African Journal of Health and Medical Sciences (AFJHMS)
Volume 11, Issue No. 2, 2026
http://www.afjhms.com
E-ISSN 2709-569X
DOI: 10.59067/afjhms.v11i2.132

RESEARCH ARTICLE

Adulterated Alcohol in Burkina Faso: Toxicological Assessment of Commercialized Beverages and Socio-Demographic Determinants of Consumption in Urban and Rural Settings

Patrick P.A. Vokouma[1,2*], Basile Tindano[3], Arouna Zoungrana[1], Ollo Youl[5], Sandaogo Sawadogo[4], Maminata Traore Coulibaly[2], Halidou Tinto[2], Albert Soudre[1] and Balé Bayala[3]

[1]Laboratoire Sciences de la Vie et de la Terre, Université Norbert Zongo, BP 376, Koudougou, Burkina Faso; [2]Unité de Recherche Clinique de Nanoro, Institut de Recherche en Sciences de la Santé (IRSS/ CNRST), 11 BP 218 CMS OUAGA 11, Burkina Faso; [3]Laboratoire de Physiologie Animale, Université Joseph KI-ZERBO, BP 7021 Ouagadougou, Burkina Faso; [4]Agence National pour la Sécurité Sanitaire de l'Environnement, de l'Alimentation, du Travail, et des Produits de Santé (ANSSEAT), 09 BP 24 Ouagadougou 09, Burkina Faso; [5]Laboratoire de Biochimie et de Chimie Appliquée, Université Joseph KI-ZERBO, BP 7021 Ouagadougou, Burkina Faso

Received: April 28, 2026
Accepted: May 29, 2026
Published: July 15, 2026

Abstract:

***Background*:** The proliferation of low-cost alcoholic beverages in Burkina Faso raises major public health concerns due to the potential presence of toxic adulterants. However, data on their chemical composition and the socio-demographic characteristics of consumers remain limited.

***Methods*:** A cross-sectional study combining toxicological analysis and a Knowledge, Attitudes, and Practices survey was conducted from October 2023 to March 2024 in Ouagadougou (urban) and Nanoro (rural) areas. Twenty-nine alcoholic beverage samples were collected from six retail outlets and analyzed using gas chromatography to detect toxic compounds. A total of 196 consumers were interviewed. Statistical analyses were performed using R software, with significance set at $p < 0.05$.

***Results*:** Overall, 62.06% of sampled beverages were adulterated. Locally produced beverages showed a significantly higher rate of adulteration compared to imported products (80% among samples produced in Burkina Faso vs. 22.22% among samples imported from Ghana). Methanol was the most frequently detected compound, often in combination with higher alcohols and ethyl acetate. Consumer characteristics revealed a mean age of 36.04 ± 13.68 years, with significant associations between drinking patterns and age as well as sector of activity ($p < 0.005$). Heavy drinking was more prevalent in rural areas.

***Conclusion*:** Adulterated alcoholic beverages are widely present in Burkina Faso and pose significant health risks. Strengthening regulatory monitoring, particularly for locally produced alcohol, and integrating socio-demographic factors into prevention strategies are essential to reduce associated harms.

Keywords: Adulteration, Alcohol, Toxicity, Methanol, Burkina Faso, Public Health.

**Correspondence should be addressed to Patrick P.A. Vokouma, Laboratoire Sciences de la Vie et de la Terre, Université Norbert Zongo, BP 376, Koudougou, Burkina Faso; Unité de Recherche Clinique de Nanoro, Institut de Recherche en Sciences de la Santé (IRSS/ CNRST), 11 BP 218 CMS OUAGA 11, Burkina Faso; E-mail: patvokouma@gmail.com*

1. INTRODUCTION

Alcohol production and trade exist both within and outside government regulations (8). Alcohol consumption in sub-Saharan Africa is a public health problem and can be influenced by recreational activities, religion, age and gender, especially within the most vulnerable population (10, 11,36).

In Burkina Faso, production, importation and commercialization of alcoholic beverages are regulated by Ministerial decree No. 2021-00381/MICA/MS/MEEVCC/MATD. Under the latter, importers and producers have the obligation to undergo a prior analysis of their products by an accredited laboratory before commercialization. However, cases of adulterated alcoholic beverages have been documented over the years by the media (22, 25).

Adulterated alcoholic beverages are defined as legal alcoholic products which have been illicitly tempered with, for instance by criminally diluting them with water, intentionally putting them in new containers to conceal their true origin, or adding toxic substances to manipulate their quality (21). Levels of alcohol consumption are dependent on demographic (5), socio-economic and level of education of individuals (6, 23) . In Burkina Faso, alcohol is consumed by approximately 25% of the population with a level of alcohol intake being associated with age (5). In addition, many media reported a rise of adulterated alcoholic beverages consumption and stores in the country (22). Legal alcoholic beverages composition mainly consists of ethanol at different level of concentration and water (34). While socio-demographic characteristics of legal alcoholic beverages consumers and their effects on human physiology have been documented in other countries (6, 7, 26, 34, 37) and in Burkina Faso (5, 28), data on the consumption of adulterated alcoholic beverages are insufficient. Alcoholic beverages consumption has several repercussions on personal, social and professional life (16). Moreover, chronic alcohol consumption is associated with an increased incidence of different types of cancer, cardio-vascular and liver diseases, birth defects, and psychiatric disorders (12, 14, 23, 24). It has been also established that the consumption of adulterated alcoholic beverages can lead to several health problems, including alcohol-related blindness (2, 17, 18, 29, 31), metabolic acidosis (2)and death (7).

