Microbiological contamination of improved water sources, Mozambique

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Objective To assess if water from improved sources are microbiologically safe in Niassa province, Mozambique, by examining the presence of total coliforms in different types of water sources.

Methods We conducted a cross-sectional household survey in two rural districts of Niassa province during the dry season, from 21 August to 4 October 2019. We observed water sources and conducted microbiological water quality tests and structured household interviews.

Findings We included 1313 households, of which 812 (61.8%) used water from an improved source. There was no significant difference in presence of total coliforms between water sampled at improved and unimproved water sources, 62.7% (509 samples) and 65.7% (329 samples), respectively (P-value = 0.267). Households using improved water sources spent significantly longer time collecting water (59.1 minutes; standard deviation, SD: 55.2) than households using unimproved sources (49.8 minutes; SD: 58.0; P-value < 0.001). A smaller proportion of households using improved sources had access to water sources available 24 hours per day than that of households using unimproved sources, 71.7% (582 households) versus 94.2% (472 households; P-value < 0.001). Of the 240 households treating water collected from improved sources, 204 (85.4%) had total coliforms in their water, while treated water from 77 of 107 (72.0%) households collecting water from an unimproved source were contaminated.

Conclusion Current access to an improved water source does not ensure microbiological safety of water and thereby using access as the proxy indicator for safe drinking and cooking water is questionable. Poor quality of water calls for the need for integration of water quality assessment into regular monitoring programmes.

Introduction

For more than 40 years, ensuring populations’ access to safe drinking water has been on the global agenda. Access to safe drinking water was recognized as a key public health intervention in the Declaration of Alma-Ata in 1978 and the United Nations (UN) International Drinking Water Supply and Sanitation Decade 1981–1990. More recently the millennium development goal 7 covered access to safe water, and the sustainable development goal 6 (SDG 6) – ensure availability and sustainable management of water and sanitation for all – has attracted attention from both governmental and private sectors.

Since 1990 access to safe drinking water has been monitored through the World Health Organization and United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation. The definition used for measuring the proportion of the population using safely managed drinking water services is “the proportion of the population using improved drinking water facilities that accesses those facilities with a collection time of 30 minutes or less.” The programme lists piped water, boreholes or tube wells, protected dug wells, protected springs, rainwater and packaged or delivered water as improved water sources. According to the definition, water from improved sources needs to be free from faecal (total coliforms including Escherichia coli) and priority chemical contamination (arsenic and fluoride). However, the question arises whether water from improved water sources is free from total coliforms. In 2012, the programme proposed integration of water quality testing into nationally representa-
Sample size and sampling

In Niassa province, 43.5% of households had access to improved water sources in 2011. By applying the proportion, the sample size was calculated with an error of 0.05, a power of 0.80 and a precision of 0.05. As the results, we calculated that 776 households was the required sample size. Applying a design effect of 1.8 for two-stage sampling and a non-response rate of 7.5%, we determined that 1342 households should be the final sample size. Of all 224 enumeration areas in the two districts, we randomly selected 94 by employing systematic random sampling and ensuring probability proportional to size. Then, 1342 households were further randomly selected from the 94 enumeration areas. We visited a household up to three times before we deemed the household unreachable.

Water source observation

Household members responsible for water collection and storage guided enumerators to water sources at the typical water collection time of the day. The enumerators confirmed water source type by both directly observing them and cross-checking them with the list of existing water sources (Japan International Cooperation Agency, unpublished data, 2019). We measured time spent collecting water, including: (i) making a round trip to the water source; (ii) waiting in a queue at water sources; and (iii) filling water in containers or buckets. In this study, we defined water collection time as the total number of minutes spent on these three elements of water collection activities. By using the Joint Monitoring Programme’s definitions, we categorized the type of water sources into either improved or unimproved water sources.

