

UiT

THE ARCTIC  
UNIVERSITY  
OF NORWAY

Faculty of health sciences / Department of community medicine

# Water, Sanitation, Socioeconomic Status and Prevalence of Waterborne Diseases: A Cross-Sectional Study at Makwanpur District, Nepal.

**Name of author**

*Prapti Sedhain*

*HEL-3950 Master's thesis in Public Health*

*May 2014*

**Supervisor:**

*Professor Jon Øyvind Odland*





## **ACKNOWLEDGEMENT**

A minimum of gratitude from someone will make your work worthwhile. And no work will be completed without acknowledging these people. I would like to extend my sincere gratitude to my supervisor Professor Jon Øyvind Odland for his immense support and motivation throughout my study period. It was a great privilege knowing him and working under his continuous supervision.

My sincere thanks and appreciation goes to Associate Professor Tonje Braaten for helping me in the statistical analysis. I would also like to thank Dr Chet N. Kharel (Chief of the District Livestock Service Office, Makwanpur), Mr. Raghavendra Mishra (Junior Technician, Livestock Service Centre, Makwanpur) and Ms. Tara Shrestha from Makwanpur who helped me to conduct the survey. Similarly, I would like to thank the villagers of Palung and Daman VDCs who directly or indirectly supported me to make my study complete with their active participation.

And lastly, genuine thanks go to Mr. Bhabuk Koirala, Ms. Prerana Bhattarai and Ms. Rangita Dawadi for their continuous supports during the study period.

Prapti Sedhain

Masters in Public Health,

University of Tromso,

Faculty of Health Sciences,

Tromso, Norway.



## ABSTRACT

**Background:** Nepal is a developing country. Lack of sustainability of water supply and sanitation services are always considered as major issue in developing countries that accounts for high prevalence of waterborne diseases such as diarrhea, dysentery, cholera, typhoid, and jaundice. In addition, socioeconomic status such as; education, income and occupation are also the bottle-necks in developing countries, like Nepal, which might be the other potential influential factors associated with prevalence of waterborne diseases. **Objective:** This study aims to assess the association of water, sanitation and socioeconomic status with the prevalence rate of waterborne diseases. **Method:** The associations were established by collecting data via a self-prepared questionnaire in Daman and Palung Village Development Committees (VDC), Makwanpur district, Nepal. Data were analyzed by performing the Mann-Whitney U test, Chi-square test of independence, univariable and multivariable logistic regression analysis. **Result:** The prevalence of waterborne diseases was found to be 50.7% in our study. This study showed a significant association between level of education and risk of waterborne diseases. However, associations could not be established between water, sanitation and waterborne diseases. **Conclusion:** Education was found to be an influential factor for the occurrence of the diarrheal diseases in the study sites. The prevalence rate of waterborne diseases was still found to be high despite the accessibility to water and sanitation.

**Key words:** Diarrheal diseases, waterborne diseases, water, sanitation, socioeconomic status, Nepal.

## Table of Contents

ACKNOWLEDGEMENT .....	1
ABSTRACT .....	3
LIST OF ABBREVIATIONS .....	6
LIST OF TABLES .....	7
LIST OF FIGURES .....	7
LIST OF APPENDICES .....	7
CHAPTER 1.....	9
INTRODUCTION.....	9
1.1 Global scenario .....	9
1.1.1 General background .....	9
1.1.2 Water, sanitation and waterborne diseases.....	9
1.1.3 Socioeconomic status as influential factors .....	10
1.2 Scenario of Nepal .....	12
1.2.1 Condition of Rural Nepal .....	12
1.2.2 Water and sanitation facility in rural Nepal .....	13
1.2.3 Water born diseases in rural Nepal .....	15
1.3 Objective .....	16
1.3.1 General Objective.....	16
1.3.2 Specific Objective .....	16
1.4 Research question.....	17
CHAPTER 2.....	19
METHODOLOGY .....	19
2.1 Study Design .....	19
2.2 Study Site .....	19
2.3 Study Population and Sampling .....	21
2.4 Data Collection.....	21
2.5 Study variables .....	21
2.5 Ethical Issues.....	23
2.6 Data analysis .....	23
CHAPTER 3.....	25
RESULTS.....	25
3.1 General characteristics of the villages.....	25
3.2 Dependent /Outcome variables .....	28
3.3 Associations between socioeconomic status and waterborne diseases .....	31
CHAPTER 4.....	35
4.1 DISCUSSION .....	35

4.2 Limitation of the reported research: .....	42
4.2.1 Sample size.....	42
4.2.2 Confounders .....	42
CHAPTER 5.....	43
CONCLUSION .....	43
CHAPTER 6.....	45
RECOMMENDATIONS .....	45
REFERENCES.....	47
APPENDICES.....	53
Appendix 1 .....	53
Appendix 2 .....	56

## **LIST OF ABBREVIATIONS**

VDC-Village Development Committee

WHO-World Health Organization

UNICEF-United Nations Children's Education Fund

HDI-Human Development Index

UNDP-United Nations Development Program

ADB-Asian Development Bank

NDHS-Nepal Demographic and Health Survey

DWSS-Department of Water Supply and Sewerage

NEWAH-Nepal for Water Health

NGO-Non-governmental Organization

EDCD-Epidemiology and Disease Control Division

DOHS-Department of Health Services

NHRC-Nepal Health Research Council

SPSS- Statistical Package for the Social Sciences

CI-Confidence Interval

NRS-Nepalese Rupees

USD- United States Dollars

OR-Odds Ratio

IFAD- International Fund for Agricultural Development

WSSCC- Water Supply and Sanitation Collaborative Council

## LIST OF TABLES

Table 1- Description of the dependent variables with their measurement scale.....	21
Table 2- Description of the independent variables with their measurement scale.....	22
Table 3- General characteristics of village 1 and 2.....	25
Table 4- Characteristics of water and sanitation in village 1 and 2.....	28
Table 5- Characteristics of the dependent/outcome variable.....	29
Table 6- Association between socioeconomic status and waterborne disease.....	31
Table 7- Association between socioeconomic status and diarrhea/dysentery.....	32
Table 8- Association between socioeconomic and diarrhea along with other waterborne diseases.....	33

## LIST OF FIGURES

Figure 1- Map of Nepal.....	20
Figure 2- Map of Makwanpur district.....	20
Figure 3- Education level in village 1.....	26
Figure 4- Education level in village 2.....	27
Figure 5- Prevalence rate of waterborne disease in Village 1.....	30
Figure 6- Prevalence rate of waterborne disease in Village 2.....	30

## LIST OF APPENDICES

Appendix 1- Consent form and questionnaire (In English).....	53
Appendix 2- Consent form and questionnaire (In Nepali).....	56



# CHAPTER 1

## INTRODUCTION

### 1.1 Global scenario

#### 1.1.1 General background

WHO and UNICEF's joint research in the year 2000 showed that 1.1 billion people throughout the world did not have enough water and 2.4 billion people lived without adequate sanitation. The situation was much worse in the rural areas than in the urban areas [1]. In 2000, the percentage of those with an adequate supply of water was found to be 94% in urban areas and 71% in rural areas worldwide. Similarly, the percentage with adequate sanitation was 86% in urban areas compared to 38% in rural areas. From the year 2000, the percentage of water supply and sanitation in the world have increased in the urban areas but situation in the rural areas are still unchanged. Till 2000, the percentage of the population with adequate sanitation in rural areas was half of that of the population in cities across the globe [1]. Elimelech (2006) mentioned that 2 million deaths per year were reported worldwide due to unsafe water, mostly due to waterborne, preventable diarrheal diseases. Out of the total mortality rate 90% belongs to the group of children under 5 years in the developing countries [2].

#### 1.1.2 Water, sanitation and waterborne diseases

A large number of people in developing countries mostly live in extreme conditions of poverty and the main factors responsible for this situation include lack of priority given to these sectors; due to inadequate financial resources, inadequate water supply and sanitation services, poor hygiene behaviors, and inadequate sanitation in public places including hospitals, health centers and schools [3].

Most of the diarrheal and other waterborne diseases are caused by contaminated water. Polluted and contaminated water can cause waterborne diseases like diarrhea, cholera, typhoid fever and dysentery. Ozkan et al. (2007) had reported that absence of adequate and safe water supply and sanitation systems were responsible for various kinds of sicknesses such as diarrhea along with other waterborne diseases in rural areas of Turkey [4]. In a meta-analysis by Fewtrell *et al.* (2005), improvement in water supply, water quality, and sanitation reduced the risk of diarrhea-related morbidity by 25%, 31%, and 32 %, respectively [5]. Bhavnani *et al.* (2014) concluded unimproved water source (rivers, ponds, lakes and unprotected springs) and unimproved sanitation to be the major risk factors of diarrhea in Ecuador [6]. The study showed that unimproved water source and unimproved sanitation increased the adjusted odds of diarrhea. Water and sanitation management practices can actually decrease diarrhea incidences by one-third to one-fourth [4].