Alcohol is also known for inducing an oxidative stress which can affect reproduction (1). Previous studies have reported the presence of methanol in adulterated alcoholic beverages (2, 8, 20) which exacerbates toxicity. However, due to the lack of studies on those types of alcoholic beverages and the non-disclosure of their chemical compounds, the risks associated with their consumption may be underestimated.

This study aims to: (i) gather valuable information on the socio-demographic characteristics of consumers of adulterated alcoholic beverages in Burkina Faso and (ii) evaluate the health risks associated with such consumption by screening these so-called “adulterated alcoholic beverages” commercialized locally, to detect higher alcohols and esters content by gas chromatography.

2. MATERIAL AND METHODS

2.1. Study Design and Setting

This study combined a toxicological analysis of alcoholic beverages with a cross-sectional Knowledge, Attitude, and Practices (KAP) survey among consumers. It was conducted between October 2023 and March 2024 in Ouagadougou (urban setting) and Nanoro (rural setting), Burkina Faso.

2.2. Sample Size and Study Design

Number of required consumers to respond to the KAP survey was evaluated using the formula for sampling size calculation for a cross-sectional epidemiological study (15). The sample size for the KAP survey was calculated using the following formula:

$$n = (Z^2 \times p \times (1 - p)) / d^2$$

Where:

$$Z = 1.96 \text{ (95\% confidence level)}$$

p = 0.25 (estimated prevalence of alcohol consumption in Burkina Faso)

d = 0.05 (margin of error)

This yielded a minimum sample size of 288 participants. Although the calculated minimum sample size was 288, logistical and field constraints limited recruitment to 196 participants. However, this sample size remains sufficient to detect significant associations and is comparable to similar exploratory studies in low-resource settings.

2.3. Sampling Alcoholic Beverages

A total of 29 alcoholic beverage samples were randomly collected from six retail outlets (three in each study area). These outlets were selected based on their known sale of low-cost alcoholic beverages.

2.4. Inclusion and Exclusion Criteria

Participants were eligible if they were aged 18 years or older, reported regular consumption of the targeted alcoholic beverages, and provided informed consent.

Women were not included due to socio-cultural constraints limiting their participation in alcohol-related surveys. This represents a limitation of the study.

2.5. Data Collection

A structured KAP questionnaire was written in local languages (Moore, Bambara, Fulfulde, and French). Data collected included socio-demographic characteristics and alcohol consumption patterns.

2.6. Toxicological Analysis

After receiving consent from the sale point owner, a thermometer was placed in the store for 18 – 24 hours to monitor temperature variations throughout the day before collecting the samples. Samples were stored at 2–8°C and analyzed using gas chromatography with flame ionization detection (GC-FID, Agilent 6890). Ten chemical compounds known to increase alcohol toxicity were screened. Screened chemical compounds are presented in Table **1** and were purchased from *Sigma Aldrich France*. A sample was considered adulterated when one or more toxic compounds not expected in standard ethanol-based beverages (*e.g.,* methanol, higher alcohols, esters) were detected.

Table 1. Retention time of screened chemical compounds

Chemical Compounds	Retention Time (mins)
Methanol	2.970
1-Propanol	3.400
2-Butanol	3.614
2 Methyl-1-Butanol	3.705
2 Methyl-1-Propanol	3.801
2 Methyl-2-Butanol	3.892
3 Methyl-1-Butanol	4.880
Ethyl-Acetate	4.923
1 Pentanol	5.394
4 Methyl-1-Pentanol	6.312

2.7. Alcohol Consumption Patterns Determination

Data about the daily and weekly consumption patterns of pure alcohol consumed grams (g) of alcohol per glass have been received from consumers through the KAP survey. This, taking into account the in-

formation about the consumed beverage, the quantity and the frequency of consumption. Drinking patterns have been determined using the guidelines of the National Institute on Alcohol Abuse and Alcoholism (14).

2.8. Data Analysis

Data of the KAP survey and store characteristics, including building materials used and diurnal temperature range were primarily recorded on paper, then entered on *Microsoft Excel 2019* and analyzed using the *R* software *v4.3.2* by the mean of the *tidyverse ggplot2* and *dplyr* libraries. Descriptive statistics were computed, and associations between variables were tested using the *Kruskal-Wallis test.* Statistical significance was set at $p < 0.05$ and applied to the variables age, age group, consumption pattern and sector of activity

3. RESULTS

3.1. Sample Size and Country of Origin

Fig. **1** shows the country of origin and sample size of alcohol collected at the different points of sale in Ouagadougou and Nanoro.

