraction of Beer on Abdominal Fat, Osteoporosis, and Body Hydration in Women. *Molecules*. 2020 Aug 27;25(17):3910.

<https://doi.org/10.3390/molecules25173910>

[9] Molina-Hidalgo C, De-la-O A, Jurado-Fasoli L, Amaro-Gahete FJ, Castillo MJ. Beer or Ethanol Effects on the Body Composition Response to High-Intensity Interval Training. The BEER-HIIT Study. *Nutrients*. 2019 Apr 23;11(4):909.

<https://doi.org/10.3390/nu11040909>

[10] 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 Jun 7;8(6):345.

<https://doi.org/10.3390/nu8060345>

[11] Daimiel L, Micó V, Díez-Ricote L, Ruiz-Valderrey P, Istaş G, Rodríguez-Mateos A, Ordovás JM. Alcoholic and Non-Alcoholic Beer Modulate Plasma and Macrophage microRNAs Differently in a Pilot Intervention in Humans with Cardiovascular Risk. *Nutrients*. 2020 Dec 28;13(1):69.

<https://doi.org/10.3390/nu13010069>

[12] Boronat A, Soldevila-Domenech N, Rodríguez-Morató J, Martínez-Huélamo M, Lamuela-Raventós RM, de la Torre R. Beer Phenolic Composition of Simple Phenols, Prenylated Flavonoids and Alkylresorcinols. *Molecules*. 2020 Jun 2;25(11):2582.

<https://doi.org/10.3390/molecules25112582>

- [13] Laurent AJ, Bindslev N, Vukojević V, Terenius L. Iso- α -acids in Nonalcoholic and Alcoholic Beer Stimulate Growth of Neuron-like SH-SY5Y Cells and Neuroepithelial Stem Cells. *ACS Bio Med Chem Au*. 2021 Sep 7;1(1):11-20.
<https://doi.org/10.1021/acsbiochemau.1c00017>
- [14] Ano Y, Dohata A, Taniguchi Y, Hoshi A, Uchida K, Takashima A, Nakayama H. Iso- α -acids, Bitter Components of Beer, Prevent Inflammation and Cognitive Decline Induced in a Mouse Model of Alzheimer's Disease. *J Biol Chem*. 2017 Mar 3;292(9):3720-3728.
<https://doi.org/10.1074/jbc.M116.763813>
- [15] Ano Y, Ohya R, Kondo K, Nakayama H. Iso- α -acids, Hop-Derived Bitter Components of Beer, Attenuate Age-Related Inflammation and Cognitive Decline. *Front Aging Neurosci*. 2019 Feb 4;11:16.
<https://doi.org/10.3389/fnagi.2019.00016>
- [16] Zhang S, Jin S, Zhang C, Hu S, Li H. Beer-gut microbiome alliance: a discussion of beer-mediated immunomodulation via the gut microbiome. *Front Nutr*. 2023 Jul 25;10:1186927.
<https://doi.org/10.3389/fnut.2023.1186927>
- [17] Myasoedova VA, Kirichenko TV, Melnichenko AA, Orekhova VA, Ravani A, Poggio P, Sobenin IA, Bobryshev YV, Orekhov AN. Anti-Atherosclerotic Effects of a Phytoestrogen-Rich Herbal Preparation in Postmenopausal Women. *Int J Mol Sci*. 2016 Aug 11;17(8):1318.
<https://doi.org/10.3390/ijms17081318>
- [18] Sirotkin AV, Harrath AH. Phytoestrogens and their effects. *Eur J Pharmacol*. 2014 Oct 15;741:230-6.
<https://doi.org/10.1016/j.ejphar.2014.07.057>
- [19] Padro T, Muñoz-García N, Vilahur G, Chagas P, Deyà A, Antonijoan RM, Badimon L. Moderate Beer Intake and Cardiovascular Health in Overweight Individuals. *Nutrients*. 2018 Sep 5;10(9):1237.
<https://doi.org/10.3390/nu10091237>
- [20] Vishwakarma B, Sawant MS, Amberkar D. The Gut Microbiome: A Comprehensive Review of its Role in Human Health and Disease. *Int J Res Stud Microbiol Biotechnol*. 2025;10(2):7–25.
<https://mail.arcjournals.org/international-journal-of-research-studies-in-micro-biology-and-bio-technology/volume-10-issue-2/>
(Accessed: 02.11.2025).
- [21] Sanz Y, Santacruz A, Gauffin P. Gut microbiota in obesity and metabolic disorders. *Proc Nutr Soc*. 2010 Aug;69(3):434-41.
<https://doi.org/10.1017/S0029665110001813>
- [22] Mostafavi Abdolmaleky H, Zhou JR. Gut Microbiota Dysbiosis, Oxidative Stress, Inflammation, and Epigenetic Alterations in Metabolic Diseases. *Antioxidants (Basel)*. 2024 Aug 14;13(8):985.
<https://doi.org/10.3390/antiox13080985>
- [23] Yahfoufi N, Alsadi N, Jambi M, Matar C. The Immunomodulatory and Anti-Inflammatory Role of Polyphenols. *Nutrients*. 2018 Nov 2;10(11):1618.
<https://doi.org/10.3390/nu10111618>
- [24] Walsh NP. Recommendations to maintain immune health in athletes. *Eur J Sport Sci*. 2018 Jul;18(6):820-831.
<https://doi.org/10.1080/17461391.2018.1449895>
- [25] World Health Organization. Global status report on alcohol and health. Geneva: World Health Organization.
<https://www.who.int/publications/i/item/global-status-report-on-alcohol-and-health>
(Accessed: 02.11.2025).

[26] Ano Y, Hoshi A, Ayabe T, Ohya R, Uchida S, Yamada K, Kondo K, Kitaoka S, Furuyashiki T. Iso- α -acids, the bitter components of beer, improve hippocampus-dependent memory through vagus nerve activation. *FASEB J.* 2019 Apr;33(4):4987-4995.

<https://doi.org/10.1096/fj.201801868RR>

[27] Ano Y, Yoshikawa M, Takaichi Y, Michikawa M, Uchida K, Nakayama H, Takashima A. Iso- α -Acids, Bitter Components in Beer, Suppress Inflammatory Responses and Attenuate Neural Hyperactivation in the Hippocampus. *Front Pharmacol.* 2019 Feb 11;10:81.

<https://doi.org/10.3389/fphar.2019.00081>