### **1.1.3 Socioeconomic status as influential factors**

Other than water and sanitation, socioeconomic status may affect diarrheal morbidity or mortality. Young and Briscoe (1987), Baltazar *et al.* (1988) and Daniels *et al.* (1990) considered socioeconomic conditions, e.g., per capita income, occupation or literacy rate, as important factors affecting diarrheal morbidity [7-10]. El-Fadel *et al.* (2014) found statistically significant difference in diarrheal cases in their study areas (Tripoli, Lebanon and Irbid, Jordan) which was correlated with the educational level of household head and financial status [11].

Level of income and better socioeconomic conditions also has a lot to do with having better living styles. Malik *et al.* (2012) considered that people having better life styles and socioeconomic condition showed more acceptability to pay for water services in the rural

communities of the developing countries [12]. This eventually reduces the chance of getting waterborne disease.

#### **1.1.4 Waterborne diseases: A threat for developing countries**

Waterborne diseases such as diarrhea, cholera, typhoid etc. have a very strong relationship with poverty and unhygienic environment. Poverty directly associates with poor housing conditions, over crowded house, lack of access to sufficient clean water and sanitary disposal of fecal waste, and cohabitation with domestic animals that may carry human pathogens [13]. All of the above mentioned issues are common among the rural parts of developing countries, especially of South Asia, and these factors are considered to be the major risk factors to increase both diarrheal morbidity and mortality.

Also diarrheal diseases are preventable if a patient receives appropriate care. But getting appropriate treatment and preventive care is even harder in the developing countries due to the lack of adequate, readily available and affordable medical care [13]. First, the people residing in the rural parts of developing countries are less educated and people usually remain unknown about the severity of waterborne diseases. Second, the income level in the rural communities of developing countries is so low that their willingness to pay for illness is almost negligible [12]. Thus they have less desire to get treated at a hospital which usually is very far away from the place they live and charges a lot for service. This leaves them untreated and increases the diarrheal morbidity and mortality rate; mostly amongst children less than 5 years [12].

## **1.2 Scenario of Nepal**

### **1.2.1 Condition of Rural Nepal**

Nepal is ranked 129<sup>th</sup> among 162 countries in the world based on the Human Development Index (HDI) in 2001 and is considered to be one of the least developed countries in Asia [14]. With a population of approximately 23.9 million, 80% of the total population of Nepal resides in rural areas. In many parts of Nepal, people have either financial or other crisis in their daily lives as illiteracy, unemployment and poverty. Almost 80% of the population depends on agriculture as their primary source of income. According to Human Development Index (2001) the literacy rate was found to be 40.4% among adult greater than 18 years which is quite low [14].

Apart from illiteracy and unemployment, the most common issue in the rural areas are factors related to social beliefs and perceptions which leads to the untimely death of patients suffering from preventable diseases (like: diarrhea). Patients in the rural areas die untimely as a result of their ignorance, superstition, cultural and traditional belief. So, Nepal is a country where government should not only focus on water supply and sanitation but also it should try to change people's perception about disease by conducting social and educational programs [14].

Some of the rural districts of Nepal are mostly located far away from the city. And thus people from those areas are far from all the facilities one can have if they have resided in the city; the most common and most important facility includes hospitals or health posts. The health posts are usually far away from the community settlement and hospitals are only present in the city areas. On top of that, health posts in the rural areas have only one doctor who is also not there for several months in a year. *The Kathmandu Post* (a local newspaper)

reported in 2000 that a health post of Dolpa (a rural district) was without a doctor since months. Having the one and only doctor gone stating that he had a seminar to attend in the city and without a sign of returning the situation was made worse by the assistant health workers who also seemed to be missing [14]. This is just an example, but it exemplifies the situation of health facilities in rural districts. The only easy, convenient and affordable way of getting treated for those people is from the health post. If there is nobody there to cure them, they should think about other option which is going to the city hospitals. For those people who have financial crisis daily just to have two times of good food a day cannot even imagine of going to the city hospitals. Travelling expenses, food and lodging expenses and on top of that expensive hospital bills are far beyond their reach. So instead of going to the city hospitals they rely on traditional options like: *dhami*, *jhakris* (traditional disease healers) without thinking of the consequences.

Even the preventable and curable diseases are turning to be the major issues in Nepal, especially in the rural parts. The lack of safe water and sanitation facilities results in worsening public health conditions, deteriorating quality of life and increased economic costs to society [14]. This can be controlled if the government and the political leaders show more concern in water and sanitation because until 1997 sanitation was not given priority by the politicians and local leaders in Nepal as reported by WHO and UNICEF in 2000 [14].

### **1.2.2 Water and sanitation facility in rural Nepal**

Nepal is considered to be the least developed countries in Asia where 80% of the population lives in the rural areas and 36% of the people practice open defecation in fields or bushes having a poor hygiene and sanitation facility [15]. An easy access to safe drinking water and proper sanitation are the basic determinants of a better health. But this has always been an

issue in Nepal as the situation is critical. Out of the total population, 89 percent obtain their drinking water from an improved source while 11 percent depend on an unimproved source [16]. Compared to rural areas, urban areas have good supply of drinking water (93 percent versus 88 percent) and proper sanitation facility (40 percent versus 9 percent), though this gap has been narrowed in the last few years [16, 17].

Aryal *et al.* (2012) reported that tap water/ piped water was found to be the most common source of drinking water in the urban areas, whereas a tube well or borehole was common source of drinking water in the rural areas or in Terai region [17]. People are more likely to drink untreated water as water supply system in the rural area does not have provision of water treatment facilities [17, 18]. During the dry seasons (March/April to May/June) there is huge scarcity of water in Nepal, while in rainy season (June/July to September/October) the availability of water increases as the quantity increases but is severely contaminated with excreted organisms due to surface water runoff [14].

This is not the only situation; even accessing drinking water is not an easy task. People have to spend around 30 minutes sometimes longer just to fetch water as each and every house does not have water source near/in their household premises. In an issue of *The Kathmandu Post* (2000) reported that women of many Village Development Committees (VDCs) of Tehrathum (rural district) walked all night, up and down the steep slope, to fetch water from about 2 to 3 AM in the morning to 10 to 11 AM before noon; every day [14].

Though the water coverage has been increasing since 2001 as it showed a 9% increase from 2001-2006 (NDHS 2001 and NDHS 2006) showing a total of 82% coverage, it cannot be assumed that the water provided is safe for drinking and sanitation purpose [19, 20]. A joint

study done by Department of Water Supply and Sewerage (DWSS) and Water Aid in 2003 estimated that around one -fifth of the materials of the projects in hilly areas were in need of rehabilitation and more than half were in need of major repair [21]. And people still do not practice any household water treatment methods (for example: boiling) due to lack of proper knowledge especially in the rural parts of Nepal [19].

Similarly, access to sanitation has also increased showing increased number of latrines but are usually shared with many families and individuals rather than having one individual family latrine for one house [19]. The condition is, if they have a latrine for each household then either the latrines are not permanently built (for example: by using bricks and cement) or they don't have a direct supply of water inside the latrine. So either ways they are affected. Not having proper sanitary disposal facilities and insufficient knowledge for maintaining hygiene (example: washing hands with soap water) are the major factors to prevent waterborne diseases.

### **1.2.3 Water born diseases in rural Nepal**

Waterborne diseases such as diarrhea, typhoid, dysentery and cholera are a major public health threats in Nepal, mostly to the rural areas. This is due to inadequate supply and unavailability of drinking water, poor sanitation and poor living conditions [18]. Outbreaks of diarrheal diseases are mostly the results of exposure of a human body to contaminated water and limited water availability for drinking and sanitation purpose [18, 14]. Poor sanitation is responsible for 70 percent of childhood illnesses with nearly 10 million cases of diarrhea among children under five every year, according to Nepal for Water Health (NEWAH, 2007) a local non-governmental organization (NGO) campaigning for clean drinking water and

sanitation [19]. Accounting infant mortality rate, the number of deaths among children below five years due to diarrhea related diseases is 10,500 per annum in Nepal [20].

Diarrheal epidemic of 2009 in mid and far western districts of Nepal was the breaking news for national and international media. According to Epidemiology and Disease Control Division (EDCD)/Department of Health Services (DOHS) of the Government of Nepal, the epidemic that began in early May 2009 recorded nearly 80,000 diarrheal cases and claimed over 300 lives, the most affected was Jajarkot (rural district), hilly district in the Mid-West Region[18]. Again in the summer of 2010, outbreaks of diarrhea and deaths in Jajarkot, Kanchanpur, Baitadi, Dailekh, Tanahun (rural districts) were reported [18]. The year is 2013; and still these kinds of diarrheal episodes are reported every now and then on the national newspapers in Nepal.