Water sampling

For each household, we collected water samples for microbiological testing at two points: (i) primary source of water for drinking and cooking; and (ii) water vessels, drinking flasks or water dispensers at households. For the households using vendor-provided water, we sampled source water from cart or truck. For those using piped private household connections, we sampled water only from water faucets since we considered the faucets as both a source and household drinking and cooking water.

Microbiological water quality test

Mozambican national guidelines for drinking water quality require drinking water to be free from total coliforms. Therefore, we examined presence of total coliforms in the sampled water without quantifying the level of their concentration. We used SUNCOLI X-type test paper (Kyoritsu Chemical Check Laboratory Co., Tokyo, Japan), which has a sensitivity of 90% and specificity of 80%. After soaking two sheets of the paper in sampled water for three seconds, we kept the soaked papers at 36–37 °C in a non-electric incubator HU-BOX-19–36 (Sanplatec Co., Tokyo, Japan) for 24 hours. After the incubation we examined the colour of the papers and a colour change indicated the presence of total coliforms.

Household interviews

By using a structured questionnaire, we interviewed household members...
Table 1. Types of source of water for drinking and cooking used by households, Niassa province, Mozambique, 2019

| Type of water source                           | No. (%) of households |
|-----------------------------------------------|-----------------------|
| **Improved water source**                    |                       |
| Piped private household connection           | 27 (2.1)              |
| Public standpipe                              | 33 (2.5)              |
| Protected well or borehole with handpump      | 620 (47.2)            |
| Protected well without handpump              | 128 (9.7)             |
| Protected spring                              | 2 (0.2)               |
| Vendor-provided water (cart and truck)        | 2 (0.2)               |
| Subtotal                                      | 812 (61.8)            |
| **Unimproved water source**                   |                       |
| Unprotected well                              | 256 (19.5)            |
| Unprotected spring                            | 193 (14.7)            |
| Surface water (river, lake, pond and reservoir)| 52 (4.0)             |
| Subtotal                                      | 501 (38.2)            |
| **Total**                                     | 1313 (100.0)          |

*Classification of water source type is based on the World Health Organization and United Nations Children’s Fund definition.*

Data analysis

We entered the data from water source observations, microbiological water quality tests and household interviews into a personal computer. By applying the data on housing materials and ownership of key properties to principal component analysis, we calculated the wealth index for each household. We used the wealth index to categorize all households into wealth quintiles. We used SPSS for Windows, version 22 (SPSS Inc., Armonk, United States of America) for statistical analyses.

Ethical considerations

We obtained ethical approval from the Mozambican National Committee for Bioethics in Health (Ref: 279/ CNBS/19). The Mozambican Ministry of Health provided official permission for the research implementation. We obtained written informed consent from household members to participate in structured household interviews, and to accompany the study team to water sources and for publication.

Results

Of 1342 households sampled, 29 (2.2%) could not be reached despite three visits. No household refused to participate. Therefore, a total of 1313 households participated in the study.

Table 1 shows the types of water sources used for drinking and cooking by households. Of all 1313 households, 812 (61.8%) used improved water sources, while 501 (38.2%) used unimproved water sources. The most used water source (620 households; 47.2%) was protected well or borehole with handpump, one of the improved water sources. The second most used sources were piped private household connection (27 households; 2.1%) and public standpipe (33 households; 2.5%).

Table 1 shows the comparison of access to and quality of water, and households’ socioeconomic characteristics between those using improved water sources and those using unimproved water sources. Total water collection time spent by households using improved water sources (mean: 59.1 minutes; standard deviation, SD: 55.2) was significantly longer than that spent by households using unimproved water sources (mean: 49.8 minutes; SD: 58.0; P-value < 0.001; Fig. 2). A smaller proportion of households using improved water sources had access to a water source available 24 hours per day than households using unimproved water sources (71.7%; 582 households versus 94.2%; 472 households; P-value < 0.001). Households using improved water sources were more likely to treat their water for drinking and cooking purposes than those using unimproved water sources (30.3%; 246 households versus 21.8%; 109 households; P-value = 0.009).

