

CONSUMER PERCEPTION OF BOTTLED DRINKING WATER QUALITY IN THE REPUBLIC OF MOLDOVA

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Summary

The population's perception of drinking water quality directly influences decisions related to consumption, hygiene, and the use of alternatives, as well as trust in water suppliers. In the Republic of Moldova, the diversity of sources and variability in water quality require authorities to ensure transparent communication and effective regulation to maintain public trust and protect population health. A descriptive, cross-sectional epidemiological study was conducted during 2024-2025 on a sample of 420 adults. Data were collected online through a structured questionnaire focused on the population's perception of bottled drinking water quality and its health implications. Statistical analysis was performed using SPSS, employing descriptive and comparative methods, while adhering to current ethical standards. The sample was predominantly composed of women (82.9%) and individuals from urban areas. Approximately half of the respondents considered themselves informed about the quality of bottled drinking water, and the majority reported reading the label at least occasionally and taking the chemical composition of the water into account. Calcium and magnesium were the most frequently mentioned substances of interest, but there were also concerns about possible contamination with heavy metals, solvents, or chemicals. Over 85% of participants shared perceptions regarding the impact of climate change on water quality (through floods, drought, and pollution). The study highlights the population's concern about the quality of bottled drinking water and the diversity of consumption attitudes, emphasizing the need for information campaigns and health education supported by authorities.

Keywords: drinking water, population perception, quality, mineral composition, public health, information

Rezumat

Percepția consumatorilor asupra calității apei potabile îmbuteliate în Republica Moldova

Percepția populației asupra calității apei potabile influențează direct deciziile legate de consum, igienă și utilizarea alternativelor, precum și încrederea în furnizorii de apă. În Republica Moldova, diversitatea surselor și variabilitatea calității apei impun autorităților nevoia de comunicare transparentă și reglementare eficientă pentru a menține încrederea publică și a proteja sănătatea populației. A fost realizat un studiu epidemiologic descriptiv, de tip transversal, în perioada 2024-2025, pe un eșantion de 420 de adulți. Datele au fost colectate online printr-un chestionar structurat, axat pe percepția populației asupra calității apei potabile îmbuteliate și implicațiile asupra sănătății. Analiza statistică a fost realizată cu SPSS, utilizând metode descriptive și comparative, cu respectarea normelor

etice în vigoare. Eșantionul a fost compus majoritar din femei (82,9%) și persoane din mediul urban. Aproximativ jumătate dintre respondenți s-au considerat informați cu privire la calitatea apei potabile îmbuteliate, iar majoritatea au susținut că citesc eticheta cel puțin ocazional și au luat în considerare compoziția chimică a apei potabile. Calciul și magneziul au fost cele mai frecvent menționate substanțe de interes, dar există și preocupări legate de posibile contaminări cu metale grele, solvenți sau substanțe chimice. Percepțiile privind influența schimbărilor climatice asupra calității apei (prin inundații, secetă și poluare) au fost împărtășite de peste 85% dintre participanți. Studiul evidențiază îngrijorarea populației față de calitatea apei potabile îmbuteliate și diversitatea atitudinilor de consum, subliniind necesitatea unor campanii de informare și educație pentru sănătate susținute de autorități.

Cuvinte-cheie: apă potabilă, percepția populației, calitate, compoziție minerală, sănătate publică, informare

Резюме

Восприятие качества бутилированной питьевой воды потребителями в Республике Молдова

Восприятие населением качества питьевой воды напрямую влияет на поведение потребителей: выбор источника, соблюдение гигиены, использование альтернатив, а также на уровень доверия к поставщикам воды. В Республике Молдова разнообразие источников и изменчивость качества питьевой воды требуют от властей прозрачной коммуникации и эффективного регулирования для поддержания общественного доверия и защиты здоровья населения. Было проведено описательное эпидемиологическое поперечное исследование в период 2024-2025 годов на выборке из 420 взрослых участников. Данные собирались онлайн с помощью структурированной анкеты, сосредоточенной на восприятии населением качества бутилированной питьевой воды и её возможных последствий для здоровья. Статистический анализ выполнялся с использованием программы SPSS, с применением описательных и сравнительных методов, при соблюдении действующих этических норм. Основную часть выборки составили женщины (82,9%) и жители городских районов. Около половины респондентов считали себя информированными о качестве бутилированной питьевой воды, а большинство отметили, что хотя бы время от времени читают этикетку и принимают во внимание химический состав воды. Наиболее часто упоминались кальций и магний как вещества, представляющие интерес, однако также выражалась обеспокоенность возможным загрязнением тяжёлыми металлами, растворенными

