A CROSS-SECTIONAL STUDY ON UNDER-FIVE DIARRHOEAL PREVALENCE AND ITS ASSOCIATED RISK FACTORS IN MATANIKO INFORMAL SETTLEMENTS, IN HONIARA, SOLOMON ISLANDS

by

AMBROSE GALI

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Applied Epidemiology in the School of Public Health and Primary Care in the College of Medicine Nursing and Health Sciences at Fiji National University

August 2017

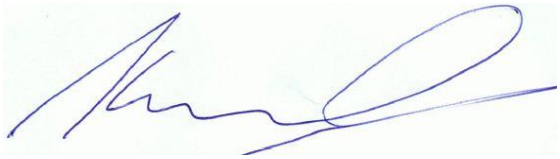
DECLARATION AND COPYRIGHT

I, AMBROSE GALI, declare that this research project is my original work and is being written for this degree award only. To the best of my knowledge it has not been submitted before for any similar form of examination.

Signature: ..... **Date:** 15th day of August 2017

CERTIFICATION

This thesis is submitted in partial fulfillment for the award of Master of Applied Epidemiology at Fiji National University (FNU) with our approval as Project Supervisors.



……

MR. KESHWA NAND KRISHNA

(Principal Supervisor)

Date: 15th day of August 2017

……

DR. JOHN LOWRY

(Co-supervisor)

Date: 15th day of August 2017

……

MRS. SABIHA KHAN

(Co-supervisor)

Date: 15th day of August 2017

DEDICATION

I dedicate this work to my beloved wife Elsie and my two children Veronica and Ambrose Junior for their prayers, encouragement and patience throughout this process.

ACKNOWLEDGEMENT

I thank the Almighty God for giving me strength, sound knowledge and good health throughout the course of this study. His grace is always sufficient and worthy to be acknowledged.

My utmost sincere gratitude goes to my project supervisors, Mr. Keshwa N. Krishna, Dr. John Lowry and Mrs. Sabiha Khan for their tireless support and guidance in the development of this thesis. Your support is remarkable and may I acknowledge that I have learnt a lot from you.

I also acknowledge the support rendered by the key informants and my Research Assistants, Philemon and Dudley; and to the Solomon Islands Government (SIG) and family members for providing funding for the initial implementation of this research project. Without them raw data required for the accomplishment of this project would not have been had.

Thank you all.

ABSTRACT

Background:

Diarrhoea is one of the leading causes of mortality in the world for children under-five. It kills 2,195 children every day; more than AIDS, malaria and measles combined. In Solomon Islands about 1 in every 10 children die from this disease before the age of five years. Though factors associated with under-five diarrhoea are well documented elsewhere in other developing regions, this is not true in many Pacific Island Countries and Territories (PICTs), like Solomon Islands.

Objective:

To assess factors which are associated with under-five diarrhoeal prevalence in Mataniko informal settlements, in Honiara, Solomon Islands.

Methodology:

A cross-sectional survey was conducted with a total of 205 caregivers being interviewed using pre-tested survey forms. Spatial data, like under-five households, were georeferenced using GPS technology. The study settlements were randomly selected, whereas caregivers were purposely selected, based on having at least one child less than five years in their care. The raw data were then entered into IBM SPSS version 23. The data was then analyzed using descriptive statistics, followed by binary logistic regression to explore the relationship between the investigated variables. A *p-value* less than 0.05 was considered to be statistically significant.

Results:

Of the 205 caregivers, the response rate was 100%. Female caregivers (95.0%) were more prominent than male caregivers (5.0%), and were usually the mothers of the children. The mean ages of caregivers and children were 30.7 (±8.2SD) years and 2.6 (±1.5SD) years, respectively. This indicated a high concentration of younger caregivers and infants (≤2 years). Nearly half (41.0%) of the caregivers had more than one child (<5 years) and a majority (79.5%) were living

in overcrowded or big household sizes. This further resulted in an average household size of 7.9 (± 2.5SD). The under-five diarrhoeal prevalence rate within 2 weeks prior to the survey was 45.9%. A number of socio-demographic risk factors including age group of children (<5 years) from 2 years and below, having at least 2 children (<5 years) per caregiver and fortnightly income less than $1,500 (SBD), were significantly associated with under-five diarrhoea ($p<0.05$). Furthermore, practice factors which were associated with under-five diarrhoea were found to be: irregular hand-washing, inappropriate methods of disposing faecal waste and using the river for bathing and laundry. In terms of environmental risk factors the presence of stagnant waste water, flies, solid waste and water-filled containers near households, and distance of under-five households less than 125 meters to the river, were independently associated with under-five diarrhoea ($p<0.05$).

Conclusion:

Under-five diarrhoea was a major public health problem in Mataniko informal settlements, in Honiara, Solomon Islands. Thus, appropriate intervention programmes targeting the associated risk factors should be designed. Further studies are needed to address other potential confounders.

DEFINITION OF OPERATIONAL TERMS

Caregiver: Refers to a man or woman who is responsible for taking care of a child below five years of age, every day.

Childhood diarrhoea: The diarrhoea episode that occurs among children under-five years of age.

Child mortality: Refers to the probability of dying between the first and fifth birthdays.

Demographic factors: Refers to the factors associated with the size and distribution of under-five households such as number of occupants, age group and other population dynamics that may affect the health of children (< 5 years).

Dependent variable: Either the prevalence or occurrence of under-five diarrhoea within 2 weeks prior to the study.

Diarrhoea: The concept diarrheoa was made in reference to the World Health Organization's definition cited in WHO/UNICEF (2009), SPC (2011), Palihawadana (2011), Uwizeye et al. (2014, p. 3), WHO (cited in Ikua 2014), and PPHSN (2015) as "having loose or watery stools at least three times per day, or more frequently than normal for an individual".

Diarrhoea morbidity: Refers to an incidence of ill health mainly caused by the passing of three or more loose or liquid stools within a 24-hour period.

Diarrhoea pathogen: An infectious agent (a germ, microbe or micro-organism) that causes diarrhoea.

Environmental factors: Refers to both community and household environmental factors. These include access to WASH (Water, Sanitation and Hygiene) facilities such as: types of safe water sources, types of toilet facilities, ownership and sharing of toilet facilities, number of people using the toilet facilities, presence of stagnant waste water, flies, scattered solid waste and water-filled containers near under-five households. This also includes physical environmental factors such as altitudes (m) and distance (m) of under-five households to the river.

Gastro intestinal infection: Diarrhoea, which is characterized by frequent and watery bowel movements, often caused by parasites, viruses or bacteria.

Health care professional: Refers to an accredited health care provider such as a doctor or nurse who has been trained to proficiency in the skills needed to manage child illnesses.

Household: Refers to a person or group of persons who reside in the same homestead and normally share food and other amenities and are answerable to the same household head.

Human setting: Refers to places where children and mothers have usually lived or spend most hours of the day including households, schools, communities and workplaces.

Independent variables: Refers to the list of socio-demographic, knowledge and practices, and environmental confounding factors.

Morbidity: Morbidity is an incidence of ill health. It is measured in various ways, often by the probability that a randomly selected individual in a population, at some date and location, would become seriously ill in some period of time.

Knowledge and practice factors: Also known as confounding factors; refers to caregiver's knowledge on causes and prevention of diarrhoea; along with caregiver's practices like regular hand-washing habits during critical times, food preparation habits, means of disposing faecal waste, and the domestic uses of the contaminated river.

Mortality: A measure of the number of deaths (in general or due to a specific cause), in this case diarrhoea.

Older children: Refers to children of age group 3-5 years, though it may define differently in other studies.

Reference Group: In this study, it is denoted by a plus sign superscript ($^{+}$) and it refers to the exposure group (often the unexposed group) to which other exposure groups are compared.

Socio-economic factors: These are factors that affect daily activities of a human being. In this study, it refers to education level of caregivers and their households' income status and size.

Under-five children: Are children within age-group 0-59 months. Similar terms and symbols like <5, u5, less than five and below five are used interchangeably in reference to children within this age-group and their attributes like households.

Under-five diarrhoeal prevalence: Refers to old and new reported cases of a diarrhoea episode among children (<5 years) within a period of 2 weeks prior to the study.

Under-five mortality rate: The probability of dying between birth and exactly five years of age, expressed per 1000 live births.

Urban informal settlement: A settlement located either within the town boundary or in the periphery of cities and big towns characterized by inadequate WASH facility services, filthy environment and lack of other basic human necessities. Other terms like slum or squatter has been used in other studies in reference to urban informal settlements. In Honiara city, informal settlement is mainly a home of low and medium wage government workers, casual laborers and unemployed individuals.

Younger children: Refers to children of age group 2 years and below, though it may define differently in other studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

CDC	Centers for Disease Control and Prevention
CHREC	College of Health Research & Ethics Committee
CMNHS	College of Medicine, Nursing and Health Sciences
DHS	Demographic Health Survey
FNU	Fiji National University
GPS	Global Positioning System
HCC	Honiara City Council
HDI	Human Development Index
HIS	Health Information Systems
HSDP	Health Services Delivery Profile
MGDs	Millennium Development Goals
MHMS	Ministry of Health and Medical Services
MICS	Multiple Indicator Cluster Survey
MLHS	Ministry of Lands, Housing and Survey
NEHD	National Environmental Health Division
NHSP	National Health Strategic Plan
ORS	Oral Rehydration Salts
PICs	Pacific Island Countries
PICTs	Pacific Island Countries and Territories
PNG	Papua New Guinea
PPHSN	Pacific Public Health Surveillance Network
SI	Solomon Islands
SINHREC	Solomon Islands National Health Research and Ethics Committee

SINSO	Solomon Islands National Statistics Office
SINHSP	Solomon Islands National Health Strategic Plan
SIWA	Solomon Islands Water Authority
SPC	Secretariat of the Pacific Community
SPEHIS	South Pacific Epidemiological Health Information Services
SPSS	Statistical Package for Social Science
UNICEF	United Nations Children's Fund
UN-HABITAT	United Nations Human Settlements Programme
WASH	Water, Sanitation & Hygiene
WHO	World Health Organization

CHAPTER 1.0: INTRODUCTION

Diarrhoea remains a global child health problem (WHO 2015); second to pneumonia (WHO/UNICEF 2009/2010). It is a symptom of human bowel infection (gastroenteritis) caused by diarrhoeal-pathogens (Palihawadana, 2011, p.5). Comparatively, under-five children are at highest risk because of their need for parental care. The existence of various factors, namely socio-demographics, practice and environmental factors, were found to be associated with under-five diarrhoeal prevalence (Ikua 2014; Diouf et al. 2014, p.5).

Globally, nearly 2 billion people are currently without better water and sanitation facilities, and most them are in developing countries (Curtis et al. 2000, p. 9). Further, dwellers of urban informal settlements are continuously reporting with high diarrhoeal prevalence due to their ill-suited location, low income status, high family size and poor access to safe WASH (Water, Sanitation and Hygiene) facility services to support hygiene knowledge and practices (WHO/UNICEF 2009; Kakulu 2012; Uwizeye et al. 2014, p.1; Ikua 2014; Diouf et al. 2014, p.5; Mohammed & Tamiru 2014, p.3; Alambo 2015, p.17). The absence of these basic life necessities has contributed to a statement made by Dutton & Pigolo (2014) and Freeman et al. (2014, p. 6), which revealed that although hygiene knowledge was extremely high among mothers, there was a wider gap between this knowledge and actual practice. This indicated that tailoring this gap by means of improving economic status of households, continuous education on child birth spacing and improved coverage of basic social services including WASH facilities, will help to narrow this gap and thus reduce under-five diarrhoea.

Regionally, urban informal settlements, like those in Solomon Islands, often lack adequate access to essential social services because they are not part of the urban town planning and development annual budget. Consequently, to such unexpected urban growth, the government is often faced with great challenges to sufficiently provide essential services for its

population. This is in agreement with a study by Uwizeye et al. (2014, p.2) in Huye town informal settlements, in Rwanda, Africa. In the Asia-Pacific region this is not a recent phenomenon but started in the last 45 years as people continue to move to urban areas in search of better livelihoods and opportunities (ESCAP 2015). This is alarming and requires urgent intervention as populated households can increase the risk of infectious disease transmission (SIG 2014; WHO 2014; Ikua 2014).