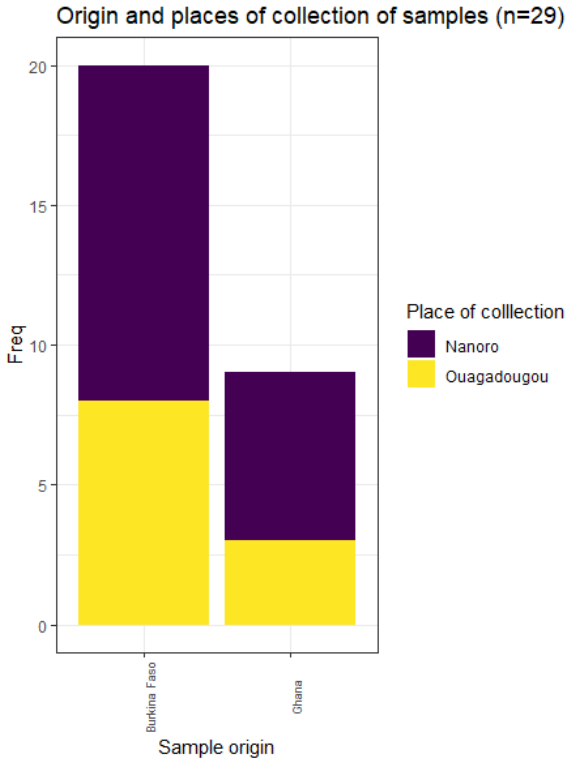

Fig. (1). Overview of country of origin and place of collection of alcoholic beverages.

A total of 29 alcoholic beverages samples were collected in Nanoro and Ouagadougou. From which, 31.03% of the samples originated from Ghana and 68.97% were locally produced in Burkina Faso.

3.2. Prevalence of Adulteration and Detected Compounds

Out of a total of 20 samples from Burkina Faso, gas chromatography revealed the presence of methanol in 80% of the samples; 10% of the samples were positive to 2-methyl-1-propanol in addition to methanol, 5% contained ethyl acetate and methanol, and 5% were positive to ethyl acetate and 2-methyl-1-propanol in addition to methanol. Out of 9 samples with origin from Ghana, 22.22% contained methanol.

Evidence of adulteration of the collected alcohols is shown in Fig. **2**.

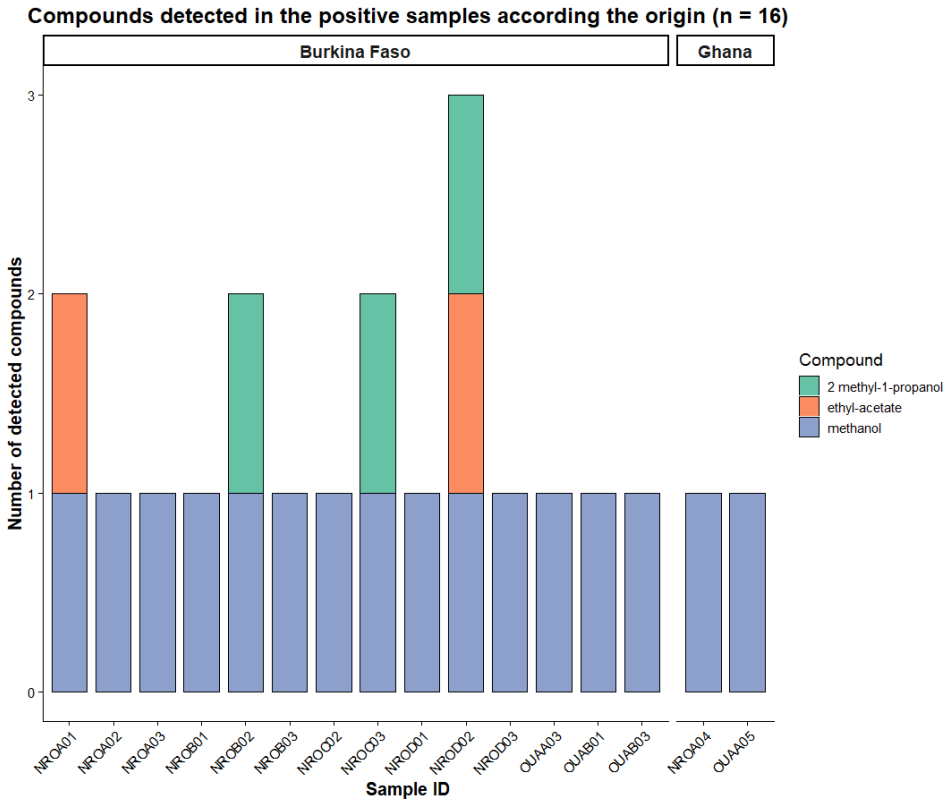

Fig. (2). Distribution of chemical compounds among collected alcoholic beverages.

3.3. Socio-demographic Characteristics of Consumers

Consumer's professional activities were classified by sector of activity. The primary sector involves the extraction or harvesting of natural resource. The secondary sector focuses on transforming raw materials into finished products. The tertiary sector is the services sector. The public sector encompasses organizations that are owned and operated by the government, providing essential services to citizens. Daily alcohol intake consists of the volume of liquor and other spirits usually drank by the consumer within the day. Consumers provided answers on how many drinks served in a measurement glass of 50 milliliters (mL) they drink daily and the number of days of consumption within the week. The characteristics of the study population are presented in Table **2**.

A total of 196 consumers were included in the study, with 124 from Ouagadougou and 72 from Nanoro. The overall mean age was 36.04 ± 13.68 years. Consumers in rural areas were older on average than those in urban settings (47.2 vs. 30.75 years). Age of consumers by study site is represented in Fig. **3**.

