Griffith
UNIVERSITY

By the authority of the Council

. Agung Saprasetya Dwi Laksana

is hereby granted the

MASTER OF SCIENCE

in Public Health

under the Common Seal of Griffith University

on the 27th day of August 2004

Vice Chancellor and President

Chancellor

2147448/ 106398

Name	Griffith Identification Number	Date of Birth	Page
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ACADEMIC RECORD

- - - Beginning of Postgraduate Record - - -

Master of Science in Public Health

Semester 1 - 2003

Program : Master of Science in Public Health
Stream : Envionmental Health Epidemiology
Academic Load : Full-Time

			Credit Points	Grade
PUB_HLTH	7311PBH	Soc&Behav Determinants of Hlth	10	Credit
ENGINEER	7067EVP	Geographic Information Systems	10	Credit
MATHS	7320PBH	Appl Stats for Public Health	10	High Distinction
PUB_HLTH	7601PBH	Envromntl Health Managmnt Syst	10	Distinction
MATHS	1204PBH	Statistics for Public Health	10	Distinction
		Total Credit	50	Cumulative GPA 5.80

Semester 2 - 2003

Program : Master of Science in Public Health
Stream : Envionmental Health Epidemiology
Academic Load : Full-Time

			Credit Points	Grade
PUB_HLTH	7114PBH	Hlth Risk Assessment&Risk Mgt	10	Distinction
PUB_HLTH	7303PBH	Health Research Methodology	10	Distinction
PUB_HLTH	7111PBH	Environment&Population Health	10	Credit
PUB_HLTH	7116PBH	Hlth Prom Strategies&Planning	10	Credit
PUB_HLTH	1202PBH	Epidemiology and Public Health	10	Distinction
		Total Credit	100	Cumulative GPA 5.70

Summer Semester - 2003/2004

Program : Master of Science in Public Health
Stream : Envionmental Health Epidemiology
Academic Load : Part-Time

			Credit Points	Grade
PUB_HLTH	7317PBH	Research Development	10	High Distinction
		Total Credit	110	Cumulative GPA 5.82

Semester 1 - 2004

Program : Master of Science in Public Health
Stream : Envionmental Health Epidemiology
Academic Load : Full-Time

			Credit Points	Grade
INFOSYS	7318PBH	Data Compilation and Analysis	10	High Distinction
PUB_HLTH	7501PBH	M Sc in Public Health Diss	0	Continuing Grading
PUB_HLTH	7502PBH	M Sc in Public Health Diss	40	Credit
		Total Credit	160	Cumulative GPA 5.69

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Academic Transcript

Name	Griffith Identification Number	Date of Birth	Page
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Notations

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KEPUTUSAN
MENTERI PENDIDIKAN NASIONAL REPUBLIK INDONESIA
Nomor: 1955/Kep.Dikti/IJLN/2004

tentang
PENETAPAN HASIL PENILAIAN IJAZAH PENDIDIKAN TINGGI LULUSAN LUAR NEGERI

MENTERI PENDIDIKAN NASIONAL

Menimbang : 1. bahwa gelar akademik dan sebutan profesional yang diberikan oleh perguruan tinggi di luar negeri perlu pengesahan dari Departemen Pendidikan Nasional;
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2. Peraturan Pemerintah Republik Indonesia
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   b. Nomor 60 Tahun 1999;
   c. Nomor 61 Tahun 1999.
3. Keputusan Presiden Republik Indonesia
   a. Nomor 85/M Tahun 1999;
   b. Nomor 177 Tahun 2000, sebagaimana telah diubah terakhir dengan Keputusan Presiden Nomor 82 Tahun 2001;
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   c. Nomor 107/U/2001;
   d. Nomor 176/O/2001;
   e. Nomor 178/U/2001
6. Keputusan Direktur Jenderal Pendidikan Tinggi, Depdiknas, Nomor 08/DIKTI/Kep/2004.

Memperhatikan: Hasil Penelitian Panitia Tetap Penilaian Ijazah Pendidikan Tinggi Luar Negeri Departemen Pendidikan Nasional pada tanggal **14 Desember 2004**.

MEMUTUSKAN

MENGESAHKAN
Salinan/foto copy Sesuai dengan aslinya
29 DEC 2004
Direktur Pembinaan Akademik dan Kemahasiswaan
Prof. Ir. SUPENO DJANALI, M.Sc. Ph. D.
NIP. 130 368 610

Menetapkan

Pertama :

Jenis ijazah	:	**MASTER OF SCIENCE**
Bidang ilmu	:	**PUBLIC HEALTH**
Tanggal ijazah	:	**27 AGUSTUS 2004**
Perguruan tinggi	:	**GRIFFITH UNIVERSITY**
Asal negara	:	**AUSTRALIA**
Dinilai setara dengan	:	**MAGISTER (S-2)**
Atas nama	:	**AGUNG SAPRASETYA DWI LAKSANA**
Tempat dan tanggal lahir	:	**PURWOKERTO, 5 SEPTEMBER 1967**

Kedua : Gelar yang digunakan adalah gelar yang diberikan oleh Lembaga Pendidikan Tinggi Luar Negeri yang bersangkutan;

Ketiga : Keputusan ini mulai berlaku pada tanggal ditetapkan;

Keempat : Segala sesuatu akan ditinjau kembali jika terdapat kesalahan dalam penetapan ini.

Ditetapkan di **Jakarta**
Pada Tanggal : **15 Desember 2004**
A.n. Menteri Pendidikan Nasional
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DIREKTORAT JENDERAL PENDIDIKAN TINGGI

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130 368 610

ASSOCIATIONS BETWEEN SOCIO-ENVIRONMENTAL FACTORS AND DIARRHOEA OCCURRENCE IN CHILDREN UNDER FIVE IN PURWOKERTO SELATAN, INDONESIA

AGUNG SAPRASETYA DWI LAKSANA

2004

ASSOCIATIONS BETWEEN SOCIO-ENVIRONMENTAL FACTORS AND DIARRHOEA OCCURRENCE IN CHILDREN UNDER FIVE IN PURWOKERTO SELATAN, INDONESIA

AGUNG SAPRASETYA DWI LAKSANA

This dissertation is submitted in partial requirement for the award of the Master of Science in Public Health at Griffith University
2004

DECLARATION OF ORIGINALITY

I hereby declare that this thesis and the work reported herein is my own work and has not been submitted in any form for another degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and in the list of references.

This dissertation is dedicated to my beloved:

Susi Eka Rianawati

Nabila Dyah Ayu Maharani

Dyah Pitaloka Kusumawardani

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I owe my loving thanks to my wife Susi Eka Rianawati and my daughters Bella and Pipit. They have lost a lot due to my study abroad. Without their

encouragement and understanding it would have been impossible for me to finish this work.

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ABSTRACT

Background: Diarrhoea is the leading cause of morbidity and mortality in developing countries, including Indonesia. In Purwokerto Selatan sub-district, diarrhoea ranks as the leading cause of child morbidity. The disease is particularly considered to have a strong relationship with poor environmental conditions. Determining the main risk factors related to the disease will allow decision-makers to build effective strategies to address the disease.

Aim: The purpose of this study was to examine the association between socio-environmental factors and the occurrence of diarrhoea in children aged under five years old in Purwokerto Selatan subdistrict, Central Java, Indonesia.

Methods: This study was an observational, cross-sectional study. Stratified random sampling was used as the sampling method. Face to face interviews with mothers of the children using a structured questionnaire was conducted to obtain data concerning physical environment, socio-demographic and behavioural factors. Microbiological examination using Completed Test Method was used to determine the presence of *E. coli* in water source in respondents' homes. Descriptive statistics, Chi-squared test and Logistic Regression were used to analyse the data. ArcView GIS was used for spatial analysis.

Results: There was a significant association between breastfeeding and diarrhoea occurrence. No association was found between the following factors and diarrhoea occurrence: water quality, source of water supply, latrine facilities, type of latrines, methods of refuse disposal, gender of the children, maternal age, maternal education and bottle-feeding practice. Berkoh borough was area with the highest risk of diarrhoea related to socio-environmental factors. Water source and breastfeeding were significantly associated with diarrhoea occurrence in the more than 24 months age group, whereas unhygienic refuse disposal methods was associated with diarrhoea occurrence in the 0-24 months age group.

Conclusion: Breastfeeding, water source and unhygienic refuse disposal methods are the most important factors related to diarrhoea occurrence. This result suggested that promoting breastfeeding practices, improved water source quality and hygienic refuse disposal methods should be considered as the main strategies for the prevention of diarrhoea occurrence in the study areas.

Key words: Diarrhoea, socio-environmental factors, physical environmental factors, socio-demographic factors, Behavioural factors.

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CHAPTER I: INTRODUCTION

1.1 Introduction

Diarrhoea is a major public health problem in developing countries (Baltazar *et al.* 2002). Diarrhoea episodes occur in both developed and developing countries, but are five to six times more common in developing countries. Children under five years of age are at highest risk (WHO 1997, p. 138). Parashar *et al.* (2003, p. 236) reported that diarrhoea is one of the leading causes of illness and death in young children. In Indonesia, diarrhoea also remains a major public health issue. In Purwokerto Selatan subdistrict, Banyumas district, Central Java, the disease is the leading cause of morbidity in children under five years old. The disease is particularly considered to have a strong relationship with poor environmental conditions (WHO 1997, p. 139).

It is known that prevention and health promotion programs are much cheaper than treatment and are considered to be the best choice in reducing diarrhoea incidence. In Purwokerto Selatan subdistrict, interventions to reduce diarrhoea incidence have been conducted through clinical, prevention and promotion programs. However, these interventions have not made much improvement because the approach probably has not been informed by adequate data about the main determinants of the disease.

Some studies also reported that spatial analysis is an important tool in obtaining important information for decision-makers in making the decision to build effective health promotion and prevention program planning and strategies to address the disease (Kisteman *et al.* 2001, p. 301). Spatial analysis also has not been used in program planning and strategies to address the main risk factors of the disease. Hence, research to identify significant diarrhoea risk factors and spatial analysis of the disease will play an important role as initial information in developing programs and strategies to reduce the burden of the disease.

1.2 Background

The WHO (1997, p. 138) has estimated that the total number of diarrhoea episodes each year is as high as 4,000 million globally. Worldwide, each year three million deaths due to this disease may occur (WHO 1997, p. 138). Parashar *et al.* (2003, p. 236) reported that analyses conducted in 1990 and 2000 estimated that in 1990 diarrhoea accounted for 21% of all deaths of children under five years old, whereas in 2000, the disease accounted for 13% of all deaths of children in the same age group. Although the last decade has demonstrated declining mortality, but relatively stable morbidity, there are at least 2.6 diarrhoea episodes per child per year worldwide (Parashar 2003, p. 236).

In Indonesia, diarrhoea morbidity rates tend to fluctuate from year to year. There are many outbreaks of diarrhoea every year, although the case fatality rate (CFR) is low. In 1998, the diarrhoea morbidity rate was 23.57

per 1,000 people, lower than that in 1995, which was 24.26 per 1,000 people. However, in 1999 the rate increased again to 26.13 per 1,000 people (Ministry of Health 2001, p. 49).

In Banyumas district in 2002, the incidence of diarrhoea ranked number one among 28 infectious diseases although the rate of diarrhoea incidence decreased from 18.7 per 1,000 people in 2001 to 17.6 per 1,000 people in 2002. In 2001, 8.77% diarrhoea cases were hospitalised (Dinas Kesehatan Banyumas 2002, n.p.). Purwokerto Selatan sub-district had the highest rate of the disease incidence. The incidence rate was 31.4 per 1,000 people in 2002 (Dinas Kesehatan Banyumas 2002, n.p.).

Although there are no data on the main microorganisms causing diarrhoea in the sub-district, some researchers suggest that most of diarrhoea cases are acute infectious diarrhoea, caused by a range of micro-organisms. Rotavirus and enteropathogenic *Escherichia coli* responsible for the greatest number of the cases (Ono *et al.* 2001, p. 520; Jongpiputvanich *et al.* 1998, p. 187). The World Health Organization (WHO, 1997, p.138) established that diarrhoea has a close relationship with poor environmental conditions. To date, no research has been conducted in Purwokerto sub-district to identify the main risk factors related to diarrhoea.

1.3 Goal and Objectives

1.3.1 Rationale

In Purwokerto Selatan subdistrict, diarrhoea ranked number one among 28 infectious diseases. Interventions to reduce the diarrhoea incidence have been made through curative, preventive and health promotion programs. However, these interventions have not made much improvement because the approach probably has not been supported by data concerning the main physical environmental, socio-demographic and behavioural factors related to the disease. Neither has spatial analysis been used in health programs to control the disease. To date, there is no comparable study to determine the main risk factors of and the spatial distribution of diarrhoea in Purwokerto Selatan subdistrict.

1.3.2 Goal

The goal of this study is to examine the association between socio-environmental factors and the occurrence of diarrhoea in children under five years old in Purwokerto Selatan subdistrict, Indonesia.

1.3.3 Objectives:

The objectives of this study are:

1. To analyse the association between physical environment factors (water quality, water source, methods of refuse disposal and latrine facilities) and the occurrence of diarrhoea.

2. To analyse the association between socio-demographic factors (gender of the child, maternal age and maternal education) and the occurrence of diarrhoea.

3. To analyse the association between behavioural factors (breastfeeding and bottle-feeding) and the occurrence of diarrhoea.

4. To describe the spatial distribution of diarrhoea in Purwokerto Selatan.

5. To propose recommendations which will contribute to prevention and control programs and strategies to reduce the occurrence of diarrhoea.

1.4 Conceptual Framework

Conceptual framework of this study can be seen in Figure 1.1 below.

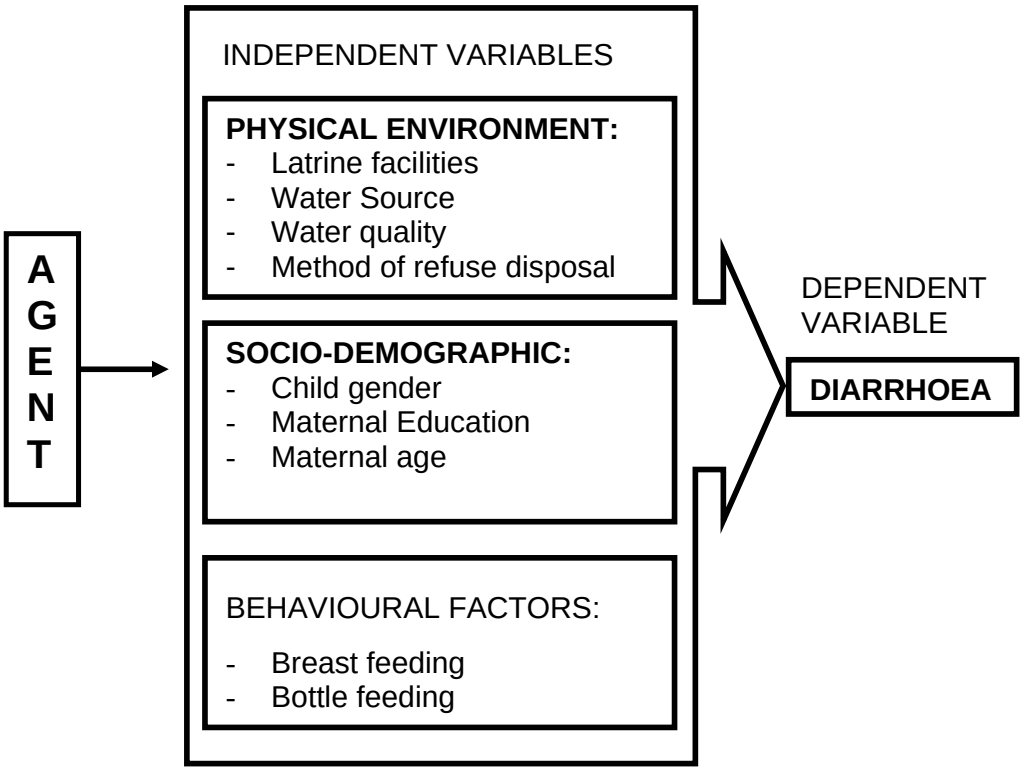


Figure 1.1 Conceptual Framework

1.5 Hypotheses

The hypotheses of this study are:

1. There are significant associations between physical environmental factors and the occurrence of diarrhoea

2. There are significant associations between socio-demographic factors and the occurrence of diarrhoea

3. There are significant associations between behavioural factors and the occurrence of diarrhoea.

1.6 The Significance of the Study

The strategies to decrease Diarrhoea incidence will be successful if informed by data showing the main risk factors and the spatial distribution of the disease. This study examines the association between socio-environmental factors and diarrhoea occurrence in children under five years old in Purwokerto Selatan subdistrict, Indonesia. This study aims to improve the knowledge of the significant physical environmental, socio-demographic and behavioural risk factors that are related to diarrhoea occurence in Purwokerto Selatan subdistrict.

The study also describes the spatial distribution of the disease to enhance understanding regarding the spatial distribution of diarrhoea in the study area. This may contribute to better understanding of the association between socio-environmental factors and the disease and the spatial distribution of the disease in the studied areas.

The study may provide important information to help decision-makers to develop more effective and efficient programs and strategies to reduce diarrhoea incidence.

1.7 Thesis Outline

This dissertation consists of six chapters. The content of each chapter is as follows:

Chapter one provides the introduction and background, goal and objectives, hypothesis, conceptual framework and the significance of the study. The introduction and background describe the important of the topic of this study, why the topic is chosen and several important issues related to the topic. Goal and objectives describes the purposes of this study. Hypothesis describes hypothesis to be proved in this study. This chapter also describes the advantages will be gained from this research.

Chapter two consists of the literature review. The literature is divided into six sub areas: burden of diarrhoea disease, definition of diarrhoea, types of diarrhoea, causes and transmission of diarrhoea, mechanism of diarrhoea, socio-environmental factors and diarrhoea and spatial analysis of diseases.

The methods used in this study are described in Chapter three. A brief description of study area is provided at the beginning if this chapter. The next section is research design, which explains sampling processes, including study population, sampling frame, sampling method and sampling size calculation. Definitions of dependent and independent variables and its category can be read in operational definition section. Data collection processes, data analysis processes and ethical implication of this study are explained at the end of this chapter.

The results are described in Chapter four and a description of these results is contained in Chapter five.

Chapter six provides the conclusion and recommendations of this study. This chapter draws the conclusion of this study based on the result and discussion. This chapter also suggests some recommendations for improving the control programs of diarrhoea in children under five.

CHAPTER II: LITERATURE REVIEW

2.1 The Burden of Diarrhoea Disease

In developing countries, diarrhoea is still one of the main causes of morbidity and mortality, especially in children under five years old. Although diarrhoea episodes occur in all countries, the disease episodes are five to six times more common in developing countries (WHO 1997, p. 138; Kosek *et al.* 2003, p. 197). In developing countries, there are six to seven diarrhoea episodes per year per child, whereas in developed countries there are only one to two episodes per child per year (Thapar and Sanderson 2004, p. 642). The WHO and Tumwine *et al.* reported that the highest risk age group is children under the age of five (WHO 1997, p. 139; Tumwine *et al.* 2002, p. 750).

Diarrhoea is still one of the leading disease causes of high morbidity in children under five years old. The WHO (1997, p. 138) has estimated that the total number of diarrhoea episodes each year is approximately 4,000 million globally. Thapar and Sanderson (2004, p. 642) estimated that in early 1980s, every year there were one billion diarrhoea episodes among children under five years old worldwide. They also reported that in the 1990s, there was a little change in the incidence of diarrhoea.