### **1.3 Objective**

#### **1.3.1 General Objective**

The main purpose of this study was to assess the interconnection between water availability, sanitation, socioeconomic status and prevalence of waterborne diseases in two Village Development Committees (VDCs), namely Daman and Palung in Makwanpur district of Nepal.

#### **1.3.2 Specific Objective**

- To explore the available water resources on which the villagers relied on and in particular their sanitation habits.
- To assess the prevalence of preventable waterborne diseases in the two VDCs.

- To identify the association between water, sanitation, socioeconomic status and waterborne diseases.

#### **1.4 Research question**

Which factors influence the prevalence of waterborne/diarrheal diseases in rural Nepal?



## CHAPTER 2

### METHODOLOGY

#### 2.1 Study Design

A cross-sectional study design was conducted during mid of January 2013 to mid of February 2013 in two village development committees, Daman and Palung in Makwanpur district, Nepal. This study design was chosen in order to measure the prevalence of a disease and the exposure status in a population at a particular point of time [22].

#### 2.2 Study Site

Makwanpur district was selected for this study. There are 46 VDCs in Makwanpur, most of which are considered to be rural area. However, Daman and Palung which were the study sites are considered to be semi-rural. Makwanpur is one of the districts in Nepal where diarrheal diseases occur very frequently. Outbreaks of diarrheal diseases mostly occur as the result of low availability of drinking water and poor sanitation. Thus, the main aim of this study was to find out the major factors causing the diarrheal/waterborne diseases in the study sites.

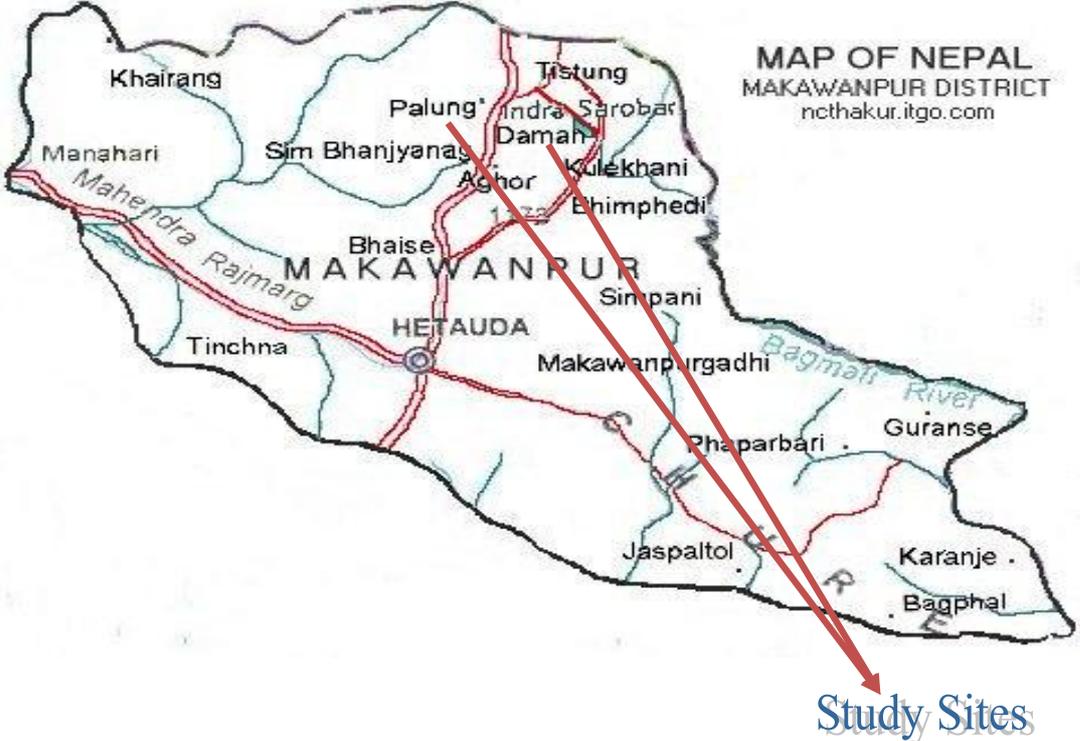
According to Nepal Census 2001, overall literacy rate in Makwanpur district was found to be 63.2%, whereas in Daman and Palung it was found to be 86.26% and 86.63% respectively [23]. And percentage of economically active people was found to be 75.86% and 75.66% in Daman and Palung respectively [23]. Majority of people in Daman and Palung depend upon agriculture as their main source of income that is why their socioeconomic status also ranges from low to medium. In this study the effort was made to analyze if any of these above

mentioned measures of socioeconomic status have any influence in causing waterborne/diarrheal diseases in the study sites.

Figure 1 Map of Nepal



Figure 2 Map of Makwanpur district



### 2.3 Study Population and Sampling

Among Daman and Palung VDCs, households were randomly selected. Household was considered as the study unit. Calculations by Fleiss' formula provided a required sample size of 300 households in order to detect an expected odds ratio of 2.25 in the exposed groups, with a ratio of unexposed to exposed of 4, and 80% power [24]. Due to lack of resources and limited time, only 140 households could be included, 70 from each VDCs.

### 2.4 Data Collection

Primary data was collected using self-prepared questionnaire by interviewing either the head of the households or adults over 18 years. The interview criterion was that the person interviewed from each household should be permanently residing in that area from past one year. In the interview, participants responded to the questionnaire that addressed the following particulars: number of family members, education, occupation, income, source of water, presence of latrines and water supply in the latrine. Any cases of waterborne diseases in the last one year period were also recorded via the questionnaire. Details of the questionnaire are given in Appendix 1 and 2.

### 2.5 Study variables

In this study three dependent and nine independent/ explanatory variables were selected for the analysis. Operational definitions along with their measurement scale are given below.

Table 1 Description of the dependent variables with their measurement scale

<b>Variables</b>	<b>Description</b>	<b>Measurement scale</b>
Waterborne diseases	Cases of waterborne diseases (diarrhea/dysentery, jaundice, typhoid, cholera) reported by at least one person of a household in the past one year was asked and categorized into 6 categories. This was later	0= No disease 1= Diseased

	recoded as dichotomous variable; 0=no disease and 1-diseased.	
Diarrhea/Dysentery	From the 6 categories of waterborne diseases; only cases of diarrhea/dysentery were separated and coded as dichotomous variable for further analysis.	0= No disease 1=Diseased
Diarrhea/dysentery along with other water borne diseases	From the 6 categories of waterborne diseases; only cases reporting a combination of diarrhea/dysentery along with other waterborne diseases (jaundice, typhoid and cholera) were separated and coded as dichotomous variable.	0= No disease 1= Diseased

Table 2 Description of the independent variables with their measurement scale

<b>Variables</b>	<b>Description</b>	<b>Measurement scale</b>
Household size	Total number of individuals staying in each of the house that was selected for an interview was noted and then distributed into 3 groups.	1= 0-4 2= 5-9 3= 10 and above
Education	Education level of the head of the household was asked and classified into 4 categories; higher, secondary, primary and uneducated. Higher and secondary were later fused as one group due to small number of observation in the highest category	0= Secondary/Higher 1= Primary 2= Uneducated
Income	Total income of the head of the household in the last one year was asked and categorized into 3 groups.	1= Lower class 2= Middle class 3= Higher class
Occupation	The occupation of the head of the household was asked and categorized into 2 groups. As the number of observation in the agriculture category was very high all the other type of occupation were merged as one group.	0= Others 1= Agriculture
Water source	The source of water used by each of the household was asked and categorized into 3 groups; tap, river, well, stream. River, well and stream were later categorized as one group due to less observation in those categories.	1= Tap water 2= River/well/stream
Presence of latrine	It was asked whether their household had at least a latrine or not and categorized into dichotomous variables.	0= Yes 1= No
Type of latrine	If a latrine was present then it was further asked about the type of the latrine; permanent (made up of concrete, cement, bricks), temporary (made up of plastic, papers). It was categorized into 2 groups.	1= Temporary 2= Permanent
Septic tank	Presence of a septic tank in a household was asked only if a latrine was present and categorized into dichotomous variable.	0= Yes 1= No
Water supply in latrine	It was asked whether their household had a direct or indirect water supply inside the latrine and categorized into 2 groups.	1= Indirect 2= Direct

Level of education, income, occupation, and household size were considered as measures of socioeconomic status.

