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ASSESSMENT OF KNOWELEDGE AND HYGEINIC PRACTICES TOWARDS BACTERIOLOGICAL QUALITY OF DRINKING WATER AT DOBE TOGA KEBELE, SHEBEDINO WOREDA, SNNPR

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Declaration

I the undersigned, declare that this thesis is my original work, has never been presented in this or any other University, and that all the resources and materials used for the thesis, have been duly acknowledged.

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Abbreviations

CFU: - Coliform Forming Unit

FC: - Feacal Coliforms

MDG's:- Millennium Development Goals

MOH: - Ministry of Health

PI: - Principal investigator

SNNPR: - Southern Nations Nationalities and Peoples Region

TNTC: - Too Numerous To Count

UNICEF: - United Nations Children's Education Fund

WHO : - World Health Organization

Summary

Background: Drinking Water becomes contaminated with faecal matter due to inadequate protection of the source, unhygienic practices of the community at the source and household level

Objectives: The aim of this study was to assess the impact of knowledge and hygienic practices of the community on bacteriological quality of drinking water at the source and point of use

Methods: A community- based cross-sectional study was conducted using interviewer-administered questionnaire, inspection check list to observe the condition of water sources, and bacteriological water quality examination of sources and household containers. The study was conducted during August 2006-June 2007 in Dobe Toga kebele of Shebedino wereda. SNNPR. Four hundred twenty households were selected using systematic random sampling method to assess the knowledge and hygienic practices of the community and gathered by health extension worker under strict supervision of principal investigator and supervisors. Bacteriological examination of six protected springs and eighty four systematically selected household containers was carried out by using Oxfam DelAgua water testing kit.

Results: Almost all of the springs were subjected to contamination of faecal coliform with high sanitary risk score. There is a significant variation between the bacteriological analysis of source water and household drinking water with a mean of 10.3 and 32.1CFU/ 100 ml of water samples respectively. Educational status was the only variables which was significant after adjustment of other socio demographic, Knowledge and practices variables [AOR: 6.64, 95% CI=1.028-42.927). However other variables like: types of household containers, washing of containers before transferring, methods of water withdrawal, duration of stored water and cover of container during transportation and storage were significant in bivariate analysis but not in multivariate analysis. This may be due to confounding effects of different variables

Conclusion and Recommendation: Protected springs with high sanitary risk score were highly subjected to bacteriological contamination and its load of feacal coliform almost tripled at household level, because of poor household management system. Proper protection of water sources, regular monitoring of water quality and hygiene education on water and sanitation, are very important strategies to improve the bacteriological water quality.

Key words: Knowledge, practice and bacteriological contamination

1. Introduction

1.1. Background

Water is the essence of life and safe drinking water is a basic human right essential to all, and for sustainable development. It is known that water is our most precious resource, vital to our economy, our daily lives & to the health of our environment.

Water & sanitation inadequacies hinder economic & social development, constitute a major impediment to poverty alleviation & inevitably lead to environmental degradation (1). A community ravaged by diarrheal diseases, dracunculiasis or schistosomiasis cannot look beyond its immediate problems towards social & economic welfare. Safe water is the door way to health & health is the pre-requisite for progress, social equity & human dignity (2).

Protection of water supply from contamination is the first line of defense against disease. Because of the essential role water plays in supporting human life, it has if contaminated, great potential for transmitting a wide variety of disease and illnesses. Source protection almost invariably is the best method of ensuring safe drinking water. However, failure to provide adequate protection, poor site selection, unhygienic practices of the consumers & deterioration of construction materials may contribute the contamination of water sources and resulting water borne diseases (3)

In Ethiopia over 60% of the communicable diseases is due to poor environmental health conditions arising from unsafe and inadequate water supply and poor hygienic and sanitation practices. About 80% of the rural and 20% of urban population have no access to safe water; which is the least among the continent. Three-fourth of the health problems of children in the country are communicable diseases arising from the environment, specially water and sanitation (4).

1.2. Rationale of the study

Although safe water supply services are available in most places, the national as well as the regional information on the water quality status and the household management of local water sources is not readily available. This research tries to identify feacal coliform loads of protected springs and household drinking water containers and the main contributing factor towards the contamination of drinking water and variation of quality at the source and household level. The findings of this study may provide important information for water and sanitation policy makers and program managers, NGOs and government bodies involved in the implementation of water and sanitation projects to improve the service in the future.

2. Literature review

2.1. Status and magnitude of the problem

More than 1.1 billion people in the world, lack access to safe drinking water sources which represented 17% of the global population. Two third of this population live in Africa. In Sub Saharan Africa, 42% of the population is still with out improved water. Similarly 2.4 billion lack accesses to even basic sanitation. As a consequence, 1.8 million people die every year from diarrhoeal diseases (including children); 90% are children under 5, mostly in developing countries. 88% of diarrhoeal disease is attributed to unsafe water supply, inadequate sanitation and hygiene (5, 6).

Freshwater is a finite and precious resource essential for sustaining life, human development and environment. A regular supply of drinking water is a basic human need and it becomes a daily factor for survival during a human crisis. In recognition of the critical importance of

water and sanitation for development, the Millennium Development Goals (MDG's) include a target to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation (5, 7).

The United Nation Center for human settlement estimated that a tenth of every individual's life is lost through water related diseases (1).

Africa contains 28.0% of world's population with out access to improved water supply. Ethiopia is one of the ten African countries, which have less than 50% water supply coverage, with only 24% of the population having access to improved water supply. The situation is much worse in rural areas where coverage is only 13.0% compared with 77.0% in urban areas (1).

The WHO 2004 water, sanitation and hygiene link to health facts and figures shows. Improved water supply reduces diarrhea morbidity by between 6% to 25. Improved sanitation reduces diarrhea morbidity by 32%. Hygiene interventions including hygiene education and promotion of hand washing can lead to a reduction of diarrhoeal cases by up to 45%. Improvements in drinking-water quality through household water treatment, such as chlorination at point of use, can lead to a reduction of diarrhea episodes by between 35% and 39 % (6).

2.2. Sanitary inspection of water sources

In the case of ground water, like protected springs and wells and protected water connection system, it should be possible to achieve very low levels of contamination (8). However different protected water sources are highly subjected to bacterial contamination, due to various reasons. To assess this problem, WHO prepared a standard protected spring evaluation check list which have a score of risk out of ten (9-10=very high risk, 6-8=high risk, 3-5= intermediate risk, and 0-2=low risk) (9). The following are included in the check list: the physical status of protection box, the situation of out let and overflow pipe the drainage system and the general sanitation of the springs. Springs with high sanitary risk score had an inferior bacteriological quality, and on the contrary those springs with low sanitary risk score found to have good quality. Liyod also indicated the higher hazard score of protected springs generally correlate well with increasing order of magnitude of faecal contamination (10).

The result of sanitary and quality monitoring in a pilot water quality surveillance study in Sirilanka, demonstrated that 65.0% to 85.0% of public water supplies; mostly springs become feacally contaminated because of poor site selection, protection and unhygienic management of facilities (11).

Study conducted in rural Zambia showed that poor community sanitary practices around the source and in the catchments area together with failurity in the protection of water sources contributed to the contamination of drinking water (12). Similarly study conducted in South Wollo, Ethiopia, clearly showed improper sanitary survey and, failurity in the protection of

water sources together with poor community sanitary practices around the source and in the catchments area contributed to the contamination of drinking water with faecal matter (13).

2.3. Water handling practices

Access to safe water alone does not reduce diarrheal diseases significantly. Even if the source is safe water become faecally contaminated during collection, transportation, storage and drawing in the home (14). Inadequate hygiene practices must be targeted as well when implementing water and sanitation projects, to decrease morbidity and mortality especially in rural area. Along with building or improving water points therefore we should provides hygiene education for all user groups. Hygiene Promoters inform community members about the correct use and storage of water, the need for safe sanitation facilities, personal and environmental hygiene and diarrhea transmission and management, aiming at sustainable behavior change (5).

Key factors in the provision of safe household water include the conditions and practices of water collection, storage and the choice of water collection and storage containers or vessels. Numerous studies have documented inadequate storage conditions and vulnerable water storage containers as factors contributing to increased microbial contamination and decreased microbial quality compared to either source waters or water stored in improved vessels (15).

Some studies documented increased risks of waterborne infectious diseases from inadequately stored water compared to water stored in an improved vessel (safe storage).In India morbidity and mortality due to waterborne diseases have not declined proportionate with increase in

availability of potable water supply, largely owing to the fact that quality of water is not maintained at consumer point and that safe water may become contaminated during storage due to poor handling practices and poor personal hygiene (14,15).

The result obtained from the study done in Northeast Thailand suggested that there was a far greater risk of ingestion faecal coliform bacteria resulting from the cross contaminations occurring within the house hold than from the faecal pollution of drinking water sources(16).

Mean coliform counts were substantially higher in household water containers than in water sources. In their study on water borne transmission of cholera in Trujillo, Peru, Swerdlow et al tested the water quality variation at the source and later in the household (i.e. stored water). The result showed that, the mean coliform counts were 1 and 20 fecal coliform /100 ml for the well water and stored water respectively (17).

A study conducted in rural Bangladesh showed water stored for longer period increase vibro cholera rate by 10 folds (18). Similar study in Venda, South Africa indicated water stored in plastic vessels have higher levels of coliform over time (19).Anther study in the same area of rural Bangladesh showed water stored in traditional pots increase faecal coliform levels and multiply antibiotic resistance flora than other storage containers (20). Similarly in Calcutta, India water storage vessels which have wide mouth increase cholera infection by 4 folds (21).

Un restricted and un hygienic water collection activities, soiled hands and un clean water collection vessels were potential contributor for the contamination of drinking water in Leseto and else where. The highest level of household water contamination found in stored water, since stored water becomes contaminated when unclean objects touch it over dipping (22).

A study conducted in South Wollo showed among the total of 192 study households 141(73.4%) rinsed their collection containers. In addition, 178(92.7%) had cover for their storage vessels and 138(72%) drew water from storage container by dipping (13).

In Garamuleta district Eastern Ethiopia, only 60.0% of the studied families stored their water in covered containers. In anther study conducted in Kidame Gebeya, it was found out that 58.0% of the households kept their water in clean and covered containers (23). Similarly study conducted in Jimma town showed 70.4% of the studied population taking water from the storage container by dipping rather than pouring, out of these, 52 .2% use cup without handle (24).

The existing water handling and management practices in the study area is similar and even worse because of poor socio-economic status and low levels of awareness's of the community so the above literatures are very much important for the success of this study.