The mortality rate attributable to diarrhoea has tended to decrease from decade to decade. Worldwide, each year three million deaths due to diarrhoea may occur (WHO 1997, p. 139). In the early 1980s, diarrhoea

accounted for 4.6 million deaths in children under five years old every year globally (Thapar and Sanderson 2004, p. 642; Victora *et al.* 2000, p. 1250). In the 1990s, after the implementation of oral rehydration therapy (ORT) - which was coordinated by the WHO, the number of deaths attributable to this disease decreased to 3.3 million per year (Thapar and Sanderson 2004, p. 642, Victora *et al.* 2000, p. 1250). This estimation was supported by Kosek *et al.* (2003, p. 236). A literature review of studies published between 1992 and 2000 in 21 countries by Kosek *et al.* (2003, p. 198) estimated that 2.5 million children under the age of five died from diarrhoea each year during this period. In 2000, according to Parashar *et al.* (2003, p. 236), worldwide, diarrhoea accounted for 1.4 million deaths among children under five years old or 13% of all children deaths.

Despite the decrease in mortality due to diarrhoea, the disease remains ranked number three after perinatal causes and acute respiratory infection as the main causes of deaths among children under five. This disease accounted for 15% of cause-specific mortality in the most recent decade (Thapar and Sanderson 2004, p. 642). In 42 countries, which account for 90% of all deaths in children under five globally, diarrhoea ranks number one as the cause of these deaths. In these countries, 22% of all deaths of children under five are due to this disease (Black *et al.* 2003, p.2226). In studies published from 1992 to 2000, the diarrhoea mortality rate was found to be 4.9 per 1000 per year (Kosek *et al.* 2003, p. 198). The World Summit goal to reduce child mortality due to diarrhoea by 50 percent has

been achieved. However, diarrhoea remains one of the main causes of mortality among children under five (Annan 2001, p. 29).

Indonesia is one developing country that has a significant problem with diarrhoea. In 1990s, diarrhoea ranked number two of the main diseases suffered by infants and children. The average prevalence was 10% (The Indonesia Government 2001, p. 9). According to the Departemen Kesehatan Republik Indonesia (the Ministry of Health of Indonesia), in 2001, there were 2,873,414 cases of diarrhoea among children under five years old in Indonesia (Departemen Kesehatan RI 2002, p. 30-31). In the same year, 4,428 diarrhoea outbreaks occurred in 12 out of 27 provinces in Indonesia. The case fatality rate in diarrhoea outbreaks in Indonesia showed a tendency to increase, from 1.4% in 1999 to 1.92% in 2000. This rate increased again to 2.26% in 2001 (Ministry of Health 2001, p. 31-32).

Diarrhoeal disease also remains the major cause of death in infants and children under five in Indonesia. Of the three main diseases causing infant and child mortality, diarrhoea ranks number two after respiratory infection diseases (The Indonesia Government 2001, p. 8). Simanjuntak *et al.* (cited in Oyofo, *et al.* 2002, p. 227) reported that in Indonesia, the disease accounts for 24.1% of all infant mortality and 40% of all deaths in children under two years old.

In 2002, in Purwokerto Selatan subdistrict, diarrhoea incidence ranked number one among 28 infectious diseases monitored. The incidence rate

was 31.4 per 1,000 people in 2002 (Dinas Kesehatan Banyumas 2002, n.p).

2.2 Definition of Diarrhoea

There are many definitions of diarrhoea, but usually the emphasis is on the change of faeces consistency rather than frequency. Diarrhoea occurs if faeces contain more water than normal. Normal faeces passed frequently in a day are not diarrhoea. Diarrhoea can be defined in terms of stool frequency, stool consistency, stool volume or fluidity and weight (Thomas *et al.* 2003, p. v1; Thapar and Sanderson 2004, p. 641; Bolin and Riordan 2001, p. 47). According to Nielsen *et al.* (2003, p. 343), in terms of frequency, diarrhoea is “three or more loose or watery non-bloody stools over a 24-hour period”. Diarrhoea with blood or mucous or Dysentery is defined as “one or more bloody loose stools over a 24-hour period” (Nielsen *et al.* 2003, p. 343). The World Health Organization (WHO 2000, p. 25), in terms of stool consistency, established that diarrhoea can be defined as “loose or watery stools”. In 24 hours, an infant produces faeces of 5-10 g/kg/day and the upper limit of normal faeces is 200 grams per 24 hours (Thomas *et al.* 2003, p v2; Bisset 2003, p. 291). Diarrhoea occurs if the total daily faeces output is more than 200 grams (Bisset 2001, p. 291).

A definition of diarrhoea which incorporates all the elements that have mentioned above is “the abnormal passage of loose or liquid stools more than three times daily and or a volume of stool greater than 200 grams per day” (Thomas *et al*. 2003, p. v1).

2.3 Types of Diarrhoea

When classified according to the duration of diarrhoea episodes, the disease may be divided into three types: Acute Diarrhoea, Persistent Diarrhoea, and Chronic Diarrhoea. Diarrhoea is categorised as Acute Diarrhoea if the episode of the disease lasts not more than two weeks (WHO 2000, p. 26). Acute diarrhoea usually lasts in few days without any medication and is usually self-limiting. If the disease lasts beyond two weeks, but not more than 30 days, it is categorised as Persistent Diarrhoea. If diarrhoea lasts more than 30 days, it is categorised as Chronic Diarrhoea (WHO 2000, p.26; Busben and Guerrant 2003, p. 139).

Generally, diarrhoea is an acute and self-limiting disease, which recovers in a few days (Busben and Guerrant 2003, p. 139). However, in developing countries, approximately 3-20% acute diarrhoea episodes become persistent (Ashraf *et al.* 2002, p. 142).

2.4 Causes and Transmissions of Diarrhoea

Both acute diarrhoea and persistent diarrhoea are mostly caused by infections (Thapar and Sanderson 2004, p. 641). A range of microorganims causes infectious diarrhoea. The main organisms causing acute diarrhoea in children in both developing and developed countries are viruses and bacteria (Mason 2002, p. 914; Jongpiputvanich *et al.* 1998, p. 187). However, the organisms, especially for the bacteria, are different. The two main organisms causing acute infectious diarrhoea in

children in developing countries are rotavirus and *E. coli* (Robinson and Roberton 1998, p. 660; Thapar and Sanderson 2004, p. 642). In developed countries, the two main causes of diarrhoea in children are rotavirus and *Campylobacter jejuni* (Robinson and Roberton 1998, p. 660).

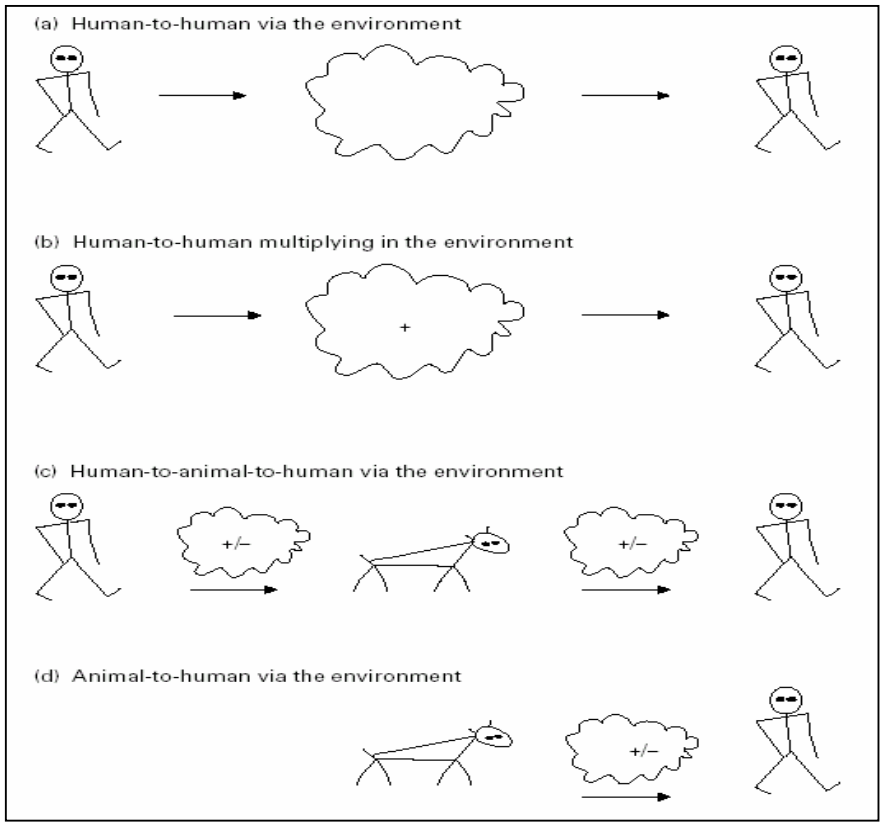
Thapar and Sanderson (2004, p. 643) reported that globally, the most frequent organism that causes severe acute diarrhoea in children in both developed and developing countries is rotavirus. Children in developing countries have the highest burden of rotavirus diarrhoea. The virus accounted for 60% diarrhoea occurrence in developing countries and 40% diarrhoea occurrence in developed countries. The virus accounts for approximately 600,000 – 800,000 deaths every year or about 5% of the deaths among children under five years old (Thapar and Sanderson 2004, p. 643; Van Man *et al.* 2001, p. 1707).

The most important bacteria causing diarrhoea among children in developing countries is *Escherichia coli*. This bacterium causes the majority of diarrhoea episodes (Robinson and Roberton 1998, p. 660). Thapar and Sanderson (2004, p. 643) reported that its prevalence is estimated to be 14-17% in developing countries, whereas in developed countries its prevalence is two to five percent.

Campylobacters are the most common bacterial infectious diarrhoea in developed countries. The most important species is *Campylobacter jejuni* (Hanninen *et al.* 2001, p.1391). In developed countries, the two peaks of *C. jejuni* infection incidence are during infancy (less than 12 months of

age) and during early adulthood, between 15 and 44 years old (Allos 2001, p. 1201 and 1203). Hanninen *et al.* (2003, p. 1391) reported that risk factors for *C. jejuni* infection are eating or handling poultry, drinking unpasteurised milk and drinking untreated water from wells or groundwater sources. According to Allos (2001, p. 1203), males are more prone to suffer from *C. jejuni* infection than females. However, the reason for this is still unknown.

Most of the pathogenic organisms that cause diarrhoea and the pathogens that are identified to be major causes of diarrhoea in many countries are transmitted primarily by the faecal-oral route (Bolin and Riordan 2001, p.48). According to Jongpiputvanich *et al.*, most diarrhoea infection is transmitted through water and food contaminated with rotavirus and enteropathogenic *E. coli* (Jongpiputvanich *et al.* 1998, p. 187). Mason (2002, p. 914) reported that faecal-oral transmission may be water-borne, food-borne or direct. Water-borne transmission may occur when water contaminated with faeces is drunk. Food-borne transmission may occur when food contaminated by faeces is eaten (Mason 2002, pp. 914-916). Direct transmission is faecal-oral transmission via finger or objects such as eating utensils, bed linen or dirt, which may be ingested by children (Curtis *et al*. 2000, p. 24).



Source: Curtis *et al.* (2000)

Figure 2.1 Routes of transmission of diarrhoea pathogens

Curtis *et al*. (2000, p.23) established that the routes of pathogen transmissions to reach new host in diarrhoea can be divided into three different routes. These, which can also be seen in Figure 2.1, are:

a. The pathogen is emitted to the environment through faeces and contaminated material that can be ingested by a new human host.

b. The same route of point (a), but the pathogen multiplies in the environment before meeting a new host.

c. The third possibility is that the pathogen emitted to the environment via faeces, in which it may or may not multiply, and is then ingested by an animal host, multiplies in the animal host, and is then released again into the environment before being ingested by a new human host.

d. The fourth possible route is through the pathogens that normally live in animals infect humans by contaminating the environment.

2.5 Mechanism of Diarrhoea

Two main functions of the intestine are digestion and fluid and electrolytes transport (Bisset 2001, p. 291-292). To understand the mechanism of diarrhoea, it is important to appreciate the normal mechanism of both the digestion and absorption processes and fluid and electrolyte transport in human body. Bolin and Riordan describe briefly the digestion processes in the human body (Bolin and Riordan 2001, p. 47). They describe the process by which digestion is started in the oropharynx where carbohydrate is hydrolysed by salivary amylase enzyme into oligosaccharides maltose, isomaltose and alpha-limit dextrins. The enzymes in the stomach in acidic pH continue the process.

In the small intestine, bile salts emulsify fat and aid in lipid digestion. Pancreatic enzymes digest lipids, protein and carbohydrate. Protein is transformed to amino acids, dipeptides and tripeptides, and oligosaccharides are transformed by disaccharidases enzyme to disaccharides and monosaccharides and limit dextrins (Bolin and Riordan

2001, p. 47-48; Bisset 2001, p. 291-292). Most nutrients produced by these digestion processes then absorbed from the duodenum and jejunum. Ileum absorbs vitamin B12 and bile acids that involved in the digestion processes of carbohydrate, protein and fats in the duodenum and jejunum.

In the colon, indigenous bacteria digest dietary nutrients that have not been digested in the small intestine. Its products are various gases and short-chain fatty acids (Bolin and Riordan 2001, p. 47-48; Bisset 2001, p. 292).

In one day, an estimate of 9 litres of fluids passes through the small intestine lumen (Bolin and Riordan 2001, p. 48). In an infant in a day, approximately 280 ml/kg body weight fluids enter the small intestine (Bisset 2001, p. 292). About five litres of these fluids comes from diet, saliva, and gastric acids, whereas the other four litres come from bile, pancreatic juice and the small intestine mucosal secretions (Bolin and Riordan 2001, p.48). Of the total fluids, only 20% pass into the colon for further absorption. Only less than two percent of the total amount of fluid and electrolytes entering the small intestine is disposed of as faeces (Bisset 2001, p. 292).

Fluid and electrolyte absorption and secretion occur in all segments of intestine from duodenum to distal colon (Field 2003, p. 931; Bisset 2001, p. 292). The mechanism of these processes occurs through active transport powered by the sodium potassium ATPase pump. This pump

assures that electrolytes in the inside of the intestine wall have a low sodium concentration and a negative charge (Bisset 2001, p. 292). By this mechanism, the pump controls most intestinal fluid and electrolyte absorption and secretion processes (Bisset 2001, p. 292).

According to Lundgren (2002, p. 109), the mechanism of diarrhoea has been debated for decades. Firstly, up to 1970s, it was considered that the loss of intestinal fluid in diarrhoea was resulting from intestinal motility disturbances. In the last 30 years, there was some evidence found that suggested that diarrhoea occurs because of disturbances in epithelial transport of water and ions (Lundgren 2002, p. 109). Field (2003, p. 932) supported this suggestion. According to Bisset (2001, p. 293), diarrhoea occurs if: (1) there is an increase in the total amount of fluids entering the colon from the small intestine; (2) there is a decrease in the colon capacity to absorb the fluid; and (3) there is an increase in the secretion of fluid from the colon.

2.6 Socio-environmental Factors and Diarrhoea

Diarrhoea occurrence has close relationships with environmental conditions (WHO, 1997, p. 7). Literally, the word environment refers to "whatever surrounds an object or some other entity" (WHO 1997, p. 6).

> "Humans experience the environment in which they live as an assemblage of physical, chemical, biological, social, cultural and economic conditions which differ according to local geography, infrastructure, season, time of day and activity undertaken" (WHO 1997, p. 7).

Bellamy (2003, p. 157) reported that unhealthy environments accounts for the greatest amount of deaths from diarrhoea. Globally, most of the 1.3 million deaths of children under five years are attributable to an unhealthy environment. As was mentioned in section 2.4, the transmissions of diarrhoea pathogens are all through environment (See Figure 2.1, page 17). This figure shows that in every potential transmission route, the pathogens must pass through the environment before meeting a human host. Wagner and Lanoix (cited in Curtis *et al*., 2000) proposed the F-diagram to describe, "what environment means in this context". This can be seen in Figure 2.2.

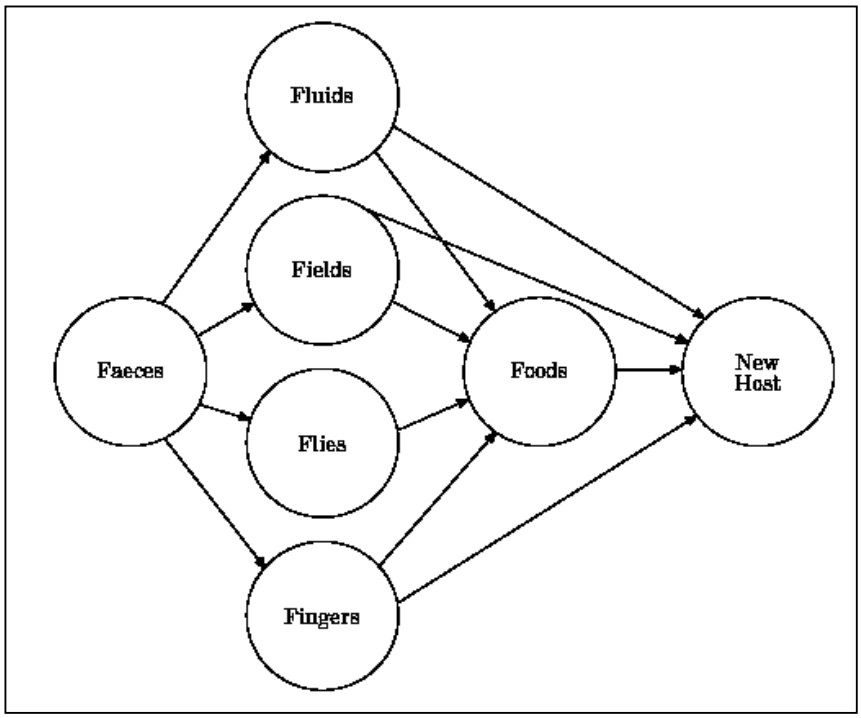


Figure 2.2 The F-diagram

Source: Wagner and Lanoix (1958), in Curtis *et al.* (2000)

The following section describes the literature on the physical environmental; socio-demographic factors and behavioural factors related to diarrhoea occurrence in children under five years old. These factors may be termed socio-environmental and it is on these factors in combination that this study focuses.

2.6.1 Physical environment and diarrhoea

Diarrhoea incidence has a close relationship with conditions in the physical environment. The WHO (1997, p. 139) established that diarrhoea is closely associated with poor sanitation and resultant contamination of water and food with faecal matter. It is estimated that approximately 90% of the disease burden is related to the environmental factors of poor sanitation and lack of access to clean water and safe food.

Water quality and water source

The National Health and Medical Research Council (NHMRC) and the Agriculture and Resource Management Council of Australia and New Zealand or ARMCANZ (1996, p. 1) stated that “drinking water should be safe to use and aesthetically pleasing”. Ideally, it should be clear, colourless, and well aerated, with no unpleasant taste or odour, and it should not contain suspended matter, harmful chemical substances or pathogenic microorganisms.

Drinking water must be protected from contamination by microorganisms such as bacteria, viral, protozoan pathogens and helminthes parasites. The greatest microbial risks are associated with human and animal excreta. Failure to provide adequate protection and effective treatment will expose the community to the risk of waterborne diseases (WHO 1993, pp. 3-5).

Szewzyk *et al*. (2000, p.103) affirm that to examine water quality, it is not necessary to isolate or detect the pathogenic organisms in raw water or drinking water. The most important method of measuring water quality is the detection and enumeration of faecal indicators. The presence of these indicators in a water sample indicates a high probability of the occurrence of pathogens excreted via faeces.

According to Szewzyk *et al*. (2000, p. 103), *Escherichia coli* detection or the increased numbers of coliform bacteria indicates the possibility of raw water contamination. Morgan *et al.*, (2003, p. 368) confirm that *Escherichia coli* is often be used as an indicator to monitor water quality. The presence of this bacterium in water indicates that the water is contaminated with faeces. According to Hanninen *et al.* (2003, p. 1391), faecal indicator organisms, such as coliforms and *E. coli* have been applied for more than one century for monitoring of drinking water, and most regulations establish that a 100 ml water sample should not contain any coliform bacteria, including *E. coli*.