In an attempt to improve WASH facilities, a bench-mark of 70% of nationwide coverage was set in 2007 by the Solomon Islands health sector, but its level of success was not evidenced in urban informal setting. Nevertheless, re-orientation of social services in a way which gives priority coverage to such deprived settings will help to bridge this gap. In all respect, children (<5 years) in urban informal settlements are part of the national population count and epidemiologic triage of any country; and therefore, their improved health status will positively impact the national disease trend.

1.1 Childhood diarrhoea transmission

Children (<5 years) often experience diarrhoeal disease when they orally injest the diarrhoeal-pathogens through contaminated food and water, or by touching contaminated objects and then placing hands into their mouth (Ahmed cited in Ikua 2014). This usual mode of transmission is termed as "faecal oral route" (WHO/ UNICEF 2009; Kakulu 2012; PPHSN 2015). It has been reported that this pathway (faecal-oral) is quite preventable, especially when caregivers regularly and consciously practice hand hygiene during critical times (Ikua 2014; Uwizeye et al.2014, p.1; Freeman et al.2014, p.6).

Diarrhoeal-pathogens are classified as viral *(e.g. norovirus, rotavirus, cytomegalovirus, herpes simplex virus, and viral hepatitis*); bacterial *(e.g. Escherichia coli, Salmonella, Shigella, Campylobacter, Clostridium perfringens toxin);* and parasitic organisms *(e.g. Giardia lamblia,*

Entamoeba histolytica, and Cryptosporidium) (Palihawadana 2011, p.5; Charles cited in Ikua 2014 and PPHSN 2015).

It is reported elsewhere that rotavirus is the leading cause of acute diarrhoea among children (<5 years) worldwide (WHO/UNICEF 2009; Tate et al. 2011); and is responsible for nearly 40% of all hospital admissions worldwide (WHO/UNICEF 2009). In 2008, the estimated child mortality caused by rotavirus were 527, 000 children; and 85% of these deaths occurred in the low-income countries of Africa and Asia (WHO Weekly Epidemiological Report 2008). In India, it accounted for more than 78,000 diarrhoeal deaths among children (<5 years) (Hopkins University 2013). Recently, in Honiara, Solomon Islands, blood samples sent for serology testing to French Polynesia revealed that rotavirus was a major cause of the outbreak (WHO 2014).

Among the bacterial agents, Escherichia coli, Shigella, Campylobacter and Salmonella were the common causes (Palihawadana 2011, p.5); while in regard to parasitic agents, Cryptosporidium was found to be the common cause of childhood diarrhoea worldwide (Sarkar et al. 2014, p.1). Further, children less than five years in resource-poor settings were at high risk of becoming infected; and within that age group, the highest prevalence was children aged 2 years and below (Ajjampur et al.; Das et al. cited in Sarkar et al. 2014, p.1). Aside from other causes, a change of diet from breast milk to solid food, and food that is not well cooked and stored for re-use, can also cause childhood diarrhoea infections.

1.2 The burden of under-five diarrhoeal disease

Childhood diarrhoea is a serious health problem in the world (WHO 2015). It kills 2,195 under-five children every day, more than AIDS, malaria, and measles combined (WHO/UNICEF 2009; CDC fact-sheet 2015). Since 2006, the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF) had termed it "The Forgotten Killer of Children" worldwide,

along with pneumonia (WHO/UNICEF 2010); and for similar reasons, Palihawadana, an epidemiologist, in one of his 2011 Weekly Epidemiological Reports, regarded diarrhoea as "the child killer". Not only that, it becomes severe when combined with other childhood illnesses like measles (WHO/UNICEF 2009; WHO cited in Palihawadana 2011; CDC 2015).

In 2009, it was reported that the global estimated yearly under-five mortality ratio of diarrhoea was 1 in every 5 children, before each child reaches his or her fifth birthday (WHO/UNICEF 2009). This global mortality estimation is higher than the recent estimation, which recorded as 1 in every 9 under-five children (WHO 2015). Nonetheless, this recent mortality ratio is equivalent to 1.5 million deaths each year, out of the 6 million under-five children worldwide (UNICEF/WHO 2009); and carefully note that this exclusively for under-five children. This is not a recent phenomenon. As shown by the WHO (cited in Curtis et al. 2000), diarrhoeal disease has been responsible for more than a quarter of the deaths of children worldwide, in the last 10 years.

Globally, the annual prevalence rate of diarrhoea among under-five children worldwide is about 42%. This was derived by using the WHO/UNICEF (2009) global estimated under-five prevalence cases of 2.5 million in a year as numerator and divided by 6 million, the global under-five years' population of the same year as the denominator.

Comparatively, diarrhoea is more prevalent in the developing world than developed countries (WHO/UNCEF 2009; Diouf et al. 2014, p.5). It was also verified that although there was a significant decline in terms of yearly global mortality trend of childhood diarrhoea from 4.5 million deaths in 1979 and to 1.6 million deaths in 2002, diarrhoea continues to increase among children in developing countries (WHO/UNCEF 2009).

Regionally, the epidemiology of diarrhoea revealed that children (<5 years) from urban informal settlements in Africa, Asia and the Western Pacific region, accounted for the highest prevalence of cases (Curtis et al. 2000, p.9). It is because children from poor-resource settings

are extremely vulnerable to poor hygiene practices and diarrhoeal disease transmission (Tate et al. 2014, p.2; Uwizeye et al. 2014, p.1). The UN-HABITAT (2012), Kiddle (2011) and Kavan (2013) have also agreed and explained that high child morbidity and mortality rates tend to be focused in places where there is a significant concentration of extreme poverty, combined with inadequate social services, overcrowded housing and households' in ill-suited locations.

In PICs, diarrhoea has been classified as one of the major causes of child mortality. In the Fiji Islands, childhood diarrhoeal disease accounted for 3% of all causes of child deaths, second to pneumonia (13%). In Solomon Islands, the WHO Health Statistics (cited in MHMS 2010), revealed that diarrhoea was one of the leading causes of child mortality (3%) whereas pneumonia (18%), other infections (14%) and malaria (9%) were the deadliest killers. This has coincided with other studies, which also agreed that child health in the Solomon Islands is characterised by high levels of infectious diseases, including diarrhoeal disease (McMurray 2005, p.12; MHMS 2010). Additionally, a recent diarrhoea outbreak in Honiara, SI, among children, claimed 16 lives and more than 1000 morbidity cases (WHO 2014).

1.2.1 Regional under-five prevalence of diarrhoea

The under-five diarrhoeal prevalence was varied across person, place and time in developing countries of Africa and the Asia-Pacific region.

Within the Africa region, several community-based cross-sectional studies about under-five diarrhoea prevalence and its associated risk factors were documented. A study by Uwizeye et al. (2014, p.6) conducted in the mountainous informal settlements of Huye town in Rwanda revealed that there was a significant variation between the prevalence of diarrhoea between seasons. Results of 2 weeks separated recalls showed that under-five diarrhoeal prevalence rates were higher in the wet season (55.1%) compared to the dry season (24.3%). This indicated that the estimated risk for diarrhoea was above half (55%) during the rainy season of the year. In

Nairobi, Kenya, Ikua (2014) found that the prevalence of diarrhoea among children (<5 years) in urban informal settlements, 2 weeks prior to the survey, was 35.6%. As shown in Magadi et al. (Mukiira 2012), Nairobi is one of the regions in Africa with comparatively high diarrhoea mortality rates in slums due to poor WASH conditions, among other determinants. A similar study design was done during the dry season in an informal settlement in Arba Minch District, Southern Ethiopia (Mohammed & Tamiru 2014, p.4). The result revealed that the prevalence of diarrhoea was about 30.5%, which was relatively high when compared with 13% shown in the Ethiopian Demographic and Health Survey (DHS) Report in 2011. In Soddo town, Southern Ethiopia, the under-five prevalence rate prior to 2 weeks of study was 11% (Alambo 2015, p.20).

In other countries in the Western Pacific region, the prevalence of diarrhoeal disease among under-five children was also high in urban informal settlements compared to DHS data. A related study was conducted in Papua New Guinea (PNG) among the informal settlements in Port Moresby City and Wewak Provincial Township, and the results showed that the diarrhoea prevalence rate was 24% in the last 2 weeks. As reported by the responders, the main causes of diarrhoea in children were dirty hands, dirty water and contaminated food (Dutton & Pigolo 2014). Moreover, in Vanuatu, the 2007 Multiple Indicator Cluster Survey (MICS) found that 14% of children (<5 years) had suffered from diarrhoea in the previous two weeks before the study. According to UNICEF (2011), inadequate WASH facilities, poor housing and living conditions were major contributing factors. In addition, only 54% of these children had received oral rehydration treatment (ORT), while the other half had no treatment. This indicated a lack of consistent public health education to improve mothers' care-seeking behavior (UNICEF 2011).

1.2.2 The under-five prevalence of diarrhoea in Solomon Islands

In Solomon Islands, it was estimated that the nationwide prevalence rate of diarrhoea among under-five children was 9.4%. This result was obtained during a DHS conducted by the

Solomon Islands National Statistics Office in 2007, in collaboration with the Ministry of Health and other stakeholders (SINSO 2007). The under-five diarrhoea prevalence rate (9.4%) obtained from DHS was low, when compared to other 2 weeks recall studies conducted in urban informal settlements in other developing countries (Alambo 2015, p.20; Mohammed & Tamiru 2014, p.4). As shown in SINSO (2009), among the under-five age group, children between above 6 months to 2 years accounted for the highest prevalence rate, which comprised of 33.4%. The least diarrhoeal prevalence cases were those below 6 months (0.9%) and above 4 years (3.1%) (SINSO 2007). This is in agreement with a study by Alambo (2015, p.20) and Mohammed & Tamiru (2014, p.4), which stated that the age group of under-five children was associated with under-five diarrhoea.

Like in other developing countries, in Solomon Islands under-five diarrhoea prevalence was also high during a period of emergencies and disease outbreak. For instance, a few days after the Honiara and Guadalcanal flash flood in April 2014, a severe diarrhoea outbreak occurred and claimed more than 1000 morbidity cases and 16 mortality cases. This was tragic because most of the case-patients were children (<5 years) and such high recorded cases within a month was almost equivalent to the annual recorded cases when there was no outbreak (SIG 2014; WHO 2014). This was associated with the fact that during cyclones and severe flash floods, the evacuation of people into temporary and overcrowded shelters is always associated with poor hygiene practices due to the disruption of safe WASH facilities. Another classic illustration was given by the Goma Epidemiology group (WHO/UNICEF 2009). They reported that during the 1994 diarrhoeal disease outbreak, in areas around Goma, in the Democratic Republic of the Congo, an estimated 50,000 deaths occurred within a month, of which 85% of those cases were due to diarrhoea.

Reasonably, such differences regarding diarrhoeal prevalence across place, person and time was primarily due to the variation in terms of scope and methodology of each study, which

also has linked to the differences in social services provision between the rich and poor people in both rural and urban areas (Mukiira 2012; Mohammed & Tamiru 2014, p.4).

In terms of diarrhoea prevalence rate among under-five children in Honiara informal settlements, it is unknown. This has hindered the ability to make a meaningful comparison.

1.3 Diarrhoeal disease protection, prevention and treatment

Diarrhoea is among other childhood illnesses that is curable and preventable. Reports elsewhere showed that the spread of diarrhoeal pathogens often occur at household level, a child (<5 years) principle habitat. This means that essential measures to prevent the spread of this disease need be improved within this domain (Cairncross cited in Curtis et al. 2000; Ikua 2014; Alambo 2015, p.20). Subsequently, a set of comprehensive intervention packages should include the protection, prevention, and treatment of childhood diarrhoea (Johns Hopkins University 2013).

It had been recommended worldwide that the protection strategies should include the prioritization of exclusive breastfeeding for 6 months, vitamin A and zinc supplementation and giving adequate nutrition to under-five children (Johns Hopkins University 2013; CDC 2015).

With the same impact, using appropriate prevention strategic measures like wider immunization (or vaccination) coverage, education and awareness, enabling environments through WASH services improvement, and enhanced government and stakeholders' political support through legislation and policy development, were effective to reduce the burden of childhood diarrhoea (Johns Hopkins University 2013; CDC 2015).