## **2.5 Ethical Issues**

Ethical approval was taken from Nepal Health Research Council Ethical Review Board for conducting the study considering the national ethical guidelines. A short description about the main objective and importance of the research was given to the participants before starting the interview. Also they were asked for their willingness in participation by means of completing a consent form (See Appendix 1 and 2).

## **2.6 Data analysis**

Data was organized, coded and entered in Microsoft Excel. It was then transferred into SPSS 19.0 version for further statistical analysis.

In the statistical assessment, Mann-Whitney U and Pearson's Chi-square test were performed to compare differences between the two villages. Finally the associations between the dependent and the independent variables were assessed via binary logistic regression analysis. For the logistic regression analysis, both the villages were analyzed together as a group with the total sample size of 140 households. Both univariable and multivariable logistic regression models were applied. In the multivariable analysis, all the independent variables were mutually adjusted. Further, the logistic regression model was adjusted for village, but it did not really affect the estimates. The level of significance was set to 5%.



## CHAPTER 3

### RESULTS

#### 3.1 General characteristics of the villages

Characteristics like household size, level of education, income per year and occupation were observed in both the villages. Frequency and percentage of each of the variable is given in Table 3 along with their p-value.

Table 3 General characteristics of village 1 and 2

Characteristics	Frequency (n=70) Village 1	Percentage (%)	Frequency (n=70) Village 2	Percentage (%)	p-value
<b>Household size</b>					0.445
0 to 4	19	27.1	19	27.1	
5 to 9	49	70	43	61.4	
10 and above	2	2.9	8	11.4	
<b>Education</b>					0.635
Uneducated	9	12.9	14	20	
Primary	33	47.1	28	40	
Secondary/Higher	28	40	28	40	
<b>Income/year</b>					0.016
Lower	29	41.4	42	60	
Middle	21	30	18	25.7	
Higher	20	28.6	10	14.3	
<b>Occupation</b>					0.50
Agriculture	54	77.1	53	75.7	
Others	16	22.9	17	24.3	

---

<sup>1</sup>P-value for the difference between the two villages according to number of family members, education and income/year was calculated via Mann-Whitney U test, and the p-value according to occupation was calculated via Pearson's Chi-square test.

Table 3 showed that most of the household had 5 to 9 members, 70% and 61.4% in village 1 and village 2, respectively. Although it was found that only a few people interviewed were uneducated, most of them were educated only up to primary level; 47.1% and 40% in village 1 and village 2, respectively, suggesting lesser number of years in school.

It was also found that most of the people (41.4% and 60%, village 1 and village 2, respectively) had an income level less than NRS 50,000 (USD 500). 77.1% and 75.7% of the respondents were dependent on agriculture as their main source of income for their livelihood in village 1 and village 2, respectively. Only the distribution of income per year showed a significant difference between the two areas, with a p-value of 0.016.

Education level of the head of the household in village 1 was found to be 40%, 47% and 13% and in village 2 it was found to be 40%, 40% and 20% for secondary/higher education, primary education, and uneducated respectively (Figure 3 and 4). Both the villages showed similar results suggesting that the majority of people were educated only up to primary level.

Figure 3 Education level in Village 1

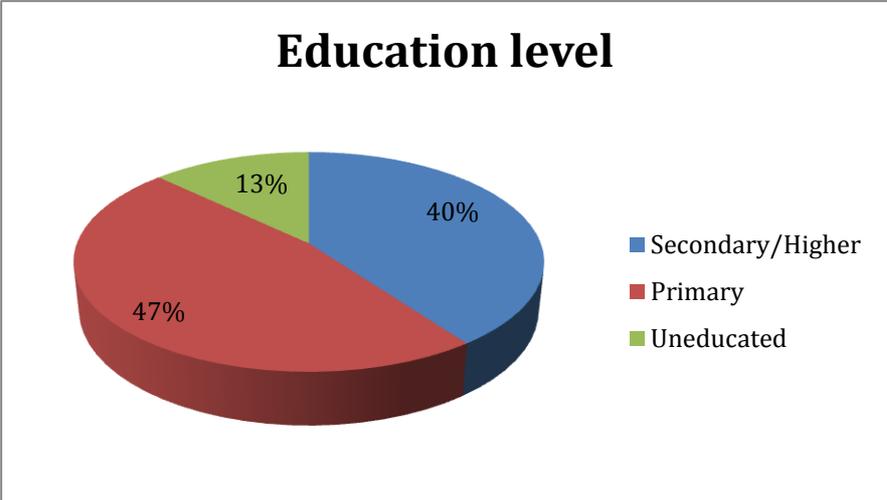


Figure 4 Education level in village 2

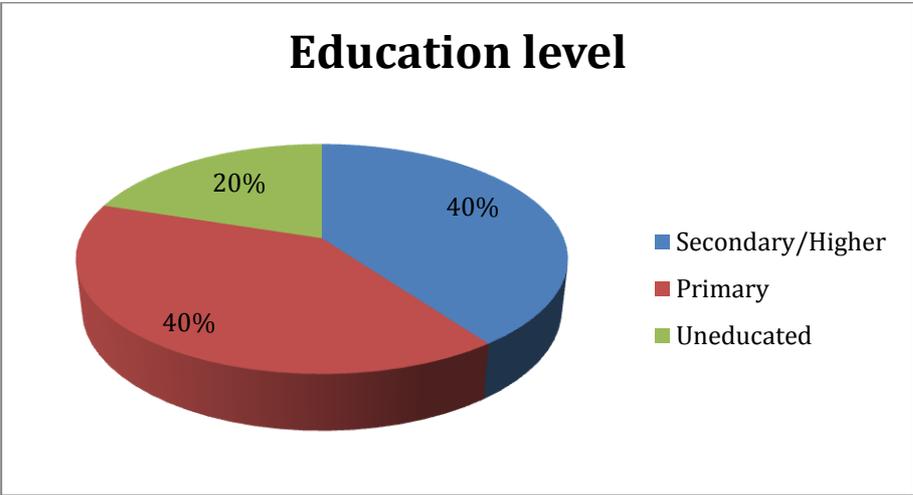


Table 4 shows the frequency and percentage of the explanatory variables based on the characteristic of the household. All the villagers, both in village 1 and village 2 used water supplied by the government of Nepal via a public tap. Each and everyone interviewed used tap water for their daily use, which made a total of 100% of the people both in village 1 and village 2. Similar results were found in case of variables such as presence of latrines, presence of septic tank and water supply in the latrines in both the villages. During the study it was found that 100% of the households had latrines along with septic tanks; but each of the latrines lacked a direct supply of water inside it. Type of latrine showed slightly different results among the two villages; where 92.9% and 97.1% of the household had a permanent latrine (made up of brick and cement) in village 1 and 2 respectively. Results showed that both the villages had similar characteristics and showed almost no variation regarding the explanatory variables. Thus, due to the lack of variation in the water and sanitation data, logistic regression analysis became impossible to perform.

Table 4 Characteristics of water and sanitation in Village 1 and Village 2

Characteristics	Frequency (n=70) Village 1	Percentage (%)	Frequency (n=70) Village 2	Percentage (%)
<b>Source of water</b>				
Tap	70	100	70	100
Others	0	0	0	0
<b>Presence of Latrine</b>				
Yes	70	100	70	100
No	0	0	0	0
<b>Type of latrine</b>				
Temporary	5	7.1	2	2.9
Permanent	65	92.9	68	97.1
<b>Presence of septic tank</b>				
Yes	70	100	70	100
No	0	0	0	0
<b>Water supply in latrine</b>				
Indirect	70	100	70	100
Direct	0	0	0	0

### 3.2 Dependent /Outcome variables

The prevalence rate of waterborne diseases in the two villages was found to be 50.7% (57.1% and 44.3% in village 1 and 2, respectively). As shown in table 5, 20% of the villagers were found to be affected by diarrhea/dysentery in both the villages, whereas 15.7% and 12.9% were found to be affected by diarrhea along with other waterborne diseases (jaundice, typhoid and cholera) in village 1 and village 2, respectively. Both the villages showed diarrhea/dysentery to be the most prevalent waterborne disease in the past one year. The only

difference between the villages was that there was no case of cholera reported in village 2 in the past one year.

A more detail information on prevalence of waterborne diseases in the sample population is obtained in the pie chart (See Figure 5 and 6). The frequency and percentage of the household affected by various types of waterborne diseases is shown in Table 5.