3.4. Alcoholic Beverage Consumption Patterns by Age

Consumers were interviewed about their drinking habit. The latter differs depending on the age and the study site. As presented in Table **3**, the number of heavy drinking consumers was higher in Nanoro than in Ouagadougou (51.38% versus 17.74%) and was represented in majority by the age group of 35 – 55+ years (45.83%) in Nanoro and the 25 -55+ age group in Ouagadougou (17.4%). In Ouagadougou, the majority of consumers had low-risk drinking (LRD) habits (69.35%) and were represented by the age group of under 25 to 34 years (61.29%). Binge drinking consumers in Ouagadougou (8.06%) were represented mainly by those aged 25 to 34 (4.83%) while in Nanoro (16.66%) those aged 45 to 54 represented the majority (6.94%). The distribution of extreme binge drinking consumers according to age in Nanoro is equitable for the age groups 25 to 34 years, 25 to 54 years, and over 55 years (1.38% for each age group). In Ouagadougou, extreme binge drinking consumers (4.83%) are mostly equally represented between those under 25 and those aged 35 to 54 (1.61% for each age group). The drinking patterns of consumers by age group and study site are presented in Table **3**.

Table 2. Characteristics of consumers by age, sector of activity and alcohol intake.

-	N	%	X^2	P value
Subjects			1013.6	<0.005
Age(years)	196	100		
Mean	36.04			
Sd	13.68			
Sector of activity			56.796	<0.005
Primary sector	49	25		
Secondary sector	40	20.40		
Tertiary sector	52	26.53		
Public sector	2	1.02		
Student/Pupil	35	17.85		
Unemployed	18	9.18		
Daily spirit intake volume (ml)			95.531	<0.005
50-	32	16.32		
100 - 150	89	45.40		
200 - 300	45	22.95		
350 – 500	17	8.67		
500+	13	6.63		
User type			115.88	<0.005
Low Risk drinking (LRD)	106	54.08		
Binge drinking	22	11.22		
Extreme binge drinking	9	4.59		
Heavy drinking	59	30.10		

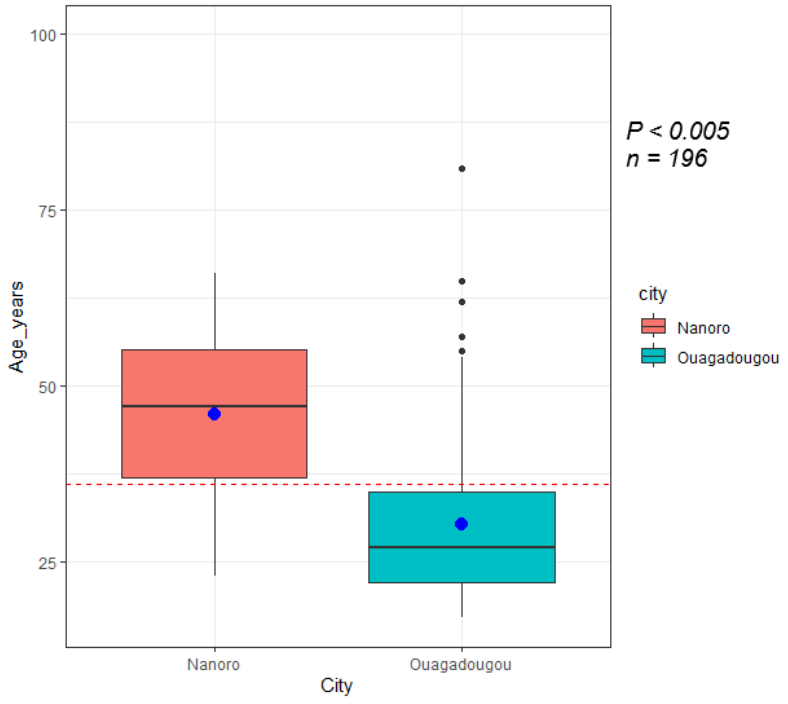

Fig. (3). Age of consumers per study site.

Table 3. Drinking patterns by age group and study site according NIAAA.

-	-	Consumption pattern				Kruskal-Wallis Test	
Study site	Age group (years)	LRD	Binge drinking	Extreme binge drinking	Heavy drinking	X^2	P- value
Ouagadougou	25 – 34	35	6	1	4		
	35 – 44	9	2	0	6		
	45 – 54	1	1	2	6		
	55+	0	0	1	6		
	Under 25	41	1	2	0	57.881	<0.005
Nanoro	25 – 34	5	1	1	4		
	35 – 44	6	2	0	12		
	45 – 54	2	5	1	13		
	55+	6	4	1	8		
	Under 25	1	0	0	0		

3.5. Alcoholic Beverage Consumption Patterns by Occupation

The primary sector records the majority of heavy drinking consumers (14.28%). The secondary sector represents 7.65% of heavy drinking consumers and the tertiary sector counts for 6.12% of heavy drinking consumers. The unemployed represents 1.53% of heavy drinking consumers and the public sector accounts for 0.51%. Extreme binge drinking consumers were distributed as follows: 1.53% for the primary sector, 1.02% for the secondary sector, 1.53% for the tertiary sector and 0.51% for the unemployed. As for binge drinking consumers, the distribution was as follows: 4.59% for the primary sector, 2.55% for the secondary sector, 2.04% for the tertiary sector, 1.02% for the unemployed and respectively 0.51% each for the public sector and pupils or students. Low Risk drinking (LRD) consumers were dominated by pupils or students with a proportion of 17.34%, followed by the tertiary sector (16.83%), then the secondary sector (9.18%), then the unemployed (6.12%) and finally the primary sector (4.59%). Consumers type of consumption patterns according to sector of activity are presented in Fig. **4**.