As a global health requirement, children below five years should be vaccinated with rotavirus vaccine, Hepatitis A/B, Typhoid, Cholera & Measles. Moreover, among all diarrhoeal vaccines, studies showed that rotavirus vaccine had been effective in addressing childhood diarrhoea and thus is used in more than 70 countries. Additionally, studies also highlighted that

there were steady reductions in diarrhoea related hospitalisations and deaths in more than 10 countries introducing the vaccine, including both low- and middle-income countries (Patel et al.; Yen et al.; Bayard et al.; De Oliveira et al.; Gastanaduy et al. cited in Johns Hopkins 2013). Furthermore, a study by John et al. (2014) to estimate disease burden and potential impacts of vaccines, revealed that the introduction of a rotavirus vaccine in the national immunization program would prevent over 25,000 deaths, about 300,000 hospitalisations, and more than 600,000 outpatient visits each year, in India. In addition, in not only the under-five children, the vaccine had significantly reduced rotavirus hospitalisations among older children who were not vaccine-eligible; and was also found to indirectly address other childhood illness like pneumonia. As a result of such benefits, rotavirus vaccines have been recommended by the WHO for use in national immunisation programs worldwide. As an effort to promote its global use, it has been listed as one of the necessary components of WHO and UNICEF's Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD); and also one of the key elements of the WHO Global Vaccine Action Plan, which is endorsed by 194 member states.

Improving health education among mothers through health promotion and disease prevention activities in communities, in collaboration with community-based organisations (NGOs, Churches, Mother's union) and public health programmes, is necessary to fight against under-five diarrhoeal infection. Diouf et al. (2014, p.5), had verified that children (<5 years) of mothers receiving community health education were more protective against diarrhoea than children (<5 years) whose mothers did not receive any health education. The use of mass media like radio and newspaper should be utilized for wider advocacy programmes, as well as weekly events like mothers' mass-gatherings and usual ports of entry (clinics, hospitals, churches). According to Dutton & Pigolo (2014) the main source of public health information for caregivers in PNG informal settlements is from health extension offices, hospitals and clinical staff, apart

from a daily radio programme. As alluded to by WHO/UNICEF (2009), the health promotion intervention programmes should include information on both hygiene knowledge and practices.

Information regarding the transmission route of diarrhoeal-pathogens, their incubation periods and factors influencing the spread of diarrhoeal disease are very essential for early prevention. For instance, in terms of rotavirus, the diarrhoeal symptoms can be seen within 24 hours, whereas Escherichia coli is seen after 3 days, and often transmitted through the faecal oral route. Early recognition of signs and symptoms is necessary to seek appropriate care, which may avoid significant fluid loss and dehydration, or even death.

At household level, diarrhoea-pathogen transmission can be prevented by a significant improvement of a WASH facility (Cairncross cited in Curtis et al. 2000). To achieve this, the public health act and laws, which guarantee the role of the Ministry of Health, government and stakeholders as funders, implementers and developers of WASH facilities nationwide, need to be strengthened or developed. Such documents have stipulated the key players and their expected role of commitments. According to the CDC (2015), over the last 20 years, the prevention focused on safe water and improved hygiene and sanitation is not only possible, but cost effective; and further revealed that every dollar invested yields an average return of $25.50. However, a major challenge in this regard is scaling up sanitation facilities to the point where they are used by an entire community (‘total sanitation’).

It had been reported that creating public health policy was also effective and classified as one of the five action areas of health promotion, to improve the health and well-being of the entire population (WHO 2014). The world health leaders have agreed that the global and regional burden of infectious diseases cannot be fully addressed without such supportive mechanisms, which also require political investment and commitment as a global community. Furthermore, WHO has entrusted the National Health sector within each country to oversee and be responsible for the provision (with support from other stakeholders) of public health services

based on their respective Health Act, which has coincided with the World Health Regulation and Legislation. In Solomon Islands, this had been stipulated in sections 10 and 13 of the Health Services Act, which allows the said Ministry to liaise with Provincial Health Assemblies, HCC ,plus the faith-based organizations and other voluntary bodies, to work together to provide public health services (JTAI cited in MHMS 2011; MHMS 2014).

The ongoing commitment towards World Health Treaties on areas relating to the health of children is also necessary. In 2015, during the 11th Pacific Health Ministers Meeting, the leaders of countries within the Western Pacific region had reaffirmed their commitment to the Yanuca Island Declaration 1995, on the Healthy Island Settings concept. One of the priorities was the health of children. As shown in WHO/SPC (2015) the vision of Healthy Islands as the unifying theme is on both health promotion and health protection. Thus, in order to make an island an important setting which protects and promotes the health of children, the physical environments must free from infectious disease transmission.

The WHO, UNICEF and SPC have encouraged and supported member countries to protect the spread and burden of diarrhoeal disease through the establishment of guidelines and action plans. This includes the inclusion of rotavirus vaccines as one of the necessary components of WHO and UNICEF's Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD) among 194 member countries (Johns Hopkins University 2013). In Solomon Islands, outcome statement number 1 of the SINHSP 2016-2020 has prioritized the health of children, especially children from the disadvantaged communities (MHMS 2016).

An active healthcare-based surveillance system is also essential to reduce the morbidity and mortality of childhood diarrhoea; and to make this eventuate, the public health sector should work in collaboration with the WHO in country office, to establish or strengthen a healthcare-based (clinics, hospitals & other health facilities) sentinel surveillance system, so that there will

be a continuous systematic reporting of diarrhoea syndrome from a network of mini hospitals and clinics, to support timely decision making and response during pre-diarrhoeal outbreaks. The WHO Weekly Epidemiological Report (2008), showed that timely availability of data on the epidemiology of any illness affecting children, is vital to policymakers to make well informed decisions and policy development.

The timely administration of diarrhoea treatment packages to children (<5 years) suffering from diarrhoea is necessary to reduce diarrhoea mortality cases. As alluded to by WHO/UNICEF (2009), reducing under-five diarrhoea deaths depends largely on delivering life-saving treatments of low-osmolarity oral rehydration salts (ORS) and zinc tablets to all children in need.

In terms of Oral Rehydration Therapy (ORT), especially in the form of ORS, it is really effective in treating mild rotavirus infections (Johns Hopkins University 2013). Johns Hopkins University (2013), further explained that when this treatment is unavailable, rotavirus can be deadly because it cannot be treated with antibiotics or other drugs and is highly contagious. However, only 39% of children (<5 years) with diarrhoea in developing countries receive the recommended treatment worldwide, and it has been suggested that little progress has been evidenced since 2000 (WHO/UNICEF 2009). This means that there is a need for the recommended treatment package to be improved worldwide. Apart from ORT, the treatment package should also include community case management, health facility case management, and improvement of care seeking behavior.

1.4 The Solomon Islands and the health system

1.4.1 The Solomon Islands

The Solomon Islands (or Solomons) is an island nation state in the Southwest Pacific region, comprised of six big islands and more than 900 smaller islands, occupying a total land area of about 28,000 square km (11,000 square miles) in Oceania. It lies to the northeast of Australia, east of Papua New Guinea (PNG) and to the northwest of Vanuatu. The central administrative capital city is Honiara, with a suburban administrative centre in each of the nine provinces (Central, Choiseul, Guadalcanal, Ysabel, Makira, Malaita, Renbel, Temotu and Western).

Solomons is also located within the Pacific "ring of fire", a region prone to earthquakes and tsunamis; and home to young mountain ranges, scattered islands, extensive coastlines and rainforests (UNESCO 2005; SIG 2014; ESCAP 2015; WHO 2015). The weather and climate systems are characterized by hot and wet weather pattern distributions over the year. Such tropical conditions are suitable for vector habitation and disease outbreaks (Tabua et al. 2013).

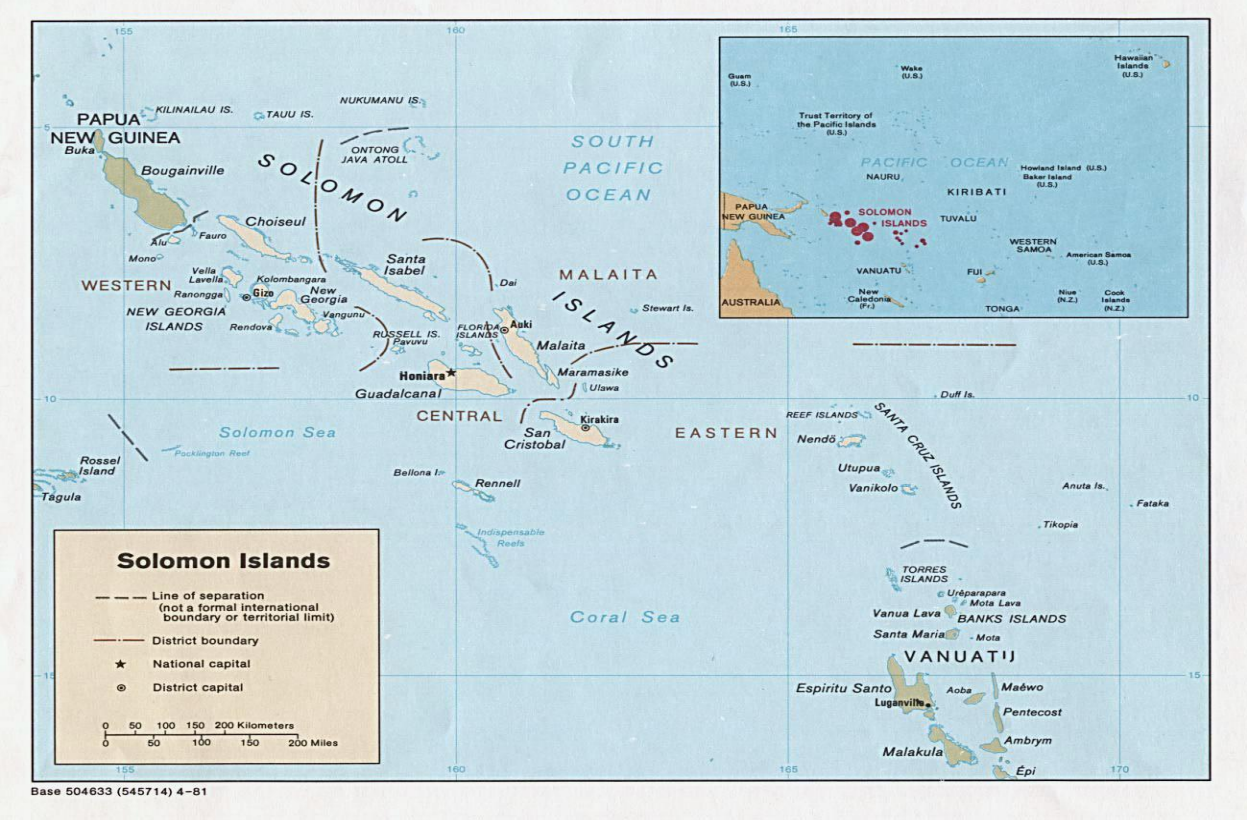
Solomon Islands is a Melanesian country; and one among the 22 Pacific Island Countries and Territories (PICTs), together with other Polynesian and Micronesian neighbouring countries like Samoa, Kiribati, Federated States of Micronesia (FSM), Tokelau, Palau and others (WHO 2015). It has shared a borderline with Bougainville, PNG and Vanuatu, and has other similar traditions and culture, like a famous tok-pisin dialect. English is a third but an official spoken language, although there are 70 plus different language groups in the country. The country's system of government has adopted a constitutional monarchy since gaining independence in 1978 (WHO 2015).

The national economy outlook revealed that it was largely driven by the service industry (accounting for around 40% of GDP), agriculture (around 15% of GDP), and forestry (around

15% of GDP). Manufacturing remains a micro-sector, and a majority of the population depends on subsistence agriculture for their livelihoods. Furthermore, in the last five years, average annual real GDP grew by 4.9% as a result of supportive external environment and strong donor support (SIG 2014; WHO 2015).

As shown in UNDP (2014), the Solomon Islands Human Development Index (HDI) is 0.491, and is ranked 157th of all nations. In comparison to neighboring PICTs, PNG ranked 156th, Vanuatu ranked 131st and Fiji Island ranked 88th. The Solomon's HDI (0.491) is an indication of an overall low level of development, based on health, education and income (WHO 2015).