Niemi *et al*. (2003, p. 1243) describe that the traditional method for the confirmation of *E. coli* in routine coliform analysis in a laboratory is identifying of gas and indole production by incubating a water sample at temperature of 44 – 44.5 degree Celsius. However, gas production is more important, as a false positive *E. coli* is possible if the analysis only based on indole test (Niemi *et al.* 2003, p. 1242).

Each year, around 2.5 million childhood deaths from diarrhoea are attributable to inadequate access to water and sanitation (the WRI, cited in Gasana *et al*. 2002, p. 77). According to the United Nations (1993, cited in Gasana *et al*., 2002, p. 77), in developing countries, approximately 80% of disease occurrence and about one third of deaths are caused by contaminated water consumption.

Many interventions to decrease diarrhoea morbidity in the developing world have been conducted, including enhancing water quality and increasing water quantity (Plate *et al.* 2004, p. 416). One of the main interventions is installing protected water sources such as boreholes, standpipes or wells to supply better water quality (Wright *et al.* 2004, p. 106). Checkley *et al*. (2004, p. 112) reported that the improvement of water supply has potential benefit in improving health and life expectancy.

Some researchers found different results of the association between water quality and diarrhoea occurrence in their studies. In a review of 144 studies conducted by Esrey *et al*. (cited in Shier *et al*. 1996, p. 335), improved water quality was found to be associated with a reduction in

diarrhoeal morbidity. In their research in Northern Pakistan, Nanan *et al.* (2003, p. 163) found that children who lived in areas included in a project to improve water quality and sanitation conditions were less likely to suffer from diarrhoea than those who lived in area outside the project. However, several studies found little or no association (Shier *et al*. 1996, p. 335; Plate *et al*. 2004, p. 416). Furthermore, a better water source does not accomplish full health benefit if it is not accompanied by improvement of sanitation and better practices in water storage (Checkley *et al*. 2004, p. 116; Taha *et al*. 2000, p. 51)

WHO (1999, p. 3) reported that adequate water availability is more important than water quality in diarrhoea prevention, because it facilitates hygiene practices. Research conducted by Checkley *et al.* (2004, p. 112) in a poor Peruvian peri-urban community concluded that inadequate water and sanitation were associated with the increase of diarrhoea incidence. A meta-analysis of 57 studies measuring water quality at the source and point of use conducted by Wright *et al*. (2004, p. 113) found that there is a decline in water quality between source and point of use. Hoque *et al*. (1999, p. 57) supported this finding. They recommended safer household water storage is an appropriate additional intervention preventing domestic water contamination. Checkley *et al*. (2004, p. 116) also found that children from households with small storage containers were more likely to suffer from diarrhoea than children from households with large containers. Not putting a lid on water storage containers is also associated with diarrhoea occurrence.

Latrine facilities and type of latrine

Associations between latrine facilities and latrine type and the occurrence of diarrhoea are well documented from several studies. Not using latrines and the condition of latrine are associated with developing, worsening and mortality due to diarrhoea in children (Kunii *et al*. 2002, p. 68). According to Hoque *et al.* (1999, p. 57), the condition of latrines is identified as an important environmental factor that showed a significant association with mortality due to diarrhoea in children. Children from families who did not use sanitary latrines were at higher risk of death from diarrhoea than those who did.

The type of latrines also has a significant relationship with the disease. In their research in Antalya, Turki, Etiler *et al*. (2004, p. 62) found that having an unhygienic toilet has a significant association with diarrhoea episodes. Pit latrine is known as an unhealthy latrine type with a significant association with diarrhoea occurrence (Etiler *et al*. 2004, p. 62). Tumwine *et al.* (2002, p. 753), in their research in East Africa, reported that among the households in the survey, 14% of those with a pit latrine had had at least one case of diarrhoea compared with only 7.4% of the household with a flush toilet. However, Marten *et al*. (cited in Curtis *et al.*, 2000, p. 26) suggested that latrine ownership was not enough to prevent diarrhoea, although it is related to safe stool disposal.

Methods of refuse disposal

Mock *et al.* (1993, p. 812) reported that the method of refuse disposal has a significant relationship with the occurrence of diarrhoea. Children whose families had refuse disposed by collection by government agency or refuse that is burned were less likely to have episodes of diarrhoea than those whose families buried or used other methods of refuse disposal, including dumping in the family compound.

2.6.2 Socio-demographic factors

Gender of the child

Gender is an important predictor for diarrhoea. Several studies have reported the association between gender and diarrhoea occurrence. A study in northern Ghana conducted by the The Navrongo Rotavirus Research Group (2003, p. 842) found that females had fewer diarrhoea episodes than males. This is supported by Etiler *et al*. (2004, p. 62). Mock *et al.* (1993, p. 810) found the gender of the child had a significant relationship with diarrhoea. Male children were more likely to suffer from diarrhoea than female children.

Maternal Age

Several studies reported different results for the association of maternal age and diarrhoea occurrence. Mock *et al.* (1993, p. 807) found that maternal age has a significant association with diarrhoea occurrence. On

the other hand, a study among Israeli Bedouin community conducted by Bilenko *et al*. (1999, p. 910) affirmed that maternal age was not an important risk factor for the occurrence of diarrhoea. Mock *et al.* (1993, p. 811) reported that older mothers, of 40 years or more, were twice as likely to have children who had diarrhoea as mothers who were less than 40 years old. However, Yassin (2000, p. 286) reported that children of teenage mothers had a significantly higher risk of the occurrence of diarrhoea.

Social support probably may explain the differences between studies. According to Millgan *et al*. (2000, p. 246), social support has been found to have a positive effect in the relationship between mothers and their babies.

Maternal Education

Several researches have shown different results for the association between maternal education and diarrhoea. Dargent-Molina *et al.* (1994, p. 343) in their study in Cebu, Philippines, reported that the protective effect of maternal education on improved infant health varied, depends on socio-economic status. Lopez-Alarcon *et al*. (1997, pp. 439-440), in their study in Itzapalapa, a slum area in the east of Mexico City, reported that low educated mothers were more likely to have children with diarrhoea. However, the correlation was not significant. Bilenko *et al.* (1999, p. 910) has also reported that maternal education did not show up as an important factor for the occurrence of diarrhoea in children. Another study conducted

by Etiler *et al*. (2004, p. 68) found that increased risk of diarrhoea episodes in children under five years old were associated with having uneducated mothers. Kunii *et al*. (2002, p. 68) and Yassin (2000, p. 282) supported this result.

In many countries, maternal education has been found to improve child survival. However, according to Dargent-Molina *et al.* (1994, p. 343), the protective effect of maternal education on diarrhoea occurrence varies, depending on the socio-economic environment in which they live. This protective effect was found in the more wealthy families, but had no effect in the disadvantaged families.

2.6.3 Behavioural factors

Breastfeeding is a significant strategy for child survival (Davies-Adetugbo *et al.* 1997, p. 161). Breastmilk is the best food for babies. It has a higher protective effect against morbidity and mortality attributable to diarrhoea compared with any other food (Bhandari *et al.* 2003, p. 1418; Davies-Adetugbo *et al.* 1997, p. 161). In the developing world, the most important advantage of breastfeeding is its barrier effect against faecal-oral contamination. This is because of the high level of environmental contamination in developing countries (Lopez-Alarcon 1997, p. 436). Brandtzaeg (2003, p. 3382) established that lactating mammary glands produce a sort of antibodies, particularly consisting of secretory immunoglobulin A (SIgA). This antibody protects babies against infectious agents, including diarrhoea pathogens.

The significant association between breastfeeding and diarrhoea have been reported by several studies. Mock *et al.* (1993, p. 812) established that maternal childcare behaviours, such as breast-feeding and bottle-feeding practices are related predictors of diarrhoea. This study established that bottle-fed babies suffered diarrhoea more frequently than breast-fed babies. On the other hand, in their study in Antalya, Turkey, Etiler *et al*. (2004, p. 64) reported that diarrhoea was not associated with breastfeeding. However, infants who were breastfed had lower risk for persistent diarrhoea.

The WHO advises exclusive breastfeeding for the first six months of life to achieve optimal growth (WHO, 1999, p. 1; Bhandari *et al*. 2003, p. 1418). However, worldwide, exclusive breastfeeding is rare and supplementary feeding is given very early in children lives (Davies-Adetugbo 1997, p. 161). Bhandari *et al*. (2003, p. 1418) also reported that in developing countries, the WHO recommendation is difficult to achieve, although breastfeeding is common. In Indonesia, it is estimated that only 24% mothers give exclusive breastfeeding (The Indonesia Government 2001, p. 13).

Bhandari *et al.* (2003, p. 1418) conducted a study to examine the effect of exclusive breastfeeding on diarrhoeal illness and growth among infants until the age of six in India. They concluded that exclusive breastfeeding at the first six months of life decreases the risk of diarrhoea and does not faltering infant growth. A study in 20 countries in Latin America conducted

by Betran *et al*. (2001, p. p. 304) found that exclusive breastfeeding in the first three months of life significantly reduced infant mortality from diarrhoea by 61%. However, insignificant association between exclusive breastfeeding and diarrhoea occurrence has been reported by Sazawal *et al.* (cited in Huttly *et al*. 1997, p. 165).

A significant association between bottle-feeding and diarrhoea occurrence has been reported by Mock *et al.* (1993, p. 807). Their study established that bottle-fed babies suffered diarrhoea more frequently than breastfed babies.

2.7 Spatial Analysis of Diseases, Including Diarrhoea

Geographic Information Systems (GIS) can be defined in several different ways. Any definition of GIS depends on the background and viewpoint of people who define it and on what is being investigated (Clark 2003, p. 3; Heywood *et al.* 2002, p. 11). In general, the definition of GIS includes three main components. These are a computer system, spatially referenced or geographical data, and management and analysis tasks on the data, including input and input (Heywood *et al*. 2002, p. 12).

GIS are increasingly being promoted as essential for the advancement of the population's health (O'Dwyer and Burton 1998, p. 819). GIS have been applied in public health in several countries (Keola *et al.* 2002, n.p.). The computer system technology allows spatial data analysis and modelling of disease, environment and health care systems (Ali *et al.* 2001, p. 100;

Pine and Diaz 2000, p. 10). It can be used to identify high-risk areas of diseases and potential health problems in a community (Pine and Diaz 2000, p. 10; Myaux *et al*. 1997, p. 181). GIS can also be used for public planning and surveillance purposes by local or national health departments (Wyatt and Liu 2002, p. 808).

The implementation of GIS has been carried out in several public health studies. Keola *et al.* (2002, n.p.) used GIS for spatial surveillance of epidemiological disease in Ayutthaya Province, Thailand. Myaux *et al.* (1997, p. 181) used spatial distribution of watery diarrhoea in children in Bangladesh to predict areas at higher risk of the disease.

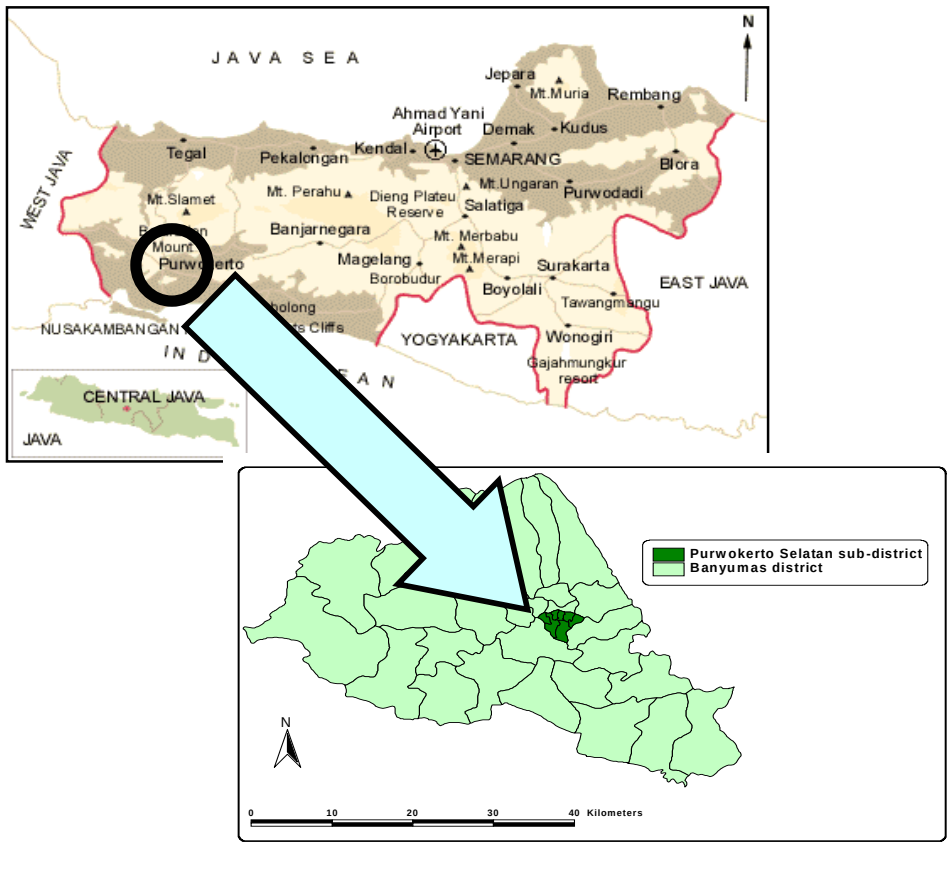
2.8 Summary

Diarrhoea is the leading cause of morbidity and mortality in developing countries, including Indonesia. In Purwokerto Selatan sub-district, diarrhoea ranks as the leading cause of child morbidity. The transmission of this disease is particularly associated with environmental factors. The literature has identified socio-environmental factors, which are important to the occurrence of diarrhoea in children under five years old. These factors in Purwokerto Selatan sub-district will be explored in the following chapters.

CHAPTER III: METHODS

3.1 Study Area

This study was conducted in *Kecamatan* Purwokerto Selatan (Purwokerto Selatan sub-district), one out of 27 sub-districts in *Kabupaten* Banyumas (Banyumas district), Central Java, Indonesia. Banyumas district located between 108^{o} 39' 17" -109^{o} 27' 15" East and 7^{o} 15' 05" – 7^{o} 37' 10" South.



Source: Anonymous (n.d.) available at:
http://www.geocities.com/kerajinan_jateng/images/peta/m-java-c.jpg

Figure 3.1 The location of Purwokerto Selatan sub-district

The total area of Banyumas district is approximately 1,327.60 km^2 or 132,759.56 hectares. According to Biro Pusat Statistik Banyumas (Statistics Banyumas District), the district has wet tropical climate with the average temperature 21.4^0 – 30.9^0 C (BPS Banyumas 2000, n.p.). Map of the location of Purwokerto Selatan sub-district is shown in Figure 3.1.

Purwokerto Selatan sub-district covers an area of 1,375.94 hectares or 13.75 square km. This sub-district consists of seven *kelurahan* (boroughs). At the end of 2003, the population of the sub-district was 63, 352, 31,512 males and 31840 females. The average population density is 4,607.42 per square km or 47.50 per hectare. The highest density borough is Purwokerto Kidul, 67.48 per hectare, whereas the lowest density borough is Karangklesem, 31.28 per hectare. Approximately 5.82% of the total population are children under five years old (BPS Banyumas 2003, n.p.). The summaries of the information are shown in Table 3.1 and Table 3.2.

Table 3.1 Total area and population density in each borough in Purwokerto Selatan sub-district

No.	Borough	Area (hectares)	Population	Population density per hectare
1	Karangklesem	302.42	9,460	31.28
2	Teluk	351.21	11,746	33.44
3	Berkoh	185.73	8,586	46.23
4	Purwokerto Kidul	111.08	7,496	67.48
5	Purwokerto Kulon	118.50	7,554	63.75
6	Karangpucung	159	10,241	64.41
7	Tanjung	148	8,269	55.87
	Total	1,375.94	63,352	47.50

Table 3.2 Population by gender and under five children in Purwokerto Selatan sub-district

No.	Borough	Gender		Total	under five children	
		Males	Females		Number	%
1.	Karangklesem	4,715	4,745	9,460	553	5.85
2.	Teluk	5,865	5,881	11,746	673	5.73
3.	Berkoh	4,318	4,268	8,586	586	6.83
4.	Purwokerto Kidul	3,616	3,880	7,496	350	4.67
5.	Purwokerto Kulon	3,707	3,847	7,554	270	3.57
6.	Karangpucung	5,115	5,126	10,241	801	7.8
7.	Tanjung	4,176	4,093	8,269	452	5.45
Total		31,512	31,840	63,352	3,685	5.82

3.2 Research Design

The research design of this study is observational studies and the type of the study is a Cross-sectional Study. In this study, data on diarrhoea and socio-environmental conditions (physical environment, socio-demographic and behavioural factors) in children under five years old in Purwokerto Selatan sub-district were collected at a particular time period to provide a "snapshot" in time of the situation.

3.3 Study Population and Sample

The population of this study was all children under five years old in Purwokerto Selatan sub-district, Central Java, Indonesia. They are the age group that is particularly at risk of diarrhoea. The sampling frame of this

study was all children under five years old in Purwokerto Selatan sub-district, Central Java, Indonesia.

This study involves a sample of the study population. Sampling was done because the population is large and there is a limitation on time (one months) and resources in collecting data.

3.3.1 Sampling method

Stratified random sampling of children within boroughs was used as the method of sampling. This method was used in order to obtain a proportional respondent from different boroughs in the study area.

The steps taken to obtain respondents were as follows:

1. Collecting data of the number of children under five in each borough in Purwokerto Selatan sub-district. The data was collected from Purwokerto Selatan Primary Health Care Centre

2. Calculating the proportion of children under five populations in each borough. The formula was as follows:

$$\% \text{ children} = \frac{\text{Total children under five in a village} \times 100}{\text{Total children under five in Purwokerto Selatan sub-district}}$$

3. Making a list of children under five in each borough and numbering the list started from number 1.

4. Choosing respondents from the list using a random table in proportion to the percentage of children under five in each of the borough.

Children under five who had diarrhoea at the time of interview were classified as the disease group. Children who had not had diarrhoea at the time of the interview were classified as the non-disease group.

3.3.2 Sample size calculation

The sample of this study was calculated using a formula for a small population (less than 10,000), as described by Notoatmodjo (2002, p. 92). The formula is as follows:

$$n = \frac{N}{1 + N (d^2)}$$

Where n is sample size, N is the total of study population; and d is level of significance.

In this study, total study population (N) was 3,685 and level of significance (d) was 0.1 or 10%. Based on these data, the minimum sample size of this study was as follows:

$$N = \frac{3,685}{1+ 3,685 (0.1^2)} = 97.36 \text{ or } 98 \text{ children}$$

In this study, at the end of data collection, the number of respondent was 206 respondents, more than twice the minimum sample.

3.4 Operational Definition

3.4.1 Dependent variable (diarrhoea)

Diarrhoea in this study is defined as the abnormal passage of loose or liquid stools more than three times daily or at least one loose stool containing blood in a day, which lasts less than two weeks. For infants who were still exclusively breastfed, diarrhoea was defined as “passing six or more stools in a day” (Etiler *et al.* 2004). This information was explored by interviewer during face to face interview.

3.4.2 Independent variables

In this study, the independent variables are socio-environmental factors. The factors were classified into three categories: physical environment, socio-demographic and behavioural factors. The classification is based on the definition of environment, which, in this study, is that used by the World Health Organization (WHO, 1997, p. 7):

> “Whatever surrounds an object or some other entity. Humans experience the environment in which they live as an assemblage of physical, chemical, biological, social, cultural and economic conditions which differ according to local geography, infrastructure, season, time of day and activity undertaken”.

The WHO definition of the environment covers very broad areas. However, this study focuses on the association between several physical environmental, socio-demographic and behavioural factors and diarrhoea occurrence among children under five years old. These three factors are

called socio-environmental factors. Below is the description of each factor and its categories. The summary of operational definition used in this study is shown in Table 3.3.