2.4. Knowledge about water handling and contamination

An assessment of knowledge regard to water sanitation and hygiene was undertaken during baseline and final surveys. When asked about how water can be contaminated, about 66% replied that water can be contaminated by due to human excreta; about 8% replied that it is due to animal excreta and 19% expressed their ignorance, in addition to this 88% of total populations wash their hands for the following reasons: 55% Cleanliness, 36% to prevent bad smell and 41% to Prevent diseases (11).

A baseline assessment conducted in Bangladesh, about 8% of the respondents were found to dip their hands during water collection to remove excess water from the container. After intervention through hygiene education and motivation, only 2% respondents were found to continue with this practice; and about 74% of the respondents covered water containers during transportation, with the remaining respondents leaving the container open. In the final survey after hygiene education, 95% users were found to have covered their vessels during transportation of water (25).

A survey conducted by Ministry of Health, Environmental Health Department showed, respondents were asked their view on the possibility of water contamination in the home, the response of the great majority was that water could be contaminated in the home, if kept uncovered or if uncleaned utensils were used. However, significant proportion between 20 and 65% of the respondents in 9 of The 11 rural woredas believed that water could not be contaminated at home. It was also reported that a high proportion, 30-99%, of the respondents have received education on water hygiene. The main sources of hygiene education on how to kept water safe were mostly health professionals. Respondents were also asked weather they knew any disease that were associated with water, most were able to relate diarrhea with water, while a lesser percentage identified intestinal parasites, malaria, skin diseases, eye infection and bilharzias in descending order (4).

2.5. Bacteriological water quality

Water bodies usually consist of a wide Varity of micro-organisms, which includes those that are pathogenic and those that are not. Some of the non-pathogenic micro-organism may lead to other problems in water supplies such as taste and odor, which may serve as indicator of safety. The principal concern for microbiological quality of water, however, is the potential contamination by pathogens. Such pathogenic contaminants include members of bacteria, helminthes, protozoa and viruses. Most of these organisms derived from faeces, indicator organism usually bacteria, are practically used to analyze the microbiological quality of drinking water. Among such indicator the most commonly used are thermotolerant (faecal) coliforms or E.coli. In addition to the above mentioned indicators of bacteriological water quality, the broader groups of coliforms known as total coliforms are also used in monitoring programme (9, 26).

Most untreated (unchlorinated) water supplies contain faecal bacteria, but in the case of protected ground water, example spring, protected wells, and tube wells, it should be possible to achieve very low levels of contamination (8). As with sanitary inspection, data on microbiological water quality may usefully be divided into a number of categories; the levels of contamination associated with each category should be selected in the light of local circumstances. A typical classification scheme is presented in here based on increasing orders of magnitude of faecal contamination. Where community water supplies are unchlorinated, they will inevitably contain large numbers of total coliform bacteria, which may be of limited sanitary significance. It is therefore recommended that the bacteriological classification scheme should be based on thermo tolerant (faecal) coliform bacteria or E. coli (9).

Table 1. Example of classification and colour-code scheme for thermotolerant (faecal) coliforms or E. coli in water supplies

Mean thermotolerant(faecal)coliform count /100ml	**Category * and color code**	**Remarks ***	**Comments ****
0	A(blue)	Inconformity with WHO guidelines	Excellent
1-10	B(green)	Low risk	Acceptable: but make regular sanitary check up
10-100	C(yellow)	Intermediate risk	Unacceptable: look for correct structural faults and disinfect equipment and

			sources
100-1000	D(orange)	High risk	Grossly polluted: look for alternative sources
>1000	E(red)	Very high risk	Grossly polluted: look for alternative sources

* WHO. Guideline for drinking water quality, volume 3, 1997.

** Chees Brough M. Medical laboratory manual, volume 2, 1984.

The situation in our country is similar and in some cases even worse because of poor socio-economic status, low level of awareness's of the community and lack of commitment both government and the community as a whole. The gap between practices of water handling, knowledge of users and bacteriological contamination of water sources and household containers are not properly addressed in a holistic manner.

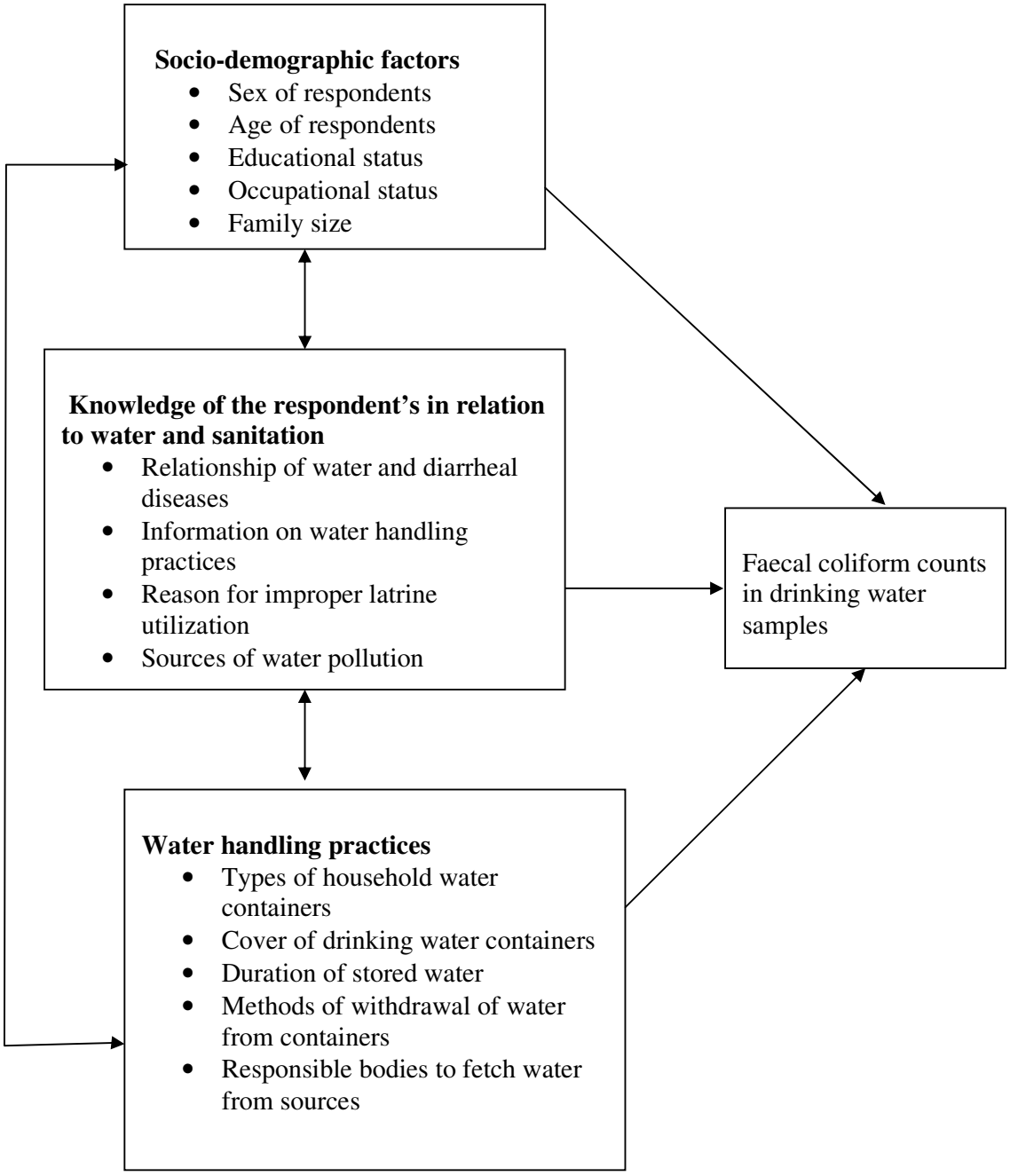


Figure1. Conceptual framework for the study of faecla coliform load in drinking water and associated risk factors.

3. Objectives

3.1. General Objective

To investigate knowledge and hygienic practices of the community with respect to bacteriological quality of water from source to home.

3.2. Specific Objectives

- To assess the knowledge and hygienic practice of the community
- To examine the bacteriological water quality of the sources and household containers.
- To assess the existing sanitary condition of water sources.
- To assess the knowledge and water handling practices in relation to bacteriological water quality

4. Methods and Materials

4.1. Study design

A community based cross- sectional study was carried out using interviewer-administered questionnaire and sanitary check list to observe the current condition of water sources and bacteriological examination of water samples.

4.2. Study area

Shebedino, one of the ten Woredas found in Sidama Zone is located south east of the capital city of SNNPRS, Awassa, at a distance of 27 and 297 kilometers South of Addis Ababa respectively. According to 1994 National Housing & Population Census, the population was 261,851, projected population of the Woreda for the year 2006/7 is 324,815 of which 165,006 are males & 159,809 are females. The woreda comprises 53 Kebeles having 67,670 residential houses with an average household size of 4.8 persons per house. Its altitude ranges from1800-2800 m above sea level & annual rainfall record of 900 -1200 mm. Drinking water coverage of the region is 48% and latrine coverage of 76 % (SNNPR Water Resource Bureau 2006 report).

The study area, Dobe Toga, having a population of 7533 and1569 households. previously a survey conducted by Plan International Ethiopia (2002) on the prevalence of intestinal parasites and the result showed that among 354 school children examined for different types of intestinal parasites 81.5% were positive, which was higher than any other kebeles found in the woreda .

4.3. Source population

Households found in Shebedino Woreda which comprises 53 kebeles and water sources served for the households

4.4. Study population

Households in Dobe Toga kebele were study units. Representative samples of household respondents (especially mothers) were considered to explore knowledge and water handling practices. In addition bacteriological (faecal coliform) test of stored water was made in selected households. Sanitary inspection and faecal coliform analysis were conducted in all protected springs served for the kebele population.

4.5. Sampling Methods

The study kebele Dobe Toga was purposefully selected for intervention activities. The reason was the community used protected water sources like other kebeles found in the woreda but the prevalence of parasitic and diarrheal diseases was significantly higher than any other kebeles of the woreda. Using systematic random sampling method representative sample of households was selected from each six villages to assess the knowledge and hygienic practices of the community with respect to bacteriological water quality. Household bacteriological water quality analysis was carried out at every 5^{th} systematically selected households from those households already selected for the assessment of knowledge and handling practices.

4.5.1. Sample size

As there was no a reliable estimation on the prevalence of faecal coliform loads in households, a 50% proportion which leads to the highest possible sample size was used. The

estimate will desire to be with 5% margin of error and 95% confidence interval. The maximum sample size of the households was calculated from the standard formula of sample size determination. i.e.