Figure 1: Map of Solomon Islands in the South Pacific



Source: https://www.mapsofworld.com/solomon-islands

As of the 2009 national census, the country's population was recorded as 515,870 (SINSO 2009), lower than 561,231 and 650,000 as being recently estimated by the World Bank in 2013 and WHO in 2015, respectively. However, a vast majority (80%) are residing in rural areas versus urban areas (20%). Of the 102,030 urban population, about 60% live in Honiara

city. The median age from the 1999 to 2009 inter-censal period was 20. The size and distribution, according to age group, revealed that 15% of the Solomon Islands population is below five years of age and a majority (49%) are from 15-49 years, than 50 years plus (36%). This trend has represented a broad base population pyramid dominated by youths and an active age group population. The life expectancy at birth is 66.2 for male and 73.1 for female. The under-five mortality per 1000 in Honiara is 23, and higher in male (27) than female (19) children (SINSO 2009). Population density was extremely high in Honiara, accounting for 2,953 people/km², whereas the country's population density was only 17 people/km². Furthermore, since the recorded annual growth rate of Honiara was 2.7%, this also indicates the unmet needs for contraceptives (SINSO 2009; WHO 2015).

1.4.2 The national health system

The Ministry of Health and Medical Services (MHMS) is the central actor in the Solomon Islands health system. It functions as funder, regulator and provider of nearly all health services. The NGOs, faith-based service providers and private sectors also provide minimal, but important roles within the health sector (WHO 2015; MHMS 2015; MHMS 2016).

There are two main sources of funding in Solomon Islands health system, namely government revenue (65%) and external development partners (29%). The remaining 6% is accounted for in out-of-pocket payments, and referred to fees from certain dental procedures, radiology, laboratory services, medical record etc (WHO 2015). Comparatively, about 60% of all health fund budgets are held and spent in Honiara with only 40% in other health facilities in rural and suburban areas (MHMS 2011). As shown in the Solomon Islands Health Services Delivery Profile (SIHSDP), curative services accounted for the largest (85%) share of budget (MHMS 2012).

In 2012, there were 329 health facilities in Solomon Islands. Nine of these facilities are provincial hospitals, proportionate to the nine provinces; and one is a National Referral Hospital (NRH). The remaining 319 health facilities are primary care facilities, of which 33 are registered area health clinics, 109 are rural health clinics and 177 are nurse aid posts. The nurse aide post is the lowest level, whilst NRH is the highest level of care. However, children health care services are mostly provided at primary level facilities (MHMS 2012; WHO 2015).

By cross tabulating the available care professionals with the recent census data, it shows that the country health care system is experiencing critical shortages of health care workers, with an estimated ratio of 1 doctor per 4,762 people, 1dentist per 9,090 people, 1pharmacist per 9,090 people, 1.7 nurses per 1,000 people and 1 midwife per 3,846 people (MHMS 2012). Georganas (WHO 2015) had verified that Solomon Islands is one among the 57 developing countries deemed to have a critical shortage of health workers. This has indicated a deliberate need to improve workforce and services infrastructure to cater for the current population. Evidence revealed that there are also critical shortages of medical laboratory staff, radiologists and other allied health professionals (Asante et al. 2011). This is not a recent problem, but started in the last 10-15 years (MHMS 2012), and could also be attributed to the continuous outflow of skilled healthcare professionals to other PICTs.

The greatest concern is the impact of low level of health service delivery across islands and communities, especially among children from the disadvantaged and remotest areas. As suggested by McMurray (2005, p.12) and MHMS (2010), shortage of health workers could have contributed to persistent and prolonged periods of preventable disease outbreaks, like dengue and diarrhoea, in Solomon Islands. This scenario was verified in a 2014 diarrhoea outbreak, which claimed more than 1000 morbidity cases and 16 deaths cases, just within a month (SIG 2014; WHO 2014). Another impact is the low usage or coverage of ORT in the form of ORS among case-children (<5 years). As alluded to by SINSO (2007) in her recent DHS Report only, 37.7%

of under-five children in the country, with diarrhoea, had received ORS; although ORS and zinc tablets are essential lifesaving treatments (WHO/UNICEF 2009). This may also indicate low care seeking behavior, as well as inadequate care and preventive services delivery by health professionals. As a result, about 1 in every 10 Solomon Islands children (<5 years) die before their fifth birthday (MHMS 2010); and among all PICs with available under-five diarrhoea data, Solomon Islands was recorded highest (Chiller et al. 2005). The country is also at its mid-phase of epidemiological transition and addressing both infectious and non-communicable diseases is a major challenge (MHMS 2011). As further revealed in MHMS (2010), diarrhoea (3%) is one of the leading causes of under-five mortality in Solomon Islands, along with neonatal (44%), pneumonia (18%), other infections (14%) and malaria (9%).

In an attempt to address the above health issues, the health of children in poor resource settings were given priority in the SINHSP 2016-2020 (MHMS 2016). Rosewell et al. (2012, p.1), had appreciated this initiative and stated that to attain adequate child-health benefits, improving population access to adequate health facility services is a significant approach. Besides that, such services should also be feasible in urban informal communities because they are also an important component of the country's permanent landscape and therefore, their health status may influence the health system status of the country (McMurray 2005, p.2; Dutton & Pigolo 2014). Furthermore, the rights of children's health and ability to survive are also incorporated into the United Nations Millennium Development Goals (MGDs) and Sustainable Development Goals (SDAs) (Jones 2012; UNDP undated); and therefore, regarded as a global health commitment for all nations.

Lastly, another challenge is the issue of missing data from the national health information system. This gap makes it difficult to compare the burden of under-five diarrhoea in Solomon Islands urban informal settlements with other related studies elsewhere; though studies revealed that children from this setting were highly at risk (UN-HABITAT 2012; Kiddle 2011; Kavan

2013; Uwizeye et al. 2014, p.1; Tate et al. 2014, p.2). This has shown the need for research and documentation. Also, this unknown data is of great importance to the responsible government ministry and partners for informed decision making.

CHAPTER 2.0: LITERATURE REVIEW

2.1 Introduction

This review is about factors which are associated with the prevalence of under-five diarrhoea. Above ninety percent of reviewed studies were conducted in other developing regions of Africa, Asia and India, whilst very few or none were conducted in other PICTs. This wider gap of information does limit the intent to make meaningful comparisons across regions. It also discusses how the investigated factors have impacted the health of children (<5 years). It then concludes by discussing some important world health treaties to address the burden of childhood illnesses.

The socio-demographic factors are the social determinants which have influenced the daily activities of a human being of any household. They are age group, household size, education level, income level and others. In Solomon Islands context, the average household size that is economical and maintainable is 5 with a fortnightly income of above $1500 (SBD) (SINSO 2009). Education is necessary because it has led to improved knowledge on recognition of signs and symptoms of diseases and guided appropriate care seeking behavior (Mukiira 2012). Studies have revealed that economic status of any household is vital to assess because it indicates its financial capability to access essential services (WHO 2011; Kakulu 2012; Ikua 2014; Palihawadana, 2011, p.5). In India, low socio-economic status had increased the burden on childhood diarrhoea (Johns Hopkins University 2013).

Practice factors are human actions and can be either positive or negative actions to disease prevention. Negative actions due to ignorance, can be avoidable by prioritizing positive actions (e.g. regular hand hygiene), whereas negative actions due to lack of knowledge and hygiene facilities, can be avoidable by intensive health education and total WASH services coverage. Nevertheless, there was a wider gap between knowledge and actual practice (Dutton &

Pigolo 2014; Freeman et al. 2014, p.6); although it had been verified that high hygiene practice level strongly contributed to improved health status (Girma et al.2008, p.44; Ikua 2014; Diouf et al.2014, p.5; Freeman et al. (2014, p.6: Alambo 2015, p.29).

The environmental factors refer to the physical environment surrounding and within the households and community, which have influenced the growth and transmission of diarrhoeal-pathogens to children (<5 years). The environmental determinants include inadequate access to a WASH facility, presence of solid waste, flies and a poor drainage system near households; and the location of under-five households to exposed areas, such as dump sites and open defecation areas, like the river.

Hence, an in depth understanding of the status of association between under-five diarrhoea and socio-demographic, practice and environmental factors is crucial in disease prevention as they constitute the epidemiologic triage. Thus, an interruption of this pathway means that it will reduce the spread of diarrhoeal-pathogens to children. As mentioned earlier, in Solomon Islands these factors and their relationship with under-five diarrhoea has not been documented. Nevertheless, this study is also intended to address this gap and purvey the way for appropriate actions.

2.2 Factors associated with under-five diarrhoeal prevalence

2.2.1 Socio-demographic factors

Socio-demographic factors like age group of under-five children and caregivers, number of children (<5 years) per caregiver, household size, education and household income level were important factors associated with under-five diarrhoeal disease in urban informal settlements in Africa and the Asia-Pacific developing regions.

A report on a community-based cross-sectional study undertaken by Mohammed & Tamiru (2014, p.3) in Arba Minch District, in Southern Ethiopia, revealed that the age group of

under five children (<5 years) was directly associated with under-five diarrhoea prevalence. The study households were selected using multistage sampling technique, which was proportionate to a sample of 590 mothers with at least a child below five years of age. Based on 2 weeks recall, the prevalence rate was 30.5%. The mean age was 29.5 (SD±6.7), indicating a high concentration of younger women. The high diarrhoea prevalence rate has been agreed to by Diouf et al. (2014, p.5) and Mukirra (2012), respectively, which stated that disease rates increase due to decreases in childcare experience in younger maternal ages. Secondly, caregivers within adolescent age were 48% more likely to seek inappropriate care than caregivers within the 30-39 years range.

The above study further illustrated that among all children (<5 years), those within 6 to 23 months were about 3 times more likely to develop diarrhoea infection than those below 5 months and above 24 months. Before that, such relationships had been previously discovered by Rohmawati (cited in Alambo 2015, p.20) in 2007, in her study in Indonesian informal settlements. Recently, another related study revealed that under-five diarrhoea was significantly associated with children in the age group 12-23 months as compared to children above 35 months (Alambo 2015, p.20). This indicated that this age group (6-24 months) should be the target for optimal parental care and public health intervention programmes at the household level. Moreover, within this age group, children start to receive a bit of solid food instead of milk and start crawling and moving around the houses where they become exposed to contaminated materials. The WHO (cited in Mohammed & Tamiru 2014, p.6) thus recommended that in such age group, caregivers regular hygiene practices are utmost necessary as they are a great contributor to the reduction of child morbidity and mortality worldwide.

In Burundi, Africa, a community-based cross-sectional study was conducted by Diouf et al. (2014). Objectively, the study was to assess the prevalence of diarrhoea among children below the age of five years in two settlements in rural Burundi, and its associated risk factors at

the household level. A total of 551 caregivers were purposely selected in the two settlements, based on having children below five years. The recorded diarrhoea prevalence rate prior to 2 weeks was 32.6%. As reported by Diouf et al. (2014, p.5), under-five diarrhoea was associated with mothers' age below 25 years. This also indicated that the older age of caregivers had significantly reduced the occurrence of under-five diarrhoea due to increases in childcare experience in terms of hygiene habits following older ages. This relationship is also discovered by Mukiira (2012).

Another community-based cross-sectional study aimed at assessing the prevalence of diarrhoeal disease among under-five children and its associated risk factors was conducted in Wolitta Soddo Town, Southern Ethiopia. A total of 970 caregivers were systematically selected. The result of the chi-square analysis revealed that the prevalence of diarrhoea was significantly associated with the presence of two or more under-five children in a family (Alambo 2015, p.20). The same relationship was also discovered in a similar study design conducted among under-five children in Eastern Ethiopia by Alemayehu et al. (cited in Alambo, p.20); and in Indonesia by Rohmawati (cited in Alambo 2015, p.20). This showed that many infants under five years in a family implies that adequate amounts of parental support in terms of food, water and time are necessary to maintain optimum health standards for children.