Table 3.3 Operational definitions of independent variables

INDEPENDENT VARIABLE	DEFINITION AND CATEGORY
Physical Environment	physical factors that influence health and well-being
1.1 Water quality	Water that fulfils a standard quality requirement, including physical, chemical and microbiological standards. In this study water quality was determined microbiology to identify the presence of *E. coli*.
1.2 Water sources	The source of water used by family members in the subject's home for personal use, including bathing, cooking and drinking. Water sources are divided into public supply, ground water-bore hole, dugout well, and other source.
1.3 Methods of refuse disposal	the method of disposing unwanted surplus substance or article that required to be disposed of because it is broken, worn out, contaminated or spoiled This variable is categorised into collected by local government, burned, buried, dumping into family compound and other
1.4 Latrine facilities	Excreta disposal facilities that provide for controlled disposal of human excreta to avoid human exposure to faeces. This variable was divided into four categories: pit latrine, water seal toilet, flush toilet and 'other' type.
Socio-demographic factors	the basic social and demographic characteristics of a defined population
2.1 Maternal age	measured in years
2.2 Gender of children	the gender of the children, male and female
2.3 Maternal education	the highest formal education certificate held by the mother of the children This variable was divided into five categories:

	a. no formal education or did not complete primary school, b. completed primary school, c. completed junior high school d. completed high school, and e. completed tertiary education (Diploma three, undergraduate and postgraduate)
Behavioural Factors	Behaviour in this study refers to the manner of acting in particular cases that relate to health and well-being
Breast feeding	Measured by asking the mother whether their children were breastfed or not and exclusively breastfed or not. Exclusive breastfeeding means that babies received nothing but breast milk in the first four months of life
Bottle-feeding	The use of bottle with artificial nipples and pacifiers (teats or dummies) for giving any liquids, such as milk, juice and any other drink

Physical environment

Physical environment in this study refers to physical factors that influence health and well-being. These include water quality and water source, latrine facilities and method of refuse disposal.

Water quality refers to water that meets a standard quality requirement, including physical, chemical and microbiological standards. However, this study focused on contamination of faecal matter in water sources. In this study, to identify the contamination of water source with faecal matter, all water samples were analysed microbiologically for total *E. coli*.

Water source means the source of water used by family members in the subject's home for personal use, including bathing, cooking and drinking. Water source was classified into four categories: public supply, ground water boreholes, dugout well, and surface source.

Public supply means piped water supply from local government. Ground water boreholes means drilled into the earth to reach a suitable water supply, whereas dugout well means dig into the earth to locate underground water (Moeller, 1997, p. 132; Morgan, 2003, p. 57).

In this study, method of refuse disposal refers to the method of disposing unwanted surplus substance or article that required to be disposed of because it is broken, worn out, contaminated or spoiled. Methods of refuse disposal were divided into four categories. They were refuse that is burned, refuse that is buried into the ground, refuse that is collected by government agency and refuse that is disposed by other means.

Latrine facilities was defined as excreta disposal facilities that provide for controlled disposal of human excreta to avoid human exposure to faeces. This variable was divided into four categories: pit latrine, water seal toilet, flush toilet and 'other' type.

Socio-demographic

In this study, socio-demographic factor is defined as the basic social and demographic characteristics of a defined population, such as gender of the child, mother's age, and mother's education.

Maternal age was measured in years. Gender was defined as the gender of the children. Maternal education was measured by the highest formal education certificate held by the mother of the children. This variable was divided into five categories: no formal education or did not complete primary school, completed primary school, completed high school, and completed tertiary education (Diploma three, undergraduate and postgraduate).

Behavioural factors

Behaviour in this study refers to the manner of acting in particular cases that relate to health and well-being. Behavioural factors measured in this study were breastfeeding and bottle-feeding.

In this study, breastfeeding was measured by asking the mother whether their children were breastfed or not and exclusively breastfed or not. Exclusive breastfeeding means that babies received nothing but breast milk in the first four months of life. Bottle-feeding means the use of bottle with artificial nipples and pacifiers (teats or dummies) for giving any liquids, such as milk, juice and any other drink.

3.5 Data Collection

3.5.1 Survey

The study involved a survey of a sample of the population. Face to face interviews with the mothers of the children using a structured questionnaire (Annex 1) was conducted during the survey. Prior to the interview, the questionnaire was piloted on outpatients at Clinic of Medical School, Jenderal Soedirman University. The aim of this piloting was to determine if any question was incomplete, ambiguous, confusing or made the respondent feel inconvenient. From the feedback of the piloting, modifications of the questionnaire were made to individual question to achieve the best questionnaire format.

From the survey or interview with respondents, the variables collected were:

1. Physical environment, with regard to water source, methods of refuse disposal and latrine facilities.

2. Socio-demographic factors, with regard to gender of the child, maternal age and maternal education.

3. Behavioural factors, with regard to breastfeeding and bottle feeding practices.

3.5.2 Water quality examination

Water quality was determined through microbiological examination of water samples from every respondent home. Water samples were collected from water source of each respondent home. The samples were collected with a sterile bottle. Prior to water sample collection, the bottle was sterilised by autoclaving it at temperature 121 degree Celsius and 15 KPa for 15 minutes. The volume of water sample collected was 100 ml per sample.

Microbiological examination was used to analyse and determine the bacteria (*Escherichia coli*) index of the water samples as a method of determining the quality of water supply. The method used was Completed Test Method (Soekanto, 2003, p. 104). In this method, the equipments needed were as follows:

1. Test tubes. These tubes were used as the container where the fermentation processes occurred.

2. Durham's tubes. An inverted Durham's tube was placed in every test tube to catch gases produced by bacteria during the fermentation process.

3. Micro pipette 10 ml, 1 ml and 0.1 ml. These micro pipettes were used to obtain an accurate volume of water sample inoculated into test tubes.

4. Incubator was used to incubate the test tubes inoculated with water sample in an optimum temperature (44.5 degree Celsius).

5. Bunsen burner. This burner was used to avoid cross contamination during the inoculation process of water sample.

6. Autoclave was used to sterilise all equipments used in the microbiological examination of water sample.

7. Magnetic stirrer. This equipment was used to ensure that the growth media was dissolved into a homogeny solution.

The growth media of *Escherichia coli* used in culture process was Oxoid ® Lactose Broth. Every 13 g Lactose Broth contains 3.0 g beef extract powder, 5.0 g peptone and 5.0 g lactose. This media was available as premixed powder. Preparation of the growth media was as follows:

1. For single strength media, 13 g Oxoid® Lactose Broth was added into distilled water to make 1.0 L and then heated on magnetic stirrer until the solution was homogenised. For double strength media, the 13 g media was added with 5 g lactose before it was added into distilled water.

2. The media distributed into test tubes fitted with inverted Durham tube in 10 ml volume. After that, the test tubes were covered with aluminium foil

and then sterilised by autoclaving at a temperature of 121 degree Celsius and pressure of 15 KPa for 15 minutes.

3. The media was then cooled quickly to 25 degree Celsius.

The procedure of water sample inoculation was as follows:

1. After the media was cooled down to reach room temperature, the water sample was inoculated into the media.

2. Each water sample was inoculated into 9 test tubes contains sterile media, three tubes contained double strength media and six tubes contained single strength media. In three double strength media, 10 ml water sample was added, whereas the single strength media, three out of six tubes were added with 1 ml water sample and the other three tubes was added with 0.1 ml water sample.

3. To avoid contamination during inoculating water sample into the media, prior to the inoculation the table where the process was carried out was sterilised with alcohol 70%, and the inoculation of water sample was done at just above the edge of the flame of Bunsen burner.

4. The inoculated media were incubated at 44.5 degree Celsius for 24 hours.

The sample was said as faecal *E. coli* positive if after 24 hours incubation period detected gas formation at the top of inverted Durham's tubes. The

most probable number (MPN) table was used to determine the MPN or the number of colony of *E. coli* in 100 ml water sample.

3.6 Data Analysis

Two main types of analyses were undertaken, statistical and spatial analysis.

3.6.1 Statistical analysis

SPSS for Windows version 10.00 software was be used to analyse the data statistically. Various statistical techniques were used to analyse the data. The statistical methods used in this study are:

3.6.1.1 Descriptive analysis

This analysis was used to describe the frequency distribution of the data. The data are presented as proportion or percentage and are showed in tables and figures.

3.6.1.2 Bivariate analysis

Chi-squared Test and Fisher's Exact Test were used to analyse the relationship between each categorical independent variable with dependent variables.

3.6.1.3 Multivariate analysis

Multivariate analysis using logistic regression was used to identify the most important risk factor or factors for diarrhoea in the study population. This analysis was also used to analyse the strength of relationship between variables of this study.

In bivariate analysis and logistic regression, the levels of confidence used were 90%. The results were said to be statistically significant if p value was less than 0.1. This value was chosen because there was a limitation on time. Stratification by dividing children's age into two subgroups was done to analyse the effect of this confounding factor on the association between variables and diarrhoea occurrence.

3.6.2 Geographic information system

The other type of analysis involved the use of ArcView Geographical Information System (GIS) for spatial analysis and mapping. From the analysis, areas of higher risk for diarrhoea in study areas were obtained. This was be used to cross-reference with the environmental factors to determine any relationship that exist.

3.7 Ethical Implication

This study uses primary data. The ethical issue related to data collection processes was informed consent. Every respondent participated in this study was given a sheet of informed consent (Annex 2) that stated:

1. Brief description of purposes of the study and procedures
2. Disclosure of risk or discomfort for participant
3. Confidentiality and anonymity
4. Voluntary participation and termination without penalty
5. Identification of researcher and contact details for more information
6. Benefits or compensation
7. Offer to provide summary of the findings.

3.8 Summary

This chapter has described the methods used in this study. This study was an observational, cross-sectional study. Stratified random sampling was used as the sampling method. Face to face interviews with mothers of the children using a structured questionnaire was conducted to obtain data concerning physical environment, socio-demographic and behavioural factors. Identification of the presence of *E. coli* in water source through microbiological examination using the Completed Test Method was used to determine water quality in respondents' homes. Descriptive statistics, the Chi-squared Test and the Logistic Regression were employed to analyse statistically the data. ArcView GIS was used for spatial analysis to identify areas with higher risk for diarrhoea in the study area and to cross-reference with the environmental factors to determine any relationships that exist. The following chapter describes the results of this study.

CHAPTER IV: RESULTS

4.1 Overview of Respondent Characteristics

In the study areas (seven boroughs from Purwokerto Selatan sub-district), the total number of children under five years old in November 2003 was 3,685. The highest proportion of children under five was found in *Kelurahan* Karangpucung (Karangpucung borough), whereas the lowest proportion was found in Purwokerto Kulon borough, 21.7% and 7.3% respectively. The number of children under five in each borough in Purwokerto sub-district is shown in Table 4.1.

Table 4.1 Children under five in each borough in Purwokerto Selatan subdistrict

No.	Borough	Children under five	
		Total	Percentage
1.	Karangklesem	553	15
2.	Teluk	673	18.3
3.	Berkoh	586	15.9
4.	Purwokerto Kidul	350	9.5
5.	Purwokerto Kulon	270	7.3
6.	Karangpucung	801	21.7
7.	Tanjung	452	12.3
Total		3685	100

There were 206 children selected randomly from the seven boroughs. They comprised of 113 males and 93 females. Sex ratio between males and females respondents is 1.22:1. The highest number of children enrolled in this study is found in Karangpucung borough that has the highest proportion of children under five years old. The total respondent from this borough is 45. Purwokerto Kulon has the lowest number of children selected in this study, only 17 respondents. Roughly, the percentage of respondent in each borough is in accordance with the percentage of children under five in each borough. The number of respondents in each borough is shown in Table 4.2.

Table 4.2 Respondent distribution in each borough

No.	Name of village	Number of respondent			Percentage
		Males	Females	Total	
1.	Karangpucung	29	16	45	21.8
2.	Berkoh	16	16	32	15.5
3.	Teluk	19	17	36	17.5
4.	Purwokerto Kidul	10	9	19	9.2
5.	Purwokerto Kulon	10	7	17	8.3
6.	Karangklesem	15	16	31	15.1
7.	Tanjung	14	12	26	12.6
Total		113	93	206	100

All children under five enrolled in this study had good nutritional status. Children were said to have good nutritional status if their weight for height

was at least 80% of 50th percentile. This was determined by examining their growth-monitoring chart.

The age range of children under five involved in this study was two to 59 months, with a mean age of 35.2 months and a median age of 36 months. The mean age of children who were suffering from diarrhoea is lower than that of children who were not suffering from diarrhoea, 31 and 36.7 months respectively. A similar pattern also can be found for the median age, with a median age of 29 months for those who were suffering from diarrhoea and of 37 months for those who were not suffering from diarrhoea.

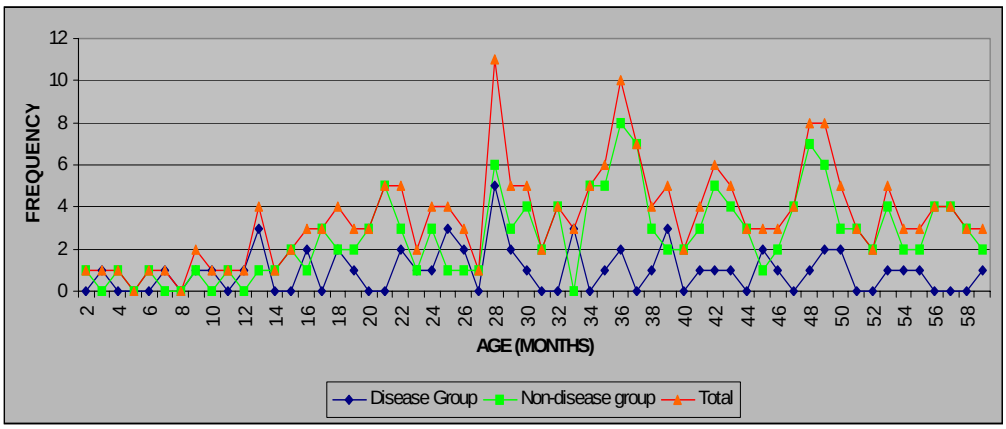


Figure 4.1 Age distribution in each group

Fifty-five out of 206 respondents were suffering from diarrhoea at the time of interview and were categorised as “the disease group”. This means diarrhoea prevalence was very high, 26.7% or 267 per 1,000 children. The other 155 respondents were not suffering from diarrhoea at the time of

interview and were categorised as “the non-disease group”. The number of males suffering from diarrhoea was higher than that of females, 33 and 22 respectively. The highest proportion of the disease group was found in Berkoh borough, 40.6%, whereas the lowest proportion was found in Tanjung, 19.2%. The summary of this data is presented in Table 4.3, whereas age distribution in each group can be seen in Figure 4.1.

Table 4.3 Diarrhoea occurrence in each borough

No.	Borough	Total respondent	Disease Group (diarrhoea +)			
			Male	Female	Total disease group	% disease group
1	Karangpucung	45	5	5	10	22.2
2	Berkoh	32	9	4	13	40.6
3	Teluk	36	5	6	11	30.6
4	Purwokerto Kidul	19	3	2	5	26.3
5	Purwokerto Kulon	17	4	0	4	23.5
6	Karangklesem	31	3	4	7	22.6
7	Tanjung	26	4	1	5	19.2
Total		206	33	22	55	26.7

4.2 Physical Environmental Factors

The physical environmental factors measured in this study were water quality, water source, latrine facilities at home and methods of refuse disposal.

4.2.1 Water quality

The majority of the water samples of respondent homes examined were contaminated with faecal matter. From 206 water samples examined, 157 were faecal *E. coli* positive and only 49 were *E. coli* negative. This means that 76.2% water sources in respondents' homes were contaminated with faecal matter (Table 4.4).

Table 4.4 Water Contamination Examination

No.	Faecal *E. coli*	Group		Total
		Disease	Non-disease	
1.	Positive	39 (70.9%)	118 (78.2%)	157 (76.2%)
2.	Negative	16 (29.1%)	33 (21.8%)	49 (23.8%)
Total		55	151	206 (100%)

The percentage of water samples contaminated with faecal *E. coli* in the disease group was lower than that of the non-disease group, 70.91% and 78.15%, respectively. However, the Chi-squared Test shows that there was no significant difference in the proportion of water contamination between the disease group (group suffering from diarrhoea) and the non-disease group (X^2=1.165, df=1, p=0.281).

The contamination of water supply from different water source is shown in Table 4.5. Public supply had the lowest proportion of water contamination in comparison with other water sources, with only 21.8% contaminated with faecal *E. coli*. All water samples from ground water boreholes were

contaminated with faecal *E. coli*. A high proportion of water contamination was also found in dug wells, 95.8%.

Statistical analysis using the Chi-squared test shows that there was a significant difference in the proportion of water source contamination between different water sources (X^2= 122.550, df=2, p=0.000).

Table 4.5 Contamination of water supply with faecal *E. coli* of different water sources

No.	Water source	Faecal *E. coli*		Total
		Positive	Negative	
1.	Public supply	12 (21.8%)	43 (76.3%)	55 (100%)
2.	Ground water bore holes	9 (100%)	0	9 (100%)
3.	Dug wells	136 (95.8%)	6 (4.2%)	142 (100%)
Total		157 (76.2%)	49 (23.8%)	206 (100%)

The number of *E. coli* per 100 ml of the water samples (the MPN) examined varied. The range was from two to more than 1100 per 100 ml water sample. The median was 150 *E. coli* per 100 ml water sample, whereas the mode was more than 1100 per 100 ml water sample. The mean number of *E. coli* per 100 ml water sample was 295.30. The mean number of *E. coli* in the disease group was higher than that of the non-disease groups, 425.29 *E. coli* per 100 ml and 385.38 *E. coli* per 100 ml

respectively. The two groups had the same mode of the MPN of *E. coli*, which was more than 1100 per 100 ml.

Based on the median of the data of the MPN of *E. coli* in both disease and non-disease groups, the MPN was divided into two levels of contamination: low-level contamination and high-level contamination. The MPN was classified as low if the number of *E. coli* per 100 ml water was less than or exactly 150. The MPN was said to be high if its value more than 150.

Table 4.6. The number of *E. coli* per 100 ml water sample

No.	Level of contamination	Number of *E. coli* per 100 ml	Group		Total
			Disease	Non-disease	
1	Low	<= 150	18 (46.2%)	66 (55.9%)	84
2	High	> 150	21 (53.8%)	52 (44.1%)	73
Total			39 (100%)	118 (100%)	157 (100%)

The number of *E. coli* per 100 ml water samples for each category in both the disease and the non-disease group is presented in Table 4.6. The disease group has a higher proportion of high-level water contamination than the non-disease group. The proportion was 53.8% and 44.1% respectively.

The Chi-squared test indicates that there were no significant differences in the proportion of levels of contamination between the disease group and the non-disease group. The p value was 0.288 (X^2= 1.127, df=1).