$n= (z_1-\infty/2)^2 p (1-p)/d^2$

n=number of sample

P=proportion of respondents knowledge and practices on clean water

D=margin of sampling error

$Z_1-\infty/2$= the standard score corresponding 95% confidence level, which is 1.96

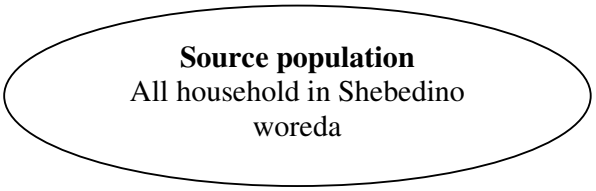
$n= (1.96)^2(0.5) (0.5)/ (0.05)^2$

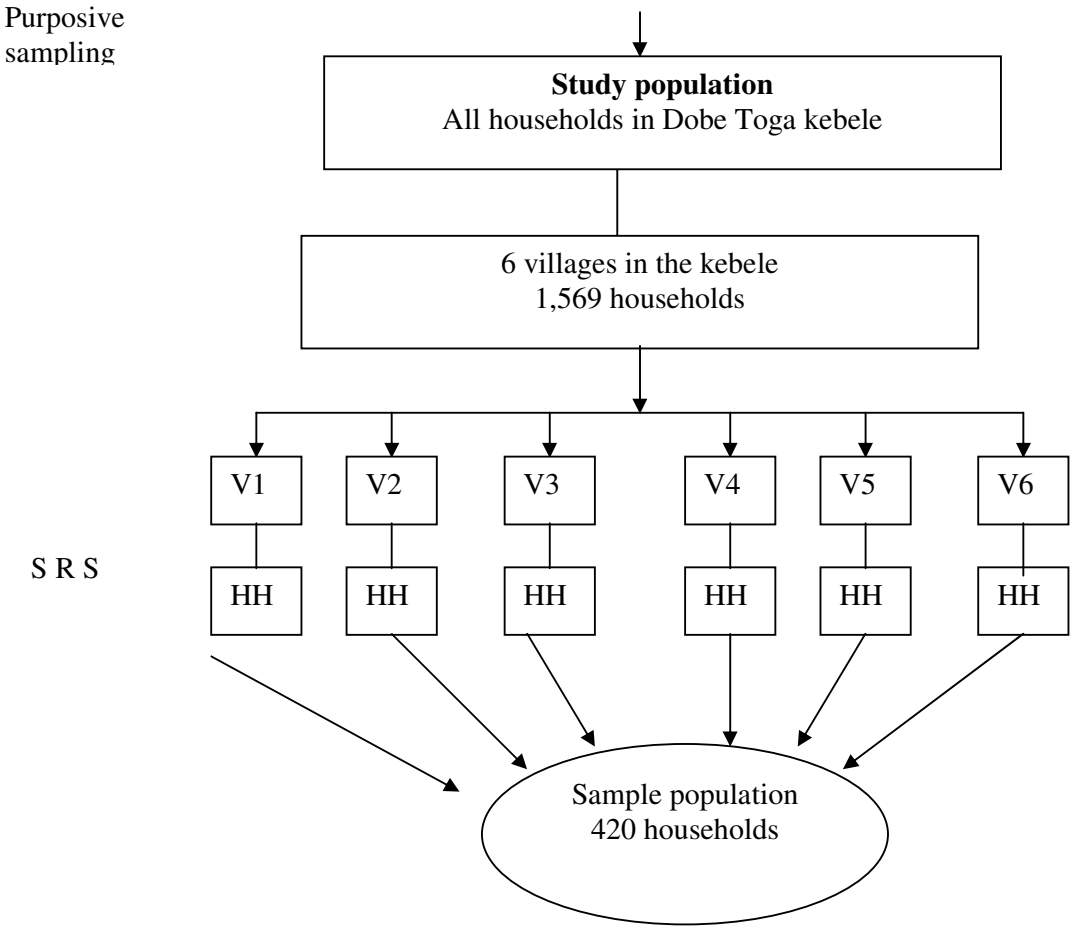
= 384

To compensate the non response rate, a 10 % contingency was added, which gives 420 households.

A total of 90 water samples (6 from spring water sources and 84 from 20% selected households) were involved in the analysis for the identification of faecal coliform bacteria. Household water sample was taken from storage containers and collection containers that used for both collection and storage as the same time. In the case of water sources all water sources (springs) were included in the analysis.

4.5.2. Sampling frame





Key

S R S: systematic random sampling

V: villages

H H: households

Figure-2. Schematic representation of sampling techniques

4.6. Data collection technique

The study used two types of data collection tools

4.6.1. Quantitative methods

Standardized and structured questionnaire was developed for the purpose of data collection after reviewing relevant literatures. The questionnaire was prepared originally in English and translated in to Amharic and back to English. Relevant comments were incorporated after consulting with senior professionals. Bacteriological water quality analysis was carried out for systematically selected household water containers and protected springs by membrane filter methods using Oxfam DelAgua portable water testing kit.

Ten data collectors (all of them are health service extension package workers that are actively involved in the community) were recruited to interview after three days training and two experts supervised and facilitated the data collection processes. The training focused on the objectives of the study and techniques of data collection. The interviewers physically observed the condition of water handling practices and sanitation facilities. Regarding the bacteriological analysis of water, two senior medical laboratory technologists and one microbiologist were involved. The principal investigator coordinates the overall activities of the study.

Water sampling procedure and analysis

Water sample was taken from protected springs by following standard procedure, sterilized sample containers were used and washing the out let pipe of the spring was done properly before sampling. Similarly sample from household containers was taken by pouring into the sample containers without any hand contact.

- Petri dishes 50 mm diameter aluminum dishes, membrane lauryl sulphate broth were sterilized using auto clave.

- Filtration apparatus and sample cups were sterilized using methanol flame (formaldehyde was produced during burning of methanol, witch have a killing effect of micro organisms).
- Sample were taken using sterile sample cup
- The filtration apparatus was assembled and using a sterile blunt-ended forceps the filter paper was transferred to the filter base.
- A sample of 100 ml was filtered through a sterile membrane filter with a pore size of 0.45 mm to retain the indicator bacteria.
- The membrane filter was transferred to a Petri dish. Which contain absorbent pad soaked with lauryl sulfate tryptose broth.
- The Petri dishes were labeled with all the necessary information.
- The plates were incubated at temperature of 44 ± 0.5 0c for 18-24 hours.
- Visually identifiable yellow colonies were counted, and the results expressed in numbers of "colony forming units" (CFU) per 100 ml of original sample.

4.6.2. Qualitative methods

Observation check list (WHO standard protected spring evaluation check list) were used to collect data on the existing water sources. All the six protected springs were included in the observation. The checklist included the physical structure of the spring the drainage system and sanitation of the area around the spring. Photos on the spring condition, laundry and bathing activities near the springs were taken.

4.6.3. Pre test: A preliminary study was carried out in both field situation and the laboratory for one day in order to validate the instruments & growth media based on the standard procedure. Similarly the questionnaire was pre-tested in 10 % of the sample population (42 households). The pre-test was conducted near the study kebele which had similar characteristics to the areas where the actual study was carried out. Vague terms, phrases and questions identified during the pre-test were modified and changed. Missing responses like "no response" and "others" were added, and skipping patterns were also corrected.

During the pre-test, the types of water containers used by the majority of the households were identified, and the capacity of containers was measured to facilitate the estimation of the mean per capita water consumption.

4.6.4. Study variables

Out come (dependent) variable

- the number of feacal coliforms (CFU) per 100ml of water samples

Explanatory (independent) variables

- Socio-demographic conditions

  Includes: age of the mothers / fathers, occupational status of mothers / fathers, occupational status of mother/fathers religion and family size

- Knowledge

  Includes: knowledge of water and risk of health, knowledge of water handling practices and knowledge of latrine utilization.

- Practices of water handling and sanitation

Includes: water collection and storage practices, bathing and laundry activities, latrine utilization and protection status of water sources

4.7.Operational definition

- Faecal coliform bacteria- are the coliform organisms which are faecal origin and its presence indicated the existence of other disease causing micro organisms and they are able to ferment lactose at 44–45°C
- Hygiene education – education given on hand washing practices, water handling practices, proper utilization of sanitation facilities and its benefit on the health of the community in order to develop good hygiene behavior or practice among the community to prevent excreta and water borne diseases.
- Per-capita water consumption- is calculated by considering frequency of water collection in a day, capacity of containers, and family size accordingly

$$\text{Per-capita water consumption} = \frac{\text{frequency of collection} * \text{capacity of containers}}{\text{family size}}$$

- Sanitary risk score- standard risk evaluation by rating the basic constructional and sanitary problems of water sources which have a score of risk out of ten (9-10=very high risk, 6-8=high risk, 3-5= intermediate risk, and 0-2=low risk).
- Sanitation of latrine – cleanness of latrine at the time of data collection including the entire superstructure.

4.8. Data handling and analysis

The collected data was tabulated in a tally sheet every day when the data collector brings the daily field questionnaires.

Computer programs were used to analyze the tabulated data using statistical soft-wares (EPINFO version-6) for data entry and clearing and (SPSS version-13) for analysis. Descriptive statistics, proportions, means were used to describe the findings. Tables were used to illustrate descriptive findings. Factor affecting the bacteriological quality of drinking water were explored using logistic regression analysis.

4.9. Data quality management

The assessment of knowledge and hygienic practices of the community was collected using pre-structured questionnaires under strict supervision of principal investigators and supervisors. The completed questionnaire was checked every day during data collection for completeness, clarity and consistency by the supervisor and principal investigator. Any mistake detected was corrected immediately for the next day. Five percent of the households were re-interviewed by the supervisors and principal investigators to check for the consistency of data collection, and correction was made at the spot.

The Petri dish contained the filtering samples were coded so as to avoid error and number of yellow colonies was counted by medical laboratory technologists. The consistency of the laboratory result was also checked by another method (dilution methods) in a Public Health Laboratory management of Health Bureau of SNNPR. Similarly it was also confirmed in Southern Nations Nationalities Peoples Regional State Water Resource Bureau Laboratory. Data entry and clearing was made by principal investigator, and 10% of the questionnaires were re-entered to check its consistence, and there was no identified variation between the actual data entry and re-entry.

4.10. Ethical consideration

This study was carried out after getting ethical clearance from Addis Ababa University, Medical Faculty. Similarly permission was secured from Southern Nation's Nationality people Regional State Health Bureau and the Dobe Toga Kebele Administrative Council. Informed consent from each study subject was obtained after giving clear explanation on the purpose of the study. To this end, the right of each respondent to refuse, answer for few or all question was rejected. Omitting name of the study subjects from the questionnaire help to assure confidentiality of the information and maximum effort was made to maintain privacy of the respondent during the interview.

4.11. Dissemination of results

The research output will be disseminated by preparing seminars and reports to the respective organization (Plan Ethiopia Shebedino Program Unit, Shebedino Woreda Health office, Shebedino Woreda Water Resource Office, Water Action) and other Governmental and non governmental organization which were responsible for intervention.