In another African region, a cross-sectional study was undertaken to explore factors influencing the occurrence of diarrhoea among children (<5 years) in urban informal settlements of Korogocho, Nairobi (Ikua 2014). The target populations were women with children below five years. Three out of the nine informal settlements were purposely sampled, whereas a total of 90 mothers as responders were selected using the minimum sample size formula. Results revealed that household size was associated with the occurrence of under-five diarrhoeal disease. This relationship has been correlated with a study by Dutton & Pigolo (2014); and APHRC (cited in Ikua 2014) done in Kenya, that overcrowded, informal households had caused the high

prevalence of diarrhoea among children (<5 years). In Honiara informal settlements, the 2009 census data revealed that the average household size was 7 people, higher than the nationwide household size of 5 people (SINSO 2009). However, in PNG informal settlements, the households range in size from 1 person to over 30 people, resulting in a median household size of 8 (Dutton and Pigolo 2014). Undoubtedly, overcrowded households can exert pressure on the available social amenities and can contribute to childhood illnesses (Ikua 2014).

Many reports have shown that high household size and rapid growth of settlements in cities was due to uncontrolled rural-urban migration in search of better livelihood and opportunities (SINSO 2009; UNICEF cited in Ikua 2014; ESCAP 2015). In the Asia-Pacific region, rapid movement of rural populace to urban areas was not a recent phenomenon, but started in the last 45 years (ESCAP 2015). Koto (2001), found similar reasons in his study of the growth of informal settlements in Suva; and further evidenced in McKay (2009), Chung & Hill (2002) and Safran (2013) findings in their respective studies of the growth of informal settlements in Honiara, Port Vila and Port Moresby. Globally, about 33% of the world's urban residents were living in slums (UN-HABITAT 2009). This trend was alarming and became a major contributor to many food and water-borne disease outbreaks in the regions (WHO 2014; SIG 2014). As verified by Mohammed & Tamiru (2014, p.1), a majority of the deaths related to childhood diarrhoea in Africa and South Asia informal settlements were a result of over-crowdedness and poor living conditions.

A study in the Western Pacific Island countries like Solomon Islands and in East African countries, have explained that informal dwellers often experience inadequate social service provisions and are at high risk to communicable diseases because the growth of informal settlements is not supported by the government annual budget for social services provision (SINSO 2009; Uwizeye et al. 2014, p.2). To address this, a significant improvement of the rural-urban migration policy and contraceptives programmes is necessary.

In regard to the status of education level and under-five diarrhoea, a community-based cross-sectional study was conducted by Mohammed and Tamiru (2014, p.4) in Arba Minch District, in Southern Ethiopia, which depicted the following scenario. A total of 590 mothers were involved in the study. The result showed that maternal education had significantly influenced the prevalence of under-five diarrhoea ($p<0.05$). They further explained that children whose mothers did not attend formal education were 89% more likely to develop diarrhoea compared to those whose mothers had attended formal education. This relationship is in agreement with a study conducted by Ikua (2014). Moreover, Zahid et al. (2014, p.5), elaborated that community health education was very effective in improving mother's knowledge on diarrhoea.

Based on a cross-sectional study on health seeking behavior of caregivers, in two informal settlements in Nairobi, Africa, Mukiira (2012) found that caregivers who had completed at least primary education were more likely to seek appropriate care than those who did not complete any level of formal education. This also indicated that health education of caregivers at community level is paramount, especially to those who did not attend formal education. This is consistent with a study conducted in rural Burundi informal settlements, that lower prevalence of diarrhoea was discovered among children whose primary caregivers had received hygiene education (Diouf et al. (2014, p.5). Although there is a significant link between caregiver's education levels and under-five diarrhoea, the study also suggested that formal education alone could not reduce the incidence of under-five diarrhoea (Ikua 2014).

A majority of the reviewed studies elsewhere relating to under-five diarrhoeal prevalence and its associated risk factors had reported that household income level was directly associated with under-five diarrhoeal infection. Apart from others, this scenario has been illustrated in a cross-sectional study conducted in Nairobi by Ikua (2014). In his study, a sample of 90 households were selected representing the same number of primary caregivers with children aged

below five years. Caregivers with language barriers and guests were excluded from the study. The raw data were entered into SPSS and analyzed using chi-square statistics. The results revealed that a low level of household monthly income was associated with under-five diarrhoea occurrence ($p<0.05$); and thus had increased the chance of children infected with diarrhoea. Such a relationship is also discovered by Alambo (2015, p.19); and further in Root (cited in Ikua 2014); and Ahmed (cited in Ikua 2014) in their separate studies in Zimbabwe. Alambo (2015, p.19), expanded that children (<5 years) from households with low monthly income were more likely to have diarrhoea. It is because low household income level has always denied household members access to better social services and to afford adequate sanitary facilities and cost of medication. Arif and Ibrahim (cited in Ikua 2014) also agreed; it was further supported by Opisa et al. (2012, p.2) and Uwizeye et al. (2014, p.1), that the better the household income level, the less likely the child is to get a diarrhoeal disease. For this reason, Ikua (2014), stated that although hygiene knowledge was an important aspect of diarrhoea prevention, due to little earning of informal households, they were not in a position to buy optimum amount of water to maintain proper hygiene and to purify drinking water.

Globally, the high prevalence of diarrhoeal disease among the urban poor is rooted to the current growing inequality of income level between the developed and developing world. This had been statistically revealed in Kakulu (2012), which stipulated that more than 50% of childhood diarrhoea morbidity and mortality cases were reported from low income countries.

Among countries in the South Pacific region, like Solomon Islands, the current status of poor social services is also attributed to constraints on economic growth due to low annual GDP, plus other related factors like corruption and poor governance, land tenure issues and rise in cost of living in urban areas. This, in turn, limits the ability of national and local government to improve conditions and social services provision in urban informal settlements (UN-HABITAT 2009).

2.2.2 Hygiene knowledge and practice factors

Irregular hygiene practice among caregivers was reported in other studies in the developing regions of Africa and Asia-Pacific. In Papua New Guinea, a cross-sectional study was undertaken in 2012 to assess the WASH service delivery and hygiene knowledge and practices, among representatives of urban informal households (Dutton & Pigolo 2014). The informal settlements within Port Moresby and Wewak were included in this assessment. Port Moresby was selected because it is a capital city and home of more than 79 informal settlements, while Wewak was selected as a typical provincial township. Among the 8 selected settlements, 25 households were randomly selected from each settlement with almost equal number of male (51.5%) and female (48.5%) responders. Of the 140 under-five households, 34 of them reported diarrhoea within 2 weeks of recall, which resulted in a prevalence rate of 24.0%.

The same assessment also found that 100% of all responders had correctly mentioned one or more causes and preventions of diarrhoeal transmission. This can be categorized as an outstanding level of knowledge. Adversely, the same study found that only one third (33%) of caregivers were committed to regular hand washing, and this one third was proportionated to the number of households with a place to wash hands. Inadequate access to hand hygiene facilities could also contribute to a wider gap between hygiene knowledge (100%) and practice (33%) in PICTs like PNG. This further agrees with a statement by Ikua (2014), in his study in the Africa region, which revealed that having good knowledge on diarrhoea will not completely prevent a child from diarrhoeal disease. On the other hand, in the context of informal settlements, a place to wash hands normally refers to either a yard tap or bucket of water outside, which may or may not have soap. Thus such facilities were not 100% protective against diarrhoeal-pathogen transmission.

Globally, hygiene behavior was also poorly practiced. This was verified by Freeman et al. (2014, p.6), in their 43 systematic reviewed studies worldwide, to estimate the global prevalence

of hand washing with soap and its effects on diarrhoeal disease. They concluded that only about 19% of the world population washes their hands with soap after contact with excreta.

This is of great concern, since many studies in urban informal communities had explained that irregular hand washing practices by caregivers was strongly associated with under-five diarrhoea (Kakulu 2012; Mukiira 2012; Ikua 2014; Mohammed & Tamiru 2014, p.4). This implies that poor hand hygiene is a major contributor to under-five diarrhoeal infections. Poor hygiene practice, combined with other physical and/or environmental factors (e.g. inadequate sanitation), may increase the prevalence of under-five diarrhoea among poor urban households (Lubaale & Musyoki; Tsinda & Abbott, cited in Uwizeye et al. 2014, p.7). For this reason, Freeman et al. (2014, p. 6) had pointed out that regular commitment to hand washing with soap, will lower the risk of diarrhoeal infection by 60%. This also agrees with Mohammed & Tamiru's (2014, p.4) findings, which showed that the risk of developing diarrhoea was about 2 times higher among children (<5 years) whose mothers had poor hand washing practice. Due to overwhelming benefits of frequent hand hygiene practice in childhood disease prevention, the WHO published a hand washing guideline in 2008 as a guide for member countries (WHO 2009).

Though regular hand hygiene is extremely beneficial in disease prevention, hygiene knowledge cannot be undermined. Mukiira (2012), found that education level had influenced the health seeking behavior of mothers, while Diouf et al. (2014, p.1) concluded that hygiene knowledge can reduce under-five diarrhoeal prevalence, and thus called for regular hygiene education targeting mothers at community level.

Regular treatment or boiling of drinking water for children (<5 years) was reported in other studies to be directly associated with under-five diarrhoea ($p<0.05$). This scenario was evidenced in a community-based cross-sectional study conducted in Korogocho informal settlements, in Nairobi. The 2 weeks' recall diarrhoeal prevalence rate was 35.6%, higher than

earlier estimated (31%) by AMREF in 2002 and APHRC in 2006 (Ikua 2014). This was not only discovered by Ikua (2014), but such a relationship is also cited in Diouf et al. (2014, p.1). According to the UN World Water Development Report (2009), access to safe and clean water supply is universally recognized as a basic human need. Diouf et al. (2014, p.1) and Ikua (2014) were in agreement and suggested that in the context of urban deprived settings, regular boiling of drinking water is an easy and economical approach to reduce the prevalence of this disease.

Despite the WHO recommendation on regular treatment of drinking water, however, not all informal households treated water collected from untreated taps and other sources before drinking (Wilson 2013; Ikua 2014; Uwizeye et al. 2014, p.7; Dutton & Pigolo 2014). This has highlighted a deliberate need for continuous awareness and advocacy programmes in regard to regular water treatment through boiling at informal household levels.

It also reported that the regular cleanliness of a toilet facility is poorly practiced in urban informal settlements in the developing regions of Africa and Asia-Pacific. In the Africa region, a cross-sectional study in Korogocho informal settlements has illustrated this scenario. Of the 90 responders, a majority (61.9%) did not regularly clean their toilet facility. The given explanations were due to high costs incurred to pay the workers to clean them, high costs of the water bill and ignorance. Within 2 weeks of recall, the study found that above half (71.9%) of all caregivers whose children (<5 years) had diarrhoea were those who had failed to regularly clean their toilet or latrine, although such difference was not statistically significant ($p>0.05$).

In the Western Pacific region, another similar study design was conducted in PNG informal settlements (Dutton & Pigolo 2014). The study revealed that most (63%) of the responders had failed to regularly clean their toilets and one of their reasons was they had experienced poor water service, though their toilets had caused health problems to their neighbors. Another reason was that the responsibility of cleaning the toilet was not a specific delegated role to any particular gender, though females often committed to it at household level.

An in depth interview in this scenario was done and 70% of responders thought that it was an adult female responsibility whereas 30% thought that it was an adult male responsibility. When conflicts of responsibility occurred, it resulted in the irregular cleanliness of a toilet facility. To prevent the occurrence of this disease, regular cleanliness of a toilet facility is paramount as bad smells and overflowed latrines during heavy rain may bring faecal waste near under-five households (Dutton & Pigolo 2014; Uwizeye et al. 2014, p.7).

Other studies had reported that open defecation has been practiced globally. According to the WHO, about 15% (n=1.1 billion people) of the global population have practiced open defecation (WHO 2016). This is quite possible because about 2.5 billion people worldwide still live without improved sanitation facilities (WHO/UNICEF 2009; CDC 2015); and a majority of them are in developing regions like sub-Saharan Africa (31%), Southern Asia (33%) and Eastern Asia (65%). As shown in the WHO and UNICEF joint monitoring report (WHO 2016), India accounted for the highest population of open defecators, which accounted for more than half (59%) of the 1.1 billion of open defecators worldwide.

