Quantitative bacterial examination of domestic water supplies in the Lesotho Highlands: water quality, sanitation, and village health

J.D. Kravitz, M. Nyaphisi, R. Mandel, & E. Petersen

Reported are the results of an examination of domestic water supplies for microbial contamination in the Lesotho Highlands, the site of a 20-year-old hydroelectric project, as part of a regional epidemiological survey of baseline health, nutritional and environmental parameters. The population’s hygiene and health behaviour were also studied. A total of 72 village water sources were classified as unimproved (n = 23), semi-improved (n = 37), or improved (n = 12). Based on the estimation of total coliforms, which is a nonspecific bacterial indicator of water quality, all unimproved and semi-improved water sources would be considered as not potable. *Escherichia coli*, a more precise indicator of faecal pollution, was absent (P <0.001) in most of the improved water sources. Among 588 queried households, only 38% had access to an “improved” water supply. Sanitation was a serious problem, e.g. fewer than 5% of villagers used latrines and 18% of under-5-year-olds had suffered a recent diarrhoeal illness.

The study demonstrates that protection of water sources can improve the hygienic quality of rural water supplies, where disinfection is not feasible. Our findings support the WHO recommendation that *E. coli* should be the principal microbial indicator for potability of untreated water. Strategies for developing safe water and sanitation systems must include public health education in hygiene and water source protection, practical methods and standards for water quality monitoring, and a resource centre for project information to facilitate programme evaluation and planning.

**Keywords:** drinking-water microbiology; *Escherichia coli*, pathogenicity; health behaviour; health surveys; sanitation; water quality.

*Voir page 834 le résumé en français. En la página 834 figura un resumen en español.*

**Introduction**

The provision of effective sanitation programmes and access to safe drinking-water have been major problems for many developing countries. In Africa, many obstacles — including bureaucratic barriers between ministries, meagre funds allocated to rural areas, and too few technically qualified persons — have retarded progress towards safe and sufficient water supplies and improved sanitation (1). Because of their perceived cost-ineffectiveness, water and sanitation projects have not been supported by some sectors in government (2), despite their considerable positive impact, such as long-term survival of children as a result of a reduction in diarrhoeal diseases. Moreover, the attempt to provide potable water by the application of new, and perhaps inappropriate, technologies in a developing country may lead to unexpected difficulties and even failure of the project. Thus Morgan, a Zimbabwean researcher, has written (3): “As a rule of thumb, it is generally far better to take an existing technology, well-established in a particular country, and build on that and develop it, rather than introduce something foreign.”

Lesotho (population: 1.8 million) is a mountainous country tied geographically and economically to South Africa. Provision of safe drinking-water and sanitation has been acknowledged as vital to health in Lesotho, and been supported by public health research and development initiatives since the 1970s (4, 5). Feachem et al. (4) and Esrey et al. (6, 7) described a matrix of factors necessary at the community level to positively influence village health. Water quality was recognized as the foundation for any health improvement strategy, accompanied by programmes for increased water quantity and sanitation. However, in the absence of changes in personal behaviour and hygiene practices, the incidence of water-related diseases, especially diarrhoeal illness, is likely to remain high in contaminated environments, where the faecal–oral route is a major source of disease transmission.

A horizontal well drilling programme was initiated in Lesotho in 1984, using mobile drilling...
equipment and limited technology (8). Development of gravity-feed watering sites for livestock was the initial objective; subsequently, the scope of the programme was extended to provide potable water and aid irrigation. The Lesotho Highlands Water Project (LHWP), a massive 20-year development venture, commenced in 1986; its main goals were water impoundment and diversion, and hydroelectric self-sufficiency. Two sites were initially involved: the remote, mountainous Katse Dam catchment area, which has been accessible by a paved service road since 1991, and 'Muela District, at a lower elevation, with reasonable proximity to a major highway. Approximately 20,000 people live in these districts. Springs and surface water are ubiquitous, but generally not well protected, with humans and animals frequently having equal access.