телями и другими химическими веществами. Более 85% участников разделяли мнение о влиянии климатических изменений на качество воды через наводнения, засуху и загрязнение. Исследование подчёркивает обеспокоенность населения качеством бутилированной питьевой воды и разнообразие потребительских установок, подчёркивая необходимость проведения информационных кампаний и мероприятий по санитарному просвещению при поддержке государственных органов.

Ключевые слова: питьевая вода, восприятие населения, качество, минеральный состав, общественное здоровье, информирование

Introduction

The population's perception of drinking water quality is an important factor in shaping consumption behavior, water resource management policies, and public health interventions. The link between drinking water quality and human health is clearly established, and the World Health Organization (WHO) has emphasized that „all people, regardless of their level of development or social and economic conditions, have the right to access an adequate source of safe drinking water” [1].

In the Republic of Moldova, drinking water quality remains a pressing public health concern. Government data from 2017–2022 show that around 65% of chemical samples from artesian wells were non-compliant (nitrates 5%, fluoride 28%, iron 7.2%), while 20% of microbiological samples also failed to meet standards, with higher rates recorded in districts such as Anenii Noi, Făleşti and Râşcani [2 - 5]. This situation has undermined public confidence in centralised water supplies and contributed to a marked increase in bottled water consumption, perceived as a safer though more costly alternative.

Public trust in responsible institutions, such as agencies and state bodies, water suppliers, and other involved entities, is essential for maintaining the functionality of water supply systems [6]. State agencies implement the regulatory framework concerning safe drinking water, which includes several initiatives such as water source assessments and state-level compliance reports. To understand and improve the population's perception of drinking water quality, annual reports on consumer trust are necessary [7].

In this context, clear communication, rigorous regulation, and institutional responsibility become fundamental pillars in building and maintaining public trust [8]. Once this trust is compromised, people seek alternatives. This trend generates not only economic and social consequences but also negative effects on health and the environment.

Perception of water quality also influences other health-related behaviours, including hygiene

practices and decisions regarding water filtration or replacing it with alternative beverages. This perception is shaped by a variety of factors: the sensory characteristics of water (taste, smell, colour), past experiences related to water quality, the level of trust in service providers, perceived risks, and the influence of mass media or social networks [8]. Perceptions of water quality are closely linked to socioeconomic factors such as education, income, minority status, and ethnicity [10].

In this context, understanding consumers' perceptions of drinking water quality becomes essential for public authorities, water suppliers, and policymakers. Knowing these perceptions enables the development of more effective communication policies and strategies that can address public concerns, strengthen trust, and contribute to ensuring equitable access to safe drinking water for all social groups. Promoting transparency, effective regulation, and community engagement can support the development of a sustainable water management system adapted to current and future challenges.

The aim of the study is to assess the perception of the population in the Republic of Moldova regarding the quality of drinking water by identifying the factors that influence this perception and the associated consumption behaviors. The study intends to provide relevant data to support public health policies and to improve communication about the safety and quality of drinking water.

Materials and methods

To achieve the general objective of the research, a descriptive epidemiological cross-sectional study was conducted during the period 2024–2025. The study was based on a survey addressed to the general adult population of the Republic of Moldova, from both urban and rural areas. This survey was an integral part of a doctoral research project, currently at the intermediate implementation phase. Methodologically, a series of complementary scientific techniques were employed: descriptive and comparative methods, alongside sociological, mathematical, and statistical methods, which allowed for rigorous data collection and analysis.