We did not detect any significant difference in household size (P-value = 0.564) and type of primary income sources (P-value = 0.204) between households using improved water sources and those using unimproved water sources. Nevertheless, the proportions of the richest and richer wealth quintiles were greater among households using improved water sources (23.4%; 190 households and 18.3%; 149 households, respectively) than among those using unimproved water sources (13.4%; 67 households and 20.4%; 102 households, respectively; P-value < 0.001).

There was no significant difference in the presence of total coliforms in sampled water between improved and unimproved water sources; 62.7% (509 samples) and 65.7% (329 samples), respectively (P-value = 0.267). However, the presence of total coliforms in water sampled at households using improved water sources (77.0%; 611 households) was higher, but not significantly, than that of water sampled at households using unimproved water sources (73.4%; 356 households; P-value = 0.153).

The proportion of samples containing total coliforms is shown by type of water source in Fig. 3. Overall proportion of samples from water sources containing total coliforms was 65.6% (838/1278). This proportion did not differ between improved and unimproved water sources (P-value = 0.203). Surprisingly, we detected total coliforms in water sampled at 25 of 27 (92.6%) piped private household connections. Moreover, in the most common water source used, that is protected wells or boreholes with handpumps, we detected total coliforms in water sampled from 62.9% (378/601) of sources. One of the two protected springs sampled contained total coliforms, and total coliforms were present in both samples from vendor-provided water. For unimproved water sources, the proportion of the presence of total coliforms varied from 60.0% (30/50) in surface water to 69.0% (174/252) in unprotected wells.

Of the 240 households appropriately treating their water collected from improved water sources, 204 (85.0%) had total coliforms in their drinking water regardless of the water quality at...
the source. A significantly higher proportion of households (37.1%; 189/509) with total coliforms in the water source appropriately treated their water than households with no total coliforms in the source (18.0%; 51/284; \( P \)-value < 0.001; Fig. 4). For the 189 households that treated their water collected from a contaminated source, only four (2.1%) households had no coliforms in their drinking and cooking water (Fig. 4).

Of the 107 households treating their water from an unimproved water source, 72.0% (77 households) had total coliforms in their drinking water (Fig. 5). This proportion was lower than for households not practising water treatment (73.8%; 279/378). However, only four households treating contaminated water from source had drinking and cooking water without total coliforms (Fig. 5).

**Discussion**

Here we show that water from many improved sources in Niassa province, Mozambique, are of poor quality. Some explanations for this result could be inadequate water treatment at production stage or lack of cleaning of water tanks located on the roofs of houses, which will affect the quality of piped private water. Similarly, water container or tanks that water vendors use have probably not been cleaned enough. Poor quality of water from these types of improved water sources was reported by several earlier studies in low- and middle-income countries such as Cambodia, Dominican Republic and Ethiopia. On the other hand, we show that 40% of surface water was not contaminated with total coliforms. The high percentage could be explained by the data collection happening during the dry season, since total coliforms in surface water may be lower in the dry season than in the rainy season. Hence, a year-round water quality examination needs to be conducted for all types of water sources. In general, the design of protected wells or boreholes with hand-pumps is better to produce adequate quality and quantity of water all year around, while some unprotected wells or springs could produce poor quality and quantity of water and could even be dried up in the dry season. In addition, households’ water collecting behaviours need to be studied for the entire year, because a certain proportion of households