The aim of the present study was to ascertain the quality of existing domestic water supplies and hygiene patterns in villages situated in proximity to the LHWP construction zones. The surveyed villages were scattered over approximately 1000 square miles (ca. 259,000 hectares) of severe, mountainous terrain, most of which is accessible only by seasonally passable dirt tracks and footpaths. The study’s findings were to serve as a baseline for efforts to improve rural water supplies and for comparison, when actions have to be considered subsequent to demographic shifts and water impoundment in the Lesotho Highlands.

Materials and methods

The Lesotho Highlands Health Survey — a baseline health, nutritional, and environmental epidemiological survey in villages affected by the LHWP — was conducted between July 1992 and January 1993. The survey included quantitative testing for bacterial indicators of faecal contamination in major domestic water sources and a household survey, which was administered to the heads of households by trained Basotho interviewers in the Sesotho language. Information was obtained concerning sources of domestic water supplies, defecation sites, and diarrhoeal illness in under-5-year-old children.

The participating villages were chosen for the winter (dry season) and summer (wet season) studies to ascertain the influence of seasonal variation and precipitation on potability. Water samples from 72 sources (27 in winter and 45 in summer) in 58 villages and five rural health centres were tested for bacterial markers of potability. The 100-ml water samples were collected in sterile containers under difficult field conditions. In sampling from open, ground sources, the inverted containers were immersed beneath the water surface and turned upright before removal to minimize surface contamination. Tap sources were sampled after allowing the water to run for 20–30 seconds.

The specimens were placed in cooler bags, stored in the shade, and refrigerated at 4–8 °C within 24 hours of collection. Incubation took place within 8–48 hours of collection. Neither ice nor electricity was available in the field. A sample was not taken if a village was too remote to permit timely refrigeration and analysis. If incubation was delayed beyond 48 hours, the sample was discarded because multiplication or death or competing organisms might interfere with coliform testing (Professor N. Sinclair, Department of Microbiology, University of Arizona, personal communication, 1992).

Selection of villages and individual households was based on a comprehensive socioeconomic census of the Lesotho Highlands Water Project Phase IA area (9), which was conducted prior to the start of the construction project. A three-level stratified, random approach was used to identify villages and households for inclusion in the study (10).

- Level 1: 22 development planning areas were categorized.
- Level 2: within these 22 planning areas, natural groupings of villages were identified, based on geographical and administrative criteria; comparable villages in each planning area were stratified for winter or summer study.
- Level 3: individual households within villages were then chosen, by use of a random number table.

From an estimated 3700 households in the Katse and 'Muela areas, 588 were studied, representing about 15% of the resident population. The selection process minimized substantial differences among the seasonally studied villages. While the same villages could have been surveyed twice for comparisons between the winter and summer, we considered it more important to involve as many villages as possible, if only once, in this relatively inaccessible environment. Exclusion of sampling from the most remote villages may have introduced some bias, but this could not be avoided because of the need for convenient road access to facilitate timely incubation of the water samples. On the other hand, sampling followed by delays in incubation, owing to difficulties in access, would have reduced the accuracy of the microbiological analysis. However, we had no reason to suspect differences in water source characteristics, wherever they were located; altitude was not a limiting factor.

Water quality analysis was based on the most probable number (MPN) method, which estimates the concentration of viable total coliforms (TCs) and Escherichia coli per 100 ml. Combination media, either Coliquik™, ONPG (o-nitrophenyl-β-D-galactopyranoside)/MUG (fluorogenic substrate, 4-methylumbelliferyl-β-D-glucurononide), or lauryl tryptose/MUG were utilized. Both media, which simultaneously detect total coliforms (ONPG or lauryl tryptose) and E. coli (MUG) in water and waste water, are formulated to minimize interference from noncoli-form bacteria and have similar sensitivity and specificity (11).

Each 100-ml sample was aliquoted into five tubes and incubated for 24–48 hours at 35 ± 0.5 °C.
The number of positive tubes gave an MPN of TCs and *E. coli* concentrations, indicated by colour change or gas production and fluorescence, respectively; 2.2 organisms per 100 ml were detected. The US Environmental Protection Agency’s limits for acceptable TCs and *E. coli* are <1 organism per 100 ml (12, 13). Lesotho standards were not available.