The sample consisted of 420 adult individuals, selected based on two main inclusion criteria: a minimum age of 18 years and providing informed consent to participate in the research. Participants were selected through a convenience sampling method, based on self-recruitment. The sample size was determined using the standard formula for prevalence studies: $n = P(1-P) (z/e)^2$, where $P = 50.0\%$ (0.5), $z = 1.96$ for a 95% confidence level, $e = 0.05$, and with an estimated non-response rate of 10.0%. Data

were collected online via a Google form distributed among the adult population of the Republic of Moldova. The research instrument, an original questionnaire developed for the study, was structured in four sections and included 60 questions with predefined answers and the possibility of multiple selections: (i) socio-demographic data; (ii) information on bottled drinking water consumption; (iii) population perception of drinking water quality; (iv) bottled drinking water and health. The central point of interest of the study was the population perception of the quality of bottled drinking water, in the context of consumption behaviour and health implications. This section included 20 questions, but this paper focused on 8 of the most informative questions. The research was conducted in accordance with the ethical standards in force and was approved by the Research Ethics Committee of the „Nicolae Testemitanu” State University of Medicine and Pharmacy, through decision no. 1 dated 09.10.2023. Participation in the study was voluntary, and the confidentiality of personal data was fully ensured.

Statistical analysis was performed using licensed SPSS software, employing descriptive statistical methods. For qualitative variables, absolute and relative values, 95% confidence intervals, and statistical significance at $p < .05$ were calculated. Parametric and non-parametric statistical tests were applied to compare the distribution of responses between men and women.

Results

The sample consisted of 420 participants. The gender distribution showed a predominance of females, representing 82.9% ($n=348$; 95% CI: 79.0-86.2) of the total participants, compared to 17.1% ($n=72$; 95% CI: 13.8-21.0) males. Participants' ages ranged from 19 to 69 years, with a mean age of 36.22 years (Standard Error = 0.54; Standard Deviation = 11.15). This suggests a predominantly adult sample with moderate variability. Analysis of participant distribution by place of residence indicated that the majority of respondents came from urban areas. Specifically, 75.7% ($n=318$; 95% CI: 71.4-79.6) reported living in urban areas, while 24.3% ($n=102$; 95% CI: 20.4-28.6) declared residing in rural areas.

According to occupational status, 68.6% ($n=288$; 95% CI: 64.0-72.9) of the participants were employed, while 31.4% ($n=132$; 95% CI: 27.1-36.0) were not employed at the time of the study.

The analysis of respondents' education level revealed a clear predominance of individuals with higher education. Thus, 72.1% ($n=303$; 95% CI: 67.7-76.3) of participants reported having completed university studies, indicating a sample largely cha-

racterized by a high level of formal education. Equal proportions of 13.6% ($n=57$; 95% CI: 10.5-17.1) were recorded among respondents with secondary (high school) education and those with specialized vocational training. A very small percentage reported lower secondary (gymnasium-level) education – 0.7% ($n=3$; 95% CI: 0.2-1.9), and no respondent declared having no formal education.

Regarding the average monthly income of the respondents' households, the analysis revealed a significantly uneven distribution, with a majority concentrated in the higher income categories. Specifically, 57.1% ($n=240$; 95% CI: 52.4-61.8) of respondents reported that their family's monthly income exceeded 10,000 MDL. A relatively substantial proportion – 24.3% ($n=102$; 95% CI: 20.4-28.6) indicated a monthly income between 7,000 and 10,000 MDL, followed by 7.1% ($n=30$; 95% CI: 5.0-9.9) in the 5,000-7,000 MDL range. Income between 3,000 and 5,000 MDL was reported by 5.7% ($n=24$; 95% CI: 3.8-8.2) of respondents, while 5.0% ($n=21$; 95% CI: 3.2-7.4) declared a household income between 1,000 and 3,000 MDL. Only 0.7% ($n=3$; 95% CI: 0.2-1.9) reported a monthly income below 1,000 MDL, which may reflect either a precarious economic situation or a lack of economic activity at the time.

The analysis of responses to the question regarding consumer awareness of the quality of bottled drinking water reveals a predominant concern among participants. Specifically, 55.7% ($n=234$; 95% CI: 50.9-60.4) of respondents stated that they are informed about the quality of the bottled water they consume. In contrast, 40.7% ($n=171$; 95% CI: 36.1-45.5) indicated that they do not have information about the quality of the water they purchase. A small proportion, 3.6% ($n=15$; 95% CI: 2.1-5.7), reported that they are not interested in this issue.