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**Table 2. Access to and quality of water and socioeconomic household characteristics by type of water source, Niassa province, Mozambique, 2019**

| Characteristic | Using improved sources of drinking water (n=812) | Using unimproved sources of drinking water (n=501) | \( P \) |
|---------------|-----------------------------------------------|-------------------------------------------------|------|
| **Socioeconomic** |
| No. of household members, mean (SD) | 5.59 (2.68) | 5.44 (2.20) | 0.564<sup>c</sup> |
| Primary income source |
| Agriculture and sales of crops | 688 (84.7) | 452 (90.2) | 0.204<sup>c</sup> |
| Livestock and sales of animals | 2 (0.2) | 2 (0.4) | |
| Fishery | 3 (0.4) | 1 (0.2) | |
| Unskilled wage labour | 20 (2.5) | 8 (1.6) | |
| Skilled labour | 19 (2.3) | 4 (0.8) | |
| Handicrafts and artisanal work | 3 (0.4) | 2 (0.4) | |
| Charcoal production | 2 (0.2) | 2 (0.4) | |
| Trading and commercial work | 31 (3.8) | 16 (3.2) | |
| Salaried worker | 40 (4.9) | 14 (2.8) | |
| Government allowance (pension, disability benefit and other social support) | 3 (0.4) | 0 (0.0) | |
| Begging and dependent on assistance | 1 (0.1) | 0 (0.0) | < 0.001<sup>d</sup> |
| **Wealth quintile**<sup>d</sup> |
| First | 158 (19.5) | 113 (22.6) | < 0.001<sup>a</sup> |
| Second | 143 (17.6) | 123 (24.6) | |
| Third | 172 (21.2) | 96 (19.2) | |
| Fourth | 149 (18.3) | 102 (20.4) | |
| Fifth | 190 (23.4) | 67 (13.4) | |
| **Water** |
| Total water collection time in min, mean (SD)<sup>e</sup> | 59.1 (55.2) | 49.8 (58.0) | < 0.001<sup>a</sup> |
| Water availability at water source<sup>f</sup> |
| 24 hours a day | 582 (71.7) | 472 (94.2) | < 0.001<sup>e</sup> |
| On and off (available only when public water attendant is on duty) | 203 (25.0) | 25 (5.0) | |
| Don’t know | 27 (3.3) | 4 (0.8) | |
| Water quality at water source<sup>i</sup> |
| Presence of total coliforms | 509 (62.7) | 329 (65.7) | 0.267<sup>c</sup> |
| Absence of total coliforms | 284 (35.0) | 156 (31.1) | |
| Not tested due to unavailability of water at source | 19 (2.3) | 16 (3.2) | |
| Water treatment for drinking and cooking<sup>i</sup> |
| Treatment | 246 (30.3) | 109 (21.8) | 0.009<sup>c</sup> |
| No treatment | 566 (69.7) | 392 (78.2) | |
| Water quality at household<sup>i</sup> |
| Presence of total coliforms | 611 (77.0) | 356 (73.4) | 0.153<sup>c</sup> |
| Absence of total coliforms | 160 (20.2) | 119 (24.5) | |
| Not tested due to unavailability of vessels/drinkware/stand and settle for 30 minutes or longer<sup>i</sup> | 22 (2.8) | 10 (2.1) | |

<sup>a</sup> If not otherwise stated values are no. (%).
<sup>b</sup> Mann–Whitney’s U test.
<sup>c</sup> \( \chi^2 \) test or Fisher’s exact test.
<sup>d</sup> First quintile is the poorest population and the fifth quintile the richest.
<sup>e</sup> Sum of time spent: (i) on round trip by routine transport means (on foot or bicycle); (ii) waiting at water sources; and (iii) filling water into containers/buckets. The number of minutes was measured by physically visiting water source with household members responsible for water collection.
<sup>f</sup> For those using piped private household connection, we considered the water quality at source the same as at household.
<sup>i</sup> Types of water treatment for drinking and cooking include: (i) boiling water; (ii) adding bleach or chlorine; (iii) water filtering; (iv) solar disinfection; and (v) stand and settle for 30 minutes or longer.15
might switch water sources between dry and rainy seasons.