Village water sources were classified, based on the following criteria, as shown below.
- Unimproved (*n* = 23): surface source; spring, creek, or river.
- Semi-improved (*n* = 37): spring surrounded by various configurations of rocks and/or tin sheeting; access and water removal using a hand-held vessel.
- Improved (*n* = 12): spring served by a delivery tap attached to a completely enclosed concrete, galvanized metal, or plastic tank; connected by gravity-feed pipe to a silt box and an enclosed water-intake collection configuration; protected from animal or human contamination; at a higher elevation.

Differences in contamination among the three classifications of water sources were compared using χ² and Fisher’s exact tests: a *P* value of <0.05 indicates statistical significance.

**Results**

The distribution of villages according to estimated total coliform and *E. coli* contamination is presented in Table 1 and Table 2, respectively, by season (dry and rainy) and water source classification (unimproved, semi-improved, and improved). Water from 100% (60/60) of unimproved and semi-improved village sources was contaminated with total coliforms, mostly at concentrations >16 organisms per 100 ml. Total coliforms were present in 97% of all tested samples, regardless of site classification (*P* >0.05). Consistent pollution patterns were demonstrated during both seasons (Table 1).

In contrast, variations in *E. coli* contamination (from <2.2 to >16 organisms per 100 ml), stratified by source classification, were very highly significant (*P*<0.001). While only 4% (1/23) of unimproved and 16% (6/37) of semi-improved sites were *E. coli*-free, 83% (10/12) of improved sites were protected from *E. coli* contamination (Table 2). All five rural health centre water sources were classed as improved and *E. coli*-free.

Domestic water supply was surveyed in 588 households: 38% had access to an improved water source. The majority of households resorted to ponds, rivers, or springs for water collection. Sources classified as semi-improved were routinely found to be compromised because the protective barriers had been dismantled. Uncovered household water storage containers with the potential for contamination were commonly observed. Rainwater catchment was uncommon. Only one household reported tap water in the home. There were striking regional differences between the mountainous Katse and lower-elevation ‘Muela samples: 58% of the Katse population drew water from unimproved sources, compared with only 6.3% of the ‘Muela population.

Sanitation was a serious problem. Fewer than 5% of surveyed villagers used latrines or toilets. The vast majority used the bush or riverside for defecation. Only 9% of small children used nappies or diapers (Table 3). The household survey revealed that 18% (62/354) of under-5-year-olds had a history of diarrhoea in the previous 2-week period (14).

**Discussion**

Quantification of the extent of microbial contamination of village water supplies in the Lesotho High-
### Table 3. Percentage distribution of adults and children, by place of defecation

<table>
<thead>
<tr>
<th>Place of defecation</th>
<th>Adult (&lt;14 years) (n = 916)</th>
<th>Older child (5–14 years) (n = 327)</th>
<th>Young child (&lt;5 years) (n = 357)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garbage pile</td>
<td>&lt;1</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>Pit latrine</td>
<td>5</td>
<td>6</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Flush toilet</td>
<td>&lt;1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>VIP toilet(^a)</td>
<td>2</td>
<td>2</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Bucket toilet</td>
<td>&lt;1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Donga(^b)</td>
<td>17</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>Riverside</td>
<td>18</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Floor/bush</td>
<td>58</td>
<td>64</td>
<td>16</td>
</tr>
<tr>
<td>Nappies (diapers)</td>
<td>N/A</td>
<td>N/A</td>
<td>9</td>
</tr>
</tbody>
</table>

\(^a\) A VIP toilet is a modified version of the traditional pit latrine and includes a screened, vertical pipe.

\(^b\) Afrikaans word for erosional gulley or ravine that has been incorporated into the Lesotho language.

\(^c\) N/A: not applicable.

In the study area, the health of children under five years of age was a major goal of this study. The presence of total coliforms in all sources tested and of *E. coli* in significantly fewer sources, depending on the type of water protection, was demonstrated. The potability and safety of most domestic water supplies in the Katse catchment and the 'Muela areas were therefore suspect. Substantial TC concentrations were found in both dry and rainy seasons. Potability would be expected to deteriorate during the rainy months since bacterial contamination of groundwater generally increases after heavy rains (3), but our finding of contaminated domestic water supplies in the dry season gave cause for concern. On the other hand, this study demonstrated that in most cases adequate protection of water sources could improve the hygienic quality of rural water supplies by effectively preventing *E. coli* from entering water systems prior to their delivery points.