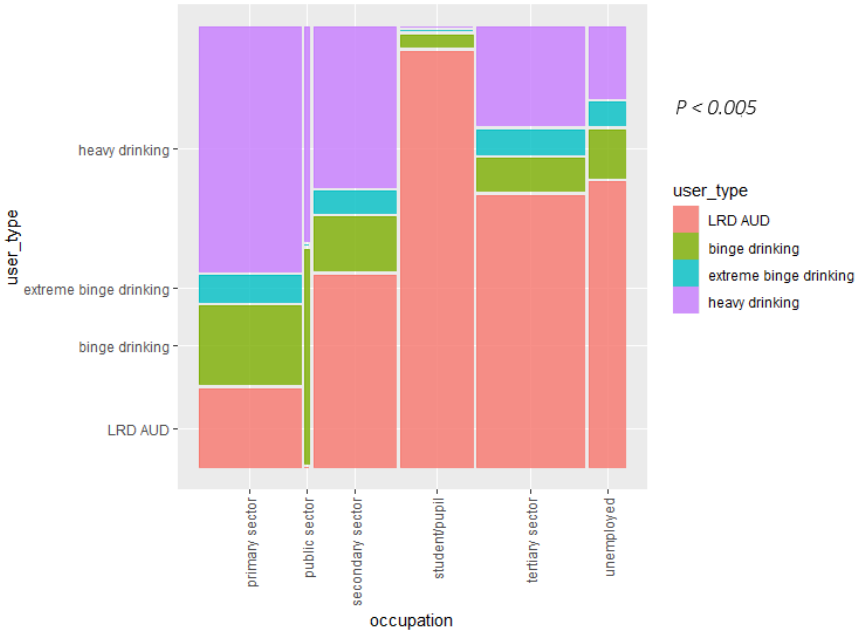

Fig. (4). Drinking patterns of consumers per sector of activity according to NIAAA guidelines (*NIAAA,2024).*

4. DISCUSSION

This study provides novel insights into the composition of low-cost alcoholic beverages and the socio-demographic characteristics of their consumers in Burkina Faso. The findings reveal a high prevalence of adulteration, particularly among locally produced beverages, representing a significant public health concern. The detection of methanol in 80% of locally produced samples is consistent with previous reports from other low- and middle-income countries (8), where adulterated alcohol has been associated with outbreaks of poisoning and mortality. Comparable outbreaks documented in Uganda in 2017 and 2022 demonstrated that methanol-adulterated locally distilled beverages caused fatality rates reaching 80% among cases, disproportionately affecting middle-aged men (8, 40). A systematic review of illicit alcohol policies has further established that methanol contamination of unrecorded beverages is a global phenomenon with a disproportionate burden in developing regions (19). These parallel reports strengthen the relevance of our findings and underscore the recurrent nature of the risk in sub-Saharan Africa. The toxicological hazard identified in this study warrants mechanistic contextualization. Methanol is oxidized in liver cells by the enzyme alcohol dehydrogenase, producing formaldehyde and then formic acid. This latter metabolite is a mitochondrial toxin that inhibits cytochrome c oxidase, thereby impairing cellular respiration in energy-demanding tissues, most critically, the optic nerve and retina (13). This mechanism explains the well-documented clinical trajectory of methanol intoxication: a latent period of 8 to 36 hours followed by sudden-onset metabolic acidosis, visual disturbances, and potentially death (13). Visual symptoms, including blurred vision progressing to blindness, occur in approximately 50% of methanol poisoning cases (13). The presence of additional compounds detected, including 2-methyl-1-propanol and ethyl acetate, could worsen the toxicity of these adulterated drinks. While their independent lethal doses have not been definitively established, acute exposure to 2-methyl-1-propanol is associated with central nervous system depression, and chronic exposure has shown carcinogenic potential in animal models (3, 11, 32). Ethyl acetate exposure causes mucosal irritation, cardiovascular instability, and liver damage (11, 16, 38). The combined presence of these substances in adulterated beverages therefore represents a polysubstance toxic exposure whose cumulative health risks remain inadequately characterized. The health risks associated with each detected compound are summarized in Table **4**. The significantly higher adulteration rate among locally produced beverages (80%) compared to imported Ghanaian products (22.22%) reflects structural weaknesses in domestic regulatory oversight. Although Ministerial Decree No. 2021-00381/MICA/MS/MEEVCC/MATD mandates pre-market laboratory analysis for all producers and importers, compliance and enforcement remain inconsistent. Evidence from other African settings suggests that this pattern is not unique to Burkina Faso. Similarly, in west Africa more broadly, weak implementation of alcohol licensing and surveillance systems has been identified as a primary structural driver of illicit alcohol availability (39). The WHO Global Alcohol Action Plan 2022–2030 has specifically called upon governments in the African Region to establish licensing systems that systematically monitor production, importation, and sale, and to set legal blood alcohol concentration standards, highlighting the urgency of strengthening regulatory infrastructure (39).