When being constructed, all the improved water sources in Majune and Muembé districts were microbiologically and chemically examined to meet the drinking water quality requirement specified in the Mozambican national guidelines (that is, no total coliforms per 100 mL of water). Yet, chronic financial and human resource constraints have been reported to prevent provincial and district health directorates from regularly monitoring water quality at all the improved water facilities. As a result, only improved water sources that serve greater populations in the districts are selectively targeted for regular water quality monitoring. Thus, quality of water from many improved sources remain neither monitored nor examined. Despite existing policies on regular water quality monitoring and long-term water source maintenance and rehabilitation planning, their implementation is likely to have been interrupted, irregular and less systematic. Probably, this operational issue has made the microbiological quality of water from improved sources equally as poor as that from unimproved sources.

We found that those using improved water sources were willing to spend significantly longer time accessing and collecting water that is significantly less likely to be available for 24 hours a day. In the districts, a household using improved water sources is charged on average 16.5 Mozambican meticais (equivalent to 0.264 United States dollars) per month, regardless of the amount of water they collect and household size. Those payments are pooled for regular and irregular maintenance of water source facilities. The monthly charge is equivalent to 0.41% of monthly household income, much lower than the water affordability threshold set by the UN Department of Economic and Social Affairs (3% of household income). Thus, water from improved sources should be affordable in both Majune and Muembé districts, implying that some residents might have been refraining from using improved water sources not for financial reasons but for other reasons, such as longer water collection time.

In addition, those using improved water sources are not only spending more temporal and financial resources, but also are more frequently practising water treatment than those households using unimproved water sources. It might be assumed that those using water from unimproved sources should be more motivated to treat water, if they are aware that the water they collect could be contaminated. One of the possible reasons for local residents to select improved water sources is the level of their water quality consciousness. The more conscious people are about water for drinking and cooking, the more often they treat water to be stored in vessels, drinking flasks and water dispensers. This finding is in line with an earlier study on household water treatment...
behaviours in Indonesia. Only about 3% of those treating contaminated water, regardless of source, were successful in removing total coliforms, probably due to inadequate treatment, such as insufficient boiling time or chlorine concentration. Also, some of those self-reporting practising water treatments might not have practised it in reality. On the other hand, those using water from unimproved sources might even have been unaware that they used contaminated water. This study did not assess whether each household was aware of which category of water source type it was using (that is, improved water source or unimproved water source). Thus, we cannot discuss further households’ water-related behaviours.

This study has several limitations. First, microbiological water quality tests were conducted only for presence or absence of total coliforms. Second, we did not do a chemical or radiological assessment of the water quality. Third, the cross-sectional data between August and October have limited representativeness to the entire year. Fourth, generalizability of the study results is limited, as the findings were based exclusively on the data collected in two districts.

To identify the relationship more precisely between water source types and water quality, microbiological water quality tests should be conducted not just by examining presence of total coliforms but also by quantifying the levels of contamination (e.g. the most probable number of total coliforms per 100 mL). However, challenges in locally setting up a laboratory-based water quality testing system in rural areas must be recognized and overcome by national and local authorities. Otherwise, integration of water quality testing into research and regular monitoring would not be realized. Moreover, a combination of microbiological and chemical quality tests (e.g. total coliforms and free residual chlorine) should be conducted as the standard package to assess broader aspects of water quality.

As of 2017, a total of 133 protected wells or boreholes with handpumps in Majune and Muembe districts were registered in Niassa Provincial Public Works Department (Japan International Cooperation Agency, unpublished data, 2019). Most of them (104; 78.2%) were constructed through external financial supports (e.g. African Development Bank, Irish Aid, Japan International Cooperation Agency, Swiss Agency for Development Cooperation and non-governmental organizations), while the rest were constructed by provincial departments of public works. Despite tremendous external support for construction of improved water sources, water quality monitoring has been sporadic, inadequate and irregular due to chronic budgetary constraints at provincial health departments responsible for water quality monitoring. In view of the current challenging

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**Fig. 3. Prevalence of total coliforms in water by type of water source, Niassa province, Mozambique, 2019**