Microbiological potability standards for drinking-water in most developed countries rely on the detection of total coliforms and *E. coli* (a coliform itself) as markers for human pathogens. The heterogeneous coliform group, which is present in human and animal faeces, as well as in soil and decomposing plant matter, is the most universal, non-specific indicator of faecal pollution, or inadequate disinfection, or post-treatment contamination of a water supply. The coliform test can, therefore, best serve as an indicator of treatment efficiency or the integrity of a distribution system (13). However, a meaningful assessment of “potability” and health risk, based solely on the ubiquitous coliform, is a problem. While many rural water systems may be protected from the hazard of faecal contamination, they are unlikely to be rid of total coliforms without expensive or unobtainable chemical disinfection. *E. coli*, the most discriminating marker for faecal contamination, is therefore the microbiological indicator of choice for drinking-water potability and safety, especially in developing countries with limited resources, where disinfection of a water source is neither economically nor technically feasible (13).

This study supports the WHO recommendation that *E. coli* should be the principal microbial potability indicator for untreated rural water supplies, which may contain nonspecific bacteria of unclear sanitary significance. Drinking-water safety dictates that no *E. coli* should be present.

A gravity-feed, improved water system in the 'Muela area, developed in 1988, was of particular interest. Even though the system was well constructed with a hillside concrete and stone siltbox connected by an underground pipe to a village tap, repeated sampling revealed >16 total coliforms and *E. coli* per 100 ml. According to the village headman who assisted our investigation, heavy rains had occurred during the weeks prior to the study. It is likely that organic pollutants had washed into a breached water collection intake above the siltbox. A lesson learned was that even outwardly “improved” water systems need to be periodically inspected to ensure their integrity.

The study villages were at an altitude of 1800–2500 metres. Although reduced levels of pollution were found at lower altitudes, a cause and effect association between coliform contamination and elevation was not established, except that lower elevation served as a surrogate indicator for accessibility to site improvement. Significant regional differences between the mountainous Katse area, where few households used improved sources, and the lower elevation 'Muela area, where most households had access to improved supplies, confirmed this observation. With the opening of a paved service road over a 3000-metre mountain pass to the Katse Dam construction area in 1991, the existing water systems in the surrounding villages can be expected to be upgraded gradually. Most villages, however, are remote and located at considerable distances from suitable access roads. Solutions based on this geographic reality remain intractable.

One complex, but necessary, approach must be to change people’s habits that contribute to the pollution of drinking-water. With the dismantling of protective tin and stone configurations at many springs, unrestricted and unhygienic water collection activities were commonly observed. Soiled hands and water collection vessels placed on the ground prior to being dipped into a semi-improved spring were potential contributors to contamination. In some instances, protective barriers had been completely removed. Strategies to promote proper household storage must be encouraged because stored water, touched by hands and unclean vessels, can become significantly more contaminated than the source (15). This approach could also promote home disinfection and the use of suitable water storage containers (16–18).

Combined environmental interventions, including water quality improvement, household sanitation, and community sanitation, which are
likely to require significant institutional and economic investments, can have a powerful impact on reducing serious diarrhoeal disease in infants who are at greatest risk (19). The risk of diarrhoea is reduced where educational programmes promote increased water use and installation of toilet facilities (20). Individual sanitary behaviour, i.e. hand washing with soap, and use of clean vessels, also have an important role. Despite evidence that increased water quantity for personal and domestic hygiene is likely to be as important as water quality (5), clear-cut solutions to improve health, based on water quality, water quantity, and hygienic behaviour, remain elusive because of the complicated nature of water-related disease transmission (21). Strategies investigating the complicated relationship between human behaviour and health are being tested and pose a challenge (22).

Since women and children are involved in most water-collecting activities, their participation in public health education programmes, organized by community-based primary health care workers (1), is essential to eliminate unhygienic water collection and promote healthy behaviours. This approach could have a notable impact in the project area, where a significant proportion (18%) of under-5-year-olds had a history of diarrhoeal illness in the two-week period preceding this survey. A more profound impact is possible at the national level, where annually over 40 000 people (25/1000) with access to primary health care seek treatment for gastrointestinal complaints (13).