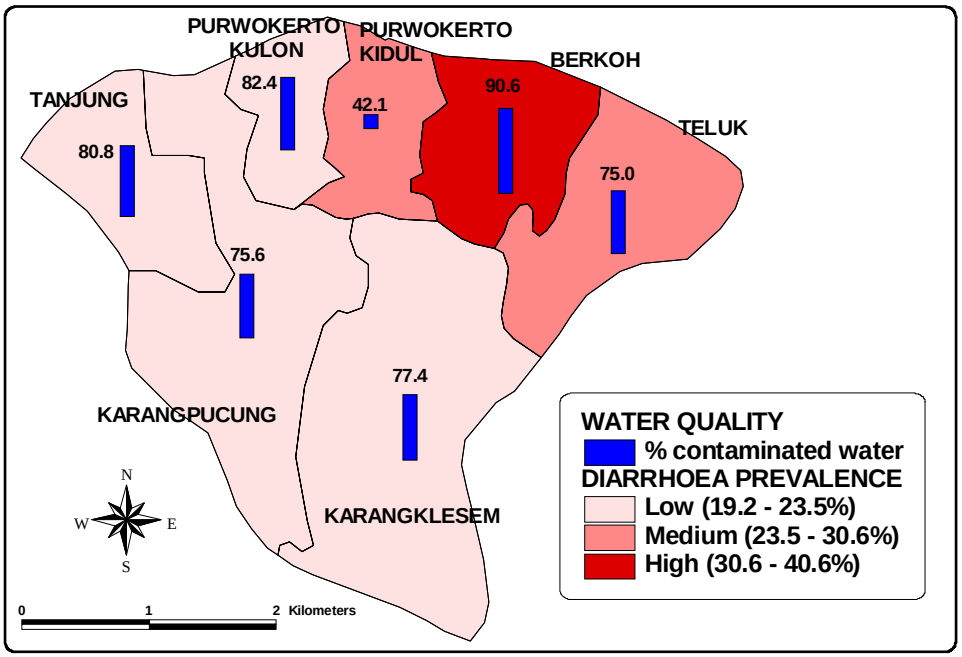


Figure 4.2 The proportion of water contamination and diarrhoea occurrence in each borough

Figure 4.2 shows the proportion water contaminated at respondents' homes in each borough. This figure shows that Berkoh borough had the highest proportion of water contamination, with 90.6% of water sources contaminated with faecal *E. coli*, followed by Purwokerto Kulon borough and Tanjung borough, 82.4% and 80.8% respectively. Berkoh borough also had the highest diarrhoea prevalence among seven boroughs in Purwokerto Selatan sub-district, whereas Purwokerto Kulon and Tanjung boroughs had low diarrhoea prevalence. From the illustration of figure 4.2

above, there does not appear to be any relationship between water quality and the occurrence of diarrhoea in children under five years old in Purwokerto Selatan sub-district.

4.2.2 Water source

Most respondents, from both the disease group and the non-disease group, used dug-wells as a water source at their home. The proportion was 68.9%. The lowest proportion water source was ground water, with only 4.4% respondents using boreholes (Table 4.6).

Table 4.6 Water Source at Respondents' Homes

No.	Water Source	Group		Total
		Disease	Non-disease	
1.	Public supply	18 (32.7%)	37 (24.5%)	55 (26.7%)
2.	Bore holes	2 (3.6%)	7 (4.6%)	9 (4.4%)
3.	Dug wells	35 (63.6)	107 (70.9%)	142 (68.9%)
	Total	55	151	206

Statistically, there was no difference in the proportion of the source of water supply in respondents' homes between the disease group and the non-disease group. The Chi-squared test showed that p=0.49 (X^2= 1.419, df=2). This means that source of water supply did not have an association with diarrhoea occurrence.

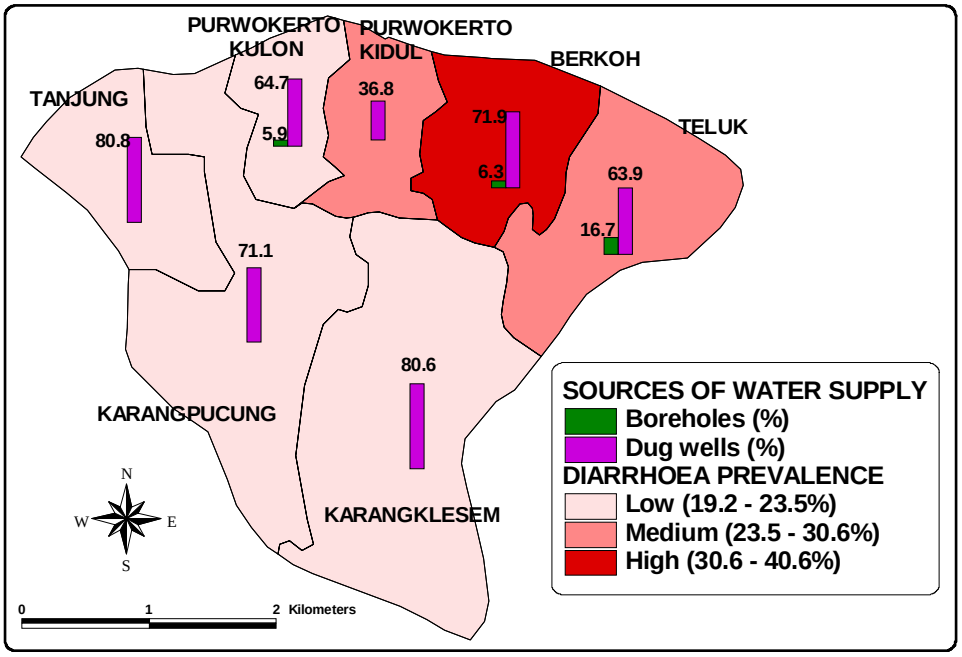


Figure 4.3 Water source at respondent homes in each borough

Figure 4.3 reveals the source of water supply in each borough. As was mentioned above, boreholes and dug wells had a high proportion of water contamination. In figure 4.3, it can be seen that Teluk borough with medium diarrhoea prevalence has the highest proportion of respondent using boreholes as their main water source at home, 16.7%. The highest proportion of dug wells as the main source of water supply was found in Tanjung borough, with 80.8% respondents using dug wells water. Spatially, there does not appear to be any relationship between sources of water supply at respondents' homes with diarrhoea occurrence in children under five in Purwokerto Selatan sub-district.

4.2.3 Latrine facilities at home

Most respondents (71.4%) had a latrine facility at their home. The proportion of respondents who had a latrine facility at home in the disease group was lower than that of the non-disease group, 65.45% and 73.51% respectively (Table 4.7). Those who did not have latrine facilities at home answered that they usually defecated in the river, canals, fishpond and public toilet.

Table 4.7 Latrine Facilities at Respondent Homes

No.	Latrine facilities at home	Group		Total
		Disease	Non-disease	
1	Yes	36 (65.45%)	111 (73.51%)	147 (71.4%)
2	No	19 (34.55%)	40 (26.49%)	59 (28.6%)
Total		55	151	206

Although the proportion of latrine facilities of the two groups was different, statistically there was no significant difference in the proportion of latrine facilities at home between the disease group and the non-disease group. Bivariate analysis using the Chi-squared test shows that its p value was 0.258 (X^2=1.280, df=1).

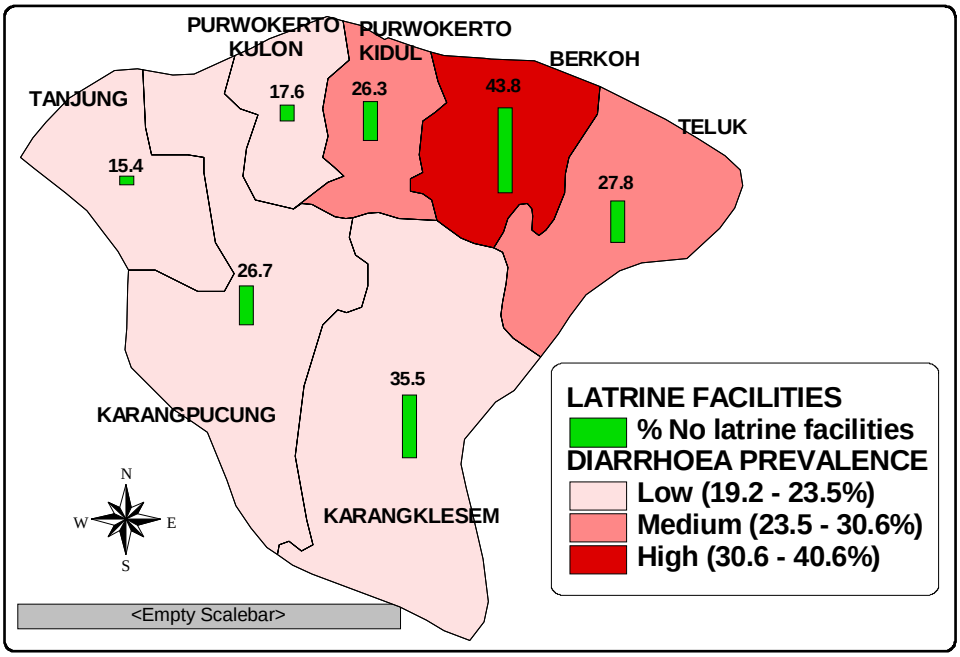


Figure 4.4 Latrine facilities at respondent homes in each borough

The proportion of latrine facilities at respondents' homes in each borough is illustrated in Figure 4.4. Berkoh borough, which had the highest proportion of diarrhoea occurrence, also had the highest proportion of respondents without latrine facilities at homes. Almost half (43.8%) of respondents in this borough had no latrine facilities at their homes. On the other hand, Tanjung borough, which had low diarrhoea prevalence in the study areas, has the lowest proportion of no latrine facilities, 15.4%. This information suggested that spatially there appears to be an association between latrine facilities at respondents' homes and the occurrence of diarrhoea.

4.2.4 Type of latrine

Type of latrine is divided into four categories: pit latrine, water seal closet, flush toilet and other latrine type. “Other” latrine type found in this study means that respondents used a water closet without septic tank. They channel the faeces from the toilet into the river or canal. The majority of respondents (81.1%) used a water seal closet. Only three respondents used a pit latrine, the same number as those who used a flush toilet (Table 4.8).

Table 4.8 Type of latrine at respondent homes

No.	Type of Latrine	Group		Total
		Disease	Non-disease	
1.	Pit latrine	3 (8.4%)	7 (63.1%)	10 (6.8%)
2.	Water seal closet	29 (80.5%)	91 (81.9%)	120 (81.1)
3.	Flush Toilet	3 (8.4%)	6 (5.4%)	9 (6.1%)
4.	Other	1 (2.7%)	7 (6.3%)	8 (6%)
Total		36	111	147

In bivariate analyses, the type of latrine was simplified into two categories, because three or 37.5% cells have an expected value of less than five. The categories were water closet, which incorporates water seal latrine and flush toilet, and other method, which incorporates pit latrines and other type of latrine. Fisher’s exact test result showed that there was no

different proportion of type of latrine in respondents' homes between the disease group and the non-disease group. The p value was one (p=1).

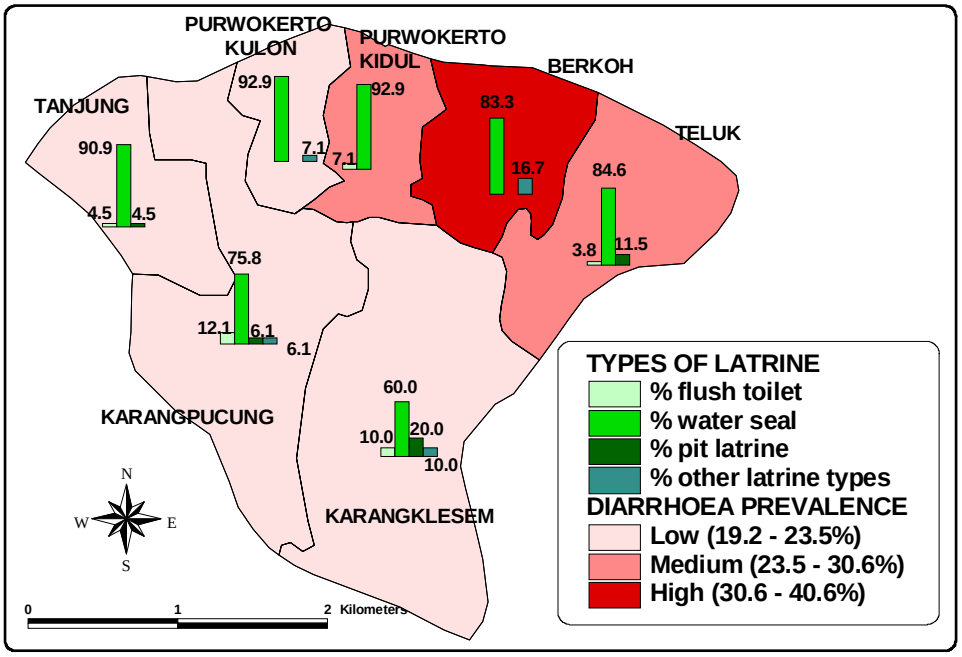


Figure 4.5 Type of latrine at respondent homes in each village

Figure 4.5 illustrates the type of latrine at respondents' homes in each borough. All boroughs had the same pattern of the highest proportion of latrine type being used by respondents. Most respondents in all boroughs used a water seal latrine at their homes. The top three boroughs with the highest proportion of water seal latrines were Tanjung, Teluk and Karangpucung boroughs and the lowest proportion was found in Karangklesem borough. Spatially there does not appear to be any relationship between diarrhoea occurrence and type of latrine being used by respondents.

4.2.5 Methods of refuse disposal

In this study, methods of refuse disposal were divided into four categories. The categories were refuse that is collected by government agency, refuse that is burned, refuse that is buried and refuse that is disposed by other means. The majority of respondents, both with diarrhoea positive (disease group) and diarrhoea negative (non-disease group) said that the main method of refuse disposal was collection by government agency.

Table 4.9 Methods of refuse disposal

No.	Method of Refuse Disposal	Group		Total
		Disease	Non-disease	
1.	Collected by government agency	23 (41.9%)	72 (47.7%)	95 (46.1%)
2.	Burned	12 (21.8)	30 (19.9%)	42 (20.4%)
3.	Buried	12 (21.8%)	19 (12.5%)	31 (15.0%)
4.	Other methods	8 (14.5%)	30 (19.9%)	38 (18.4%)
Total		55	151	206

Thirty-eight respondents gave “other” methods as the method of refuse disposal. “Other” methods consisted of disposing the refuse into river or waterworks or canal and disposing of it on the riverside. The summary of the method of refuse disposal is shown in Table 4.9.

Statistically, there was no different proportion of methods of refuse disposal between the disease group and non-disease group. The p value of its chi-squared test was 0.35 (X^2=3.28, df=3).

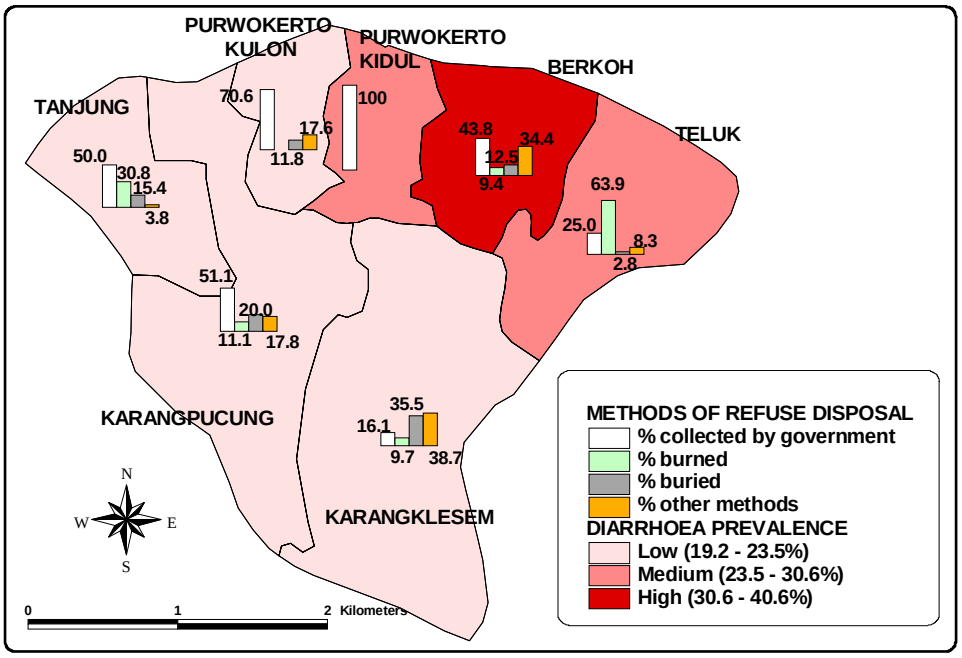


Figure 4.6 Methods of refuse disposal at respondents' homes in each borough

Figure 4.6 shows the methods of refuse disposal used by respondents in each borough. From the figure, in can be seen that the highest refuse disposal method used by most respondents in five out of seven boroughs was collection by government agency, including in Berkoh borough, which had the highest proportion of diarrhoea occurrence. Burning refuse was the most common method of refuse disposal used by respondents in Teluk borough, whereas in Karangklesem borough the most common method was refuse that is buried. This figure indicates that spatially, there does not

appear to be any relationship between methods of refuse disposal and the occurrence of diarrhoea in children under five in Purwokerto Selatan sub-district.

4.3 Socio-demographic Factors

Socio-economic factors measured in this study were gender of the children, the age of the mothers of children and mothers' education.

4.3.1 Gender of the child

The number of diarrhoea occurrences by gender is summarised in Table 4.10. Male children had higher diarrhoea occurrence (disease group) than female children. Of 55 children who were suffering from diarrhoea, 33 were males and 22 were females. A larger percentage of males suffered from diarrhoea (29%) than females (24%).

Table 4.10 Diarrhoea occurrence by Gender

No.	Gender of children	Group		Total
		Disease	Non-disease	
1	Male	33 (29.2%)	80 (70.8%	113
2	Female	22 (23.6%)	71 (76.4%)	93
Total		55	151	206

Although the percentage of males who suffered from diarrhoea was higher than that of females, statistically, there was no significant difference in the

proportion between males and females suffering from Diarrhoea. The p value of its chi-squared test result was 0.37 (X^2=0.802, df=1).

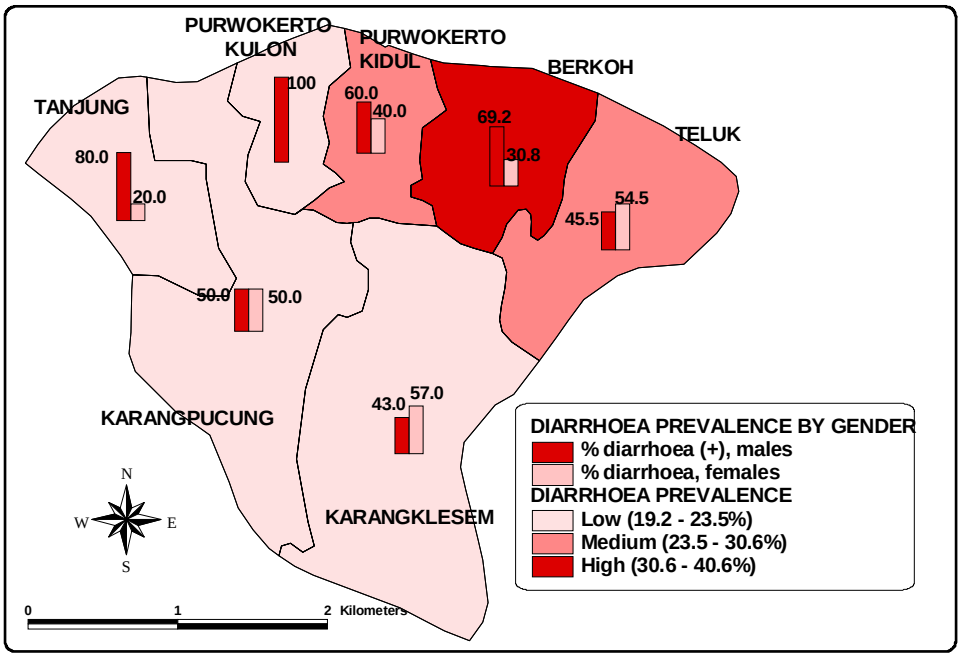


Figure 4.7 Diarrhoea occurrence by gender in each borough

The comparison of diarrhoea occurrence by gender in each borough is shown in Figure 4.7. It can be seen that in five out of seven boroughs, except for Teluk and Karangklesem boroughs, males suffered a higher proportion of diarrhoea occurrence. This figure showed that spatially there does not appear to be any relationship between gender and the occurrence of diarrhoea.