From a socio-demographic perspective, this study highlights significant differences between urban and rural populations in Burkina Faso, regarding alcohol consumption. Rural consumers in Nanoro were older on average (47.2 vs. 30.75 years) and exhibited significantly higher rates of heavy drinking (51.38% vs. 17.74%). This rural-urban divergence aligns with wider evidence from sub-Saharan Africa. A cross-national analysis using WHO STEPS survey data from twelve African countries found that rural residents reported higher illicit alcohol use (12.6%) compared to urban dwellers (4.9%), and that prevalence increased with age and was consistently higher in males (28). The same study identified self-employed individuals as disproportionately likely to use illicit alcohol, a finding that resonates with our observation that primary and secondary sector workers accounted for the majority of heavy drinkers in the present cohort. Occupational context is a plausible explanatory factor: agricultural laborers may face limited access to formal social and recreational infrastructure, and seasonal income instability may create conditions favorable to increased alcohol consumption during periods of lower farming activity (30, 37). A systematic review and meta-analysis of alcohol use and disorders across sub-Saharan Africa further documented that adult lifetime prevalence of alcohol use is nearly 35%, with considerable heterogeneity driven by socio-

demographic and contextual factors, confirming that age and occupation are among the most consistent determinants of consumption patterns (4). The predominance of male consumers in our sample is consistent with the broader epidemiological picture in the region: the health burden of alcohol is notably higher among men, with 7.4% of all male deaths linked to alcohol consumption compared to 1.4% among women in the African Region (28). Although women were excluded from our study due to socio-cultural constraints, it is important to acknowledge that women also consume adulterated alcoholic beverages, and their exclusion constitutes a significant limitation. The growing body of evidence on alcohol use among women in sub-Saharan Africa, driven by socio-economic transitions and increased female participation in the workforce, underscores the need for gender-inclusive surveillance in future research (33). Regarding low-risk consumers, the predominance of this pattern among students and younger urban consumers in Ouagadougou (under 25 years, 61.29% LRD) is noteworthy and may reflect protective social norms, educational influence, or simply lower purchasing power. However, even low-risk exposure to adulterated beverages carries health risks due to the presence of toxic contaminants at potentially harmful concentrations, as the minimum lethal dose of methanol is 1 g/kg body weight (11, 35).

These findings collectively suggest that prevention and regulatory strategies should be differentiated according to sociodemographic profile. Targeted interventions for agricultural and informal sector workers in rural areas, combined with community-level awareness campaigns about the specific toxicological hazards of adulterated beverages, would address the dual burden of heavy drinking patterns and chemical exposure. From a regulatory standpoint, the strengthening of laboratory surveillance capacity—particularly for local distilleries and informal vendors—should be prioritized. The experience of outbreak investigation frameworks developed in Uganda (40) and the broader policy recommendations of the WHO African Region (39) provide actionable models for adaptation in Burkina Faso. Future research should focus on addressing the key gaps identified in this study: quantifying toxic compounds to allow for dose-response assessment, extending the study to women, using larger and geographically broader samples, and longitudinally follow-up of the health effects on exposed consumers. The development of validated rapid screening tools deployable at the point of sale would additionally offer a practical complement to laboratory-based surveillance. This study provides valuable baseline data to guide integrated public health action combining regulatory enforcement, community education, and clinical awareness of the toxicological risks associated with adulterated alcoholic beverages in Burkina Faso.

Table 4. Toxicity risk assessment for consumers.

Compounds	Toxicity	References
Methanol	Formaldehyde is produced from methanol metabolic processes in the nonhuman primate brain; May cause toxic effects if inhaled or ingested. Contact with substance may cause severe burns to skin and eyes. May result in blurred vision, headache, dizziness, and nausea; Minimum lethal dose is 1 g/kg.	(11,31,35,41)
2 methyl-1-propanol	Acute exposure: CNS depression, hypotension, nausea, vomiting, and diarrhea; If aspirated: hemorrhagic pneumonitis may be noted; Chronic exposure in rats: liver carcinomas & sarcomas, spleen sarcomas, proventricular carcinomas, and myeloid leukemia; No lethal doses.	*(3,11,32)*
Ethyl acetate	Acute exposition: nose and throat irritation, nausea, ataxia, urines and feces incontinence, peripheral vascular collapse, tachycardia, hypotension; Chronic exposure: abnormalities in cornea, merely hyperemia of bulbar conjunctiva, lung, liver and heart damages; No lethal doses.	*(11,16,38)*

CONCLUSION

Adulterated alcoholic beverages are widely present in Burkina Faso, with a particularly high prevalence among locally produced products. The results showed that consumption patterns depend on age and sector of activity, with the primary sector being the most at risk of engaging in excessive alcohol consumption. The detection of methanol and other toxic compounds highlights a significant risk to public health. Efforts to address this issue should prioritize the strengthening of regulatory monitoring systems, particularly for local production, and the implementation of targeted prevention strategies based on socio-demographic risk factors. Future research should include larger and more diverse populations, including women, to provide a more comprehensive understanding of alcohol consumption patterns and associated risks.

AUTHORS' CONTRIBUTIONS

PPAV participated in the design of the study, data collection, analysis and interpretation of data and writing the first version of the manuscript; BT and AZ contributed to the design of the study and critical revision of the manuscript; HT, OL and SS revised the first version of the manuscript. MTC, AS and BY participated in the design of the study and edited the manuscript.

ETHICS APPROVAL DECLARATION

This study was conducted as part of a PhD project which has been registered by "Comité d'éthique pour l'expérimentation animale de l'Université Joseph KI ZERBO" under the reference CE-UJKZ/2023-08. Participants were interviewed in accordance with the principles of the declaration of Helsinki.

FUNDING

This research received no external funding

DATA AVAILABILITY STATEMENT

All data used during this study may be find by following links: link1, link2.