From a global perspective, the development of a comprehensive and reliable rural water supply system in Lesotho has been impeded by the inability of a central agency to chronicle, monitor, and evaluate an estimated 300 projects sponsored by short-term nongovernmental organizations and foreign governments over the past 25 years (B. Aleobua, Lesotho Village Water Supply, personal communication, 1993). Programme planning must take into account the actual functioning and utilization of existing water supplies (23). Yet, even with a monitoring system in place, reliance on a technologically dependent microbiological standard for determining water quality in a developing country without greater attention to sanitation issues may not be the most successful strategy. Research has demonstrated consistent reductions in morbidity and mortality in children in developing countries with a high prevalence of diarrhoeal disease where proper excreta disposal was addressed (7). This is particularly relevant to the rural areas of Lesotho, where the majority of villagers do not have access to latrines and where most domestic water sources are poorly protected.

The basis of the present study was to quantify faecal contamination of domestic water supplies, but a sanitary survey (3) could also have served as a pragmatic environmental assessment tool to identify groundwater sources suspected of being contaminated. This well-known field methodology was acknowledged in the administered questionnaire and during village health indicator appraisals. Under different circumstances the sanitary survey option should be considered if further microbiological study of rural water supplies in Lesotho is contemplated, or if reliance on a laboratory-based surveillance programme is likely to present logistic problems.

Conclusions

A safe and reliable water supply is certainly of prime importance for community health. However, the successful implementation of a safe drinking-water and effective sanitation programme in developing countries is not a simple process. Three major elements are involved: protection of water resources, change in people’s behaviour in collecting and using water, and expanded use of latrines. Each intervention calls for public health education, technical expertise, and parallel development of human resources and infrastructure. Furthermore, an evaluation of previous development projects and water quality monitoring by practical methods would help to promote community health goals.

The 1980s were the International Drinking Water Supply and Sanitation Decade (IDWSSD) (24). The goal was to improve health through national and international collaborative efforts by the development of self-reliant and sustainable safe community water supply and sanitation programmes for all by 1990. The main target was rural and urban underserved populations. Safe drinking-water implies the absence of biological contamination. While progress was demonstrated in the Lesotho Highlands where improved water systems were, in most cases, free of E. coli, much work remains before the IDWSSD goal is attained. Most domestic drinking-water sources are potentially contaminated by enteric pathogens. A comprehensive development programme must include a practical and cost-effective approach to provide potable water and a more aggressive strategy to reduce the risks of water-related transmission of disease.