Table 5 Characteristics of the dependent / outcome variable

Characteristics	Frequency (n=70) Village 1	Percentage (%)	Frequency (n=70) Village 2	Percentage (%)	p-value
<b>Waterborne diseases in a household</b>					0.213
No disease	30	42.9	39	55.7	
Diarrhea and Dysentery	14	20	14	20	
Jaundice	11	15.7	4	5.7	
Typhoid	2	2.9	4	5.7	
Cholera	2	2.9	0	0	
Diarrhea along with other waterborne diseases	11	15.7	9	12.9	

<sup>2</sup>

---

<sup>2</sup> P-value for difference between the villages in prevalence of waterborne diseases was calculated via Pearson's Chi-square test.

Figure 5 Prevalence rate of waterborne disease in Village 1

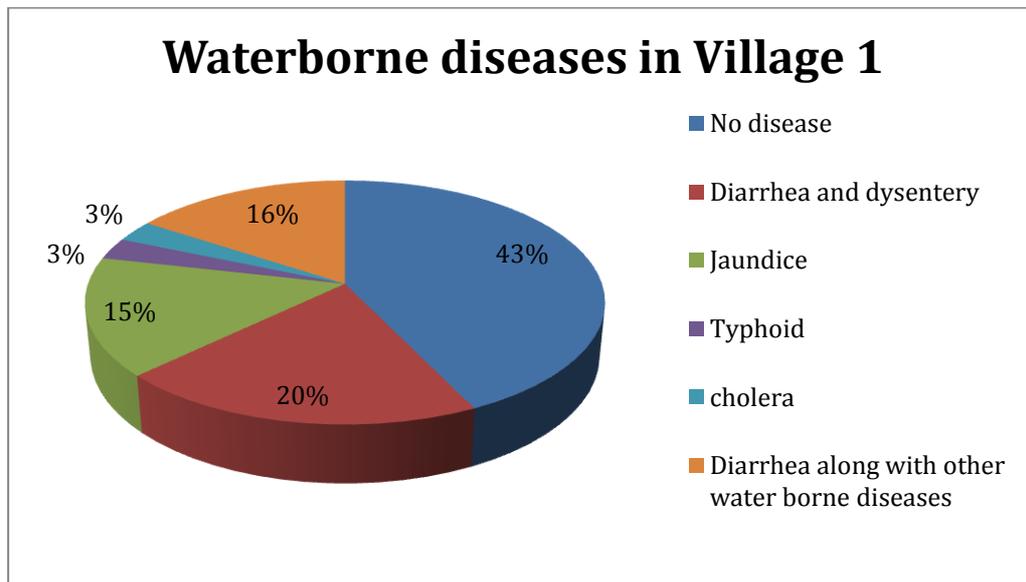
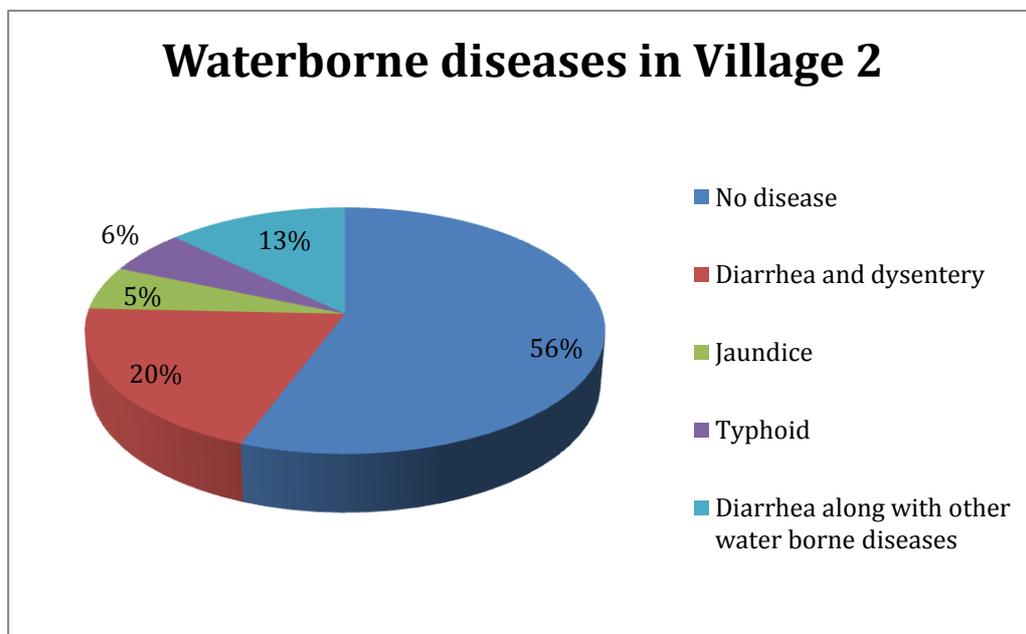


Figure 6 Prevalence rate of waterborne disease in Village 2



### 3.3 Associations between socioeconomic status and waterborne diseases

For the logistic regression analysis only education, income, occupation and household size were included as independent/explanatory variables to find out the association with the dependent variables.

Table 6 Associations between socioeconomic status and waterborne diseases

Explanatory variables	Waterborne diseases		Univariable		Multivariable	
	Yes	No	OR	CI of 95%	OR	CI of 95%
<b>Household size</b>						
0-4	22	16	1	Ref.	1	Ref.
5-9	44	48	0.67	0.31-1.43	0.59	0.26-1.33
10 and above	5	5	0.73	0.18-2.94	0.71	0.17-2.99
<b>Education</b>						
Secondary/Higher	24	32	1	Ref.	1	Ref.
Primary	31	30	1.38	0.66-2.86	1.34	0.63-2.86
Uneducated	16	7	3.05	1.08-8.57	2.64	0.88-7.88
<b>Income</b>						
Lower class	35	36	1	Ref.	1	Ref.
Middle class	23	16	1.48	0.67-3.26	0.68	0.68-3.42
Higher class	13	17	0.79	0.33-1.86	0.85	0.35-2.06
<b>Occupation</b>						
Others	13	20	1	Ref.	1	Ref.
Agriculture	58	49	1.82	0.82-4.03	1.48	0.65-3.4

The univariable logistic regression analysis showed a significant association between level of education and waterborne diseases. The uneducated group showed increased risk of waterborne diseases compared to the secondary/higher education level group (OR=3.05; CI=1.08-8.57) with a p-value=0.035 (see Table 6), whereas the other variables did not show any significant statistical association with waterborne diseases.

Table 7 Association between socioeconomic status and diarrhea/dysentery

Explanatory variables	Diarrhea/Dysentery		Univariable		Multivariable	
	Yes	No	OR	CI of 95%	OR	CI of 95%
<b>Household size</b>						
0-4	8	16	1	Ref.	1	Ref.
5-9	19	48	0.79	0.29-2.15	0.75	0.26-2.17
10 and above	1	5	0.40	0.04-4.02	0.38	0.03-4.11
<b>Education</b>						
Secondary/Higher	13	32	1	Ref.	1	Ref.
Primary	8	30	0.65	0.24-1.80	0.55	0.19-1.61
Uneducated	7	7	2.46	0.71-8.42	1.78	0.47-6.69
<b>Income</b>						
Lower class	15	36	1	Ref.	1	Ref.
Middle class	7	16	1.05	0.36-3.07	1.08	0.4-3.22
Higher class	6	17	0.84	0.28-2.57	0.90	0.3-2.82
<b>Occupation</b>						
Other	5	20	1	Ref.	1	Ref.
Agriculture	23	49	1.88	0.63-5.63	1.50	0.48-4.70

As shown in Table 7 no statistically significant association could be established between socioeconomic status and diarrhea/dysentery.

Table 8 Association between socioeconomic status and diarrhea/dysentery along with other waterborne diseases

Explanatory variables	Diarrhea/dysentery along with other waterborne diseases		Univariable		Multivariable	
	Yes	No	OR	CI of 95%	OR	CI of 95%
<b>Household size</b>						
0-4	8	16	1	Ref.	1	Ref.
5-9	10	48	0.42	0.14-1.23	0.38	0.11-1.35
10 and above	2	5	0.80	0.13-5.07	0.96	0.12-7.32
<b>Education</b>						
Secondary/Higher	7	32	1	Ref.	1	Ref.
Primary	6	30	0.91	0.28-3.03	0.78	0.21-2.93
Uneducated	7	7	4.57	1.21-17.26	4.15	0.91-18.82
<b>Income</b>						
Lower class	8	36	1	Ref.	1	Ref.
Middle class	9	16	2.53	0.82-7.75	2.44	0.69-8.58
Higher class	3	17	0.8	0.18-3.4	1.02	0.20-5.16
<b>Occupation</b>						
Others	2	20	1	Ref.	1	Ref.
Agriculture	18	49	3.7	0.8-17.31	2.66	0.47-14.86

Table 8 shows the association between the socioeconomic status and diarrhea/dysentery along with other waterborne diseases. The uneducated group showed increased risk of diarrhea/dysentery along with jaundice, typhoid and cholera compared to the secondary/higher education level group (OR=4.57; CI=1.21-17.26) with a p-value of 0.025.