Notes: Classification of water source types is based on the updated World Health Organization and United Nations Children’s Fund. We calculated the $P$-value by using $\chi^2$ test. We were unable to measure water quality for 35 households, due to unavailability of water upon the visits to water sources. Therefore, the total number of households and $P$-value for $\chi^2$ test are slightly different from those in Table 2.
### Microbiological water quality and water treatment practices at households using improved water sources, Niassa province, Mozambique, 2019

**Fig. 4.** Microbiological water quality and water treatment practices at households using improved water sources, Niassa province, Mozambique, 2019

- **793 samples from improved sources for drinking water:**
  - 284 samples with no total coliforms (35.8%)
  - 509 samples with total coliforms (64.2%)

- **Quality of drinking and cooking water at household:**
  - 51 samples appropriately treated (6.4%)
  - 233 samples not appropriately treated (29.4%)
  - 189 samples appropriately treated (23.8%)
  - 320 samples not appropriately treated (40.4%)

- **Self-reported appropriate water treatment for drinking and cooking:**
  - 27 samples with no total coliforms (3.5%)
  - 22 samples with total coliforms (2.9%)
  - 129 samples with no total coliforms (16.7%)
  - 87 samples with total coliforms (11.3%)
  - 4 samples with no total coliforms (0.5%)
  - 182 samples with total coliforms (23.6%)

- **P-values:**
  - \( P < 0.001 \)
  - \( P = 0.021 \)

* a Out of the 793 households, we were unable to test the water quality at 22 households.

Notes: Improved facilities for water source include: (i) piped private household connection indoor/in yard; (ii) public standpipe; (iii) protected well/borehole with handpump; (iv) protected well without handpump; (v) protected spring; and (vi) vendor-provided water such as cart and truck.\(^6,9\) We were unable to measure water quality for 19 households due to unavailability of water upon the visits to water sources. Types of appropriate water treatment include: (i) boiling water; (ii) adding bleach or chlorine; (iii) water filtering; (iv) solar disinfection; and (v) stand and settle for 30 minutes or longer.\(^15\) We calculated \( P \)-values using \( \chi^2 \) tests.

### Microbiological water quality and water treatment practices at households using unimproved water sources, Niassa province, Mozambique, 2019

**Fig. 5.** Microbiological water quality and water treatment practices at households using unimproved water sources, Niassa province, Mozambique, 2019

- **485 samples from unimproved sources for drinking water:**
  - 156 samples with no total coliforms (32.2%)
  - 329 samples with total coliforms (67.8%)

- **Quality of drinking and cooking water at household:**
  - 33 samples appropriately treated (6.8%)
  - 123 samples not appropriately treated (25.4%)
  - 74 samples appropriately treated (15.3%)
  - 255 samples not appropriately treated (52.6%)

- **Self-reported appropriate water treatment for drinking and cooking:**
  - 25 samples with no total coliforms (5.3%)
  - 8 samples with total coliforms (1.7%)
  - 90 samples with no total coliforms (18.9%)
  - 24 samples with total coliforms (5.3%)
  - 4 samples with no total coliforms (0.8%)
  - 69 samples with total coliforms (14.5%)
  - 0 samples with no total coliforms (0%)

- **P-value:**
  - \( P = 0.003 \)

* a Out of 485 households, we were unable to test the water quality at 10 households.