This unhygienic practice is also practiced in many PICTs. In early 2012, a WASH service assessment was conducted in PNG urban informal settlements, and the result revealed that defecating in the open was reported to be widely practiced among household members (Dutton & Pigolo 2014). In Solomon Islands, the result of the 2009 Population & Housing Census revealed that one third (33%) of urban households did not have access to any toilet facility, therefore they used the river, sea, beach or nearby land. In regard to disposing of children's' stool, the nation-wide DHS Report showed that only 29% of children's stools were disposed of hygienically (in toilet or buried) (SINSO 2007). Comparatively, children's stools were more likely to be disposed of safely in urban areas (81%) than in rural areas (19%).

The high rate of open defecation is alarming and should be regarded as a matter of great concern for sectors responsible. Secondly, such practice has provided opportunities for flies to

land on faeces and then food (Water-Aid 2008; WHO 2009; Ikua 2014). In 2012, the World Health Report illustrated that 88% of childhood diarrhoeal deaths worldwide were due to drinking contaminated water, contaminated by faeces from hill sides and nearby land during heavy rain.

2.2.3 Environmental factors

Studies in the regions had reported the link between under-five diarrhoea and environmental factors; and the importance of addressing environmental factors to interrupt the pathway of disease transmission.

In the African regions, the association between under-five diarrhoea and environmental factors was illustrated in studies conducted in the years, 2011, 2012, 2014 and 2015. The authors argued that domestic water sources, which had been contaminated with faecal waste, agricultural activities and unsustainable economic activities like logging and mining were associated with under-five diarrhoea (UNICEF 2011; Kakulu 2012; Ikua 2014; Uwizeye et al. 2014, p.7). Along with that, food-crops were being irrigated using contaminated water, and fish and seafood being collected from polluted water, also contributed to diarrhoea (McMurray 2005, p.12; Kakulu 2012).

A previous study by Uwizeye et al. (2014,) in the mountainous informal settlements of Huye town, Rwanda, elaborated on this scenario. Objectively, the study was to determine the prevalence and correlates for diarrhoea in the informal settlements during wet and dry seasons. The household was used as a basic unit of analysis rather than individuals. A total of 214 households were randomly selected, and study variables were gathered using structured questionnaires and transect walks. The altitudes and distance of households to the main road were captured using GPS technology, a laser distance meter and a compass. The result revealed

that poor sanitation within and around homes was significantly associated with diarrhoeal prevalence; and was higher during the wet season (55.1%) than the dry season (24.3%).

The same study reported that quality of toilet facilities, presence of stagnant water, flies and scattered solid waste near households were also directly associated with diarrhoeal prevalence in either season ($p<0.05$). This is in agreement with a finding by Ikua (2014) in Nairobi; other studies which reported that the presence of flies near households due to uncollected garbage plus the presence of faecal waste on footpaths were associated with under-five diarrhoeal infection (Water-Aid 2008; Girma et al. 2008, p.44; Lopez & Murray cited in Ikua 2014). Girma et al. (2008, p.44), expanded that children (<5 years) from households in which feces were seen around the pit hole/on slab were 3 times more likely to have diarrhoea compared with children (<5 years) from households without observed feces on pit holes. Further, households using fairly improved and households using modern toilet facilities were 50% and 60%, respectively, less likely to experience diarrhoea in either wet or dry seasons, compared with households using traditional pit toilets (Uwizeye et al. 2014, p.9).

In terms of accessing and ownership to any toilet facility, the previous studies in this review had reported that they were not directly associated with under-five diarrhoea (Uwizeye, et al. 2014, p.9; Ikua 2014; Diouf et al. 2014, p.5). In addition, a cross-sectional study in rural Burundi revealed that access to an improved water source was not significantly associated with under-five diarrhoea prevalence (Diouf et al. 2014, p.5). Such insignificant association ($p>0.05$) was further evidenced in Girma et al. (2008, p.44); despite of the fact that about 88% of diarrhoea cases worldwide were related to unimproved access to a clean water source (WHO cited in Kakulu 2012; WHO/UNICEF 2009; Kakulu 2012).

Studies in Africa and Pacific regions found that households' altitude was associated with disease prevalence like diarrhoea (Lau et al. 2012, p.6; Uwizeye et al. 2014, p.6; Dutton & Pigolo 2014).

In the African region, this scenario was well explained by Uwizeye et al. (2014, p.6) in their study in Rwanda's mountainous informal settlements. Based on 2 weeks' recall, they found that 76% of all reported diarrhoea cases were accounted for in households located in low altitude areas (≤1700 m, above sea-level), though most (93.9%) of the households were located in high altitude areas (>1700m, above sea-level). A community woman, aged 60 years, explained how faecal waste was brought to households in low altitude areas which I quoted. "During the December rainy season, the runoffs invaded our home and collected all types of waste. It even invaded my toilet and those of my neighbours" (Uwizeye et al. 2014, p.7). This is consistent with other studies which reported that the poor sanitation status and inadequate waste management during heavy rain and flooding season in urban informal settlements are factors associated with childhood diarrhoea (Kulabako; Saha; and UN-HABITAT cited in Uwizeye et al. 2014, p.7); and also supported by Karangwa (cited in Uwizeye et al. 2014, p.7) in his related study. Hohne (cited in Uwizeye et al. 2014, p.8) added that poor drainage systems had led to the accumulation of a mixture of waste carrying diarrhoeal pathogens to lower altitude areas.

The above association was also evidenced in studies conducted in countries in the Western Pacific region. In PNG informal settlements, the pit latrines were overflowing during the heavy rainy season causing a high accumulation of solid waste and diarrhoeal pathogens around the houses in the lower areas. In a similar cross-sectional study to estimate the leptospirosis seroprevalence in American Samoa, Lau et al. (2012, p.6) also found that altitude and location of backyard piggeries were significantly associated to leptospirosis seroprevalence, and regarded as useful variables to identify high risk areas of leptospirosis occurrence; and to implement possible public health intervention.

Comparatively, this indicated that informal households built in high altitude areas are less likely to experience diarrhoea outbreaks than those in lower altitude areas. This also showed the

deliberate need to improve WASH and drainage system facilities among households in lower altitude areas as suitable approaches to reduce the spread of this disease.

Further, substantive findings which unfolded the true status about WASH facility services among the rural and urban rich and poor, were revealed in studies conducted in developing regions of Africa, India and Asia-Pacific. This variation is a barrier to attain equal child-health standards across the globe.

Globally, nearly 2 billion people are currently without better water and sanitation facilities, and many of them in developing countries (Curtis et al. 2000, p. 9; UN World Water Development Report 2009; Opisa et al. 2012, p.2). In the last 7 years, the WHO and UNICEF estimated that people worldwide, without improved sanitation facilities, was about 2.5 billion and those without good access to safe drinking water was about one billion people. This figure (about 1 billion) was almost equal to what was recently reported by CDC (2015). Further, as revealed in WHO and UNICEF (cited in CDC 2015) the regions with the lowest coverage of improved sanitation were sub-Saharan Africa, Southern Asia and Eastern Asia. This had led to the statement by the worlds' leading children rights organization, UNICEF, in working in 190 countries and territories, which stated that the rights of children (<5 years) to access better health services had been denied in these regions.

In India alone, 97 million people were without access to improved drinking water, second to China (WHO 2016). Regionally, water and sanitation accessibility is regarded as one of the annual PICTs health sector priorities due to their importance as child-health determinants and their current low coverage level in the region. In a study to assess the water situation faced in PICs informal settlements, Wilson (2013) concluded that most Pacific women are frequently faced with water shortage problems.

In PNG, it had been reported that most toilets (85%) used by households in slums were simple dry pit latrines. As a result, 80% of all children (<5 years) had practiced open defecation

since they cannot use the pit latrine by themselves (Dutton & Pigolo 2014). Not only in PNG, but also in Solomon Islands, sanitation coverage was only 32%, while the regional average was 46%. This situation is tragic among urban informal households in which very few households were found to have access to flush toilets (2%), whilst the majority (55%) are without access to any toilet facility (SINSO 2009).

Regarding access to safe drinking water, it was also reported low among PICTs. In Vanuatu and Solomon Islands about 15% and 67%, respectively, of households were without good access to clean and safe water sources. This indicates that these households (15% vs. 67%) depend largely on untreated communal stand-pipes, unprotected wells, river/lake, spring or bore (Census data cited in UNICEF 2011; SINSO 2009). This situation is relatively high in urban informal settlements in PICTs. Further reports revealed that among informal households along the Mataniko River corridor in Honiara, 80% of them hardly have access to a safe water supply (SINSO 2009).

Studies illustrated that informal households were often built on areas prone to diarrhoeal disease transmission. In PICTs urban areas like Nuku'alofa, Suva and Lautoka, squatter settlements are located on former mangrove swamps, leaving people vulnerable to storm flooding, water borne diseases and sanitation problems. In Port Moresby, Madang and Honiara, informal settlements are located on town garbage dump sites, steep slopes, near rivers and coastal areas (SINSO 2009; UN-HABITAT 2010; Singh 2011, p.1; UN-HABITAT 2012).

Moreover, most urban informal houses in Solomon Islands are non-permanent and semi-permanent building structures, built without municipal approval, without access corridors and without basic services (UN-HABITAT 2012; SIG 2014). This poor standard of building, combined with the location of some households on steep slopes and near rivers creates major health risks (Wilson 2013; SIG 2014). For this reason, a few days after the 2014 Honiara-

Mataniko river flash floods, a severe diarrhoea outbreak occurred, which claimed 16 lives and more than 1000 morbidity cases among children (SIG 2014; WHO 2014).

With the above overwhelming evidences, addressing the environmental determinants associated with under-five diarrhoea should be regarded as one of the priority agendas of responsible government and public health sectors.

2.3 The impacts of diarrhoeal disease in the health of children (<5 years)

Diarrhoeal disease continues to impact the life of many under-five children worldwide, though it is highly preventable. It was previously reported that around 6 million children (<5 years) suffered with diarrhoea each year (UNICEF/WHO 2009); and more than half of the annual reported diarrhoea cases were from developing regions in Africa and South Asia, where childhood diarrhoea is more likely to result in death (WHO/UNICEF 2010). Furthermore, a Weekly Epidemiological Report by Palihawadana (2011), showed that most children who had died from diarrhoea were mainly due to severe dehydration and fluid loss.

However, childhood diarrhoea is more deadly when it is associated with other health complications and illnesses. For children with HIV, the death rate is 11 times higher compared with children without HIV (CDC 2015). Another report revealed that when it is combined with pneumonia, the annual mortality rate was 40% higher than children who suffered with diarrhoea alone (WHO/UNICEF 2009); and thus was termed as "The Fast Forgotten Killer of Children" worldwide. Palihawadana (2011), added that malnourished children were also at high risk of dying when infected with diarrhoea because they could not resist the infectious agents due to their weak immune system. In Solomon Islands, 1 in every 10 children was malnourished and more than 4,000 children were suffering from measles (MHMS 2016).

As shown in other studies, poverty was believed to be a root cause of poor child health all over the world, which had caused children to be socially, economically and environmentally

vulnerable to dangers (Lucy et al. 2012; Mohanty 2007). It also reported that children residing in the poorest 20% of all households worldwide were far more likely to die before their fifth birthday than those living in the richest households (UNICEF 2012). In fact, millions today are living in urban slums all over the world (The State of the World's Children 2012; Lake cited in UNICEF 2012). Jones (2012, p.1), argued that out of all the MDGs targets, minimal support had been provided to improve the health of children (<5 years) living in slums. This indicated an urgent need for WHO and UN member countries like Solomon Islands, to recommit themselves to UN goals which are subjected to the health of children and mothers. Ongoing education and advocacy programmes among primary caregivers are of utmost necessity.

2.4 Commitments to improve the health of children (<5 years)

The right of children (<5 years) to survive and their health was previously incorporated into the United Nation MGDs and was re-emphasized in the SDGs (Jones 2012, p.1; UNDP undated). This initiative had also been supported by recommendations from other studies, which argued that under-five children in urban slums were a vital component of the city's permanent population, and therefore their socio-economic status is equally important to everybody else; as it has the potential to influence the status of health care systems within each country (McMurray 2005, p.2; Dutton & Pigolo 2014).