5. Results

5.1. Socio-demographic characteristics of the respondents

Of the 420 households visited in the kebeles, data were collected from all households. From the total respondent 365 (86.9%) were women and the rest 55 (13.1%) were males. The

median age of the respondents was 34.2 years and the average number of family members in the households was 5.7 people (Table 2).

The majority of the respondents were Christian 357 (85%), 55 (13.1%) were Muslim, and 8 (1.9%) without religion. Regarding occupational status of the respondent 347 (82.6%) were housewives, and 67 (16%) were farmers. Concerning their educational status 328 (78.1%) of the respondents were illiterate (did not able to read and write) and the rest 92 (21.9%) of the respondent were literate (included: formal education and able to read and write) (Table 2).

Table 2: socio-demographic characteristics of respondents of Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

Characteristics (n=420)	Number	Percent
Age of the respondents		
15-24 years	73	17.4
25-34 years	175	41.7
35-44 years	92	21.9
>44 years	80	19.0
Gender		
Male	55	13.1
Female	365	86.9
Religion		

Christian	357	85.0
Muslim	55	13.1
Others	8	1.9
Educational status		
Illiterate	328	78.1
Read and write	72	17.1
Elementary	19	4.5
Secondary and above	1	0.2
Occupational status		
Farmers	67	16.0
Merchant	4	1.0
Governmental employers	2	0.5
Housewives	347	82.6
Family size		
<=5 family	205	48.8
>5 family	215	51.2

5.2. Knowledge of the respondents about water and sanitation

Assessment of knowledge was done among 420 house holds. Of this majority of the study subjects 304(72.4%) knew that water can transmit diarrheal diseases. Among them two hundred twenty eight (75%) of the respondent believed feacally contaminated water was responsible to cause diarrheal diseases. The main sources of information about the relationship of water and diarrheal diseases 212(69.7%) was hygiene education given by the community health workers, followed by health professionals 67(22%) (Table 3).

More than half 259(61.7%) of the study subjects could not understand the possibility of contamination of protected sources; one hundred sixty one (38.3%) believed water may be contaminated even if the source is safe. The main contribution for the sources of contamination was storing water using unclean containers which accounted one hundred seventeen (72.7%), secondly when water stored in uncovered containers 88(54.6%), followed by un sanitary hands 50(31%) (Table 3).

Two hundred fifty nine (61.7%) of the study subjects received information about water handling and management. The most frequently mentioned source of information about water handling and management in the study area was community health workers 201 (77.6%), followed by health professional 54 (20.8%). The most commonly mentioned reason for improper utilization of latrine by the households were due to bad odor and resulting diseases each constituted 130 (30.9%)and 132 (31.4%) respectively, and 116 (27.6%) of the respondents were due to cultural influences(Table 3).

Table 3. Knowledge about water and sanitation of the study households of DobeToga kebele, Shebedino woreda, SNNPR, January 2007.

Characteristics	Number	Percent
Can water transmit diarrheal diseases(n=420)		
Yes	304	72.4
No	116	27.6
Type of water resulting diarrheal diseases (n=304)		
Any type of water	22	7.2
Feacally polluted water	228	75.0
Animal contaminated water	144	47.4
Others	27	8.9
Sources of information(n=304)		
Broad casting agency	38	12.5
Health professional	67	22.0
Community health workers	212	69.7
Neighbors	32	10.5
Others	26	8.5

Water from safe sources can be contaminated(n=420)		
Yes	161	38.3
No	259	61.7
Sources of contamination(n=161)		
Unsanitary hands	50	31.0
Un cleaned containers	117	72.7
Un covered containers	88	54.6
Insects	40	24.8
Others	1	0.6
Do you get information about water handling(n=420)		
Yes	260	61.9
No	240	38.1
Sources of information(n=260)		
Broad casting agency	32	12.4
Health professional	54	20.8
Community health workers	201	77.6
Neighbors	8	3.1
Others	17	6.7
Reason for improper utilization of latrine(n=420)		
Bad odor	130	40.0
Resulting diseases	132	31.4
Un sanitary	39	9.3
Lack of privacy	53	12.6
Culture	116	27.6
Lack of knowledge	98	23.3

Health professionals are qualified personnel graduated from higher institution with certificate, diploma or degree.

5.3. Water handling practices of the respondents

5.3.1. Water handling practices related to collection and transportation

Majority of the respondents were found to collect water from three springs named Bakico which accounted 174 (41.4%), Dirka spring one hundred forty five (34.5 %,) and Shigae spring fifty eight (13.8%). Maximum time required to fetch water was one and half hours and minimum of five minutes (Table 4).

The study revealed that the most commonly preferred type of water collection container was jerrican which accounted three hundred thirteen (78.6%), followed by clay pots 90 (21.4%). Only two hundred sixty two (62.4%) of the respondents cleaned their containers before collection. Similarly 248 (59%) of the study subject had cover for their collection container during transportation (Table 4).

Majority two hundred sixty three (62.6%) of the study subjects were found to collect water once, 117 (27.9%) of the respondent twice a day and the remaining 30 (7.1%) collect every other day. Daughters were highly responsible three hundred sixteen (75.2%) followed by mothers 136 32.4%) to fetch water from a source. Among the responsible children one hundred thirty three (42%) of their age was below 10 years (Table 4).

Table 4. Water handling practices related to collection and transportation of Dobe toga kebele community, Shebedino woreda, SNNPR, January 2007. (n=420)

Characteristics	Number	Percent
Sources of water		
Bakico spring	174	41.4
Handesa spring	27	6.4
Dirka spring	145	34.5
Hanfota spring	14	3.3
Shigae spring	58	13.8
Gelelcha spring	31	7.4
Time required to fetch water		
Below 30 minutes	190	45.2
31-60 minutes	180	42.9
Grater than 60 minutes	50	11.9
Types of collection containers		
Clay pot	90	21.4
Jerrican	330	78.6
Cover during transportation		
Yes	248	59.0

No	172	41.0
Container rinsing before collection		
Yes	262	62.4
No	158	37.6
Responsible body for water collection		
Mothers	136	32.4
Son	17	4.1
Daughter	316	75.2
Fathers	5	1.2
Ages of responsible children		
Less than or equal to 10 years	133	42.0
Greater than 10 years	183	58.0
Interval of water collection		
Every other day	30	7.1
Once per day	263	62.6
Twice a day	117	27.9
Three times a day	10	2.4

5.3.2. Water handling practices related to storage and usage by households of Dobe Toga kebele

Among the study population using separate container to store water 186 (66.2%) preferred clay pots and the rest 95 (33.8%) used jerrican, and one hundred twenty five (45.5%) of them didn't wash storage containers before re-filling, similarly 133 (47.3%) of the separate containers were without cover materials. Majority 290 (69%) of the households stored water for a day and less and the rest one hundred thirty (31%) for more than a day (Table 5).

According to the observation during the data collection, the sanitation of the area near the storage containers was poor 222 (52.9%). In addition 99 (23.6%) of the storage container have a possibility of reaching animals

Concerning the way that the respondents' with-drew water from containers, 333 (79.3%) preferred pouring and the remaining 87 (20.7%) by dipping. Among those respondent using dipping, cups without handle accounted 40 (51.3%). In addition 291 (69.3%) of the respondents placing dipping or drinking utensils on the floor, the result was also consistent with the observation that was seen during data collection (Table 5).

Table 5. Water handling practices related to storage and usage by households of Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

Characteristics	Numbers	Percent
Type of storage containers (n=281)		
Clay pots	186	66.2
Jerrcan	95	33.8
Washing of container before re felling(n=281)	156	55.5
Yes	125	44.5
No		
Cover of the storage containers(n=281)		
Yes	148	52.7
No	133	47.3
Sanitation of the storage areas(n=420)		
Good	198	47.1
Poor	222	52.9
Possibility of reaching animals(n=420)		
Yes	99	23.6
No	321	76.4
Methods of withdrawal from storage		

container (n=420)		
Pouring	333	79.3
Dipping	87	20.7
Dipping cups (n=87)		
With handle	40	45.9
Without handle	47	54.1
Placement of dipping and drinking cups(n=420)	129	30.7
On a safe place	291	69.3
On the floor		
Duration of stored water in the containers(n=420)		
A day and less	290	69.0
More than a day	130	31.0

5.4. Practices related to liquid and solid waste management and personal hygiene

Two hundred twenty four (53.3%) of the study subjects had traditional pit latrine. From this 214 (95.5%) were privately owned and the rest 10 (4.5%) were shared with their neighbors. Even though latrine were available only 139 (62%) used the latrine frequently, eighty three (37%) were sometimes and 2 (1%) never used at all. Concerning the sanitation of the latrine only 119 (53.1%) was found in a good condition (Table 6).

One hundred thirty (66.3%) of the respondents who had no latrine, usually practiced defecation on their farm fields and the rest 66 (33.7%) used open field defecation. Feaces were physically observed in two hundred ninety eight (71%) of households.

Regarding the solid waste management practices of the respondents' majority, four hundred four (96.2%) disposed their solid wastes (mostly garbage) on their farm fields considering

them as fertilizers. Concerning personal hygiene the majority 326 (77.6%) of the respondents took shower every week. The place where bathing were takes place, most of the respondents took baths near the spring and river which accounted one hundred ninety two (45.7%) and 199(47.4%) respectively. Most of the respondents 361 (86%) wash their clothes near the river and two hundred ninety five (70.3%) near the spring (Table6).

Table 6 Practices related to liquid and solid waste management and personal hygiene in Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

Characteristics	Number	Percent
Latrine availability(n=420)		
Yes	224	53.3
No	196	46.7
Ownership of latrine(n=224)		
Private	214	95.5
Shared	10	4.5
Latrine utilization(n=224)		
Frequently	139	62.0
Sometimes	83	37.0
Never at all	2	1.0
Sanitation of the latrine(n=224)		
Good	119	53.1
Poor	105	46.9
Households without latrine used (n=196)		
Open field	66	33.7
Farm field as fertilizers	130	66.3
Feaces seen around the house(n=420)		
Yes	298	71.0
No	122	29.0
Solid waste disposal system(n=420)		
Pit	2	0.4
Open field	22	5.2
Farm field as fertilizers	404	96.2
Where do you take shower(n=420)		
Home	91	21.7

Near the spring	192	45.7
Rivers	199	47.4
Others	5	1.2
Frequency of taking shower(n=420)		
Every other day	26	6.2
Once a week	326	77.6
With two week interval	60	14.3
Above two week	8	1.9
Place of washing clothes(n=420)		
Up heal of the spring	104	24.8
Down heal of the spring	115	27.4
On the collection box	76	18.1
Home	8	1.9
River	361	86.0
Others	4	1.0

5.5. Bacteriological quality of protected springs

The bacteriological (faecal coli form) result of the six protected springs were as follows: Backicho, Dirka and Shigae springs were poor quality and graded as class C, which had intermediate risk where as Gelelcha and Hanfota springs were considered low risk (class B) and Handessa spring was compliance with the WHO guideline values graded as class A (Table 7).