Notes: Unimproved or no facilities for water source include: (i) unprotected well; (ii) unprotected spring; and (iii) surface water (river, lake, reservoir).\(^6,9\) We were unable to measure water quality for 16 households due to unavailability of water upon the visits to water sources. Types of appropriate water treatment include: (i) boiling water; (ii) adding bleach or chlorine; (iii) water filtering; (iv) solar disinfection; and (v) stand and settle for 30 minutes or longer.\(^15\) We calculated \( P \)-values using \( \chi^2 \) tests.
circumstances, we recommend that external development agencies provide post-construction supplementary or counterpart funding for water quality monitoring activities. This funding will help enhance and sustain integration of water quality assessment into regular monitoring, through collaboration among all the actors (government, UN, bilateral agencies and nongovernmental organizations). Water quality assessment and nationally representative household surveys should be part of regular water source monitoring. Globally, the proportion of those having access to improved sources of water increased from 82% in 2000 to 93% in 2020.18 Now that more people have access to improved water sources, greater attention should be paid to the quality of water. Access to improved water source does not ensure microbiological safety of water and thereby using access as the proxy indicator for safe drinking water is questionable. Poor quality of water, regardless of type of water source, calls for integration of water quality assessment into regular monitoring programmes.

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ملخص

التلوث الميكروبيولوجي لمصادر الماء المحكمة، موزامبيق

المتى تجميع مصادر الماء المحكمة أمثلة من الناحية الميكروبيولوجية في مقاطعة نياسا بموزامبيق، وذلك من خلال فحص وجود بكتيريا القولونية الكلية في أنواع مختلفة من مصادر الماء، طرقية أجرينا مسحًا مقطعيًا أُسريًا في منطقتين ريفيتين في مقاطعة نياسا خلال موسم الجفاف من 21 أغسطس/أب 4 أكتوبر/تشرين الأول 2019. فحصنا على المحاكمة مصادر الماء وإجراء اختبارات لموضوعية الميكروبيولوجية، وإجراء مقابلات أسرية منتظمة. نتائجنا يتضمن 1313 أسرة، منها 1218 (91.2%) تستخدمن مصادر ماء من مصدر محسّن، ملخص فحص وجود ملوثات ميكروبيولوجية في مصادر المياه، بينما الماء من مصدر محسّن ولديها إمكانية الوصول إلى مصادر المياه المتاحة طوال السنة. لم يكن هناك فارق ملموس في وجود ملوثات ميكروبيولوجية بين الماء المأخوذ من مصادر محسّنة وغير محسّنة، في حين أن الماء المأخوذ من مصادر محسّنة ووجدنا معنويًا تم لاستخدام مصادر ماء محسّنة ونسبة الأسر التي تستخدم مصادر ماء محسّنة، فص политикية (P=0.267) ونسبة الأسر التي تستخدم مصادر ماء محسّنة.5

اللغز

من الأسر التي تجمع المياه من مصدر غير محسّن، من أصل 77 القولونية الكلية في مياههم، بينما المياه المعالجة من مصدر محسّن، تستدعي جودة المياه الرديئة الحاجة إلى دمج تقييم جودة المياه في كمصدر بديل لمياه الشرب والطهي الآمنة، هو أمر مشكوك فيه. السلامة الميكروبيولوجية في مقاطعة نياسا بموزامبيق، وبالتالي فإن استخدام الوصول كمصدر محسّن لا يضمنIllegal ماء محكم. لايوجد هناك ماارب من ملوثات ميكروبيولوجية في مصادر المياه، بينما الماء من مصدر محسّن، لم يكن هناك فارق ملموس، في وجود ملوثات ميكروبيولوجية بين مصادر المياه، ولا يوجد هناك ما ارب من ملوثات ميكروبيولوجية في مصادر المياه، بينما الماء من مصدر محسّن، لم يكن هناك ملوثات ميكروبيولوجية في مصادر المياه، بينما الماء من مصدر محسّن.

 الدولي

ملخص للرسالة

 Safe water from improved source, Mozambique Hirotsugu Aiga et al.

Purpose

The purpose of this study was to assess the microbiological quality of water sources in Niassa province, Mozambique, and to evaluate the impact of access to improved water sources on the safety of drinking water. The study was conducted during the dry season from August 21 to October 4, 2019, in two rural areas in Niassa province, Mozambique. A total of 1313 households were surveyed, of which 1218 (91.2%) had access to improved water sources. No significant difference was found in the microbiological quality of water from improved and non-improved sources. However, households with access to improved water sources had a higher prevalence of safe drinking water (P=0.267), compared to households without access to improved water sources. The study found that households with access to improved water sources had a higher prevalence of safe drinking water (P=0.267), compared to households without access to improved water sources. Therefore, integrating microbiological water quality assessment into routine water monitoring activities is recommended.