Regarding the perception of the mineral content in bottled drinking water, the majority of respondents – 71.4% ($n=300$; 95% CI: 67.0-75.6) believe that it contains mineral substances. On the other hand, 13.6% ($n=57$; 95% CI: 10.5-17.1) indicated that they do not believe bottled water contains minerals. An identical proportion – 13.6% ($n=57$; 95% CI: 10.5-17.1) stated that they do not know whether or not bottled water contains such substances, highlighting an area of uncertainty or lack of clear information. A small number of participants – 1.4% ($n=6$; 95% CI: 0.62-2.9) declared themselves indifferent to this issue, suggesting a low level of interest in the qualitative characteristics of the water they consume.

In relation to the perception of potential contamination of bottled drinking water with petroleum (Table 1), only 10.0% of respondents answered affirmatively, 60.0% denied this possibility, and

29.3% stated that they did not know. Only women (12.1%) considered that the water might contain petroleum, while no male respondents gave this answer. The gender-based differences in perception were statistically significant ($\chi^2=39.43$; $p<.001$), with women expressing a higher degree of uncertainty and concern regarding this potential risk.

Regarding the potential contamination of bottled drinking water with solvents (Table 1), 27.9% of respondents answered affirmatively, 35.0% denied it, and 36.4% stated that they did not know. Women were more likely to consider that the water might contain solvents (23.6% compared to 4.3% of men) and exhibited a higher degree of uncertainty. The gender-based differences in perception were statistically significant ($\chi^2=20.78$; $p<.001$).

To the question regarding the possible presence of chemical substances in bottled drinking

A quarter of respondents (25.0%) believe that bottled drinking water may contain heavy metals (Table 1), while 41.4% answered negatively and 32.9% stated that they did not know. Women indicated this possibility more frequently (22.9%) compared to men (2.1%). Gender-based differences were statistically significant ($\chi^2=49.02$; $p<.001$).

The majority of respondents (85.7%) believe that floods, as an effect of climate change, can influence the quality of drinking water. Only 7.1% do not share this opinion, and another 7.1% are unsure. The analysis of gender differences revealed a statistically significant association ($\chi^2=29.443$; $p<.001$). While 13.6% of male respondents expressed this view, the proportion was 72.1% among women. No male respondent selected the „don't know" option, compared to 30 women (7.1% of the total).

Table 1

The population's perception regarding the possible contamination of bottled drinking water

Respondents' opinions on the questions	Yes	No	Don't know	Indifferent regarding the issue	Total
<i>Do you believe that bottled drinking water can contain: [petroleum] $\chi^2=39.43$; $p<.001$</i>					
male	0	60 (14.3%)	9 (2.1%)	3 (0.7%)	72 (17.1%)
female	42 (10.0%)	192 (45.7%)	114 (27.1%)	0	348 (82.9%)
Total	42 (10.0%)	252 (60.0%)	123 (29.3%)	3 (0.7%)	420 (100%)
<i>Do you believe that bottled drinking water can contain: [solvents] $\chi^2=20.78$; $p<.001$</i>					
male	18 (4.3%)	33 (7.9%)	18 (4.3%)	3 (0.7%)	72 (17.1%)
female	99 (23.6%)	114 (27.1%)	135 (32.1%)	0	348 (82.9%)
Total	117 (27.9%)	252 (35.0%)	153 (36.4%)	3 (0.7%)	420 (100%)
<i>Do you believe that bottled drinking water can contain: [chemical substances] $\chi^2=48.86$; $p<.001$</i>					
male	30 (7.1%)	36 (8.6%)	3 (0.7%)	3 (0.7%)	72 (17.1%)
female	156 (37.1%)	78 (18.6%)	114 (27.1%)	0	348 (82.9%)
Total	186 (44.3%)	114 (27.1%)	117 (27.9%)	3 (0.7%)	420 (100%)
<i>Do you believe that bottled drinking water can contain: [heavy metals] $\chi^2=49.02$; $p<.001$</i>					
male	9 (2.1%)	51 (12.1%)	9 (2.1%)	3 (0.7%)	72 (17.1%)
female	96 (22.9%)	123 (29.3%)	129 (30.7%)	0	348 (82.9%)
Total	105 (25.0%)	174 (41.4%)	138 (32.9%)	3 (0.7%)	420 (100%)

water (Table 1), 44.3% of respondents answered affirmatively, 27.1% said „no," and 27.9% did not know how to respond. The answer „yes" was much more frequent among women (37.1%) compared to men (7.1%). The gender-based differences were statistically significant ($\chi^2=48.86$; $p<.001$).