4.3.2 Maternal Age

The mean maternal age was almost 31 years old. The youngest mother was 20 years old, whereas the oldest mother was 45 years old. The

median age in both disease and the non-disease group was 30 years old. The mean of maternal age in the disease group was lower than that of the non-disease group, 29.91 and 31.37 years old respectively.

Based on the median of maternal age in the frequency distribution of both disease and non-disease groups, maternal age was divided into 2 categories, less or exactly 30 years old and more than 30 years old. The summary of this data can be seen in Table 4.11.

Table 4.11 Maternal age category

No.	Mothers age	Group		Total
		Disease	Non-disease	
1	<=30 years old	31 (56.4%)	78 (51.6%)	109
2	>30 years old	24 (43.6%)	73 (48.4%)	97
	Total	55	151	206

Bivariate analysis using the Chi-squared test shows that statistically, there is no different proportion of maternal age between the two groups. The p value of chi-squared test was 0.55 (X^2=0.36, df=1).

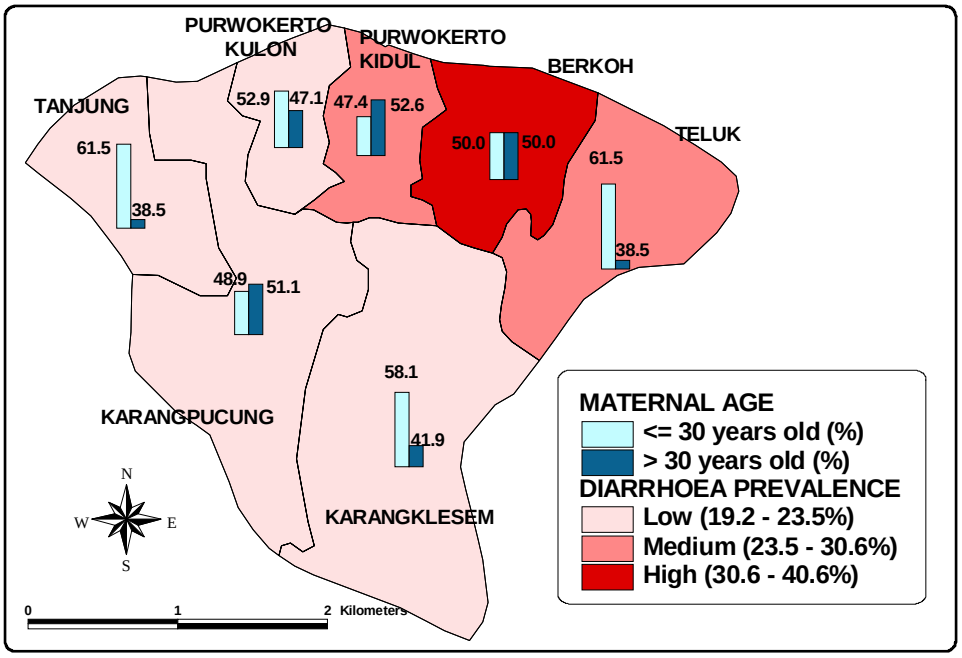


Figure 4.8 Diarrhoea occurrence by maternal age in each borough

Figure 4.8 illustrates diarrhoea prevalence by maternal age in each borough. Tanjung and Teluk boroughs, which had low and medium proportion of the disease group in the study areas, respectively, had the highest proportion of mothers aged less than 30 years old, 61.5%. On the other hand, Berkoh borough, which has the highest proportion of the disease, is a one out of three borough with a low proportion of mothers' aged less than 30 years old. This description suggested that spatially there seemed to be no association between maternal age and the occurrence of diarrhoea among children under five in Purwokerto Selatan sub-district.

4.3.3 Maternal Education

Most respondents had a low education level. Approximately 92% or 189 respondents held an elementary school certificate. This pattern was the same in both the disease group and the non-disease group. Only two (3.6%) mothers in the disease group and four (2.7%) mothers in the non-disease group held tertiary education certificates (Table 4.12).

Table 4.12 Maternal education

No.	Education	Group		Total
		Disease	Non-disease	
1	Elementary school	49 (89.1%)	140 (92.7%)	189 (91.7%)
2	Junior high school	0	3 (1.9%)	3 (1.5%)
3	Senior high school	4 (7.3%)	4 (2.7%)	8 (3.9%)
4	Tertiary education	2 (3.6%)	4 (2.7%)	6 (2.9%)
	Total	55	151	206

In bivariate analysis, because the small numbers of respondents held more than elementary school certificate, education level was divided into 2 categories: low education level and high education level. Low educated mothers were those who held elementary school certificates, whereas high education level was those held junior high school, senior high school and tertiary education certificates. Bivariate analysis using Fisher's exact test

reveals that there was no different proportion of maternal education between the disease and the non-disease group (p=0.4).

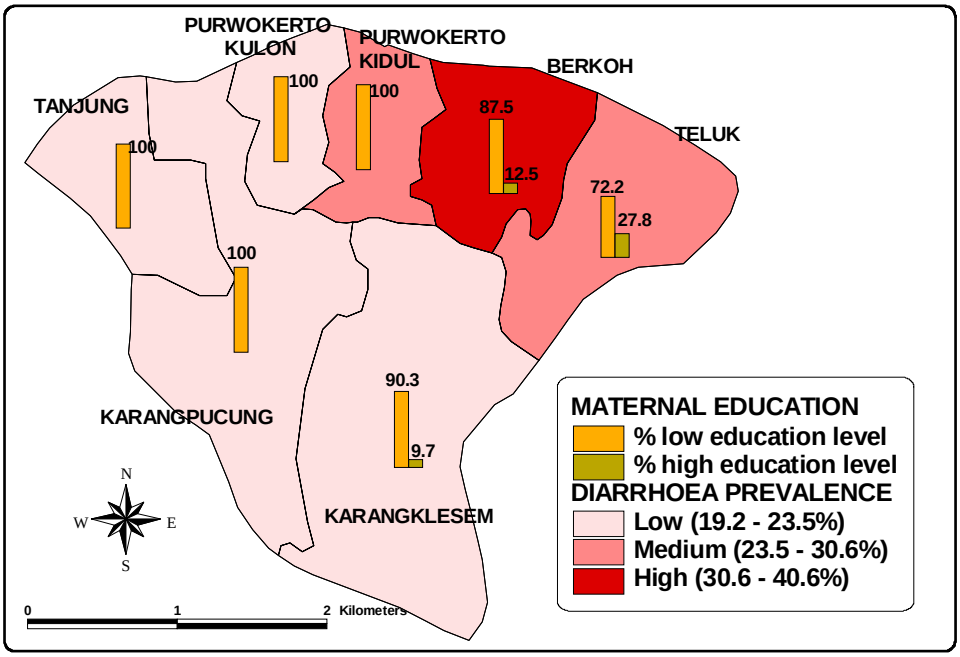


Figure 4.9 Diarrhoea occurrence by mother's education level in each borough

The summary of spatial distribution of maternal education level in each borough can be seen in Figure 4.9. In four out of seven boroughs in Purwokerto Selatan sub-district, all respondents (100%) had a low education level. They only held an elementary school certificate. The four boroughs were Tanjung, Karangpucung, Purwokerto Kulon and Purwokerto Kidul boroughs. The borough that had highest percentage of mothers with high education level was Teluk borough, with 27.8% mothers had a high education level, followed by Berkoh borough, 12.5%. Spatially, it appears there was no relationship between mothers' education level and

diarrhoea occurrence among children under five years old in Purwokerto Selatan sub-district.

4.4 Behavioural Factors

4.4.1 Breastfeeding

Most children (96.6%) were breastfed by their mother. Only 7 (3.4%) out of 206 respondents were not breastfed and four children who were not breastfed suffered from diarrhoea. The proportion of breastfeeding in children who suffered from diarrhoea was slightly higher than that of children who did not suffer from diarrhoea, 92.7% and 98% respectively. The summary of this can be seen in Table 4. 13.

Table 4.13 Number and proportion of breastfed children

No.	Breastfeeding	Group		Total
		Disease	Non-disease	
1	Yes	51 (92.7%)	148 (98%)	199 (96.6%)
2	No	4 (7.3%)	3 (2%)	7 (3.4%)
Total		55	151	206

Statistically, at the 90 ($p<0.1$), there was a significant difference in the proportion of breastfeeding between children who were suffering from

diarrhoea and those who were not suffering. The p value of its Fisher's Exact test was 0.084.

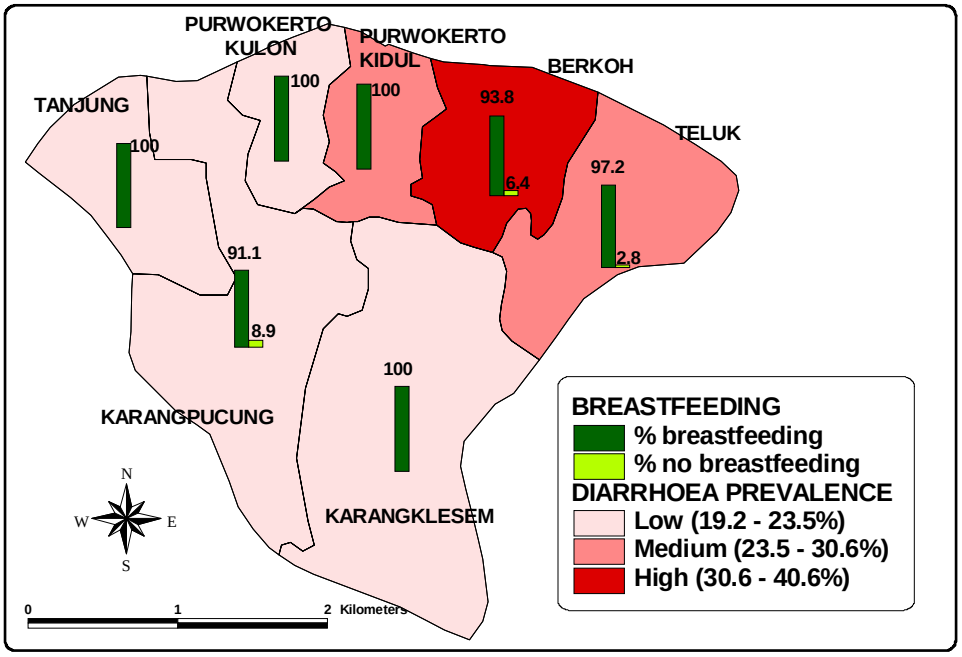


Figure 4.10 breastfeeding and diarrhoea occurrence in each borough in Purwokerto Selatan sub-district

Figure 4.10 presents the spatial distribution of breastfeeding practices in each borough in the study areas. All children in four out of seven boroughs in the study areas were breastfed by their mother. These are Tanjung, Purwokerto Kulon, Purwokerto Kidul and Karangklesem boroughs. The highest percentage of children who were not breastfed was found in Karangpucung borough, 8.9%, followed by Berkoh borough, which had the highest proportion of diarrhoea occurrence in the study areas. Spatially, there does not appear to be any association between breastfeeding and diarrhoea prevalence.

Exclusive breastfeeding practices are shown in Table 4.14. Less than half of respondents (45.7%) were exclusively breastfed by their mother in the first four months of life. The disease group had lower proportion of exclusively breastfed babies than the non-disease group. Respondents generally said that they did not exclusively breastfed their babies, because generally, they believed that their breast milk did not adequately satisfy and did not fulfil the nutritional needs of their babies.

Bivariate statistical analysis using the Chi-squared test shows that there was no significant difference in the proportion of exclusive breastfeeding practices between the disease and the non-disease group (X^2=0.186, df=1, p=0.667). No association was found between exclusive breastfeeding and diarrhoea occurrence.

Table 4.14 Exclusive breastfeeding practices

No.	Exclusive breastfeeding	Group		Total
		Disease	Non-disease	
1	Yes	22 (43.1%)	69 (46.6%)	91 (45.7%)
2	No	29 (56.9%)	79 (53.4%)	108 (54.3%)
Total		51	148	199

Figure 4.11 shows exclusive breastfeeding and diarrhoea occurrence in each borough. Purwokerto Kidul borough had the highest percentage of no exclusively breastfed children, 68.4%, followed by Purwokerto Kulon

and Berkoh boroughs, 64.7% and 59.4% respectively. Purwokerto Kidul, Purwokerto Kulon and Berkoh boroughs had medium, low and high diarrhoea prevalence respectively. From this figure, it appears that there is no spatial association between exclusive breastfeeding and the occurrence of diarrhoea.

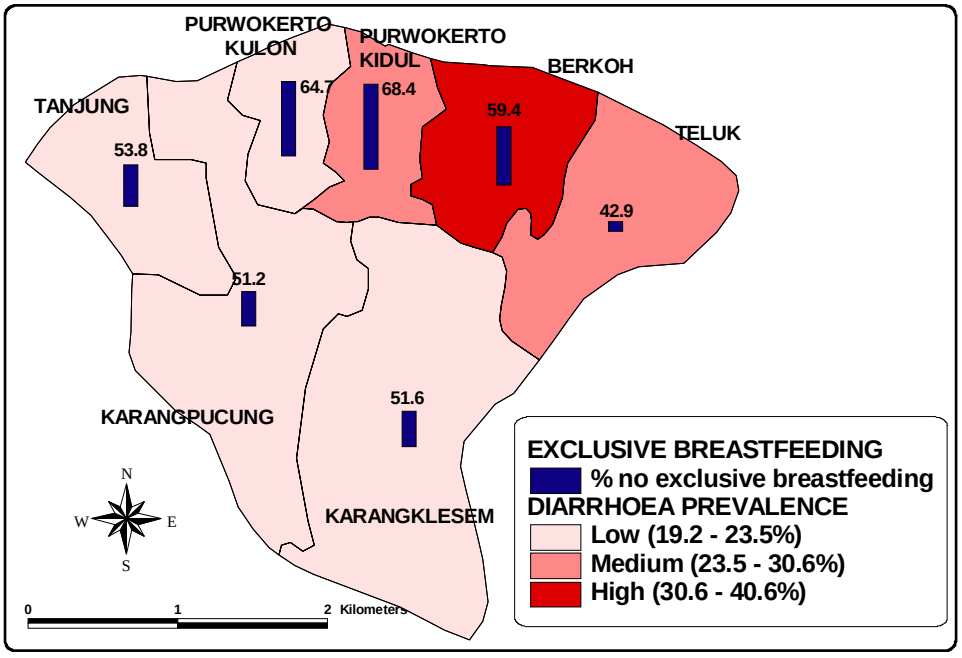


Figure 4.11 Exclusive breastfeeding and diarrhoea occurrence in each borough in Purwokerto Selatan sub-district

4.4.2 Bottle-feeding

Only 64 (31.1%) of 206 children involved in this study were bottle-fed by their mother. Children in the disease group had a higher proportion of bottle-feeding than the non-disease group. The percentages are 36.36% and 29.14% respectively. The summary of the data can be seen in Table 4.15.

Although there was a different proportion of bottle-feeding between the disease group and the non-disease group, statistically the difference was not significant. The result of bivariate analysis using chi-squared test shows that its p value was 0.32 (X^2=0.983, df=1).

Table 4.15 Bottle-feeding and diarrhoea occurrence

No.	Bottle-feeding	Group		Total
		Disease	Non-disease	
1	Yes	20 (36.4%)	44 (29.1%)	64 (31.1%)
2	No	35 (63.6%)	107 (70.9)	142 (68.9%)
		55	151	206

Figure 4.12 illustrates the spatial distribution of bottle-fed children in each borough in the study area. This figure shows that Purwokerto Kidul, which had medium diarrhoea prevalence, had the highest proportion of bottle-fed children. On the other hand, Berkoh borough had a relatively low proportion of bottle-fed children, with only 28.1% of them were bottle-fed. All the information above suggests that spatially there does not appear to be any relationship between bottle-feeding and diarrhoea occurrence among children under five in Purwokerto Selatan sub-district.

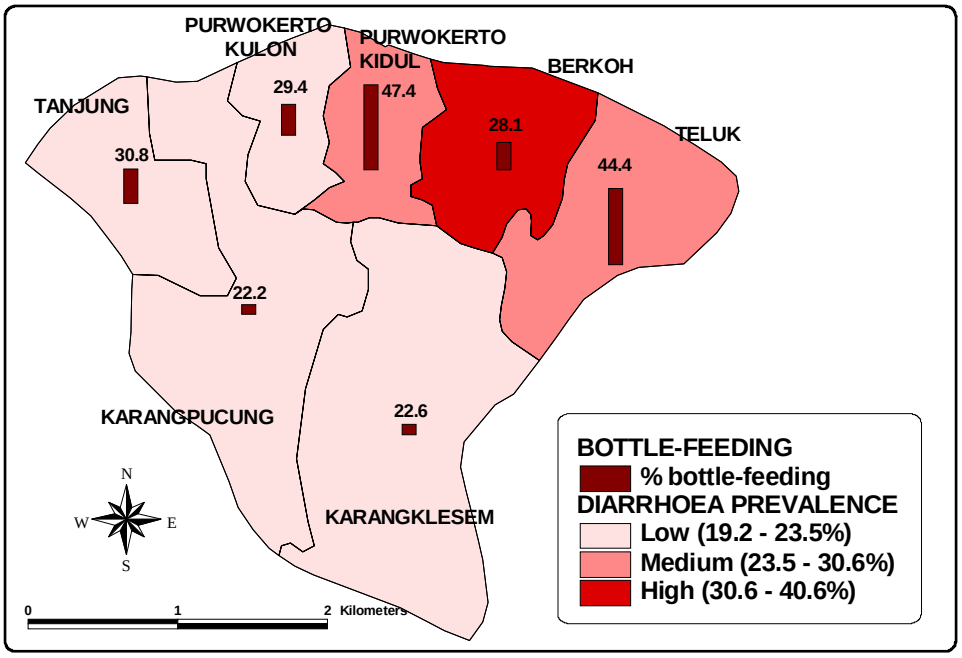


Figure 4.12 Bottle-feeding and diarrhoea occurrence in each borough in Purwokerto Selatan sub-district

4.5 Diarrhoea by Age Group

Age is an important predictor for diarrhoea (Mock *et al.* 1993, p. 810). Hence, in this study, the children were divided into 2 subgroups. These were the 0-24 months and the more than 24 months age groups. Table 4.16 presents diarrhoea occurrence by age group.

Bivariate analysis using the chi-squared test showed that there was no significant difference in the proportion of diarrhoea occurrence between age groups (X^2=1.798, df=1, p=0.180).

Table 4.16 Diarrhoea occurrence by age group

Age group	Diarrhoea		Total
	Yes	No	
0-24 months	17 (34%)	33 (66%)	50
More than 24 months	38 (24.4%)	118 (75.6%)	156
Total	55	151	206

In bivariate analysis for socio-environmental factors, water source and latrine types were simplified into two categories, because more than 25 cells have expected value less than five. Water source was divided into two categories, the same as that of section 4.2.4 (page 62).

The summary of the chi-squared test results by age groups can be seen in Table 4.17. Generally, the results of the chi-squared test between groups were the same as that of before sub-grouping. Different results were only be found for methods of refuse disposal and breastfeeding. After sub-grouping, method of refuse disposal was statistically significant among children in the 24 months age group, whereas in breastfeeding, the significant result was found only in the more than 24 months age group.

Table 4.17 Summary of the chi-squared test results by age group

Independent Variables	0-24 months			More than 24 months		
	X^2	df	p value	X^2	df	p value
Water quality	0.128	1	0.720	0.803	1	0.370
Level of water contamination	0.366	1	0545	0.762	1	0.383
Water source	0.849	1	0.357	3.757	1	0.053
Latrine facilities	0.591	1	0.442	0.554	1	0.457
Type of latrine	-	-	1.000	-	-	1.000
Methods of refuse disposal	3.628	1	0.057	0.027	1	0.870
Maternal age	2.439	1	0.118	0.225	1	0.636
Maternal education	-	-	0.162	-	-	1.000
Gender of the children	0.015	1	0.903	1.082	1	0.296
Breastfeeding	-	-	1.000	-	-	0.093
Exclusive breastfeeding	0.042	1	0.838	0.148	1	0.701
Bottle-feeding	1.957	1	0.162	0.050	1	0.823

*= Fisher's exact test

4.6 Areas with High Risks

4.6.1 Physical Environmental Factors

Figure 4.13 shows the spatial distribution of physical environment high-risk areas. It can be seen that Karangklesem borough had the highest risk physical environmental factors related to diarrhoea, followed by Berkoh

and Karangpucung boroughs. These boroughs are the top three boroughs with high physical environmental risk factors related to diarrhoea.