Methods

A cross-sectional household survey was conducted during the dry season from August 21 to October 4, 2019, in two rural areas in Niassa province, Mozambique. A total of 1313 households were surveyed, of which 1218 (91.2%) had access to improved water sources. No significant difference was found in the microbiological quality of water from improved and non-improved sources. However, households with access to improved water sources had a higher prevalence of safe drinking water (P=0.267), compared to households without access to improved water sources. Therefore, integrating microbiological water quality assessment into routine water monitoring activities is recommended.

Results

A total of 1313 households were surveyed, of which 1218 (91.2%) had access to improved water sources. No significant difference was found in the microbiological quality of water from improved and non-improved sources. However, households with access to improved water sources had a higher prevalence of safe drinking water (P=0.267), compared to households without access to improved water sources. Therefore, integrating microbiological water quality assessment into routine water monitoring activities is recommended.

Conclusion

Integrating microbiological water quality assessment into routine water monitoring activities is recommended, as it may help improve the safety of drinking water in households with access to improved water sources. Moreover, using access to improved water sources as a proxy indicator for safe drinking water may not be reliable. Therefore, integrating microbiological water quality assessment into routine water monitoring activities is recommended.
Contaminación microbiológica de las fuentes de agua mejoradas en Mozambique

Objetivo Determinar si las fuentes de agua mejoradas son seguras desde el punto de vista microbiológico en la provincia de Niassa (Mozambique), mediante el análisis de los diferentes tipos de fuentes de agua.

Métodos Se realizó una encuesta transversal de hogares en dos distritos rurales de la provincia de Niassa durante la estación seca, del 21 de agosto al 4 de octubre de 2019. Se observaron las fuentes de agua y se realizaron pruebas microbiológicas de la calidad del agua y entrevistas estructuradas en los hogares.

Resultados Se incluyeron 1313 hogares, de los que 812 (61,8%) utilizaban agua de una fuente mejorada. No hubo diferencias significativas en la presencia de coliformes totales entre el agua obtenida de fuentes de agua mejoradas y no mejoradas, 62,7% (509 muestras) y 65,7% (329 muestras), respectivamente (valor de p = 0,267). Los hogares que utilizaron fuentes de agua mejoradas trabajaban en promedio 204,85 (4,4%) tenían coliformes totales en el agua, mientras que el agua tratada de 77 casos (72,0%) se provino de la fuente de agua no mejorada que estaba contaminada.

Resumen

Microbiológico, are considered as improved sources of water in the province of Niassa, in Mozambique. The study aimed to investigate the presence of total coliforms in different types of water sources.

Methods The study was carried out as a cross-sectional survey of households in two rural districts of Niassa province during the dry season, from August 21 to October 4, 2019. The study observed the water sources and performed microbiological tests on water samples and household interviews.

Results A total of 1313 households were included, of which 812 (61.8%) used improved water sources. There were no significant differences in the presence of total coliforms between water obtained from improved and non-improved sources, 62.7% (509 samples) and 65.7% (329 samples), respectively (p-value = 0.267). Households using improved water sources worked an average of 204.85 (4.4%) hours, while households using non-improved water sources had 77 cases (72.0%) of contaminated water.
107 (72,0 %) hogares que recogían agua de una fuente no mejorada estaba contaminada.

**Conclusión** El acceso actual a una fuente de agua mejorada no garantiza la seguridad microbiológica del agua y, por lo tanto, utilizar el acceso como indicador indirecto de agua potable y para cocinar es cuestionable. La mala calidad del agua exige que se integre la valoración de la calidad del agua en los programas regulares de control.

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