Other independent variables did not show any significant association with the dependent variable.

## CHAPTER 4

### 4.1 DISCUSSION

Most of the households had 5 to 9 members in their family. Heads of the households were mostly educated with majority up to primary level. Majority of the households interviewed belonged to the low socioeconomic class with the head of the household's income less than USD 500 (NRS 50,000). Their major source of income seemed to be agriculture. The characteristics between the two villages were quite similar. Only income per year showed a significant difference between village 1 and village 2. Every households interviewed were found using tap water supplied from the Government of Nepal . Each and every household had latrines with septic tanks and did not have a direct water supply inside the latrine.

As reported by International Fund For Agricultural Development (IFAD 2013), households in the rural area of Nepal have very little or no access to education, safe drinking water, sanitation or other basic services. Generally having large number of family members, the literacy rate was found to be very low [25]. In 2011, Bureau of Statistics of Nepal reported agriculture as the main source of income that accounts for 38% of Gross Domestic Products (GDP), providing livelihood for three-fourths of the population of Nepal [26].

In this study the results found seemed to be different compared to the results found by IFAD in terms of education, availability of drinking water, sanitation or other basic services. The difference in the result might be attributed to the fact that although Daman and Palung VDCs are also listed as rural areas of Nepal, these villages are along the side of highway, the location is only seventy kilometers away from Kathmandu metrcity and people have opportunity to share the information; and these locations are quite different from the areas surveyed by IFAD (as IFAD is supporting the poor people residing in the very remote areas

of Nepal). Due to those reasons there might be an increased number of educated people in the village in the present context. Similarly, access to drinking water (via tap water) and sanitation in every household with fair knowledge about sanitation and sanitary health shows the improving lifestyle and conditions in these villages.

Regarding water and sanitation, as reported by Nepal population and housing census (2011), 73.5% population in the entire Makwanpur district had access to tap or piped water, about 60% of the population in the district had access to latrines out of which 42.7% of the population had latrines with septic tank (without a flush toilet), 15.4% had ordinary latrine (temporary) and only 1.2% with a proper flushing type of toilets [27].

The villagers of both Daman and Palung mentioned that the condition of latrine has been tremendously improved since the year 2012. Daman and Palung both VDCs were declared as **“an open defecation free zone”** from the year 2012. This was a step taken by the government of Nepal in order to make the village **“an open defecation free zone”** and encourage people to use latrines to improve their health and cleanliness habits. People of those VDCs explained that as the government of Nepal enforced a very strict rule amongst the villagers that they should have at least one latrine in one household and the household lacking a latrine would not get their official work done in the government offices until a latrine is built in their houses. Similar statements were made by the Water Aid (2011) explaining that the improved sanitation conditions in the rural communities of Nepal were because of the involvement of governmental and non-governmental organizations mainly focusing on building toilets, drainage systems, tube-wells and water supplies [28].

50.7% of the total households interviewed were affected by waterborne diseases at least once in the past one year. Out of them 20% of the households both in village 1 and village 2 were affected by diarrhea/dysentery. Compared to other waterborne diseases (as listed above) diarrhea/dysentery were mostly prevalent in both the villages.

Source of water, presence of latrines and water supply in the latrines were suspected to be the major factors responsible for the occurrence of waterborne/diarrheal diseases. As reported by the Water Aid (2011), there was an inversely proportional relationship between sanitation coverage and number of diarrheal cases in Nepal; more the presence of latrines lesser will be the diarrheal cases and vice-versa. Also there was a reduction rate of diarrheal cases by 36% with access to sanitation and cleanliness habits; only washing of hands could reduce diarrheal cases by 45%. Water Supply and Sanitation Collaborative Council (WSSCC), 2008 had reported that almost 88 percent of diarrheal cases worldwide were caused either by drinking of contaminated water (from well, river, stream), inadequate sanitation or insufficient hygiene (washing hands after the use of latrines) [28]. Daniels *et al.*(1990), Haggerty *et al.* (1994), LaFond (1995), MacDougall and McGahey (2003) had also listed little or no access to water and sanitation, poor hygiene and feces disposal practices at home as major risk factors for waterborne/diarrheal diseases [10, 29-32].

Even though presence of latrines, availability of drinking water and direct water supply (in order to flush or wash hands) in the latrines were considered to be the major risk factors to increase the instances of diarrheal diseases, the results were unable to find any statistical associations between the risk factors and diarrheal diseases due to the lack of variation in our data. This is because all the villagers had a common source of water (tap water supplied from the government), almost all the villagers had pit latrines outside their house with a septic tank

and did not have direct water supply inside their latrines; thus no statistical analysis could be performed.

The other potential independent variables such as income and occupation (socioeconomic status) did not show any statistically significant association with waterborne diseases. Though the overall education level group did not show an association; uneducated group showed a significant relationship with waterborne diseases. Similarly, uneducated group showed a significant association with the episodes of diarrhea along with other waterborne diseases.

Hypothetically, with the increase in level of education, income and occupation (socioeconomic status) there should be a decrease in the occurrence of diarrheal diseases. Siddiqui *et al.* (2012) also found waterborne diseases to be significantly associated with financial status and literacy rate [33]. Colombara *et al.* (2013) had also explained that maternal education and income were the factors influencing diarrheal risk [33]. Urban children from households with income ranging from 34 to 84 USD/month had a 30% increased risk compared to those from households with income more than 84 USD/month. They listed lower socioeconomic status (education, income, occupation) as the risk factors of cholera in rural and urban Bangladesh [34].

Although the literacy rate was found to be fair in both the villages under this study, majority of people were only educated up to primary level (See figure 3 and 4). Lower the number of years in school lower will be the knowledge regarding personal hygiene and cleanliness. This was further suggested by Yilgwan and Okolo (2012) that in Nigeria, educated mothers were found to be conscious regarding importance of hygiene, better childcare and feeding practices

and were more aware of disease causation factors and preventive measures [35]. Their study showed a significant impact of education on morbidity caused by diarrhea.

Even with the accessibility to water and sanitation, prevalence of waterborne/diarrheal incidences was still found to be high. Latrines with septic tanks were found in every household but they were without flushers and there was no direct supply of water inside the latrines. This suggests that there might be negligence in washing hands or maintaining a clean and hygienic sanitary environment. Maintaining personal hygiene and cleanliness comes with an increase in level of education which eventually helps in preventing diarrheal diseases. Even hand washing with soap reduces the risk of endemic diarrhea [28]. Karambu *et al.* (2013) also reported not washing hands before eating or after the use of toilets to be significantly associated with diarrheal diseases in South Africa [36]. Also most of the households interviewed belonged to the low socioeconomic status that might have influenced their hygienic behaviors and thus increased the diarrheal instances. It was further explained by Halder and Luby (2008) that handwashing indicators were strongly influenced by socioeconomic status and that handwashing behaviours were more common among households with higher socioeconomic status [37].

Colombara *et al.* (2013) mentioned that there was an increase risk of diarrhea among rural children with one of their family members being affected by diarrhea in the past week [34]. Households with large family were few in this study suggesting that there should be lower prevalence of waterborne diseases but results were unable to establish any significant association. This might be because even if less number of people were residing in a household, if one of the members was affected by diarrheal disease, due to lack of proper medical care, less knowledge about the disease and less effort in maintaining personal

hygiene and cleanliness regarding sanitary habits the other members might have been affected as well.

Quality and Quantity of water has a huge impact on diarrheal illness. Availability of safe water helps to reduce the diarrheal illness. Due to some limitations (duration, finance and access to the reliable laboratory) in the study, quality and quantity of water could not be assessed. Hence, relationship between the quality and quantity of water with waterborne diseases could not be performed in this study.

Bartram *et al.* (2010) reported that many piped water systems in developing and middle level income generating countries work only for few hours per day and/or are unsafe [38, 39]. “Supply and Sanitation Global Assessment Year 2000 Report” by WHO and UNICEF mentioned that, in Asia, more than one out of five water supplies does not meet the national water quality standards [40]. Maharjan (2013) reported that, in Nepal, there are frequent reports of fecal contamination in drinking water even in piped supply and outbreaks of waterborne diseases were very common, particularly in monsoon as there was not any provision of water treatment facilities in the rural areas [18].

Storage of water was common among the villagers due to lack of direct supply of water in their households. There is always an association between point of source and point of use of water. “The Journal of the American Medical Association”, 1995 reported that water at the point of source usually determines the water quality and the chances of diarrheal diseases; but there might be contamination of stored household water either at the point of source or post- collection during utilization by the family [38, 41].