Table 7. Bacteriological quality of protected springs, Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

Spring sites	**Fecal coli form count per 100 ml**	***Category**	**Quality remark**
Bakicho	21	C	Intermediate risk
Dirka	12	C	Intermediate risk
Hanfota	5	B	Low risk
Shigae	17	C	Intermediate risk

Gelelcha	7	B	Low risk
Handesa	0	A	Compliance with the WHO guideline

* WHO guide line for drinking water quality, Vol. III. 1997.

5.6. Bacteriological quality of household drinking water

Among those water samples taken from storage containers for bacteriological water quality analysis, only 3 (3.6%) compliance with the Who guideline value 0 CFU/100 ml of sample, twenty three (27.4%) of the samples was low risk, majority 52 (61.9%) of the result was intermediate risk, and 6 (7.1%) of the sample was high risk for human health. The mean faecal coliform loads of household water samples was 32 CFU/100ml sample (Table 8).

Table 8. Summery of Bacteriological quality of household water storage containers found in Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

Fecal coli form count per 100 ml	**Number**	**Percent**	***Category**	**Quality remark**
0	3	3.6	A	Compliance with the WHO guideline
1-10	23	27.4	B	Low risk
11-100	52	61.9	C	Intermediate risk

>100	6	7.1	D	High risk

* WHO guide line for drinking water quality, Vol. III. 1997.

5.7 logistic regression analyses

Educational status of the respondents was significantly associated with bacteriological quality of drinking water. Illiterate respondents were more than 4 times more likely contaminate household drinking water with faecal coliforms compared to those who were literate [OR:4.5, 95% CI=1.655-12.258]. This was also significant after adjustment of other socio demographic, Knowledge and practices variables [AOR: 6.64, 95% CI=1.028-42.927) (Table 9).

Respondents having health education about water handling and management were less likely to contaminate their drinking water with faecal coliforms than respondents who didn't have education about water handling [OR: 0.28, 95% CI=0.092-0.836], But not significant after adjustment (Table 9).

An association has been found in the type of household water storage containers. Respondents who were used clay pots were five times more likely contaminate household drinking water with faecal coliforms than those who preferred jerrican [OR: 5.05, 95% CI= 1.074-23.729]. Similarly respondents using covered water collection container during transportation, reduced

the risk of fecal coliform contamination of household drinking water by three-forth than households used uncovered containers [OR: 0.24, 95% CI=0.080-0.730] (Table9).

Households practiced cleaning of their containers before collection were less likely contaminate drinking water compared to those who didn't cleaned their containers [OR: 0.2, 95% CI=0.060-0.644]. This was not significant after adjustment with other soc-demographic knowledge and practices variables (Table 9)..

Regarding the storage condition, respondents who cleaned their storage containers before transferring water were prevented their drinking water from faecal contamination than who didn't clean their containers [OR: 0.14, 95% CI=0.036-0.569]. Similarly respondents who were used covered storage containers were more likely protect drinking water at household from faecal contamination than those who preferred uncovered containers [OR: 0.17, 95% CI= 0.034-0.816]. This was not significant after adjustment of other socio-demographic, Knowledge and practice variables (Table 9)..

Statistical significant association was found between the methods of water withdrawal and the occurrence of faecal coliform contamination of drinking water, and the risk was almost 5 times higher [OR: 4.69, 95%CI: (1.258-17.448)] in households who were using dipping than pouring. This was not significant after adjustment of other socio-demographic, Knowledge and practice variables (Table 9).

Duration of water storage was significantly associated with feacal coliform loads. Drinking water stored for a day and less had less likely contaminated with faecal coliforms than water stored for more than a day [OR: 0.19, 95% CI=0.050-0.689] (Table 9).

Table 9. Comparison of fecal coli form load in relation to socio-demographic factor knowledge and practices about water handling of the community of Dobe Toga kebele, Shebedino Woreda, SNNPR, 2007

Characteristics	Fecal coli form loads per 100 ml of water		Crude OR 95% CI	Adjusted OR 95% CI
	≥	<		
Educational status				
Illiterate	4	1	4.51(1.655-12.258)**	6.64(1.028-42.927)*
Literate	1	1	1.00	1.00
Received information about water handling				
Yes	3	2	0.28(0.092-0.836)*	0.94(0.148-5.914)
No	2	5	1.00	1.00
Type of storage containers				
Clay pot	1	2	5.05(1.074-23.729)*	4.77(0.312-43.087)
Jerrican	4	2	1.00	1.00
Cover during transport				
Yes	2	2	0.24(0.080-0.730)*	1.19(0.180-7.858)
No	3	5	1.00	1.00
Washing of container before collection				
	3	2	0.20(0.060-	0.15(0.017-1.361)

Yes			0.644)**	1.00
No	2	4	1.00	
Washing of storage containers before transferring	1	1	0.14(0.036-	0.42(0.075-2.413)
Yes			0.569)**	1.00
No	2	3	1.00	
Cover of storage containers				
Yes	2	1	0.17(0.034-	0.47(0.054-4.124)
No			0.816)*	1.00
	2	2	1.00	
Methods of water withdrawal				
Pouring	2	3	4.69(1.258-	3.83(0.399-
Dipping		2	17.448)*	36.843)
	3		1.00	1.00
Duration of stored water				
A day and less	3	2	0.19(0.050-	0.27(0.018-4.038)
More than a day			0.689)*	1.00
	2	3	1.00	

*** * P-value < 0.01 * P-value < 0.05**

Results of qualitative findings

5.8. Sanitary conditions of the six protected springs

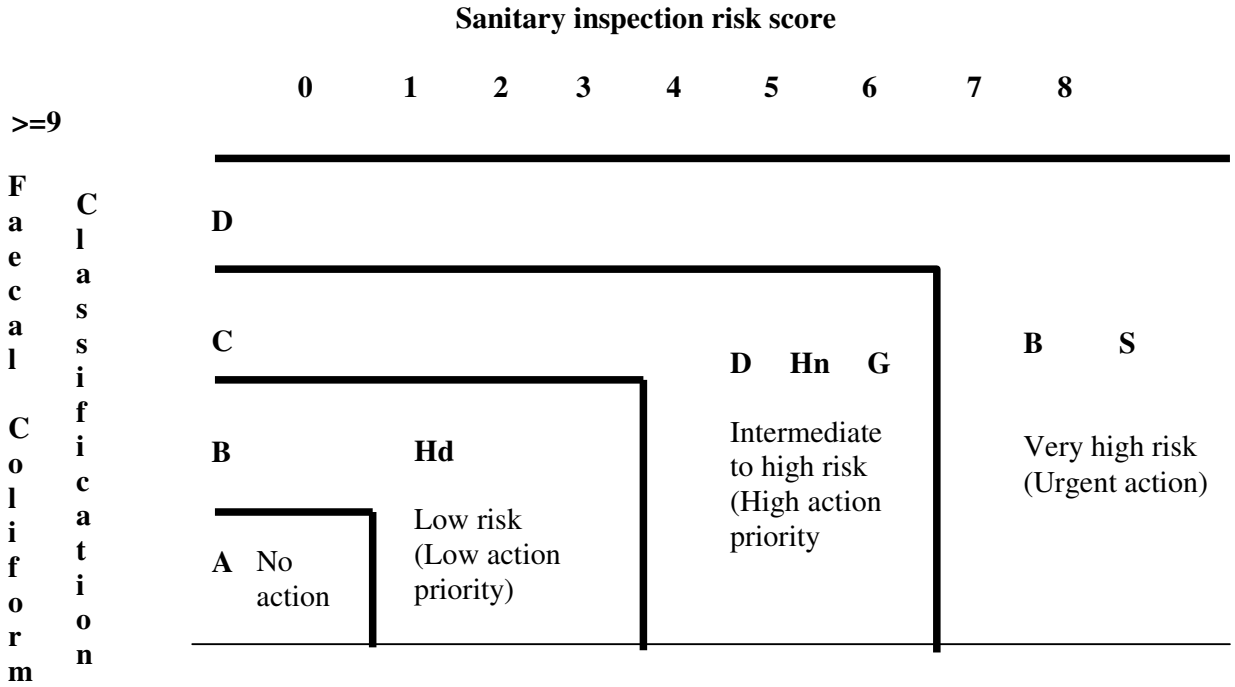
Bacteriological (fecal coli form) test were done for those six protected springs found in the kebele. The sanitary survey result revealed that; Bakico and Shigea springs found to have very high and high sanitary risk score (9 & 8) respectively. The most significant defects were in-adequate protection, absence of surface water diversion ditch, unsanitary overflow pipe and cover, lack of fencing, open for surface water contamination and poor drainage system. Dirka, Handessa, Hanfota and Gelelcha springs were graded as an intermediate level of risk some of

the defects were: in sanitary over flow pipe, lack of surface water diversion ditch, lack of fencing and also open for surface water contamination (Table 10).

Table 10. Sanitary condition of six protected springs found in Dobe Toga kebele, Shebedino woreda, SNNPR, January 2007.

	Spring site	*Sanitary risk score	Risk of contamination
	Bakicho	9	Very high risk
	Dirka	5	Intermediate risk
	Hanfota	4	Intermediate risk
	Shigae	8	High risk
	Gelelcha	4	Intermediate risk
	Handessa	3	Intermediate risk

* WHO guide line for drinking water quality, Vol. III. 1997.



Hd=Handesa spring, **D**=Dirka, **Hn**=Hanfota, **G**=Gelelcha, **B**=Bakicho, **S**=Shigae

Figure 3. Assessment of priority of remedial action by risk analysis for protected springs Dobe Toga kebele, SNNPR, January 2007.

The cross tabulation of faecal coliform loads found in household water sample by its sources was made. The result indicated that water sample taken from households whose sources of water was springs contain high faecal coliform load the household samples also contain high number of faecal coliforms. Water sample taken from households whose sources was springs with low faecal coliform loads contain low number of faecal coliforms (Table 11).

Table 11. Cross tabulation of household faecal coliform load with its sources Dobe Toga kebele, SNNPR, January 2007.