A high proportion of respondents (85.0%) believe that droughts, as a phenomenon associated with climate change, can influence the quality of drinking water, while only 7.9% deny this possibility. The proportion of those undecided („don't know") is 7.1%. Statistical analysis indicates a significant association

between biological sex and responses ($\chi^2=6.898$; $p=.032$), although the differences between response proportions are not marked as significant within each individual category. Women expressed this belief more frequently (72.1%) compared to men (12.9%), but the overall distribution of responses is relatively similar between the two genders.

The majority of respondents (88.6%) believe that pollution, as a phenomenon exacerbated by climate change, affects the quality of drinking water. Only 5.7% deny this connection, and another 5.7% state that they do not know. The chi-square analysis indicates a statistically significant association between biological sex and perception of this issue ($\chi^2=11.979$; $p=.003$). Women express this belief at a higher rate (73.6%) compared to men (15.0%). However, for the „no“ and „don't know“ responses, the proportion differences between genders are significant only within certain categories, according to the post-hoc analysis.

To the question „Do you usually read the label on the bottled drinking water before purchasing it?“, the responses were varied. The most common answers were „sometimes“ – 37.9% ($n=159$; 95% CI: 33.3-42.6) and „rarely“ – 20.2% ($n=85$; 95% CI: 16.6-24.3), while only 11.7% ($n=49$; 95% CI: 8.9-15.0) stated that they do this „very often“, and 16.7% ($n=70$; 95% CI: 13.3-20.5) – „often“. A percentage of 13.6% ($n=57$; 95% CI: 10.5-17.1) reported that they „never“ read the label.

Analyzing respondents' perceptions of the content on bottled drinking water labels revealed a diversity of opinions. Specifically, 35.7% ($n=150$; 95% CI: 31.2-40.4) of participants consider the label information to be clear, indicating a good understanding of the data presented. Nearly a quarter of respondents, 22.9% ($n=96$; 95% CI: 19.0-27.1), find the label content informative, highlighting the usefulness of the information in making consumption decisions. On the other hand, a significant proportion, 27.1% ($n=114$; 95% CI: 23.1-31.5), believe the label is unclear, suggesting potential difficulties with the accessibility or wording of the information. A smaller percentage, 9.3% ($n=39$; 95% CI: 6.8-12.3), perceive the content as uninformative, while a minor segment of 5.0% ($n=21$; 95% CI: 3.2-7.4) show no interest in the information displayed.

The vast majority of respondents – 333 (79.3%; 95% CI: 75.2–83.0) – reported that information on the chemical composition of bottled water (both mineral and still) influences their purchasing decisions. According to national regulations, the declaration of chemical composition on the label is mandatory for natural mineral water and spring water, whereas for bottled drinking water this requirement is not standardised, which may limit the level of consumer

awareness. Nevertheless, the findings highlight a strong public interest in water quality and concern for its mineral content. In contrast, a smaller proportion – 39 individuals (9.3%; 95% CI: 6.8-12.3) reported that they do not take the chemical composition into account when choosing a product. Only 3.6% ($n=15$; 95% CI: 2.1-5.7) of respondents stated that they are not interested in this issue, while 7.9% ($n=33$; 95% CI: 5.6-10.7) admitted they do not know whether this characteristic influences their choice.