Link 1 : https://docs.google.com/spreadsheets/d/1s5A7DVBUDfPlQiw-yuycUX5smWr_jFeo/edit?rtpof=true&sd=true&pli=1&gid=1062182970#gid=1062182970

Link 2 : https://drive.google.com/file/d/1Z35zeS17ydP3oRHzSVQnFA09Uf2akr_J/view?pli=1

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study

DECLARATION OF NON-CONFLICTS OF INTEREST

The authors have not declared any conflicting interests.

REFERENCES

[1] Agarwal A, Gupta S, Sharma RK. Role of oxidative stress in female reproduction. 2005;21:1–21.

[2] Alqurashi GI, Alqurashi FS, Alhusayni KM, Falemban AH, Alhindi YZ, Alsanosi SM, *et al.* Case Reports Study on Methanol Poisoning in King Abdul Aziz Specialist Hospital, Taif, Saudi Arabia. J Clin Med. 2023 Jul 1;12(13).

[3] Astrand I, Ovrum P, Lindqvist T, Hultengren M. Exposure to butyl alcohol. Uptake and distribution in man. Scand J Work Environ Health. 1976;2(3):165–75.

[4] Belete H, Bhagavathula AS, *et al.* Alcohol use and alcohol use disorders in sub-Saharan Africa: A systematic review and meta-analysis. Addiction. 2024. doi: 10.1111/add.16514.

[5] Bonnechère B, Samadoulougou S, Cisse K, Tassembedo S, Kouanda S, Kirakoya-Samadoulougou F. Alcohol consumption and associated risk factors in Burkina Faso: Results of a population-based cross-sectional survey. BMJ Open. 2022 Feb 10;12(2).

[6] Calling S, Ohlsson H, Sundquist J, Sundquist K, Kendler KS. Socioeconomic status and alcohol use disorders across the lifespan: A co-relative control study. PLoS One [Internet]. 2019 Oct 1 [cited 2024 Sep 10];14(10). Available from: /pmc/articles/PMC6797188/

[7] Donohue TM, Kharbanda KK, Osna NA. Alcoholic Liver Disease: Pathogenesis and Current Management. Alcohol Res. 2017;38(2):147–61.

[8] Doreen B, Eyu P, Okethwangu D, Biribawa C, Kizito S, Nakanwagi M, *et al.* Fatal Methanol Poisoning Caused by Drinking Adulterated Locally Distilled Alcohol: Wakiso District, Uganda, June 2017. J Environ Public Health. 2020;2020.

[9] Euromonitor International. Alcohol in the Shadow Economy. International Alliance for Responsible Drinking. 2018;(June):1–9.

[10] Ferreira-Borges C, Parry CDH, Babor TF. Harmful use of alcohol: A shadow over sub-Saharan Africa in need of workable solutions. Int J Environ Res Public Health. 2017 Apr 1;14(4).

[11] Gosselin RE. Clinical Toxicology of Commercial Products. 5th ed. Williams, Wilkins, editors. 1984. 169–170 p.

[12] Graff-Iversen S. JMD, HDA, HG, KGP, MP, MJ, NPT, NOE, TK. Divergent associations of drinking frequency and binge consumption of alcohol with mortality within the same. J Epidemiol Community Health. 2013 Apr;67(4):350–7.

[13] Grzybowski A, Zulsdorff M, Wilhelm H, Tonagel F. Methanol-induced optic neuropathy: a still-present problem. Graefes Arch Clin Exp Ophthalmol. 2022;260(2):361-373. doi: 10.1007/s00417-021-05498-z.

[14] Gunzerath L, Faden V, Zakhari S, Warren K. National Institute on Alcohol Abuse and Alcoholism report on moderate drinking. Alcohol Clin Exp Res. 2004 Jun;28(6):829-47. doi: 10.1097/01.alc.0000128382.79375.b6. PMID: 15201626.

[15] Hajian-Tilaki K. Sample size estimation in epidemiologic studies. Caspian J Intern Med. 2011 Fall;2(4):289-98. PMID: 24551434; PMCID: PMC3895825.

[16] Jürgen Rehm. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet. 2009 Jun;373(9682):2223–33.

[17] Kleinbeck S, Juran SA, Kiesswetter E, Schäper M, Blaszkewicz M, Brüning T, *et al.* Evaluation of ethyl acetate on three dimensions: Investigation of behavioral, physiological and psychological indicators of adverse chemosensory effects. Toxicol Lett [Internet]. 2008 Nov 10 [cited 2025 May 22];182(1–3):102–9. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0378427408012563 . Accessed 2025 May 22

[18] Koehrer P, Creuzot-Garcher C, Bron AM. Methanol poisoning: two case studies of blindness in Indonesia. Int Ophthalmol. 2011 Dec;31(6):517–24.

[19] Lachenmeier DW, Kanteres F, Rehm J. Carcinogenicity of acetaldehyde in alcoholic beverages: risk assessment outside ethanol metabolism. Addiction. 2009;104(4):533-550. doi: 10.1111/j.1360-0443.2009.02516.x.

[20] Litovitz T. The Alcohols: Ethanol, Methanol, Isopropanol, Ethylene Glycol. Pediatr Clin North Am. 1986 Apr 1;33(2):311–23.

[21] Magnúsdóttir, Kristín & Kristinsson, Jakob & Jóhannesson, Borkell. (2010). Adulterated alcoholic beverages. Læknablaðið. 96. 626-8.

[22] M. O. Alcools frelatés au Burkina : L'importation se poursuit malgré l'interdiction. LEFASONET [Internet]. 2021 Jan 23 [cited 2024 Sep 19]; Available from: https://lefaso.net/spip.php?article102188#:~:text=Sopal%2C%20lion%20d'or%2C,petit%20feu%20la%20jeunesse%20burkinab%C3%A8. Accessed 2024 Sep 19.