Water sources	Faecal coliform count per 100ml sample	
	>10	<= 10
Bakicho spring	15	22
Handesa spring	1	5
Dirka spring	4	19
Hanfota spring	1	2
Shigae spring	7	5
Gelelcha spring	0	3

The sanitary inspection of protected springs was also strengthened by taking relevant photos. The existing protection status and the sanitation of Dirka and Shigae spring were questionable as showen in the picture (Figure 4&5). Majority of the households fetch water from these two springs. On the contrary the existing status of Handesa and Gelelcha springs were good, but the number of users was small. The photo also showed unhygienic practices of the community (laundry and bathing activities) near the springs which had a significant contribution for the contamination of the sources (Figure 8&9). Containers used to collect waters were dumped in the waste water with out considering its consequence in drinking water contamination (figure 10).



Figure-5. The existing condition of Shigae spring



Figure-4. The existing condition of Dirka springs





Figure-6. The present status of Handesa spring

Figure-7. The present status of Gelelcha spring



Figure-8. The community practicing Laundry activities near Dirka spring



Figure-9. The community practicing bathing activities and entrance of animals near Dirka spring



Figure-10. Collection containers discarded in waste water



Figure-11. Children less than 10 years involved in fetching water from source

6. Discussion

The majority of diseases in developing countries are infectious diseases in nature which are found mainly in human faeces and polluted water supplies. Unsafe water supply is a major

constraints and faecal contamination of water source is a persistent problem in developing countries (1, 5)

The results of this study indicated that protected springs were subjected for high levels of faecal contamination in all most all cases. Study in Sirilanka, demonstrated that 65% to 85% of public water supplies; mostly protected springs become feacally contaminated (11).

Community unhygienic practices increase the sanitary risk of the springs, as the result indicated springs with high sanitary risk score had an inferior bacteriological quality (Bakicho and Shigae springs). On the contrary those springs with low sanitary risk score found to have an intermediate bacteriological quality (Hanfota, and Gelelcha springs), and Handessa spring has excellent quality. Lioyd also indicated the higher hazard scores of protected springs generally correlate with increasing order of magnitude of faecal contamination (10). The reason behind the variation of sanitary risk scores between springs may be due to its location. Those springs having high sanitary risk score were found in a densely populated area and the number of households who practiced bathing and laundry activities are increasing.

In the present study almost half of the study subjects live without latrines, using open defecation. The presence of latrine in households didn't indicate its utilization, faeces that were commonly observed in the premises of households regardless of its availability of latrine.

More than half of the respondents were doing laundry and bathing activities near the water sources. A similar study in rural Zambia and in South Wollo Ethiopia showed that poor community sanitary practices around the sources and near the catchment areas together with

inadequate protection of water sources increased the sanitary risk scores of the springs and contributed to the bacteriological contamination of ground water (12,13).

Two hundred fifty nine (61.7%) of the study subjects received information about water handling and management. This was consistent with a survey conducted by Ministry of Health, Environmental Health Department. A high proportion between 30-99% of the respondent received education on water hygiene (4). Even if, the risk of the occurrence of faecal coliforms and receiving information on water handling not statistically significant. Respondents having health education on water handling reduced faecal coliform loads than who don't have

The study indicated that 72.4% of the respondent perceived that water can transmit diarrheal diseases and out of this 75% of the respondents believed feacally polluted water was responsible to cause diarrheal diseases. This was consistent with a survey conducted by Ministry of Health; Environmental Health Department the great majority believed water can transmit diarrheal diseases (4). However the result of latrine utilization showed very small number of households used their latrine frequently. This findings were similar with a study conducted in Malaysia; the study communities had sufficient knowledge on sanitation and household water management but still their practice in using the facility was poor and health impact reduction still marginal (29).

The reason for improper latrine utilization by the community included cultural influence, bad odor and cause of diseases. This is supported by a similar study conducted in Nepal. Cultural influence and lack of knowledge were the major reasons (25).

Water obtained from high microbial quality, including protected and treated supplies may become contaminated by household water handling practices. In India morbidity and mortality due to waterborne diseases have not declined proportionately with increase in availability of potable water supply, largely owing to the fact that quality of water is not maintained at consumer point (21, 25).

The result indicated only 3.6% of water samples collected from household containers was incompliance with the WHO guideline value 0 coliform/100 ml sample (9). The average number of coliforms found in protected springs and eighty four household storage containers were 10 and 32 faecal coliform /100ml respectively. Consistence with study conducted in Trujillo, Peru, 1 and 20 fecal coliform /100 ml for the well water and stored water respectively (17). Similarly in Malawi water from borehole yield zero indicator bacteria but household container showed 91% positive for faecal coliforms (30).

The higher proportion of inferior water quality observed in storage containers may be the cumulative effect of collection and storage practices. Sixty two percent of the interviewed households in the study kebele cleaned their containers when collecting water this was lower than previous report done in Jimma town and South Wollo 86%, and 73% respectively (13,24). The reason for this much difference may be in the case of this study area 42% the responsible bodies to bring water from sources were children under 10 years.

Majority 66.2% of households used clay pots for household water storage while the remaining 33.8% stored in jerrican. Even if the risk of the occurrence of faecal coliforms and type of

containers not statistically significant. Respondents preferred clay pots increase the risk of faecal coliforms than those respondents who were using jerrican. Which is consistence with different findings: in rural Bangladesh traditional pots increased faecal coliforms and multiply antibiotic resistance flora (18). Similarly Mertenes and Tiku. S. showed the proportion of faecal coliform load was higher in water stored in earthen jar than narrow necked container (11, 13).

Only 55.5% of the respondents cleaned their container before transferring water from collection to storage containers which was much lower than a study done in Jimma town 91% (24). Similarly only half (52%) of the respondents covered their storage container, which was almost similar with the study conducted in Garmuleta district 60%, and Kidame Gebya, 58%, but much lower when comparing with a study done in South wollo, 92.7% (13, 23).

In this study, it was found that, only 20.7% of the respondent dipped out water rather than poured when taking from the storage container which is a commendable practice. This was much lower when comparing with studies conducted in Zambia, 80%, and in south Wollo 72% of the households (12, 13). The reason for these much difference may be due to the use of narrow naked clay pots and jerrican which is inconvenient for dipping in the study area. Transfer of water out of storage containers by pouring showed statistically significant reduction on the concentration of faecal coliforms than dipping in the study area. In Calcutta, India water storage container with wide mouth increased cholera infection by 4 folds (21).

The occurrence of faecal coliforms in water storage container was not also statistically significant with duration of water storage in multivariate analysis; however the risk of the

occurrence of faecal coliforms was higher in longer storage time than short storage time. Consistent with different studies conducted in Rural Bangladesh, Venda, South Africa and South Wollo, Ethiopia; water stored for longer time increase the number of faecal coliforms and vibro cholera rate by 10 folds (19, 20). This may be due to majority of the households in this study area didn't washed their storage container before transferring so that the particles found in the storage containers serves as bacterial nutrition. Since the water was stored for two or three days the depletion of bacterial nutrition not that much expected. In addition to this during sampling I have shacked the water in the containers to mix, at this time the sediments disturbed and the faecal coliform loads increased.

The reason for the non significant of variables in multivariate analysis which were already significant in bivariate analysis may be due to the smaller sample size. One of the cell in the two by two table was 5 and below in all cases except educational status (the only variables significant in the multivariate analysis). However, the multicollnearity of different variables were cheeked by using correlation matrix and by removing some expected confounded variables and there was no any multicollnearity.

7. Strengths and Limitations

7.1 Strengths

This study will give a clue to Ministry of Health, Ministry of Water Resources, non governmental organization focusing their implementation on water and sanitation particularly among rural community having the following strengths

- The study was community based particularly addressing the rural community.
- Data collectors have basic knowledge on water and sanitation.
- The study used bacteriological water quality analysis

7.2. Limitations

- As being cross-sectional study in nature, it might have drawbacks on the actual situation of the seasonal difference of the occurrence of faecal coliform.
- Due to limitation of financial resources all interviewed households were not involved in bacteriological water quality analysis.
- Latrine assessment was not included with the description of its relevance

8. Conclusion and Recommendation

8.1. Conclusion

- Source protection found to be necessary condition, but never be sufficient for the provision of safe water supply and in reduction of diarrheal diseases.
- Almost all protected springs were grossly polluted with faecal matter.
- The high sanitary risk score and presence of faecal coliforms in the existing water sources is attributed to constructional defects, lack of follow up, bathing and laundry activities undertaking near the source.

- There was a significant variation of bacteriological water quality between source water and household drinking water. Water obtained at household level is more bacteriological concentration than its origin.
- The main contribution for household water contaminations were Unrestricted and unhygienic water collection and storage activities such as: selection household containers, lack of cover, ignorance of washing of containers before collection and transferring to storage containers, transfer of water out of storage container by dipping and placement of drinking or water drawing utensils on floor, because of this the feacal coliform load increases by two fold in household container than sources.
- Health education in water handling and management improve the quality of drinking water.

8.2. Recommendations

- The concerned sectors (Ministry of Health, Ministry of Water Resources, Non Governmental Organizations involved in water and sanitation activities and the beneficiaries) must increase their effort in spring protection, monitoring and evaluating the existing facilities, including regular check up of its bacteriological safety, and undertaking source maintenance if needed.
- The above mentioned responsible bodies should focus on the adoption of water supply facilities; users practice and behavior, personal and domestic hygiene which are the most neglected aspects of the soft were components.

- Hygiene education should be targeted on women and children, because they are highly involved in most water collection and management activities.
- The community should actively participate in the implementation of water and sanitation projects from the beginning of its planning to its operation to ensure sustainability and self-reliance.
- Clean water availability latrine utilization and hygiene education go side by side.

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Annex-I. Questionnaire- English version

Verbal Consent Letter

Dear respondent, my name is ---------- I am working in a research team of Addis Ababa University. We are interested in learning more about your knowledge and hygienic practices in relation to bacteriological contamination of drinking water from source to home. This questionnaire is designed for a research work which will be approved by AAU, medical faculty, department of community health to be conducted in partial fulfillment of Masters Degree in public health. We hope you will help us by answering this question none of your answer will be available to any one. Do not give your name. All the information you give us will be kept private. Any one who will not be willing to participate in the study will have the right to discontinue at any time in the process. Confidentiality and privacy will be maintained by ensuring the respondents answering the question on a separate place where no one can see them we really need your honest responses to better understand on the knowledge and hygienic practices to wards bacteriological quality of water. The result of the study will

hopefully serves an important input to intervention programmes that aim at improving drinking water quality of the communities.

We thank you in advance for taking your time to answer our questions.

Would you be willing to participate in the study?

Agree _____, Disagree _____

Interviewer's name_____, signature_____

Date of interview_____

Supervisor's name_____, signature_____.

Additional instructions to the Interviewers:

1. The interview will continue only after the respondent will agree on the consent
2. Fill the questionnaire only with pen
3. Circle the answer from the options of possible responses
4. Strictly follow the skipping pattern

Thank you!!