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Résumé
Examen bactériologique quantitatif des réserves d’eau à usage domestique sur les hautes terres du Lesotho : qualité de l’eau, assainissement et questions de santé au niveau des villages
Dans le cadre d’une enquête épidémiologique nationale destinée à établir les paramètres sanitaires, nutritionnels et environnementaux de base, nous avons examiné les réserves d’eau à usage domestique sur les hautes terres du Lesotho, sur le site d’une installation hydroélectrique remontant à une vingtième d’année. Nous avons également étudié les comportements de la population en matière d’hygiène et de santé. Nous avons procédé au classement de 72 sources d’eau villageoise : 23 on été jugées sans amélioration ; 37 partiellement améliorées et 12, améliorées. D’après la numération des coliformes totaux, qui constitue un indicateur non spécifique de la qualité de l’eau, la totalité des sources sans amélioration ou partiellement améliorées seraient considérées comme impropres à la consommation. La plupart des sources jugées améliorées ne contenaient pas d’Escherichia coli, qui constitue un indicateur plus précis de la pollution fécale (p < 0,001). Sur les 588 ménages enquêtés, 38% seulement avaient accès à une source d’eau « améliorée ». Il y avait de sérieux problèmes d’assainissement, puisque par exemple, moins de 5% des villageois utilisaient des latrines. La présente étude montre que la protection des sources d’eau peut améliorer la qualité hygiénique de l’approvisionnement en eau en milieu rural, dans les cas où, pour des raisons techniques, il n’est pas possible de procéder à une désinfection. Nos observations viennent à l’appui de la recommandation de l’OMS, à savoir d’utiliser E. coli comme principal indicateur de la potabilité d’une eau non traitée.
Les interventions concertées destinées à améliorer la qualité de l’eau et l’assainissement ainsi qu’à accroître les volumes délivrés exigent des investissements importants au niveau de l’infrastructure. Malheureusement, le caractère complexe de la transmission des maladies par l’eau, et plus particulièrement par la voie orofécale, rend encore illusoire toute solution précise au problème de l’amélioration de la santé par une action aux niveaux du volume et de la qualité de l’eau délivrée ou des comportements en vue d’une meilleure hygiène. La modification des habitudes de la population pour éviter la pollution des eaux potables constitue une possibilité importante. Comme ce sont essentiellement les femmes et les enfants qui se chargent de l’approvisionnement en eau, il est capital de les faire participer aux programmes de santé publique destinés à apprendre à recueillir l’eau de manière hygiénique. Cette façon de procéder pourrait avoir des conséquences importantes dans la zone étudiée, où 18% des enfants de moins de 5 ans ont eu récemment des diarrhées.
L’inaptitude à recenser, suivre et évaluer les quelque 300 projets d’aide internationale mis en place au Lesotho au cours des 25 dernières années a fait obstacle à l’organisation d’un programme général d’approvisionnement en eau en milieu rural. Néanmoins, même en disposant d’un système de surveillance, il n’est pas certain qu’un contrôle de la qualité de l’eau s’appuyant techniquement sur des normes microbiologiques soit la bonne solution. Cela vaut en particulier pour les zones rurales du Lesotho où une proportion importante des villageois n’utilise pas de latrines et où la plupart des sources d’eau sont mal protégées.
Pour mettre en place avec succès un programme d’approvisionnement en eau saine et d’assainissement efficace, il faut que soient réunies les conditions suivantes : protection des ressources en eau, modification des comportements vis-à-vis de l’approvisionnement en eau et de son utilisation, développement de l’usage des latrines, et création d’un centre d’information sur les projets destiné à faciliter la planification et l’évaluation du programme. Toute intervention exige un effort d’éducation dans le domaine de la santé publique, des compétences techniques et le développement parallèle des ressources humaines et de l’infrastructure.
Les années 80 ont été celles de la Décadence internationale de l’eau potable et de l’assainissement, dont la finalité était l’amélioration de la santé par une action nationale et internationale concertée pour la mise en place, à l’horizon 1990, de programmes autonomes d’approvisionnement en eau et d’assainissement s’inscrivant dans la continuité. L’effort devait principalement porter sur les populations rurales ou mal desservies. Qui dit eau potable, dit absence de contamination biologique. Il a certes été possible de constater des progrès sur les hautes terres du Lesotho, où la plupart des systèmes améliorés d’approvisionnement en eau délivrent une eau exempte d’E. coli, mais beaucoup reste à faire. La majeure partie des sources d’eau destinée à la consommation domestique sont sous la menace d’une contamination par des germes pathogènes d’origine fécale. Tout programme de développement qui se veut complet doit prévoir des moyens pratiques et économiques d’assurer l’approvisionnement de la population en eau potable et une stratégie volontariste en vue de réduire le risque de transmission de maladies véhiculée par l’eau.