The results of the response analysis highlight a variety of criteria regarding the population's preferences related to the mineral composition of bottled water. Predominantly, respondents stated that they choose water based on its calcium (Ca) and magnesium (Mg) content, which are considered essential for bone health, the nervous system, and maintaining electrolyte balance. A significant proportion of participants also consider other essential electrolytes such as potassium (K) and sodium (Na), recognizing their importance for muscle function and blood pressure regulation. Additionally, a considerable number of respondents mention fluoride (F) as an element of interest for the prevention of dental caries, although in higher doses it may raise concerns regarding long-term consumption safety. A separate category of respondents shows interest in a more complex mineral composition, which includes, besides Ca, Mg, K, and Na, elements such as iron (Fe), zinc (Zn), iodine (I), as well as chlorides, sulphates, or manganese (Mn). These consumers appear to have a higher level of knowledge and a greater concern for nutritional balance and water quality. At the same time, an important segment of the surveyed population states that they do not base their choice on mineral content, either due to lack of information or disinterest in these chemical details. Some admit that they „do not know“ which minerals would be relevant or useful, which may reflect a need for health education on conscious water consumption. Thus, calcium and magnesium are the most frequently mentioned factors in choosing bottled drinking water, followed by potassium, sodium, and fluoride.

Discussions

The study results highlight the perceptions and preferences related to the consumption of bottled drinking water among a sample of respondents from the Republic of Moldova. The majority of participants stated that they choose bottled water based on criteria of quality, taste, and safety, indicating a clear concern for health and personal well-being.

A high level of education (72.1%) and above-average income (57%) support health literacy and interest in water quality, as seen in European studies

where perception of water quality positively correlates with attention to health and the social environment [11]. Interestingly, women demonstrated a stronger tendency to consider bottled water safer than tap water, with significantly greater concerns regarding contamination of water with petroleum, solvents, chemicals, and heavy metals. These gender differences are consistent with studies from the USA and Europe, which show greater sensitivity among women to health risks related to water [12].

The results obtained highlight the predominant perception among respondents that climate change negatively affects drinking water quality through extreme events such as floods, droughts, and increased pollution [13]. Over 85% of participants associated these phenomena with the degradation of drinking water, and statistical analysis revealed significant differences between the responses of men and women, with women demonstrating a higher degree of awareness and concern. These perceptions are supported by global data confirming the actual deterioration of water quality in various regions: in India, droughts have led to alarming increases in nitrate levels and bacterial contamination; in Europe, global warming has promoted the proliferation of toxic algae; and in North America, changes in precipitation patterns have resulted in increased concentrations of heavy metals such as lead [13].

The finding that packaging and brand reputation significantly influence consumer choices [14], especially among women, is also supported by the specialized literature, which emphasizes the importance of branding and quality perception in consumption decisions. Women tend to pay more attention to labels and product origin, aspects associated with preventive and health-oriented behaviour [11]. The study of labels mainly „sometimes” or „rarely” and the importance of brand reputation reflect responsible but inconsistent behaviour. Saylor et al. (2011) demonstrate that sensory perceptions and brand image are major factors in water choice [15]. This suggests opportunities for consumer education aimed at encouraging the reading of essential health-related information.

Significant gender differences in risk perception associated with tap water and trust in alternative water sources suggest the need for tailored education and information campaigns adapted to consumer profiles. For example, since women are more likely to perceive bottled water as safer, this insight can be leveraged in strategies promoting quality water regardless of its source as well as to counteract possible misconceptions.

The significant proportion of informed respondents (55.7%) reflects the level of education and access to information, but the lack of awareness

among 40.7% underscores the need for awareness campaigns, as suggested by Doria (2006) in the Quebec study, which indicates that satisfaction with water quality is directly influenced by knowledge and effective communication [16].

Limitations

The study has several limitations. First, the sample may lack representativeness, as the online distribution of the questionnaire could exclude certain population groups (older adults, rural residents, or those without internet access). Second, the predominance of female participants and individuals with higher education may introduce selection bias. These factors require the results to be interpreted as indicative trends rather than as estimates generalizable to the entire population.

Conclusion

The study highlights a moderate to high level of concern among the participating population regarding the quality of bottled drinking water, particularly in relation to potential pollution risks. Although the responses cannot be considered representative of the entire adult population of the Republic of Moldova, the identified trends provide useful insights into consumer perceptions.

An informed minority focuses on the mineral composition of water (Ca, Mg, K, Na, F), while many consumers do not, reflecting diverse attitudes towards bottled water quality. These findings should be viewed in light of regulations on mandatory labelling of chemical composition.

The findings highlight the need for targeted health education and transparent, evidence-based communication to enable consumers to make informed choices about water sources.

Declaration of conflict of interest

The authors declare no conflict of interest.

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