I. General description

101. House number----------

102. Age of the respondents----------

103. Sex

1. Male ----------
2. Female ----------

104. Religion

1. Orthodox ----------
2. Protestant ----------
3. Muslim ----------
22. Others ----------

105. Educational level of the father/ mother

1. Illiterate----------
2. Read and write----------
3. Primary----------

4. Secondary and above--------

106. Occupation of the father/ mother

1. Government employee----------
2. Merchant----------
3. Farmer----------
22. Other----------

107. Number of person in the household----------

108. Number of under 5 children in the household----------

II. Knowledge about water handling practices, sanitation and related health issue.

S. No	Question	Response	Code	skip
201	Can water transmit diarrheal disease?	1.Yes-------- 2.no--------		If no skip to Q.204
202	What type of water is responsible to cause diarrheal diseases	1.any type of water---------- 2. faecally contaminated water- 3. contaminated by animals--- 22.other (specify)---------		
203	Where do you get the information that water transmits diarrheal disease?	1.broadcasting agency--- 2.health professionals---- 3.Community health workers-- 22.Other (specify) ---------		
204	Do you think protected spring can be contaminated?	1.yes --------- 2.no----------		If no skip to Q.206
205	If yes in what way it will be contaminated?	1.un clean hands---------- 2. unclean container---- 3.uncovered container---------- 4.insects/ rodents-------		

		22.other/ specify----------		
206	Do you get information about water handling practices	1.yes --------- 2.no----------		
207	If yes where do you get the information about water handling practices?	1.broadcasting agency--- 2.health professionals---- 3.Community health workers-- 22.Other (specify) ---------		
208	Do you think children's faeces contain disease causing MO	1.yes --------- 2.no----------		
209	Do you know a near by latrine to water sources can result water pollution?	1.yes --------- 2.no----------		
210	What do you think the main reason for improper utilization of latrines?	1.smelled---------- 2.resulting disease------- 3.not cleaned---------- 4.lack of privacy---------- 5.cultueral issue---------- 22. others (specify)---------		

III. Water handling practice

S. No	Question	Response	Code	skip
301	Where do you get water?	1.Bakicho spring---------- 2. Handesa spring---------- 3. Dirka spring ---------- 4. Hanfota spring---------- 5. Shegae spring---------- 6. Gelelcha spring---------- 22. Others (specify)----------		
302	How much is your per-capita water consumption	In liters----------		
303	Who is responsible to fetch water	1.mother---------- 2.son---------- 3.daughter-------- 4.father----------		

		22.other/specify----------		
304	Age of responsible children	In years----------		
305	How much time do you take to fetch water from the source?	1. <30min---------- 2. 31-60 minutes-------- 4. >60 minutes----------		
306	Types of collection container (observe)	1.Clay pots---------- 2. Jerricans---------- 3 Plastic buckets------- 4.Metal buckets---------- 22.other/ specify----------		
307	How much is the capacity of water collection containers?	In liter----------		
308	Is the water collection container has cover material?	1.yes --------- 2.no----------		
309	Do you wash your hand and container before water collection	1.yes --------- 2.no----------		
310	In what interval do you collect water	1.every other day---------- 2.every day---------- 3.twice a day---------- 22.other/ specify----------		
311	Do you use collection containers to store water?	1.yes---------- 2. no----------		
312	Types of storage container (observe)	1.Clay pots---------- 2. Jerricans---------- 3 Plastic buckets------- 4.Metal buckets---------- 22.other/ specify----------		
313	Is the water storage container used for storing other liquid/ solid? (observe)	1.yes --------- 2.no----------		If no skip to Q.214
314	If yes for what purpose do you use?	Specify----------		
315	Do you wash water storage container before storing water	1.yes --------- 2.no----------		
316	Cover of containers during storage	1. yes---------		

		2. no----------		
317	Is the area around the storage container in sanitary? (observe)	1.yes --------- 2.no----------		
318	Is there a possibility to reach animals to the storage container	1.yes --------- 2.no----------		
319	What methods do you use to withdraw water from container	1.pouring---------- 2.dipping----------		
320	Are the utensils used to draw water from the container with handle?	1.yes --------- 2.no----------		
321	Where do you put water drawing utensils?	1.Table or shelves---------- 2.Inside the container------- 3.Storage cover---------- 4Hang on well---------- 5.Floor---------- 22.other/ specify----------		
322	For how long the water will be stored in the container	1.for 1 day and below-------- 2. a day and above ----------		

IV. Liquid and solid waste management system

Sr. No	Question	Response	Code	skip
401	Do you have a latrine	1.yes --------- 2.no----------		If no skip to Q.404
402	Owner ship of the latrine	1.privat---------- 2.Shared with neighbors----------		
403	Utilization of latrine	1.always---------- 2. sometimes--------- 3. never at all---------		
404	Sanitation n of the latrine	1.good ---------- 2. poor ----------		
405	If latrine is not available where the families dispose their faeces?	1.Open field---------- 2.farm land---------- 3.Other (specify----------		
406	Is faeces seen around the house?	1.yes----------		

		2.no----------		
407	If there is water source near the latrine how much is the distance	Specify in meter----------		
408	Where do you dispose refuse? (observe)	1.Pit---------- 2.Open field---------- 3.water body---------- 4.Burning---------- 5. used as fertilizers---------- 22.Other (specify) -------		
409	Where do you take shower	1.home---------- 2.near the spring---------- 3. river ---------- 22. Other (specify) --------		
409	frequency of taking shower	1.every other day---------- 2. every week---------- 3. every two week---------- 22. others (specify)---------		
410	Where do you wash your cloth?	1.above the spring---------- 2.below the spring---------- 3.on the collection box---------- 4. house---------- 5. river---------- 22. Other (specify) --------		

Annex –II. Questionnaire-Amharic version

¾lw[}cu<" ¨<H ›ÖnkU vl]" ÁK¨<" Ó"³u? K¨<H uv¡}@]Á SuŸM ¾T>•[¨<" ›e}ªê*" ¾w¡Kƒ Å[Í KT¨p ¾}²ÒË SÖÃp::

nK SÖÃl" ŸTÉ[Ó uòƒ ¾}d□ò-‹ ðnÅ˜"ƒ SÖ¾mÁ pî

Ö?" ÃeØM˜& □'@ _____ □vLKG<:: □²=I ¾S×G<ƒ ÃI"" Ø"ƒ uT>Á"H>Å¬ ¾›Ç=e ›uv ¿'>y`c=+ Q¡U" ó"M+ ¾Qw[}cw Ö?" ƒUl`ƒ ¡õM u<É" ›vM J–@ '¨<:: ¾²=I Ø"ƒ ª" ¯LT ¾lw[}cu<" ¨<H ›ÖnkU vl]" ÁK¨<" Ó"³u? K¨<H uv¡}@]Á SuŸM ¾T>•[¨<" ›e}ªê*" ¾w¡Kƒ Å[Í KT¨p ¾}²ÒË '¬:: uSJ'<U ÃI"" S[Í KTÓ–ƒ u?ƒ Ku?ƒ SÖÃp uT"H@É LÃ □"Ñ—K"::

ÃI Ø"ƒ c=Ö"kp ¾lw[}cu<" Ö?" KThM uT>Å[Ñ¬ Ø[ƒ Ÿõ}— □Ñ³ Ã•[ªM:: uØ"~ ¾U"dƒõ-ƒ ¾□`e-" S<K< ðnÅ˜ƒ e"Ñ˜ w‰ '¨<:: Ÿ□`c- ¾U"Ñ–¨<" T"—¨<"U SMe uT>eØ` □"ÖwnK":: eKS<K< ðnÅ˜"ƒ-" eKT>ÁÅ`Ñ<ƒ ÉÒõ G<K< Ÿð}— UeÒ" □Ák[w"&ŸG<K<U uLÃ ÃI Ø"ƒ u□`e-" uu?}cw- LÃ U"U ¯Ã'ƒ Ñ<Çƒ □"ÅTÁeŸƒM T[ÒÑØ □¨ÇKG< :: u¬ÃÃ~U Ñ>²? ¾TÃeTT- 'Ó` "K ¾Ts[Ø Swƒ- uT"—¬U c¯ƒ ¾}Öuk '¬::
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201	¨<H ui" Áe}LMóM wK¨< ÁevK<	1 ›- _____ 2 ›Áe}LMõU_____		SMc< ›Áe}LMõU ŸJ' ¨Å ØÁo 2®3 ÃKõ
202	Áe}LMóM "K< ƒUl`~" Ÿ¾ƒ ›Ñ–<ƒ	1 ŸSÑ“— w²<G" _____ 2 ŸÖ?“ É`Ïƒ _____ 3 ŸÑÖ` Ö?“ W^}™‹ _____ 4 ŸÑA[u?ƒ _____ 22 K?L/ÃÑKî _____		
203	¨<H u›Ã' UÉ` K=uŸM Ã‹LM;	1 ›- _____ 2 ›Ã‹MU _____		
204	uc=T>"„ }Ñ"w„ Ÿ}c^ U"ß ¾T>Ñ˜ ¨<H K=uŸM Ã‹LM;	1 ›- _____ 2 ›Ã‹MU		SMc< ›Ã‹MU ŸJ' ¨Å ØÁo 2®6 ÃKõ
205	¾ØÁo 204 SMe Ã‰LM ŸJ' uU" SMŸ<	1 "èl vMJ' Ïl c='" 2 "èl vMJ' °n c=kÇ/c=Ö^kU 3 ¾¨<H °n¨<" vKS¡Å" _____ 4 u'õdƒ _____ 22 K?L/ÃÑKî_____		
206	eK¨<H "êl“ ›Övup/›ÁÁ´ ƒUl`ƒ ›Ó¯}¨< Á¨<nK<	1 ›- _____ 2 ›LÑ–G<U _____		
207	SMc< ›- ŸJ' S[Í¨<" Ÿ¾ƒ ›Ñ–<ƒ	1 ŸSÑ“— w²<H" _____ 2 ŸÖ?“ É`Ïƒ _____ 3 ŸÑÖ` Ö?“ W^}™‹ _____ 22 K?L ÃÑKî _____		
208	¾lí" ›Ã'UÉ` ui ›Uß }ªIeÁ"" ÃÃ³M;	1 ›- _____ 2 ›Ã´U _____		
209	¾SìÇÍ u?ƒ“ ¾¨<H U"ß u×U Sk^[w K¨<H w¡Kƒ ›e}ªê* Ã•[ªM ÃLK<	1 ›- _____ 2 ›Ã•[¨<U _____		
210	SìÇÍ u?„‹" u›Óvu< LKSÖkU ª“¨< U¡"Áƒ U"É""¨< wK¨< ÁU"K<	1 SØö i eLK¨< _____ 2 ui eKT>ÁS× _____ 3 "îl“¨< eKTÃÖup _____ 4 Ÿ Ã ¾T>ŸLŸM ŸKL eKK?K¨< _____ 5 vlL‹" eKTÃðpÉ _____ 22K?L/ÃÑKî -		