Resumen
Examen bacteriológico cuantitativo de las fuentes de agua de uso doméstico en las tierras altas de Lesotho: calidad del agua, saneamiento y salud en las aldeas
Como parte de un estudio epidemiológico nacional sobre los parámetros sanitarios, nutricionales y ambientales basales, examinamos la contaminación microbiana de los sistemas de abastecimiento de agua doméstica en las tierras altas de Lesotho, donde funciona desde hace 20 años una central hidroeléctrica. Se analizó asimismo
la higiene de la población y su comportamiento en lo tocante a salud. Un total de 72 fuentes de agua rurales fueron clasificadas del siguiente modo: no mejoradas ($n = 23$), semimejoradas ($n = 37$) y mejoradas ($n = 12$). Según el número total estimado de coliformes, magnitud utilizada como indicador bacteriano inespecífico de la calidad del agua, todas las fuentes de agua no mejoradas y semimejoradas fueron conceptuadas como no potables. No se detectó ($P < 0.001$) *Escherichia coli*, que constituye un indicador más preciso de contaminación fecal, en la mayoría de las fuentes de agua mejoradas. Entre los 588 hogares sondeados, sólo un 38% tenían acceso a sistemas «mejorados» de abastecimiento de agua. El saneamiento deficiente constituía un problema grave; por ejemplo, menos del 5% de los lugareños usaban letrinas. El presente estudio demuestra que la protección de las fuentes de agua puede mejorar la calidad higiénica de los sistemas rurales de abastecimiento de agua en los casos en que la desinfección, por razones económicas o técnicas, no es viable. Nuestros hallazgos respaldan la recomendación de la OMS de considerar *E. coli* como el principal indicador microbiano de la potabilidad de las aguas no tratadas.

Las intervenciones ambientales combinadas destinadas a mejorar la calidad del agua y el saneamiento y a proporcionar mayores cantidades de agua obligan a realizar inversiones sustanciales en infraestructura. Sin embargo, seguimos sin encontrar soluciones bien definidas para mejorar la salud interviendo en la calidad del agua, la cantidad de agua y las medidas personales de higiene, dada la complejidad que caracteriza a la transmisión de enfermedades a través del agua o por contacto fecal-oral. Una táctica importante consiste en cambiar los hábitos personales que contribuyan a la contaminación del agua de bebida. Puesto que la mayoría de las mujeres y los niños intervienen en las actividades de recogida de agua, su participación en programas de educación de salud pública destinados a disuadir de las prácticas no higiénicas en esas actividades resulta fundamental. Esa táctica podría tener un gran impacto en la zona estudiada, donde el 18% de los menores de 5 años presentan una historia reciente de diarrea.

Un programa integral de abastecimiento rural de agua llevado a cabo en Lesotho se ha visto dificultado por la incapacidad de registrar, vigilar y evaluar los aproximadamente 300 proyectos de ayuda internacional que según las estimaciones se han implementado a lo largo de los últimos 25 años. Sin embargo, incluso con un sistema de vigilancia en funcionamiento, la dependencia de criterios microbiológicos que exigen tecnología para determinar la calidad del agua, sin prestar mayor atención a diversos aspectos del saneamiento, no parece la estrategia más adecuada. Esta observación resulta especialmente pertinente en las zonas rurales de Lesotho, donde una gran proporción de la población no usa letrinas, y donde la mayoría de las fuentes de agua de uso doméstico apenas están protegidas.

Para tener éxito, un programa de abastecimiento de agua salubre y de saneamiento en los países en desarrollo debe incluir los siguientes elementos: protección de los recursos hídricos, cambios del comportamiento en relación con la recogida y el uso de agua, ampliación del uso de letrinas, y un centro de recursos de información de los proyectos que facilite la planificación y evaluación de los programas. Cada una de esas intervenciones exige educación en salud pública, la aplicación de conocimientos técnicos y el desarrollo paralelo de recursos humanos e infraestructura.

El de los ochenta fue el Decenio Internacional del Agua Potable y del Saneamiento Ambiental. Su objetivo era mejorar la salud mediante la colaboración nacional e internacional en materia de elaboración de programas autosuficientes y sostenibles para hacer realidad en 1990 el abastecimiento público de agua salubre y el saneamiento para todos. El destinatario principal eran las poblaciones rurales y subatendidas. El concepto de agua potable entraña la inexistencia de contaminación biológica. Aunque se observaron progresos en las tierras altas de Lesotho, donde la mejora de los sistemas de abastecimiento de agua se tradujo en la mayoría de los casos en la desaparición de *E. coli*, queda aún mucho por hacer. La mayoría de las fuentes de agua de bebida doméstica están potencialmente contaminadas por patógenos entéricos. Todo programa de desarrollo integral debe incluir un sistema práctico y eficiente de suministro de agua potable y una estrategia más energética de reducción de los riesgos de transmisión de enfermedades a través del agua.

### References