As reported by Esrey *et al.* (1991), 'Centre for Affordable Water and Sanitation Technology', mentioned other risk factors for contamination of water at the water source, collection point and during transport [42]. Even with improved, uncontaminated sources for drinking water, human behaviors may contaminate the household drinking water and promote pathogen transmission. Some of them are: poor site selection of the water source, poor protection of the water source against pollution (e.g. agricultural runoff, contaminated with manure and fertilizers), poor structure design or construction (e.g. lack of a well lining and/or cover, tank sealing, poor pipe connections), deterioration or damage to structures (e.g. cracks can be entry points for contaminants), lack of knowledge on hygiene and sanitation practice in the community [42].

Badowski *et al.* (2011) mentioned that studies from many developing countries showed that microbial contamination increases significantly between the point of source and the point of use in the household [43]. Their research also revealed that insufficient hand washing procedures, unsafe disposal of waste water, uncovered household drinking water containers, lack of water treatment prior to consumption, and use of inappropriate toilets by small children were practiced in Dar es Salaam and these activities were responsible for the contamination of water after collection from the point of source [43].

Significant associations between the suspected risk factors and waterborne diseases could not be established in this study. But factors like cleanliness, personal hygiene, quality of water (both at the point of source and point of use), storage of water in the households after collection and water treatment methods before drinking might be the factors responsible for high prevalence of diarrheal diseases in both the villages.

## **4.2 Limitation of the reported research:**

### **4.2.1 Sample size**

Due to logistical and technical, as well as economic constraints, the sample size was too small to detect significant associations with prevalence of waterborne diseases for most of the factors included.

### **4.2.2 Confounders**

Potential confounding factors such as quality of water at the point of source and point of use, storage of water in the households, personal hygiene and cleanliness habits (such as hand washing) and maternal education could not be included in this study.

## CHAPTER 5

### CONCLUSION

This study was conducted in Daman and Palung VDCs of Makwanpur district of Nepal. Out of the total households interviewed, 50.7% of the respondents were affected by waterborne diseases. Compared to other waterborne diseases, the prevalence rate of diarrhea/dysentery was found to be the highest in both the villages. Majority of people had primary level education, low income and relied on agriculture as their occupation. The logistic regression analysis showed that lack of education of the head of the household was significantly associated with waterborne diseases and with diarrhea/dysentery along with other waterborne diseases (jaundice, typhoid and cholera).

No association could be established between water, sanitation and waterborne diseases due to the lack of variation amongst the households. Also the analysis was unable to find any significant association between income and occupation.



## CHAPTER 6

### RECOMMENDATIONS

On the basis of the findings of this study following points can be recommended:

1. Socioeconomic inequalities such as education, income and occupation in the rural parts should be taken care of by the Government of Nepal. Education should be prioritized especially in the rural areas.
2. Educational interventions regarding personal hygiene, cleanliness and sanitary programs should be organized especially in the rural areas.
3. Quality assessment of the water source should be conducted time to time to assure that safe drinking water of national quality standards is available to everyone.
4. Awareness programs related to water treatment, water quality and importance of flush toilets should be carried out in the rural areas to improve the status of public health.
5. The sample size for each village was too small in this study to detect the actual incidence rates of diarrhea and dysentery. But this model can be used as a research model for further investigation.



## REFERENCES

1. WHO and UNICEF. Global water supply and sanitation assessment 2000 report [Internet]. [updated 2000; cited 2013 August 16]. Available from:  
[http://www.who.int/water\\_sanitation\\_health/monitoring/Globassessintro.pdf](http://www.who.int/water_sanitation_health/monitoring/Globassessintro.pdf)
2. Elimelech M. The global challenge for adequate and safe water. *Journal of Water Supply: Research and Technology – AQUA* 2006;55:3-10.
3. World Health Organization. Water supply, sanitation and hygiene development [Internet]. [cited 2013 August 16].  
Available from: [http://www.who.int/water\\_sanitation\\_health/hygiene/en/](http://www.who.int/water_sanitation_health/hygiene/en/)
4. Ozkan S, Tuzun H, Gorer N, Ceyhan M, Aycan S, Albayrak S, and Bumin MA. Water usage habits and the incidence of diarrhea in rural Ankara, Turkey. *T Roy Soc Trop Med H* 2007;101(11):1131–5.
5. Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, & Calford JM. Water, sanitation, and hygiene interventions to reduce diarrhea in less developed countries: a systematic review and meta-analysis. *The Lancet Infectious Diseases*. 2005; 5, 42–52.
6. Bhavnani D, Goldstick JE, Cevallos W, Trueba G, Joseph Eisenberg JN. Impact of rainfall on diarrheal disease risk associated with unimproved water and sanitation. *Am J Trop Med Hyg* 2014 Apr;90(4):705-11.
7. Wilbow D, and Tisdell C. Health, safe water and sanitation: a cross-sectional health production function for Central Java, Indonesia. *Bull World Health Organ* 1993; 71(2):237-45.
8. Young B, and Briscoe J. A case-control study of the effect of environmental sanitation on diarrhea morbidity in Malawi. *Journal of Epidemiology and Community Health* 1987;42:83-8.

9. Baltazar J, Briscoe J, Mesola V, Moe C, Solon F, Vanderslice J, and Young B. Can the case-control method be used to assess the impact of water supply and sanitation on diarrhea? A study in the Philippines. *Bull World Health Organ* 1988;66(5):627-35.
10. Daniels DL, Cousens SN, Makoae LN, Feachem RG. A Case-Control Study of the Impact of Improved Sanitation on Diarrhea Morbidity in Lesotho. *Bulletin of the World Health Organization* 1990;68:455–63.
11. El-Fadel M, Maroun R, Quba'a R, Mawla D, Sayess R, Massoud MA, Jamali I. Determinants of diarrhea prevalence in urban slums: a comparative assessment towards enhanced environmental management. *Environ Monit Assess* 2014 Feb;186(2):665-77.
12. Malik A, Yasar A, Tabindha AB, and Abubakar M. Waterborne diseases, cost of illness and willingness to pay for diseases interventions in rural communities of developing countries. *Iranian J Publ Health* 2012;41(6):39-49.
13. *Disease Control Priorities in Developing Countries*. 2nd edition. (Editors: Jamison DT, Breman JG, Measham AR, et al.). Washington (DC): World Bank 2006.
14. Pokhrel D, and Viraraghavan T. Diarrheal diseases in Nepal vis-à-vis water supply and sanitation status. *Journal of water and health* 2004;2(2):71-81.
15. Lee K, Yoon Y, Sajo M, Kim C, Khanal N, Do Y, Kim P, and Ahn D. Assessment of drinking water and sanitation habits in rural Tikapur, Nepal. *Rural and Remote Health* 2013;13: 2401.
16. The World Bank. *Nepal demographic and health survey 2011*. 2011. [updated 2013; cited:16 August 2013].  
Available from: <http://microdata.worldbank.org/index.php/catalog/1466>
17. Aryal KK, Joshi HD, Dhimal M, Singh SP, Dhakal P, Dhimal B, and Bhusal CL. Environmental burden of diarrheal diseases due to unsafe water supply and poor sanitation coverage in Nepal. *J Nepal Health Res Counc* 2012;12(21):125–9.

18. Maharjan M. Diarrheal diseases in Nepal: Risk factors and prevention measures. 2013.  
[cited 2013 September 9]. Available from: <http://www.wash-rcnn.net.np/images/pdf/lead-article-by-mr-maharjan.pdf>
19. IRIN. NEPAL: Lack of toilets, poor hygiene fuel water-borne diseases [Internet]. [cited 2013 August 16]. Available from: <http://www.irinnews.org/report/75570/nepal-lack-of-toilets-poor-hygiene-fuel-waterborne-diseases>
20. Improving water and sanitation governance through citizens' action. Water Aid. 2008.
21. Yakami S. Present scenario of drinking water, sanitation and hygiene in rural Nepal. Water, Sanitation and Hygiene Resource Centre Network Nepal. 2013. [cited 2013 August 16] Available from:  
<http://www.wash-rcnn.net.np/images/pdf/article-by-saroj-yakami-may-2011.pdf>
22. California Department of Public Health. What is a cross-sectional study [Internet]. [Updated 2009 December 28; cited 2013 May 6]. Available from:  
[http://www.ehib.org/faq.jsp?faq\\_key=41](http://www.ehib.org/faq.jsp?faq_key=41)
23. Tibetan and Himalayan Historical and Cultural Geography. Nepal Census Data 2001 [Internet]. [Cited 2013 May 6]. Available from:  
<http://www.thlib.org/places/culturalgeography/nepal/census/index.php?selection=42>
24. Fleiss: Statistical methods for rates and proportions, Wiley, 1981.
25. International Fund for Agricultural Development. Enabling Poor Rural People to Overcome Poverty in Nepal. 2013. [cited 2014 March 4]. Available from:  
<http://www.ifad.org/operations/projects/regions/pi/factsheets/nepal.pdf>
26. "Nepal Agriculture: Statistical Profile", NationMaster. [cited 2014 March 4]. Available from: <http://www.nationmaster.com/country-info/profiles/Nepal/Agriculture>
27. E Pop Info. District-Makwanpur [Internet]. [cited 2014 March 4]. Available from:  
<http://e-pop.mohp.gov.np/index.php/districts/details/id/31>