Furthermore, WHO has entrusted the national health sector in each country (with partners) to oversee and be responsible for the provision of adequate child-health services. Within each country, such commitment was also stipulated in the Health Act, which has coincided with the World Health Regulation and Legislation. In Solomon Islands, section 10 of the Health Services Act enables the Health Ministry to work with Provincial Assemblies and HCC to undertake related public health services; and section 13 is to make the same arrangements with faith-based organisations and voluntary bodies (JTAI cited in MHMS 2011).

The political endorsement of World Health Treaties by members of the WHO is part of the above commitment. Regionally, in 2015, during the 11th Pacific Health Ministers Meeting, the leaders of countries within the Western Pacific region, including Solomon Islands, had reaffirmed their commitment through the Yanuca Island Declaration 1995, based on the Healthy Island Settings initiative. One of the primary focuses was on the health of children and mothers. The WHO/SPC (2015) had explained that this can be achieved through active participation in making an island a friendly setting for children, to nurture in body and mind. Creating a child- and mother-friendly environment, with supportive facility and policies, are important to improve child-health. Based on this initiative, world health leaders themselves also agreed that the global and regional burden of under-five diarrhoea cannot be fully addressed without such a supportive mechanism (WHO 2014).

Regional bodies like the WHO, UNICEF and SPC have continually supported member countries to prevent the spread and burden of diarrhoeal disease through the establishment of guidelines and action plans. This includes the inclusion of rotavirus vaccines as one of the necessary components of WHO and UNICEF's Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD); and also one of the key elements of the WHO Global Vaccine Action Plan, which was endorsed by 194 member states (Johns Hopkins University 2013).

Further commitments had also been reported in PICTs. In Solomon Islands, it has been stipulated in its recent health sector strategic plan 2016 to 2020, the importance of child survival, especially children in the disadvantaged communities, remote-ness and hard to reach areas" (MHMS 2009; MHMS 2016). This has coincided with the Solomon Islands Health Act 2010 (MHMS 2014).

CHAPTER 3.0: PROBLEM STATEMENT, OBJECTIVES AND METHODOLOGY

3.1 Introduction

This chapter briefly describes the burden of, and reasons why, diarrhoea is a major public health problem among children below five years of age in Solomon Islands. It also outlines the research questions and objectives; and explains the significance of this study in answering them. It further discusses an overview of the study area, study type, variables and major data sources; plus the technique and instrument used to collect the study variables and how the data was analyzed, processed and interpreted. It then concludes by explaining the ethical procedures involved to implement this study and to report the findings.

3.2 STATEMENT OF THE PROBLEM

Childhood diarrhoea is among the leading causes of infant mortality in Solomon Islands (Mckay 2009; MHMS 2009); which resulted to about 1 in every 10 children dying before the age of five years (MHMS 2010). It was also confirmed by Chiller et al. (2005), that Solomon Islands recorded the highest diarrhoeal disease cases among children (<5 years) as compared to the nine PICs with available data, and this accounted for half (8,437/16,954) of the overall morbidity cases of the year. As further evidenced in SINSO (2007), more than 65% of children below five years were at high risk to this disease.

This epidemiologic situation is tragic and spotted an urgent need for wider sector approaches to health promotion and prevention intervention at community level among caregivers. The deliberate action by responsible sectors to improve WASH facility coverage in urban poor setting is very important approach to reducing the gap between hygiene knowledge and practice level.

Nevertheless, it had been reported that total WASH coverage was a bigger challenge faced by responsible sectors due to the current population growth. A benchmark of 70% nationwide coverage was set in 2011 (MHMS 2011); however, 35% of the city's populations resided in urban informal settlements, are still facing the health consequences of inadequate water supply and sanitation (Wilson 2013).

Another challenge is lack of documented findings regarding the burden and prevalence of under-five diarrhoea in informal settlements. By identifying this gap and its influential factors, it will promote informed decision making practices and possibly reduce the risk factors.

3.3 RATIONALE

This study has identified factors which are associated with under-five diarrhoeal prevalence. The study outcome may contribute towards activities of public health sectors and other sectors with similar interests in identifying, managing and addressing public health determinants. In addition, it will guide policy makers to tailor their approach according to the identified exposures.

The intended users and implementers of the survey results will be the Solomon Islands MHMS, Honiara City Council (HCC), National Environmental Health Division (NEHD), the Solomon Water Authority (SWA), and Solomon Islands Ministry of Lands, Housing and Survey (MLHS). The findings will guide them to work towards short and long term strategic plans aimed at addressing issues relating to child-health, such as water and sanitation services. Specific findings and recommendations therein are important to support the work of health promotion division and other community-based organizations in terms of education, advocacy and policy development.

Furthermore, the unknown prevalence rate of under-five diarrhoea in Honiara informal settlements has also added value to this study and the need for other future studies. In this study,

the under-five age group is used because children within this age range require parental support. Secondly, 3-4 years is the beginning of school enrolment age. Also, many studies have focused on children under five years and thus baseline literatures is often available.

3.4 RESEARCH QUESTIONS

1. What is the prevalence of diarrhoea among children (<5 years) in Mataniko informal settlements, in Honiara, Solomon Islands, in 2016?

2. Which socio-demographic, knowledge and practice, and environmental factors are associated with diarrhoea prevalence among children (<5 years) in Mataniko informal settlements, in Honiara, Solomon Islands, in 2016?

3.5 STUDY OBJECTIVES

3.5.1 General objective

To explore the relationship between socio-demographic, knowledge and practice, and environmental risk factors in relation to under-five diarrhoea prevalence in Mataniko informal settlements, in Honiara, Solomon Islands, in 2016.

3.5.2 Specific objectives

3.5.2.1 To explore the relationship between socio-demographic factors and under-five diarrhoea prevalence.

3.5.2.2 To examine the relationship between knowledge and practice factors and under-five diarrhoea prevalence.

3.5.2.3 To assess the relationship between environmental factors and under-five diarrhoea prevalence.

3.6 METHODOLOGY

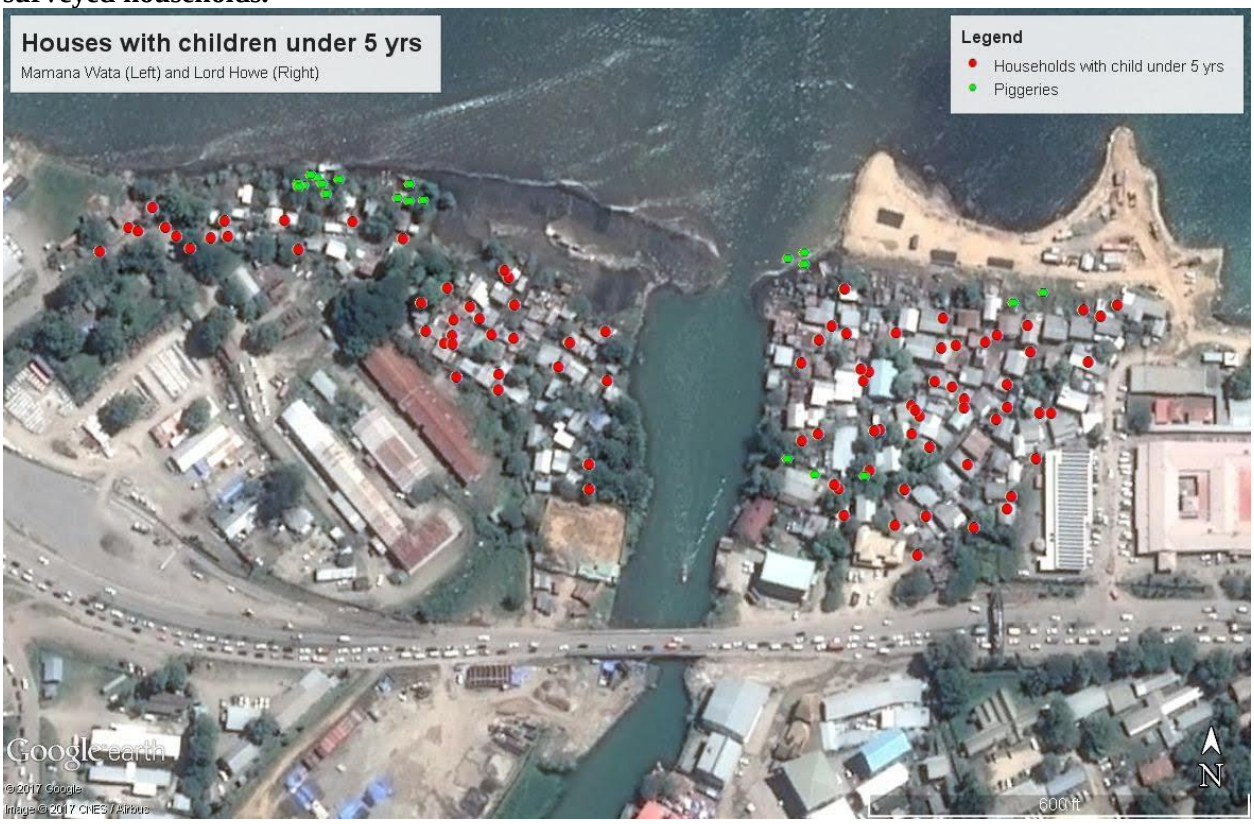
3.6.1 Study Area

This study was conducted at three (3) Mataniko informal settlements, namely Mamana Wata, Lord Howe and Koa Hill (refer to figures 2-3) situated along the Mataniko River corridor, in Honiara, Solomon Islands from June to July 2016. Honiara is the capital city of Solomon Islands, located on the island of Guadalcanal with an estimated population of 64,609 people, as of 2009 census (SINSO 2009; UN-HABITAT 2012).

There are 38 informal settlements located within Honiara's town boundary, of which 6 are situated along the Mataniko River corridor, a well-known flood prone area which is ill-suited for human habitation. Due to uneven distribution of social services between the urban rich and poor residents, dwellers of these settlements lack many of life's basic necessities, such as improved water and sanitation. Besides that, these settlements often lack these basic services because they are classified as informal, built without the approval of the town planning authority (UN-HABITAT 2012; Wilson 2013). This has caused under-five children in these settlements to be at high risk to diarrhoeal disease transmission.

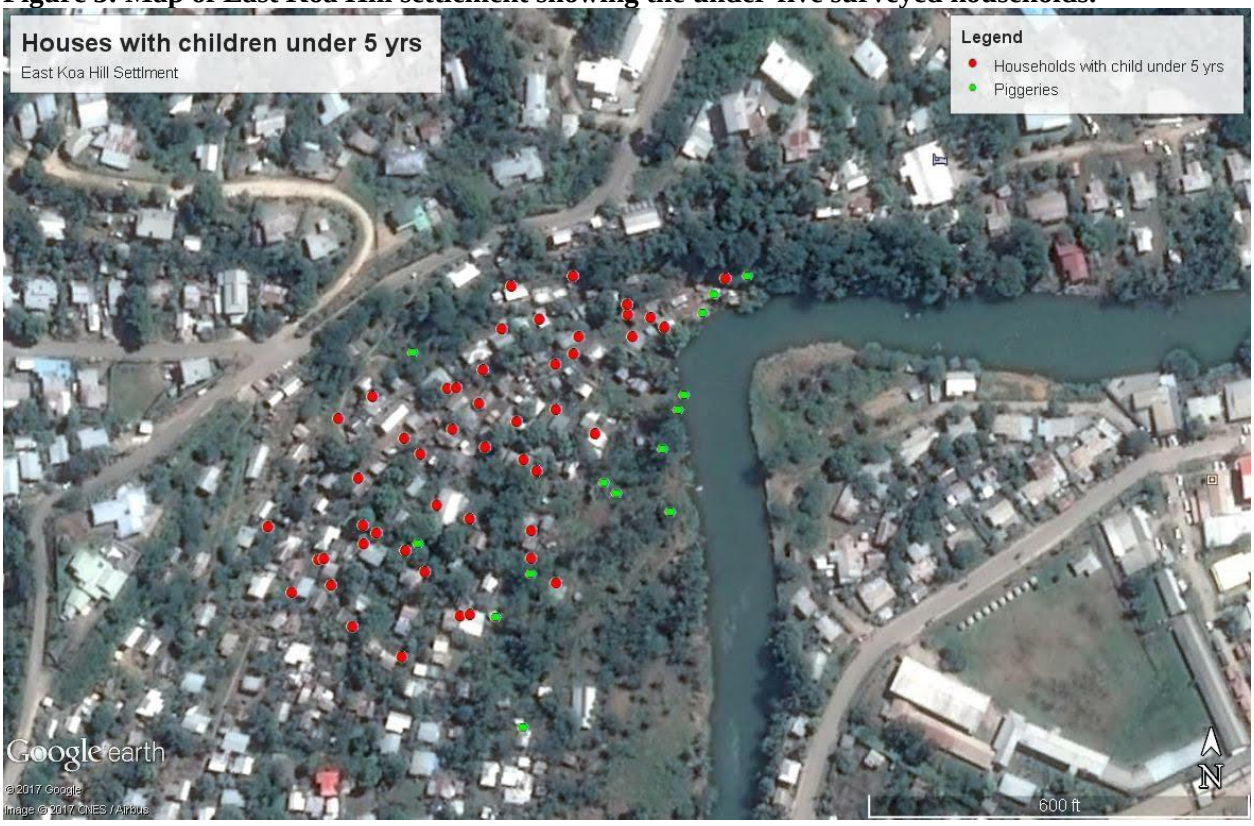
As a daily practice, settlers and business houses along the river corridor have continuously used the river as a garbage dumpsite for solid and liquid waste. Human and animals have also defecated directly into the river on a daily basis. In terms of child health care services, under-five children are often taken to Mataniko clinic and National Referral Hospital (NRH), the two nearest health facilities.