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301	¨<H ¾U Ñ–<ƒ Ÿ¾ƒ ’¨<;	1 ŸS<^”Œ U”ß _____ 2 ŸÅ”w_ U”ß _____ 3 J-K=f U”ß _____ 4 ÑA•ª ÒvKA U”ß _____ 22 K?L/ÃÑKî _____		
302	uk” u’õe ¨Ÿõ e”ƒ K=ƒ` ƒÖkTL‹G<	1 Ÿ1® K=ƒ` u‹ _____ 2 Ÿ10-15 K=ƒ` _____ 3 Ÿ15-20 K=ƒ` _____ 4 Ÿ20-25 K=ƒ` _____ 5 Ÿ25 K=ƒ` uLÃ _____		
303	¨<H u}ÅÒÒT> ŸU”Û ¾T>ÁSLMc¨< T” ’¨<	1 “ƒ _____ 2 Ií“ƒ _____ 3 ›vƒ _____ 22 K?L/ÃÑKî _____		
304	¾ØÁo 303 SMc< Ií“ƒ ŸJ’ ÉT@Á†¨< e”ƒ ÃJ“M	_____ Sƒ		
305	¨<H ¾T>kÆuƒ °n uK=ƒ` e”ƒ ÃÃ³M	_____K=ƒ`		
306	¨<H¨<” KSpÇƒ uÅ`f SMe ¾T>ðË¨< Ñ>²? uÅmn e”ƒ ÃJ“M	1 Ÿ10 Ámn Á’c _____ 2 Ÿ10-30 Åmn _____ 3 Ÿ30-60 Åmn _____ 4 Ÿ60 Åmn uLÃ		
307	¨<H ŸU”ß ¾U SÖ<uƒ °n ¡Ç” ›K¨< (°n¨<” ”Ç=Ád¿l ÖÃp)	1 ›- _____ 2 ¾K¨<U _____		
308	¨<H ŸSpÇ‹G< uòƒ Í‹G<” /¾SpÍ °n¨<”/ Øu<L‹G<	1 ›- _____ 2 ›”ÖwU/›“ØwU _____		
309	¨<H ŸU”ß ¾UƒkÆƒ uU” ›Ã’ƒ °n ’¨< (°n¨<” ”Ç=Ád¿l ÖÃp)	1 ”e^ _____ 2 Ë]”” _____ 3 ¾–L”+¡ vMÇ= _____ 4 ¾w[ƒ vMÇ= _____ 22 K?L/ÃÑKî _____		
310	¨<H ŸU”ß ¾UƒkÆƒ uU” ÁIM ¾Ñ>²? M¿’ƒ ’¨<	1 uG<Kƒ k” ›”Ë k” _____ 2 u¾k’< _____ 3 uk” G<Kƒ Ñ>²? _____ 22 K?L/ÃÑKî _____		
311	¾¨<H TÖ^kT>Á °n‹G< U” ›Ã’ƒ ’¨< (°n¨<” ”Ç=Ád¿l ÖÃp)	1 ”e^ _____ 2 Ë]”” _____ 3 ¾–Le+¡ vMÇ= _____ 4 ¾w[ƒ vMÇ= _____ 22 K?L/ÃÑKî _____		
312	¨<H TÖ^kT>Á °n‹G<” KK?L ðdi ¨ÃU Öv` ’Ñ` TekSÝ ƒÖkS<uL‹G<	1 ”ÖkTK” _____ 2 ›”ÖkUU		›”ÖkUU ŸJ’ ¨Å ØÁo 214 ÃKõ

313	¾ØÁo 312 SMe □"ÖkUu□K" ŸJ' KU" ›ÑMÓKA*ƒ*	ÃÑKî _____		
314	¨<H ŸU"ß ŸS× u%EL ¨ÅTÖ^kT>Á¨< °n ŸSÑMu×‹G< uò*ƒ* °n¨<" □Øu<□L‹G<	1 ›- _____ 2 ›"ØwU _____		
315	¨<H ¾kÇ‹G<u*ƒ*" °n KTÖ^kT>Á *ƒ*ÖkTL‹G</TÖ^kT>Á °n Kw‰¨< ¾L‹G<U	1 ›- _____ 2 ›"ÖkUU/¾K"U_____		
316	¨<H TÖ^kT>Á °n ¡Ç" ›K¨< (°n¨<" □"Ç=Ád¿l ÖÃp)	1 ›- _____ 2 ¾K¨<U _____		
317	¨<H TÖ^kT>Á °n ¾}kSÖu*ƒ* ›"vu= êÇ~ U" ÃSeLM (›"vu=¨<" □"Ç=Áen–<l ÖÃp)	1 Ø\ '¨< _____ 2 SØö '¨< _____		
318	¾¨<H TÖ^kT>Á °n vKu*ƒ* ›"vu= □"ed*ƒ* ÃÅ`c<u□M	1 ›- _____ 2 ›ÃÅ`c<U _____		
319	KSÖØ ¾T>J" ¨<H ŸTÖ^kT>Á °n¨< □"È*ƒ* '¨< ¾T>kÆ*ƒ*	1 uT"q`q` _____ 2 uSØKp _____		SMc< uT"q`q` ŸJ' ¨Å ØÁo 321 Ã□Kõ
320	¾ØÁo 319 SMe uSØKp ŸJ' ¾SØKmÁ °n¨< Ð`/□Î□ ›K¨< (°n¨<" □"Ç=Ád¿l ÖÃp)	1 ›- _____ 2 ¾KU _____		
321	¾SØKmÁ (¾SÖÝ) °n¨< ¾*ƒ* ÃkS×M	1 Ö[â?³ LÃ _____ 2 ¾TÖ^kT>Á °n¨< ¨<eØ ___ 3 uTÖ^kT>Á °n¨< ¡Ç" LÃ _ 4 ÓÉÓÇ LÃ uT"ÖMÖM _____ 5 ¨KM LÃ _____ 22 K?L ÃÑKî _____		
322	¨<H uTÖ^kT>Á ¨<eØ KU" ÁIM Ñ>²? ÃkS×M	1 ŸG<K*ƒ* k" uLÃ _____ 2 KG<K*ƒ* k" _____ 3 K›"É k" □" Ÿ²=Á u□‹ __		

IV. ¾õdi" Å[p qhh ›ÁÁ³†¨<" u}SKŸ}

}.l	**ØÁo**	**SMe**	**UM¡*ƒ***	**¨ÅT>kØK¨< Ã□Kõ**
401	¾SìÇÍ u?*ƒ* ›L‹G< (SìÇÍ u?~" □"Ç=Ád¿l ÖÃp)	1 ›- _____ 2 ¾K"U		SMc< ¾KU ŸJ' ¨Å ØÁo 404 Ã□Kõ

402	¾ØÁo 401 SMe ›- ŸJ’ ¾vKu?ƒ’ƒ Ãµ¨< U” ÃSeLM	1 uÓL‹” _____ 2 uÒ^ _____		
403	¾SìÇÍ u?ƒ ›ÖnkU G<’@	1 G<MÑ>²? _____ 2 ›Mö ›Mö _____ 3 }ÖpS” ›“¨<pU _____		
404	¾SìÇÍ¨< u?ƒ ¾”îl“ G<’@ U” ÃSeLM	1 Ø\ ’¨< _____ 2 Ø\ ›ÃÅKU _____		
405	¾SìÇÍ u?ƒ ŸK?L†¨< ¾ƒ ÃÖkTK<	1 uT@Ç LÃ _____ 2 u`h†¨< LÃ _____ 22 K?L ÃÑKî _____		
406	cÑ^ u›"vu=¨< T@Ç LÃ Ã¨ÁM (›"vu=¨< ”Ç=Áen–<I ÖÃp)	1 ›- 2 ›Ã¨ÃU _____		
407	›"vu=¨< U”ß/¾Ñ<ÉÕÉ ¨<H "K `k~ uT@ƒ` e”ƒ ÃJ“M	_____T@ƒ`		
408	¾Å[p qhh ¾ƒ Áe¨ÓÇK<	1 Ñ<ÉÕÉ qõ[¨< uSpu` _____ 2 T@Ç LÃ uSu}” _____ 3 u¨<H ›"M LÃ uS×M _____ 4 uTnÖM _____ 22 K?L/ÃÑKê _____		
409	c¨<’¨‹G<” ¾Uƒ¨Öu<ƒ ¾ƒ ’¨<	1 uS•]Á u?ƒ _____ 2 ¾¨<H U”ß ›"vu= _____ 22 K?L ÃÑKê _____		
410	c¨<’¨‹G<” uU” ÁIM ¾Ñ>²? M¿’ƒ ƒ¨ÖvL‹G<	1 u¾Zeƒ k’< _____ 2 udU”ƒ ›”É k” _____ 3 uG<Kƒ dU”ƒ ›”É k” _____ 22 K?L ÃÑKê _____		
411	Mwf” ¾ƒ ÁØvK<	1 ŸU”Û ue}LÃ uŸ<M _____ 2 ŸU”Û u¨‹ uŸ<M _____ 3 uTÖ^kT>Á¨< Ñ”Ç LÃ _____ 4 uS•]Á u?¨†¨< _____ 22 K?L ÃÑKê _____		

Annex- III. Protected spring sanitary inspection check list

I. General information:

1. Address----------

2. Water authority/community representative signature----------

3. Date of visit----------

4. Water sample taken? ----------, Sample no----------

II Specific diagnostic information for assessment Risk

Sr No	Specific diagnostics information	Risk	Remark
1	Is the spring source unprotected by masonry or concrete wall or spring box and therefore open to surface contamination?	Yes---- No-----	
2	Is the masonry protecting the spring source faulty?	Yes---- No-----	
3	If there is a spring box, is there an unsanitary inspection cover in the masonry?	Yes---- No-----	
4	Does the spring box contain contaminating silt or animals?	Yes---- No-----	
5	If there is an air vent in the masonry, is it unsanitary?	Yes---- No-----	
6	If there is an overflow pipe, is it unsanitary?	Yes---- No-----	
7	Is the area around the spring unfenced?	Yes---- No-----	
8	Can animals have access to within 10 m of the spring source?	Yes---- No-----	
9	Does the spring lack a surface water diversion ditch above it, or is it nonfunctional?	Yes---- No-----	
10	Are there any latrines uphill of the spring?	Yes---- No-----	

Total score of risks..... /10

Contamination risk score: 9–10 5 very high; 6–8 5 high; 3–5 5 intermediate;

0–2 5 low

III Results and recommendations

The following important points of risk were noted: ..... Signature of sanitarian.....