[23] Mathilde Touvier. Demographic, socioeconomic, disease history, dietary and lifestyle cancer risk factors associated with alcohol consumption. Wiley. 2013 Jul 3;134(2):445–59.

[24] Neo K Morojele. Alcohol consumption, harms and policy developments in sub-Saharan Africa: The case for stronger national and regional responses. Drug Alcohol Rev . 2021 Feb 25;40(3):402–19.

[25] Obissa Juste Mien. Consommation d'alcools frelatés au Burkina : Pourquoi toujours ce regain malgré l'interdiction ? Radars Info Burkina [Internet]. 2020 Feb 21 [cited 2024 Sep 19]; Available from: https://www.radarsburkina.net/index.php/fr/societe/1971-consommation-d-alcools-frelates-au-burkina-pourquoi-toujours-ce-regain-malgre-l-interdiction Accessed 2024 Sep 19.

[26] Osna NA, Affairs V, Health N western I, Donohue TM, Affairs V, Health N western I, *et al.* Alcoholic Liver Disease : Pathogenesis and Current Management. 1996;1:147–61.

[27] Ouattara ZD, Koura M, Serme AK, Somda KS, Coulibaly A, Zoungrana SL, *et al.* Sociodemographic Factors of Alcohol Consumption in a Population of Hospitalized Patients in Ouagadougou (Burkina Faso). Open J Gastroenterol. 2017;07(03):96–104.

[28] Owusu-Kwarteng YA, Mustapha S, *et al.* The prevalence and patterns of illicit alcohol consumption in twelve African countries: Evidence from WHO STEPS Surveys (2014-2019). medRxiv. 2026. doi: 10.64898/2026.01.16.26344252.

[29] Roldán J, Frauca C, Dueñas A, Roldán Ramírez J. Suplemento 1 Palabras clave. Vol. 26, Etanol. Metanol. Intoxicación. Fomepizol. Etilenglicol. ANALES Sis San Navarra. 2003.

[30] Romuald Boua P, Debpuur C, Nkoana S, Asiki G, Mickelseld LK, *et al.* Prevalence and Socio-Demographic Correlates of Tobacco and Alcohol Use in Four Sub-Saharan African Countries: A Cross-Sectional Study of Middle-Aged Adults. BMC Public Health 21, 1126(2021). https://doi.org/10.1186/s12889-021-11084-1

[31] Samanta SK, Fariduddin K, Mahapatra N, Bhunia J, Mondal P. Hooch blindness: a community study report on a few indoor patients of toxic optic neuropathy following consumption of adulterated alcohol in West Bengal. Nepal J Ophthalmol. 2012 Jan-Jun;4(1):162-4. doi: 10.3126/nepjoph.v4i1.5868. PMID: 22344014.

[32] Snyder R. Toxicity and Metabolism of Industrial Solvents. second edition. Ethel Browning's, editor. Vol. 3. New York: Elsvier; 1992. 46–46 p.

[33] Seekles W, Mhangara M, Mburu G, *et al.* Measuring alcohol use among adolescents in Africa: A systematic scoping review. Drug Alcohol Rev. 2023;42(7):1756-1768. doi: 10.1111/dar.13715

[34] Subramaniyan V, Chakravarthi S, Jegasothy R, Seng WY, Fuloria NK, Fuloria S, *et al.* Alcohol-associated liver disease: A review on its pathophysiology, diagnosis and drug therapy. Toxicol Rep. 2021;8(February):376–85.

[35] Tephly TR. The toxicity of methanol. Life Sci [Internet]. 1991;48(11):1031–41. Available from: https://www.sciencedirect.com/science/article/pii/0024320591905045

[36] Tumwesigye, Nazarius Mbona. Alcohol consumption patterns: Do neighborhoods matter? A multilevel analysis of alcohol consumption patterns in Uganda . : AfDB , 2013. African Statistical Journal / Journal statistique africain, Vol. 16, May/mai 2013, pp. 46-60 - Available at: https://library.au.int/alcohol-consumption-patterns-do-neighborhoods-matter-multilevel-analysis-alcohol-consumption-4

[37] Vignesh BT, Singh AK, Mohan SK, Murthy S, Joshi A. Association between socio-demographics and alcohol dependence among individuals living in an Indian setting. Glob J Health Sci. 2014 Jan 23;6(3):16-26. doi: 10.5539/gjhs.v6n3p16. PMID: 24762342; PMCID: PMC4825467.

[38] W. Morton Grant. Toxicology of the Eye. 3rd ed. Charles C, editor. Springfield; 1986. 412–412 p.

[39] World Health Organization Regional Office for Africa. Framework for implementing the Global Alcohol Action Plan 2022-2030 in the WHO African Region. AFR/RC73/8. Brazzaville: WHO AFRO; 2023.

[40] Zavuga R, Kiggundu T, Ninsiima M, *et al.* Methanol poisoning caused by adulteration of alcohol at production stage in a factory in North Western Uganda, August 2022. Uganda Natl Inst Public Health Q Epidemiol Bull. 2022;7(4):Article 1.

[41] Zhai R, Zheng N, Rizak J, Hu X. Evidence for Conversion of Methanol to Formaldehyde in Nonhuman Primate Brain. Analytical Cellular Pathology. 2016;2016.