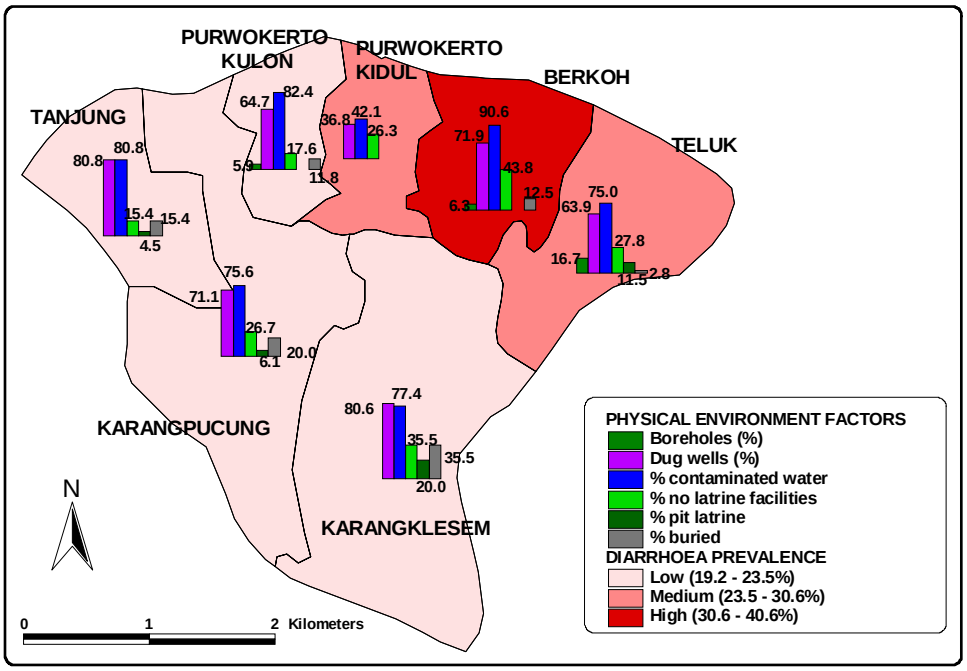


Figure 4.13 Areas with higher risk for physical environment factors

4.6.2 Socio-demographic Factors

Figure 4.14 illustrates areas with higher risk socio-demographic factors. Purwokerto Kulon borough had the highest risk of diarrhoea related socio-demographic factors, followed by Tanjung borough and Purwokerto Kidul borough. Teluk borough had the lowest risk due to socio-demographic factors, although the occurrence of diarrhoea in this borough is relatively high. From the figure, it can be concluded that the top three boroughs with high-risk socio-demographic factors are Purwokerto Kulon, Tanjung and Purwokerto Kidul.

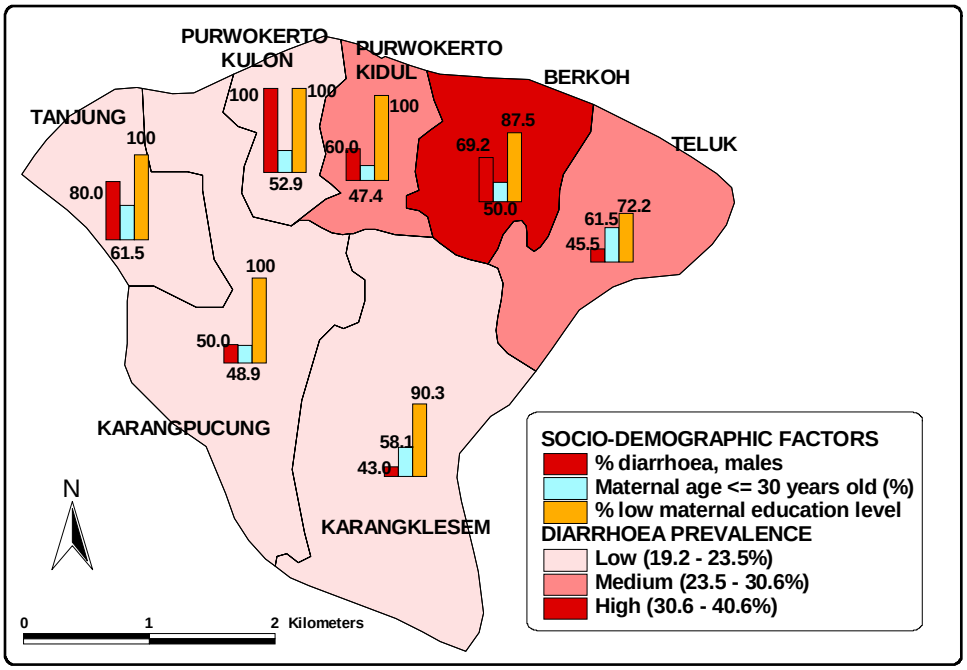


Figure 4.14 Areas with higher risk of socio-demographic factors

4.5.3 Behavioural Factors

Areas with higher risk behavioural factors related to diarrhoea occurrence are illustrated in Figure 4.15. This figure shows that Purwokerto Kidul borough had the highest risk of diarrhoea due to behavioural factors compared with other boroughs, followed by Purwokerto Kulon borough and Berkoh borough. These boroughs are the top three boroughs with high-risk behavioural factors.

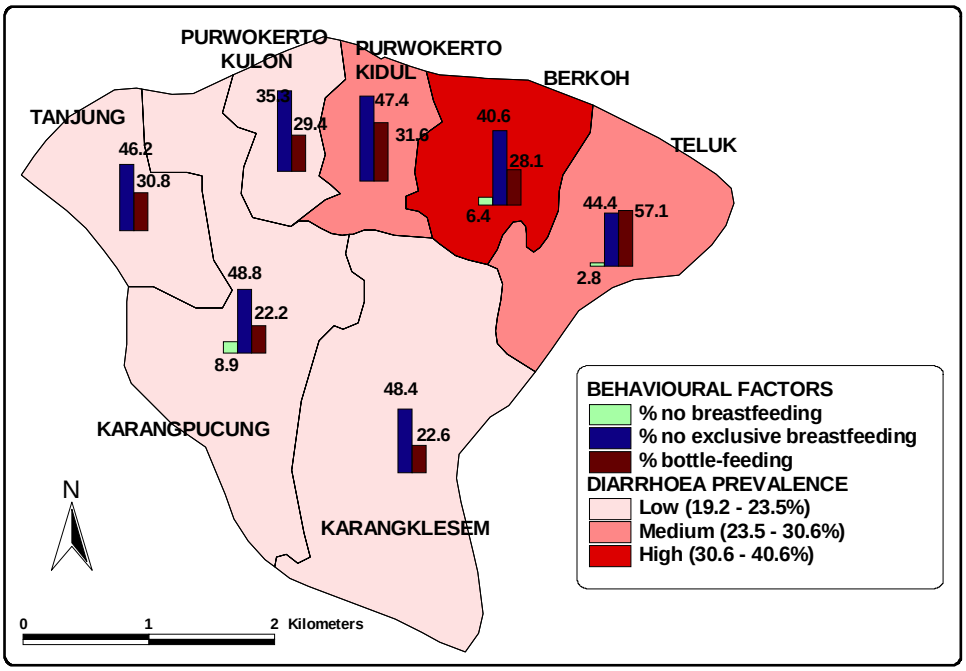


Figure 4.15 Areas with high risks of behavioural factors

The summaries of the spatial analysis for areas with high risk of diarrhoea related to socio-environmental factors are shown in Figures 4.13, 4.14, 4.15 and Table 4.16. Overall, Berkoh borough, which had the highest diarrhoea prevalence, had the highest socio-environmental risk factors among the seven boroughs in Purwokerto Selatan sub-district, followed by Purwokerto Kulon borough, which had low diarrhoea prevalence. Among the three categories of risk factors, behavioural risk factors seemed to be the most important factors related to diarrhoea. In Table 4.16, it can be seen that Boroughs with medium to high diarrhoea prevalence tended to have higher behavioural risk factors, except for Purwokerto Kulon borough.

Table 4.18 Summary of spatial analysis

Diarrhoea prevalence	Borough	Risk Factors Rank*		
		Physical environment	Socio-demographic	Behavioural
Low	Tanjung	4	2	5
	Karangpucung	3	5	6
	Karangklesem	2	6	7
	Purwokerto Kulon	6	1	2
Medium	Purwokerto Kidul	7	3	1
	Teluk	5	7	4
High	Berkoh	1	4	3

*Rank 1 = the highest risk, rank 7 = the lowest risk

4.7 Logistic Regression

Table 4.17 shows the chi-squared test results for all independent variables. From 11 variables analysed in this study, only breastfeeding showed a significant association with diarrhoea.

To examine the influence of the interaction between the variables on diarrhoea, logistic regression was employed. In logistic regression modelling, level of water contamination, latrine type and exclusive breastfeeding were not included in the analysis, because there would be almost 50% (101) missing cases if these three variables were included in the analysis. This would have significantly affected the result of the logistic

regression. The result of the logistic regression is summarised in Table 4.18.

Table 4.19 Summary of the chi-squared test results

Independent Variables	X^2	df	p value	Conclusion
Water contamination	1.165	1	0.281	Insignificant
Level of water contamination	1.127	1	0.288	Insignificant
Water source	1.419	2	0.492	Insignificant
Latrine facilities	1.280	1	0.258	Insignificant
Type of latrine	-	-	1.000*	Insignificant
Methods of refuse disposal	0.558	1	0.455	Insignificant
Maternal age	0.359	1	0.549	Insignificant
Maternal education	-	-	0.400*	Insignificant
Gender of the children	0.802	1	0.370	Insignificant
Breastfeeding	-	-	0.084*	Significant
Bottle-feeding	0.983	1	0.322	Insignificant

* = Fisher's exact test

The result of the logistic regression indicated that breastfeeding remained significantly associated with diarrhoea (Table 4.18). This result is the same as the results of the bivariate analysis. Thus, only breastfeeding might be included in the regression model. The risk of diarrhoea occurrence among breastfed children was only one fifth that of not breastfed children.

Table 4.20 Summary of logistic regression result

Independent Variables	B	P value	OR	90% CI for OR	
				Lower	Upper
Source of water supply	0.228	0.412	1.256	0.795	1.984
Water quality	0.53	0.926	1.055	0.412	2.702
Latrine facilities	-0.618	0.109	0.539	0.286	1.015
Methods of refuse disposal	-0.002	0.985	0.998	0.821	1.213
Gender of child	0.405	0.234	1.500	0.857	2.625
Maternal age	0.093	0.782	1.098	0.632	1.907
Maternal education	-0.390	0.498	0.677	0.263	1.744
Breastfeeding	-1.491	0.072	0.225	0.058	0.880
Bottle-feeding	0.270	0.400	2.379	0.719	2.387

Overall, the logistic regression model only explained 4.3% of the independent variables (R square = 0.043). This means that this model is not good to predict diarrhoea occurrence among this study population. However, this model would be useful if the number of respondents is larger, because the correct predicted value of diarrhoea occurrence in this model was only 7.3%. Among 100 children enrolled in this study, only seven to 8 children might be correctly predicted to have diarrhoea with this model.

4.7 Summary

This chapter has presented the results of this study. This study demonstrated there was a significant association between breastfeeding and diarrhoea occurrence. No association was fond between diarrhoea and the following factors: water quality, source of water supply, latrine facilities, type of latrines, methods of refuse disposal, gender of the child, maternal age, maternal education and bottle-feeding practice. Berkoh borough was the area with the highest risk of diarrhoea related to socio-environmental factors. The results will be discussed in the next chapter.

CHAPTER V: DISCUSSION

5.1 Physical Environmental Factors

5.1.1 Water Source and Water Quality

Many interventions to decrease diarrhoea morbidity in the developing world have been conducted, including enhancing water quality and increasing water quantity (Plate *et al.*, 2004, p. 416). One of the main interventions is installing protected water sources such as boreholes, standpipes or wells to provide better water quality (Wright *et al.* 2004, p. 113). However, the results of statistical analysis of this study did not show a relationship between water quality and type of water sources and the occurrence of diarrhoea, with all boreholes and most dug wells being found to be contaminated with faecal matter. Dug wells are the most common water source being used by respondents in both the disease and the non-disease group.

Some researchers found different results from the association between water quality and diarrhoea occurrence in their studies. In a review of 144 studies conducted by Esrey *et al*. (cited in Shier *et al*., 1996, p. 335), improved water quality was found to be associated with a reduction in diarrhoeal morbidity. However, several studies found little or no association (Shier *et al*. 1996, p. 335; Plate *et al*., 2004, p. 416).

According to Plate *et al*. (2004, p. 416) and Gasana *et al*. (2002, p. 77), the better the water quality, the lower the risk of exposure to diarrhoea pathogens through water. However, this route is not the only route for diarrhoea transmission. In the present study, the insignificant relationship found in the results between diarrhoea and water quality and type of water source are probably caused by the transmission of diarrhoea disease through other, more dominant transmission routes. Exposures may also result from vehicle-borne transmission within households, food or from direct faecal-oral transfer. Furthermore, a better water source does not accomplish full health benefits if it is not accompanied by improvement of sanitation and better practice in water storage (Checkley *et al*. 2004, p. 116; Taha *et al.* 2000, p. 51).

This study also did not measure water storage practices and adequacy of water quantity, but only measured water quality at the source and type of water source. The WHO (1999, p. 3) reported that adequate water availability is more important than water quality in diarrhoea prevention, because it facilitates hygiene practices. Wright *et al*. (2004, p. 113) and Hoque *et al*. (1999, p. 57) in their study found that there is a decline in water quality between source and point of use. Thus, they recommended safer households water storage is an appropriate additional intervention preventing domestic water contamination. Checkley *et al*. (2004, p. 116) found that children from households with small storage containers were more likely to suffer from diarrhoea than children from households with large containers. Not putting a lid on water storage containers was also

associated with diarrhoea occurrence. Hence, it is recommended for future study to measure adequacy of water quantity and water quality at the point of use.

5.1.2 Latrine Facilities and Latrine Type

Associations between latrine facilities and latrine type and the occurrence of diarrhoea are well documented from several studies. Not using latrines and latrines condition are associated with developing, worsening and mortality due to diarrhoea in children (Kunii *et al*. 2002, p. 68). Children from families who did not use sanitary latrines were at higher risk of death from diarrhoea than those who did (Hoque *et al*. 1999, p. 57). The type of latrines also has a significant relationship with the occurrence of this disease (Tumwine *et al.* 2002, p. 752). Having an unhygienic toilet also has a significant association with diarrhoea episodes (Etiler *et al*. 2004, p. 62).

Spatial analysis of this study showed that there was a tendency for an association between latrine facilities and diarrhoea occurrence. This result is in accordance with the results of a study conducted by other researchers (Kunii *et al*. 2002; Hoque *et al*. 1999, p. 57). However, spatial analysis for type of latrines did not support its association with diarrhoea occurrence. Statistical analysis also showed that there were no significant difference in the proportion of latrine facilities and type of latrines and the occurrence of diarrhoea. These results are not in line with the results of

several studies mentioned above (Hoque *et al*. 1999, p. 57; Tumwine *et al*., 2002, p. 753; Etiler *et al*., 2004, p.62).

The different result between spatial analysis and statistical analysis of the association between latrine facilities and diarrhoea occurrence is caused by the approach of the two methods. Statistical analysis did not measure the difference of latrine facilities at borough level, as there were not sufficient data.

The small number of pit latrines being used by respondents also probably caused the insignificant result of the association between latrine type and diarrhoea occurrence in this study. Only three respondents in the disease group used pit latrines. Thus, in fact there was insufficient data to calculate the difference statistically. Curtis *et al*. (2000, p. 26) suggested that diarrhoea might be prevented by safe stool disposal. The pit latrine is known as an unhealthy latrine type with a significant association with diarrhoea occurrence (Etiler *et al*., 2004, p. 62). Tumwine *et al*. (2002, p. 753) reported that children who used pit latrines were twice as likely to suffer from diarrhoea than those who used a flush toilet. However, according to Martens *et al.* (cited in Curtis *et al*. 2000, p. 26), latrine ownership was not enough to prevent diarrhoea. It was instead, related to safe stool disposal.

Evidence appears to support the suggestion that a sanitary latrine facility is one of the main keys to halt the transmission of pathogens causing diarrhoea. However, it is difficult to obtain good measures of what people

actually do about stool disposal. In addition, the distance between latrine and water source is also an important factor associated with water source contamination that leads to diarrhoea occurrence (Thankappan 2002, p. 14).

5.1.3 Methods of Refuse Disposal

This study showed no association between methods of refuse disposal and the occurrence of diarrhoea. This result is different with Mock *et al.* (1993, p. 816). They reported that the method of refuse disposal has a significant relationship with the occurrence of diarrhoea. The difference is probably because the majority of respondents in the present study disposed of their refuse by collection by government agency. Mock *et al*. (1993, p. 812) reported that children whose families had refuse collected were less likely to have episodes of diarrhoea than those whose families buried or used other methods of disposal, including dumping in the family compound. This reason may explain the insignificant result in this study.

5.2 Socio-demographic Factors

5.2.1 Gender of the child

In this study, no significant difference was found between males and females in terms of the number of diarrhoea cases. However, males have a higher proportion of diarrhoea occurrence than females. This result is in

accordance with several previous studies conducted by Etiler *et al*. (2004, p. 62), The Navrongo Research Group (2003) and Mock *et al*. (1993).

In their study, The Navrongo Research Group (2003, p. 842, p.842) suggested that there were fewer diarrhoea episodes in females than males. Mock *et al.* (1993, p. 812), in accordance with this study, found that male children were more likely to suffer from diarrhoea than female children were. However, the study conducted by Navrongo Research Group (2003, p. 840) focused on rotavirus diarrhoea, whereas the present study and Mock *et al*. (1993, p. 807) measured diarrhoeal disease in general, regardless the causes. The reason for the difference in diarrhoea prevalence between males and females is still unknown (Allos 2001, p. 1203).

5.2.2 Maternal age

The present study showed no association between maternal age and diarrhoea occurrence. Studies have shown varying results with respect to the association between maternal age and diarrhoea. The result of the present study is in line with that of a study conducted by Bilenko *et al*. (1999, p. 910). They found that mother's age did not appear to be an important risk factor for the occurrence of diarrhoea in children. However, Yassin (2000, p. 286) reported that children of teenage mothers had a significantly higher risk of the occurrence of diarrhoea. On the other hand, Mock *et al*. (1993, p. 811) found that older mothers, of 40 years or more,

were twice as likely to have children who had diarrhoea as mothers who were less than 40 years old were.

Social support probably may explain the difference between the present study and some other studies' results. People in Purwokerto Selatan sub-district live in a Javanese culture. In Javanese communities, first-timer mothers are generally supported by their own mother or older sisters in caring for their babies. During at least the first 40 days after they deliver their babies, they stay at their mothers' homes. They learn from their families how to care for their babies. According to Milligan *et al*. (2000, p. 246), social support has been found to have a positive effect in the relationships between mothers and their babies.