28. Water Aid. People's Perception on Sanitation: Findings from Nepal. 2011. [cited 2014 March 4]. Available from: <http://www.wateraid.org/~media/Publications/perception-sanitation-nepal.pdf>
29. Boschi-Pinto C, Lanata CF, Mendoza W, et al. Diarrheal Diseases. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. Disease and Mortality in Sub-Saharan Africa. 2nd edition. Washington (DC): World Bank; 2006.
30. Haggerty PA, Muladi K, Kirkwood BR, Ashworth A, Manunebo M. Community-Based Hygiene Education to Reduce Diarrheal Disease in Rural Zaire: Impact of the Intervention on Diarrheal Morbidity. *International Journal of Epidemiology* 1994; 23:1050–59.
31. LaFond AK. A Review of Sanitation Program Evaluation in Developing Countries. 1995. Activity Report 5, Environmental Health Project, Arlington, VA.
32. MacDougall J, and McGahey C. Three Community-Based Environmental Sanitation and Hygiene Projects Conducted in the Democratic Republic of Congo. 2003. Activity Report 119, USAID, New York.
33. Siddiqui MS, Amin M, Amber M, Abbas M, Sherwani SK, Malik MW, Hussain M. Association of Socioeconomic Features, Hygienic Status, Age Groups and Gender with Prevalence of Waterborne Diseases in Rawalpindi and Islamabad. *Sci., Tech. and Dev* 2012;31 (3):219-226.
34. Colombara DV, Cowgill KD, and Faruque ASG. Risk factors for severe cholera among children under five in rural and urban Bangladesh, 2000–2008: A Hospital-Based Surveillance Study. *PLoS ONE* 2013;8(1).
35. Yilgwan CS, and Okolo SL. Prevalence of diarrhea and risk factors in Jos University Teaching Hospital, Nigeria. *Annals of African Medicine* 2012;11(4):217-21.

36. Karambu S, Matiru V, Kiptoo M, Oundo J. Characterization and factors associated with diarrheal diseases caused by enteric bacterial pathogens among children aged five years and below attending Igembe district hospital. *Pan Afr Med J* 2013;16:37.
37. Luby SP, and Halder AK. Associations among handwashing indicators, wealth, and symptoms of childhood respiratory illness in urban Bangladesh. *Tropical Medicine & International Health* 2008;13:835–44.
38. Alexander KA, and Blackburn JK. Overcoming barriers in evaluating outbreaks of diarrheal disease in resource poor settings: assessment of recurrent outbreaks in Chobe district, Botswana. *BMC Public Health* 2013;13(775).
39. Bartram J, and Cairncross S. Hygiene, sanitation, and water: Forgotten foundations of health. *PLoS Med* 2010;7(11).
40. WHO and UNICEF. Water supply and sanitation global assessment year 2000 report. Joint Monitoring Program for Water Supply and Sanitation.
41. Mintz ED, Reiff FM, and Tauxe RV. Safe water treatment and storage in the home. *The Journal of the American Medical Association*. 1995;273(12):948-53.
42. Esrey SA, Potash JB, Roberts L and Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ* 1991;69(5):609-21.
43. Badowski N, Castro CM, Montgomery M, Pickering AJ, Mamuya S, and Davis J. Understanding household behavioral risk factors for diarrheal disease in Dar es Salaam: a photovoice community assessment. *Journal of Environmental and Public Health*. 2011.



# APPENDICES

## Appendix 1

### Data collection form (questionnaire)

#### INFORMED CONSENT

Hello. My name is Prapti Sedhain and I am Masters Student of Public health. I am conducting a survey about water, sanitation and rural health at Makwanpur distric (Daman and Palung). I will appreciate your participation in this survey. The information you provide will help to know prevalent waterborne diseases and the factors associated with it. The survey usually takes between 10 and 20 minutes to complete.

Participation in this survey is voluntary and you can choose not to answer any individual question or all of the questions. However, I hope that you will participate in this survey since your views are important.

You will not have to financially support this survey.

At this time, do you want to ask me anything about the survey? You may leave the interview in between if you want to.

May I begin the interview now?

.....

Signature

### QUESTIONNAIRE:

#### SECTION A

1. Name:

2. Age:
3. Number of family members:

#### SECTION B

4. Head of the household:
5. Education level :
6. Occupation:
7. Income:

#### SECTION C

8. Source of water
  - Tap water
  - River
  - Stream/well

#### SECTION D

9. Latrine:
  - Yes
  - No

9.1 If yes: Types of latrines

9.1.1 Temporary (made up of)

- Bamboo
- Plastic/Paper
- Clothes

9.1.2 Permanent (made up of)

- Brick/wood
- Mud

10. Septic tank

- Yes
- No

11. If yes

- Temporary (Pit/hole)
- Permanent (Cemented)

12. Water supply in latrines

- Yes
- No

SECTION E

13. Prevalence of waterborne disease

- Diarrhea
- Dysentery
- Cholera
- Typhoid
- Jaundice

12.1. Number of members who were affected by those diseases?

12.2. How many times have they been affected by those diseases in the past year?

*Thank you for taking the time to complete the questionnaire and support this research.*

## Appendix 2

नमस्कार ! म प्राप्ती सेढाई स्नाकोत्तर जनस्वास्थ्यको विद्यार्थी अहिले म खानेपानी, सरसफाई तथा ग्रामिण स्वास्थ्यको बारेमा अध्ययन गरि रहेको छु । यस अध्ययनमा तपाईंहरूको सहभागीताको अपेक्षा राख्दछु । तपाईंले दिनुभएको सुचनाहरूले हाल विद्यमान रहेका पानीवाट फैलिने रोगहरूका बारेमा र तिनलाई फैलन सघाउने कारणहरूका बारेमा जानकारी दिनेछ र स्वास्थ्य सेवामा टेवा पुग्नेछ ।

यो अध्ययन जम्मा १०-२० मिनेट सम्मको हुनेछ । तपाईं यस अध्ययनमा बिना करकाप भाग लिन सक्नुहुनेछ । भाग लिनु भएमा तपाईंका विचारहरू अमूल्य हुनेछन् ।

तपाईंले यस प्रक्रियामा कुनै आर्थिक सहयोग गर्नुपर्ने छैन ।

तपाईंलाई यस अध्ययनका बारेमा केही जिज्ञासा छ यदी छ भने निर्धक्क मलाई सोध्न सक्नुहुनेछ ।

तपाईंलाई केहि संकोच भए यो प्रकृया विचमै छोड्न सक्नुहुनेछ ।

के तपाईंलाई अब म प्रश्न गर्न सक्छु ?

.....

हस्ताक्षर

**प्रश्नावली**

**खण्ड क**

१. नाम :

२. उमेर :

३. परिवार संख्या :

### खण्ड ख

४. घरमुली :

५. अध्ययनको तह :

६. पेशा :

७. आमदानी :

### खण्ड ग

८. पानीको स्रोत :

- धारा
- खोला
- मूल / इनार

### खण्ड घ

९. चर्पी

- छ
- छैन

९.१. छ भने : कस्तो प्रकारको चर्पी छ ?

९.१.१. अस्थायी (के वाट बनेको छ ?)

- बाँस
- प्लाष्टिक / कागत
- कपडा

९.१.२.स्थायी (के वाट बनेको छ ?)

- ईट र काठ
- माटो

१०.सेप्टि टंकी

- छ
- छैन

१०. छ भने

- अस्थायी (खाल्डो)
- स्थायी (सिमेन्ट लगाएको)

११. चर्पीमा पानी आपूर्ती

- छ

- छैन

## खण्ड ड

१२. विद्यमान पानीबाट फैलने रोगहरु

- पखाला
- रगतमासी
- भाडापखाला
- टाइफाइड / म्यादे ज्वरो
- जन्डिस / कमलपित्त

१२.१. त्यस रोगबाट प्रभावित हुनेको संख्या

१२.२. वितेका सालहरुमा कति पटक ति व्यक्तिहरुलाई सो रोग लागेको थियो ?

तपाईंको सहयोगको लागि धन्यवाद ।