5.2.3 Maternal education

In this study, the majority of respondents have low education level, with 91.7% only holding an elementary school certificate. Analyses showed no significant association between maternal education level and the occurrence of diarrhoea. This result is in accordance with Lopez-Alarcon *et al.* (1997, p. 339-340). They found that maternal education level was not significantly correlated with diarrhoea. Bilenko *et al*. (1999, p. 910) also reported that maternal education did not show up as an important factor for the occurrence of diarrhoea in children. However, this result is not in line with that of some other studies. Dargen-Molina *et al*. (1994, p. 343) reported that maternal education had a protective effect on improved infant health. Another study conducted by Etiler *et al*. (2004, p. 68) found

that increased risk of diarrhoea episodes in children under five years old were associated with uneducated mothers. Kunii et al. (2002, p. 68) and Yassin (2000, p. 282) supported this result.

In many countries, maternal education has been found to improve child survival (Wagstaff *et al*. 2004, p. 726). There are some possible reasons to explain the association between maternal education and children morbidity, including diarrhoea morbidity. Compared to low educated mothers, educated mothers may place greater value on child welfare and health. Educated mothers also have greater decision-making power in the family, have better information about disease prevention and management and are more likely to adopt innovative behaviours. However, according to Dargent-Molina *et al*. (1994, p. 343), the protective effect of maternal education on diarrhoea occurrence varies, depends on the socio-economic environment in which they live. This protective effect was found in the more wealthy families, but had no effect on the disadvantaged families. The present study did not measure socio-economic factors.

In this study, there were a small number of mothers with high education levels. Only four mothers held a senior high certificate in each group. Only two mothers in the disease groups and four mothers in the non-disease group held tertiary education certificates. The small number of mothers with high education levels affected the significance of the statistical analysis. Further study with larger number of respondents with high education levels is recommended.

5.3 Behavioural Factors

The study showed that the majority of mothers practiced breastfeeding. However, less than 50% of infants were exclusively breastfed by their mother in the first four months of their life. This study showed that breastfeeding is associated with diarrhoea occurrence at a 90% confidence level, whereas exclusive breastfeeding and bottle-feeding were not associated with diarrhoea occurrence.

The significant association between not breastfeeding and diarrhoea occurrence in this study is in accordance with a study conducted by Mock *et al*. (1993, p. 812). On the other hand, in their study in Antalya, Turkey, Etiler *et al*. (2004, p. 64) reported that diarrhoea was not associated with breastfeeding. However, infants who were breastfed had lower risk for persistent diarrhoea.

In the present study, breastfeeding was significantly associated with diarrhoea in the more than 24 months age group. This result is in accordance with Huttly *et al.* (1997, p. 164). According to Huttly *et al.* (1997, p. 164), children under five years old were less likely to have diarrhoea and were less likely to be admitted to hospital due to diarrhoea if they were still breastfed.

Antibodies in breast milk are the most important component of breastfeeding in preventing diarrhoea. Brandtzaeg (2003, p. 3382) established that lactating mammary glands produce antibodies, particularly

consisting of secretory immunoglobulin A (SIgA). This antibody protects babies against infectious agents, including diarrhoea pathogens.

Exclusive breastfeeding has been proved to be associated with prevention of diarrhoea occurrence. The insignificant association between exclusive breastfeeding and diarrhoea occurrence is in line with Sazawal *et al*. (cited in Huttly *et al*., 1997, p. 165), but is not in line with some other studies. A study in 20 countries in Latin America conducted by Betran *et al.* (2001, p. 304) found that exclusive breastfeeding in the first three months of life significantly reduced infant mortality from diarrhoea by 61%. In their study, Bhandari *et al.* (2003, p. 1418) concluded that exclusive breastfeeding at the first six months of life decreases the risk of diarrhoea. A suggestion by Huttly *et al*. (1997, p. 164) that the most important protective effect of exclusive breastfeeding is during the early months of infancy probably explains the differences of the results.

Respondents generally said that they did not breastfeed their babies exclusively, because generally, they believed that their breast milk did not adequately satisfy and did not fulfil the nutritional needs of their babies. This belief is not in line with the results of study conducted by Bhandari *et al.* (2003, p. 1418). They concluded that exclusive breastfeeding in the first six months of life decreases the risk of diarrhoea and does not slow down infant growth.

The insignificant result of the association between bottle-feeding and diarrhoea occurrence is different with that of Mock *et al.* (1993, p. 807).

Their study established that bottle-fed babies suffered diarrhoea more frequently than breast-fed babies did. This difference is probably due to most children still being breastfed by their mothers even though they are also given bottle-feeding. Only seven children (3%) enrolled in the present study were not breast-fed.

5.4 Socio-environmental Factor in Each Group

This study showed there were significant associations between diarrhoea and water source and between diarrhoea and breastfeeding in the more than 24 months age group. A significant association was found between methods of refuse disposal and diarrhoea in the 0-24 months age group. This means that age is a predictor for the occurrence of diarrhoea.

The significant association between diarrhoea and not breastfeeding in children more than two years old is probably because their mothers have weaned them. Hence, they did not gain the protective effect of breastfeeding against diarrhoea anymore. This also explains the association between water source and diarrhoea occurrence in this age group. They have to drink more water after they have weaned by their mothers.

The significant association between methods of refuse disposal and diarrhoea in the 0-24 age group is probably related to the low proportion of exclusively breastfed babies. Unhygienic refuse disposal is a good media for the transmission of diarrhoea. However, children can be protected from

infectious diarrhoea id they were exclusively breastfed (Huttly *et al*. 1997, p. 164).

5.5 Strengths and Limitations of the study

5.5.1 Limitation of study design

The limitation of the cross sectional study was that exposure and disease were assessed at the same time. Hence, it was not possible to establish whether the exposure caused or was the result from the disease. However, most independent variables studied are unlikely to be affected by diarrhoea in the children. The other limitation is that this study design considered prevalence rather than incidence.

5.5.2 Chance

Sample size influences the significance result of statistical analysis. The sample size of the study was quite large. However, the present study used a significance level of 10%. Although statistically this level is acceptable, a further study with a larger sample size is recommended.

5.5.3 Error/Bias etc

Potential errors/bias of this research is selection bias and observation bias (measurement error, interviewer bias and recall bias). Selection bias was addressed using inclusion and exclusion criteria of respondents and using random sampling methods. Employing one interviewer for all respondents

controlled interviewer bias. Measurement bias was controlled using the same structured questionnaire for all respondents and standards method of laboratory examination.

5.5.4 Confounding factors

The potential confounders of this research are age, sex, nutritional status and immunisation status, especially measles immunisation. Age was controlled by choosing respondents at the same age group and by stratification in statistical analysis; in this case, the age group was children under 5 years old and in stratification, age was divided into two subgroups. Sex or gender was included as an independent variable in this study.

Although nutritional status is a potential confounder, all children under five years old included in this study, which were chosen randomly, had good nutritional status. Good nutritional status was determined by looking at their growth-monitoring booklet. All children also had completed basic immunisations, especially measles immunisation. According to the WHO, measles immunisation is one of the main strategies to reduce diarrhoea episodes in children under five years old (WHO, 1999, p. 2). Immunisation status was determined by looking at their immunisation record on their immunisation-monitoring booklet.

5.6 Summary

This chapter has discussed the results of this study. The similarities and differences of the results of this study with other studies and literature were identified and discussed in detail. This chapter also has described the reason for the similarities and differences. In summary, this study found that breastfeeding is the main risk factor related to diarrhoea. This finding is consistent with the literature. The study design and confounding factors were the main limitations of this study. The next chapter presents the conclusions and recommendations of this study.

CHAPTER VI: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The main conclusions of this research are:

1. Diarrhoea is a leading cause of morbidity among children under five in Purwokerto Selatan sub-district.

2. Not breastfeeding is significantly correlated (at the 90% level) with diarrhoea occurrence among children under five in Purwokerto Selatan sub-district.

3. Water source and breastfeeding are significantly associated with diarrhoea in the more than 24 months age group.

4. Unhygienic refuse disposal method is associated with diarrhoea occurrence in the 0-24 months age group.

5. Bottle-feeding is not significantly correlated with diarrhoea occurrence among children under five in Purwokerto Selatan sub-district.

6. Physical environment factors examined in this study – water quality, source of water supply, latrine facilities and methods of refuse disposal – were not significantly correlated with diarrhoea occurrence among children under five in Purwokerto Selatan sub-district.

7. Socio-demographic factors, such as gender of children, maternal age and maternal education are not significantly correlated with diarrhoea occurrence among children under five in Purwokerto Selatan sub-district.

8. Most water sources in respondents' homes were highly contaminated. Most respondents had low education levels. The proportion of mothers providing exclusive breastfeeding is low. Exclusive breastfeeding of infants less than six months of age was found in less than 50% of participants.

9. In spatial analysis, Berkoh borough had the highest risk of diarrhoea related to socio-environmental factors.

6.2 Recommendations

1. Health promotion strategies to prevent diarrhoea should emphasise breastfeeding, especially exclusive breastfeeding during the first four months of life, as the main strategy.

2. A strategy to improve water quality and water storage practice is needed because of the high proportion of homes with contaminated water in Purwokerto Selatan sub-district.

3. High proportion of water source contamination and low level of exclusive breastfeeding should be addressed in future diarrhoea prevention programs.

4. Most respondents have low education levels; hence, the enhancement of community empowerment will play an important role in the success of health promotion and health education strategies to address diarrhoea.

5. As this study only examined some socio-environmental factors with limited number of respondents, future studies with greater sample size and examining more comprehensive socio-environmental factors, including socio-economic factors at borough level, are recommended.

6. Mapping of diarrhoea cases in every borough in Purwokerto Selatan sub-district is needed to identify high-risk areas and to design the most appropriate strategies to address diarrhoeal disease at borough level.

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Note: When more than five authors, the first five are listed followed by *et al*.

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ANNEXES

ANNEX : QUESTIONNAIRE

PROJECT TITLE:

Association between environmental factors and Diarrhoea occurrence in children under 5 years old in Purwokerto subdistrict, Central Java, Indonesia

Survey Code No. : ……
Water Sample No. : ……
Date of Survey : ……

SUBJECT PERSONAL DETAIL

Name : ……
Date of birth : ……
Age : …… years …….months
Gender : Male/Female
Address :
……
:
……
:
……
Phone number : ……

1. Was your child suffering from Diarrhoea in the last 14 days (two weeks)?
   a. Yes
   b. No

2. What kind of water supply do you have at home?
   a. Public supply
   b. Ground water, bore hole
   c. Dug-out well
   d. Surface source

3. What is the method of refuse disposal in your home?
   a. Collected by government agency
   a. Burned it
   b. Buried it
   c. Dumping into family compound

4. Does your home have latrine?
   a. Yes

b. No.

5. If yes, what type of latrine do you have?
   a. Pit latrine
   b. Water seal closet
   c. Flush toilet
   d. Others ……..

6. Mother's age : ……. years old
7. Mother's education:
   e. Elementary school
   f. Junior high school
   g. Senior high school
   h. Tertiary education

8. Has your child ever been breastfed?
   a. Yes.
   b. No.

10. How long your child being breastfed?
   a. Less than 6 months
   b. Six months to 1 year
   c. More than 1 year

11. Is your child only breastfed during the first 4 months of his/her life?
   a. Yes
   b. No.

12. Is he/she still being breastfed?
   c. Yes
   d. No.

13. Has your child been given anything to drink from a bottle with a nipple or teat?
   a. Yes
   b. No

ANNEX 2: INFORM CONSENT

GRIFFITH UNIVERSITY
FACULTY OF HEALTH SCIENCES SCHOOL OF PUBLIC HEALTH
BRISBANE, AUSTRALIA

INFORMATION SHEET

Project Title :
Associations between environmental factors and Diarrhoea occurrence in children under five years old in Purwokerto Selatan subdistrict, Central Java, Indonesia

Researcher:
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Dear Resident,

You are invited to participate in this research. As you may know, Diarrhoea is a major health problem in children under five years old in Purwokerto Selatan subdistrict. Interventions to reduce Diarrhoea incidence in the areas have been made through clinical, prevention and promotion programs. However, these interventions have not made much improvement. Literature indicates that Diarrhoea has a close relationship with environmental condition.

This research will examine associations between environmental factors and Diarrhoea occurrence in the children in the study areas. This research is a study towards meeting Master of Science in Public Health degree requirements.

Participation in this study is voluntary and can be terminated by you at any time during the research without explanation. Participation would involve a 15 minutes interview in your home or alternate location at a convenient location and time. Sample of your home water source will also be collected. This sample will be analysed in a laboratory to analyse and determine the quality of water source in your home.

There are no known or anticipated risks to your participation in this study. The questions are quite general (for example, what is the source of water supply in your home?). You may decline answering any questions you feel you do not wish to answer. All information you provide will be considered confidential and grouped with responses from other participants. Furthermore, you and your child will not be identified by name in my thesis or in any report or publication resulting

from this research. The data collected through this study will be kept for a period of 5 years at School of Public Health, Griffith University, Brisbane, Australia.

The University requires that all participants be informed that if they have any complaints concerning the manner in which a research project is conducted, it may be given to the researcher, or, if an independent person is preferred, either

the University's Research Ethics Officer, Office for Research, Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, telephone (07) 38756618

or

the Pro Vice-Chancellor (Administration), Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, telephone (07) 38757343.

Thank you for your assistance with this research project.

PARTICIPATION CONSENT FORM

Project Title:

Associations between environmental factors and Diarrhoea occurrence in children under 5 years old in Purwokerto subdistrict, Central Java, Indonesia

Brief Description of Project:
Diarrhoea is a major health problem in children under five years old in Purwokerto Selatan subdistrict. Interventions to reduce Diarrhoea incidence in the areas have been made through clinical, prevention and promotion programs. However, these interventions have not made much improvement. Literature indicates that Diarrhoea has a close relationship with environmental condition.

This research will examine associations between environmental factors and Diarrhoea occurrence in the children in the study areas. This study involves children under five years old in the areas. Participation would involve a 15 minutes interview with the mother of the child in participant home or alternate location at a convenient location and time. Sample of participants home water source will also be collected. This sample will be analysed in laboratory to analyse and determine the quality of water source in your home. There are no known or anticipated risks to your participation in this study.

Researcher:
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I,…… as the mother of my child, agree to be interviewed by Agung Saprasetya Dwi Laksana from the School of Public Health, Griffith University, for the purposes of his Master research. I understand that participation in the research is completely voluntary and can be terminated by me at any time during the research without explanation. I understand that while the information gained during the research may be published or presented at conferences, neither the company nor I will be identified and my personal details and responses will remain strictly confidential. I also understand that there is no monetary remuneration offered.

Signature……..
Date ……..
Researcher ……...
Date ……

If you would like to receive a summary of the research results please tick the box below and complete the mailing address details.

☐ Yes, I would like to receive a summary of the research results

Mailing address : ……………………………………………………………………….
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GRIFFITH UNIVERSITY
FACULTY OF HEALTH SCIENCES SCHOOL OF PUBLIC HEALTH
BRISBANE, AUSTRALIA

LEMBAR INFORMASI

Judul Penelitian:
Hubungan antara factor-faktor lingkungan dan kejadian Diare pada anak-anak Balita di Kecamatan Purwokerto Selatan, Jawa Tengah, Indonesia

Peneliti:
Agung Saprasetya Dwi Laksana
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Dengan hormat,
Kami mengajak anda untuk berpartisipasi dalam penelitian ini. Seperti yang mungkin sudah anda ketahui, Diare merupakan salah satu masalah kesehatan utama bagi Balita di Kecamatan Purwokerto Selatan. Berbagai program telah dilakukan untuk mengurangi angka kejadian Diare, akan tetapi tampaknya belum memberikan hasil yang optimal. Penelitian menunjukkan bahwa Diare sangat erat kaitannya dengan kesehatan lingkungan.

Penelitian ini bertujuan untuk menganalisa hubungan antara faktor-faktor lingkungan dengan kejadian Diare pada Balita di Kecamatan Purwokerto Selatan. Penelitian ini dilakukan untuk memenuhi sebagian syarat memperoleh gelar Master of Science in Public Health.

Partisipasi anda dalam penelitian ini bersifat sukarela dan bisa diakhiri kapan saja tanpa anda harus mengemukakan alasannya. Partisipasi anda hanya sekitar 15 menit, berupa tanya jawab yang akan dilakukan di rumah anda atau di tempat lain pada waktu yang menurut anda paling tepat. Sampel air minum dari rumah anda akan diambil untuk dilakukan pemeriksaan laboratorium> Pemeriksaan ini bertujuan untuk menilai kualitas air minum di rumah anda.

Dalam penelitian ini anda tidak akan dihadapkan pada resiko yang tidak mengenakkan anda. Pertanyaan-pertanyaan yang diajukan merupakan pertanyaan yang bersifat umum (misalnya, dari manakah sumber air minum di rumah anda?). Anda berhak menolak menjawab pertanyaan apabila anda keberatan dengan pertanyaan tersebut. Semua informasi yang anda berikan akan dirahasiakan dan digabungkan dengan jawaban dari partisipan lainnya. Nama anda juga tidak akan dicantumkan dalam thesis saya dan dalam laporan atau publikasi hasil penelitian ini. Data yang didapat dari penelitian ini akan disimpan selama 5 tahun di School of Public Health, Griffith University, Brisbane, Australia.

Universitas Griffith meminta apabila anda punya keluhan terhadap pelaksanaan penelitian ini, anda dapat menghubungi peneliti atau menghubungi salah satu alamat di bawah ini:

the University's Research Ethics Officer, Office for Research, Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, telephone (07) 38756618

or

the Pro Vice-Chancellor (Administration), Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, telephone (07) 38757343.

Terima kasih atas kesediaan anda untuk berpartisipasi dalam penelitian ini.

CONSENT FORM

Judul Penelitian:
Hubungan antara faktor-faktor lingkungan dan kejadian Diare pada anak-anak Balita di Kecamatan Purwokerto Selatan, Jawa Tengah, Indonesia.

Gambaran Singkat Penelitian Ini:
Diare merupakan masalah kesehatan utama pada anak Balita di Kecamatan Purwokerto Selatan. Program-program penanggulangan Diare telah dilakukan untuk mengurangi angka kejadian Diare. Akan tetapi, program-program tersebut belum mencapai hasil yang optimal. Berbagai buku menyatakan bahwa penyakit Diare sangat erat kaitannya dengan kondisi lingkungan.

Penelitian ini bertujuan untuk menganalisa hubungan antara faktor-faktor lingkungan dengan kejadian Diare pada Balita di Kecamatan Purwokerto Selatan. Penelitian ini dilakukan untuk memenuhi sebagian syarat memperoleh gelar Master of Science in Public Health. Waktu yang diperlukan untuk berpartisipasi dalam penelitian ini hanya sekitar 15 menit tanya jawab yang dilakukan di rumah atau di tempat lain sesuai dengan tempat dan waktu yang menurut anda paling tepat. Sample air dari rumah anda akan diambil untuk pemeriksaan laboratorium untuk menentukan kualitas air minum di rumah anda. Tidak ada resiko yang membahayakan anda dalam berpartisipasi dalam penelitian ini.

Peneliti:
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Saya, ……., setuju untuk diinterview oleh dr. Agung Saprasetya Dwi Laksana dari School of Public Health, Griffith University, dalam penelitian yang sedang dilakukannya. Saya mengerti bahwa keikut sertaan saya dalam penelitian ini bersifat sukarela dan bisa diakhiri kapan saja tanpa harus memberikan alasan. Saya mengerti bahwa informasi yang didapat akan dipublikasikan atau dipresentasikan dalam suatu seminar, tanpa menyebutkan identitas saya dan identitas dan jawaban yang saya berikan tetap dijaga kerahasiaannya. Saya juga mengerti bahwa tidak akan dibayar untuk berpartisipasi dalam penelitian ini.

Tanda Tangan : …….
Tanggal : ……..
Tanda Tangan Peneliti: …….
Tanggal : …….

Apabila anda menginginkan untuk menerima ringkasan hasil penelitian ini, silakan beri tanda silang pada kotak di bawah ini dan isilah alamat lengkap anda.

☐ Ya, saya ingin menerima ringkasan hasil penelitian ini dikirim ke alamat saya.

Alamat : ……
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