Figure 2: Map of Mamana Wata (left) and Lord Howe settlement (right) showing the under-five surveyed households.



Source (Figure 2-3): Researcher

Figure 3: Map of East Koa Hill settlement showing the under-five surveyed households.



3.6.2 Study design and variables

A cross-sectional study was conducted among caregivers to assess factors which are associated with under-five diarrhoea prevalence. The dependent variable is the occurrence or prevalence of diarrhoeal disease among under-five children within 2 weeks.

In this study, some households have more than one caregiver and also some caregivers have more than one child (<5 years). In the analysis, a caregiver with more than one child was treated the same as a caregiver with only one child. This indicated that there was only one child (<5 years) per caregiver in the analysis. However, in a situation where a caregiver had 2 or more children (<5 years) and only one experienced diarrhoea, the case-child was considered in the analysis.

The independent variables are *socio-demographic* (age, sex, locality, number of under-five children, household size, education and income level), *knowledge and practices* (causes and prevention of diarrhoea, hand hygiene practice, treating or boiling drinking water, cleaning the toilets, ways of disposing solid waste, and domestically using the river) and *environmental variables* (status of WASH facility, observed stagnant water, flies, solid waste, and altitude and distance of under-five households to the river).

The categorical independent variables are defined in Table 1.0 below.
U5_hlds=Under-five households

Table 1.0 Classification and description of categorical independent variables.

Variables	Category	Main description/definition
SOCIO-DEMOGRAPHIC		
Household size	Big	6 or more people as permanent residents.
	Small	5 people or less as permanent residents.
Education level	High	Upper secondary (Form 4 - Form 7) and tertiary level.
	Low	Primary and lower secondary (Form 1 - Form 3).
	No-education	Never attended or completed formal education.

3.6.3 Study period and target population

Fortnightly income level	High Low	Income above $1500 (>$1500 SBD). Income equal to $1500 or less (≤$1500 SBD).
KNOWLEDGE & PRACTICE		
Knowledge	Have knowledge Did not have knowledge	Able to know at least one possible cause and prevention of diarrhoea. Unable to know any possible cause and prevention of diarrhoea.
Methods of disposing of child feces	Appropriate Inappropriate	Disposed child feces in toilets or bury. Disposed child feces in open-yard, river or sea.
Methods of disposing solid waste	Appropriate Inappropriate	Disposed solid waste in government bin, bury or burn. Disposed solid waste in backyard, river or sea.
Caregiver seeking behavior	Appropriate Inappropriate	Able to initially seek a care professional when children (<5 years) got diarrhoea. Unable to initially seek a care professional when children (<5 years) got diarrhoea.
ENVIRONMENTAL		
Water sources	Safe Unsafe	Chlorinated/protected source (SIWA metered stand-pipe, water tank and shop water). Unchlorinated/unprotected source (communal stand-pipe, well and river).
Toilet facility (quality)	Good facility Poor facility	Flush/modern toilet with running waste system. Water sealed/latrine toilets without running water system.
Toilet facility daily use	High Low	≥5 people have used any toilet facility per day ≤4 people have used any toilet facility per day
Altitudes (m) of u5_hlds	High altitude Low altitude	20 meters or more, above sea-level. 19 meters or less, above sea-level.
Distance (m) of u5_hlds	Near Far	A distance of 124 meters or less to the river. A distance of 125 meters or more to the river.

The study was conducted from June to July 2016. The target population was caregivers.

In this study, caregiver refers to a man or woman who is responsible for taking care of a child below five years of age every day.

3.6.4 Sampling methods

Table 2.0 Population and household distribution based on 2009 census data estimates.

Code #	Name of	Population	Number of

	settlements		households
1	Koa Hill*	1,166	167
2	Aekafo	715	102
3	Cana Hill	697	100
4	Mamana Wata*	230	33
5	Gegema	456	65
6	Lord Howe*	524	75
	Total	**3,788**	**541**

*Randomly selected settlements

In this study, three settlements were randomly selected from the six settlements. All under-five households in each settlement were purposely selected based on having at least one child below five years of age. Every caregiver in each household was interviewed after obtaining his or her consent.

Initially, Koa Hill settlement was supposed to be completely covered. However, due to other unexpected situations, only caregivers in East Koa Hill were part of the interview process. One foremost important reason was for safety since we had noticed that some households were involved in illegal drug, or home-brewery production and distribution locally, termed as kwaso, as a form of household earning. The fear of being wrongly interpreted as law enforcers was also high among researchers. Though community elders were well informed, to maximize the safety of researchers and data quality we deliberately forfeited the western side of the settlement. This situation could have been minimized if we had adequate funds to recruit any community elder as a tour guide. On the other hand, covering East Koa Hill alone did not cause any discrepancy because the surveyed under-five households in East Koa Hill still dominated the under-five households in either of the other two settlements.

3.6.5 Data collection methods

Two Research Assistants (RAs) were recruited and trained to assist with the household interview process. The key agendas of RA's training were methods and procedures of conducting

household interviews, filling survey forms and understanding the types of variables for investigation.

A voluntary informed consent was issued to each child's caregiver. However, those who were not willing, and others unable to participate due to reasons like language barrier or regarded as guests in the house, were excluded in the study. A callback visit was made for caregivers who were not available in the first household visit.

Instruments employed to collect the independent and outcome variables were Global Positioning System (GPS) Technology and structured questionnaire (refers to Appendix 3). A pilot testing exercise was carried out to validate the data collection forms prior to the actual survey.

The outcome variable was collected based on a 2-week recall on diarrhoea episodes. A recall period less than a month is sufficient to resemble good memory and limit recall bias rather than longer recall periods (Smith & Subandoro 2007). Also, using a 2 weeks' recall has a potential to obtain at least 1 or more diarrhoea case rather than using a 1 week recall. Furthermore, 100% of reviewed articles in this study had used 2 weeks' recall, which provided a baseline for comparison.

To avoid double-counting, each surveyed household was geo-referenced (assigned *x* and *y* coordinates and a unique code number) using GPS.

The definition of diarrhoea was translated and defined to caregivers using a well-known Pidgin English, as to maintain the original meaning and to minimize the over counting of cases.

As part of the duty of care while in the field, the RAs were also trained to handle other unexpected health related situations. These included providing advice on home management of childhood diarrhoea to caregivers whose child was currently suffering with diarrhoea and also the administration of ORS. Moreover, households with children who had diarrhoea and were unable to participate were noted for re-visit.

3.6.6 Statistical tests

The raw data collected were entered into the SPSS software for data cleaning and analysis. In univariate analysis, the categorical variables were displayed as counts and percentage and continuous variables were expressed as mean ± standard deviation. For bivariate analysis, binary logistic regression was used to measure the strength of association between under-five diarrhoea and the independent variables by calculating the odd ratios (OR) and 95% Confidence Intervals (CIs). A *p-value* less than 0.05 was considered as statistically significant ($p<0.05$).

3.6.7 Ethical consideration

The College of Medicine, Nursing and Health Sciences (CMNHS) Research and Ethics Committee, of the Fiji National University (FNU) and the Solomon Islands Ministry of Health (SI-MoH) Research and Ethics Committee officially approved this study. Permission was further granted by the Director of NEHD and NHPD to conduct the study in Honiara.

Effort has been made to ensure the confidentiality of collected data. Confidentiality on data storage and usage includes the issue of a unique code number to each participant instead of his or her name. All hard and electronic copies of the data have been stored in a secured place and are only accessible by the principal investigator and supervisors.

Participation was voluntarily and the overall purpose of the study was well explained to caregivers. Voluntary participation was well stated in all surveyed forms (questionnaire, introduction script, consent form) and a request letter was given to community leaders. In addition, this study was also scheduled at their best time, which resulted to 100% response rate.

The research team was also obligated not to give promises to participants in either goods or cash as incentives to participate. Self-leading answers from field staff was prohibited and strictly excluded pieces of information in the analysis.

To maintain a relationship, the community standard protocol and procedures of asking direct and in-direct questions were well considered and also part of the field RAs' training.

CHAPTER 4.0: RESULTS AND DISCUSSION

4.1 Introduction

This chapter gives a description of the main univariate and bivariate analysis results plus the under-five diarrhoea prevalence rate within 2 weeks prior to the survey. Results have been displayed in the form of counts and percentages. The study objectives are mostly answered by the bivariate analysis in the results section, whereby factors associated with the health outcome (under-five diarrhoea) have been determined and explained based on odds ratio (OR) with 95% confidence intervals and assigned a significant level ($p<0.05$) result. However, in depth discussion and comparison of the results with previous studies elsewhere have been covered in the discussion section.

4.2 RESULTS

A total of 205 caregivers with at least one child under-five years participated in the study. The results are displayed in the following tables: Table 3-9.

4.2.1 Univariate Analysis

4.2.1.1 Socio-demographic charateristics of under-five children and caregivers

The demographic characteristics were age, gender, household size, locality, usual place of residence and the number of years each caregiver lived within the settlements. These are summarized in table 3.

The mean ages of caregivers and the children (<5 years) were 30.7 (±8.2SD) years and 2.6 (±1.5SD) years, respectively. This indicated a high concentration of younger caregivers as well as younger children. The majority of caregivers were female (95.0%) and were the mothers of the children. Nearly half (41.0%) of the caregivers had 2 children or more below five years of age. In comparison to caregivers by locality, there was little discrepancy. However, participants

from Koa Hill (38.0%) had outnumbered Lord Howe (37.6%) and Mamana Wata (24.4%); and a majority (79%) of them had resided for more than 5 years in their respective settlement.

The average household size was 7.9 (± 2.5SD); and most (79.5%) of the caregivers resided in over-crowded or big household size. In terms of formal education, 84.4% of caregivers had completed formal education and many were within low the education category (78.6%). Furthermore, everyone had reported at least one source of income. Comparatively, many had depended on wages/salary (30.1%) and market vendors (54.7%) as major sources of household earning. In regards to fortnightly income level, only 9.8% accounted for high income level.

Table 3: Demographic characteristics of under-five children and caregivers

4.2.1.2 The under-five diarrhoea prevalence

Variables	Category	Frequency (N=205)	%
Age of child (in years)	≤2	120	58.5
	3-5	85	41.5
Age of caregiver (in years)	≤29	101	49.3
	≥30	104	50.7
Sex of caregiver	Male	10	5.0
	Female	195	95.0
Locality (settlements)	Mamana Wata	50	24.4
	Lord Howe	77	37.6
	Koa Hill	78	38.0
No. of years lived in Mataniko IS	<12 months	12	6.0
	1-2 years	16	8.0
	3-5 years	16	8.0
	>5 years	161	79.0
No. of u5 children per caregiver	1 child	121	59.0
	≥2 children	84	41.0
Household size	Small	42	20.5
	Big	163	79.5
Formal education level	No-education	32	15.6
	Low	136	66.3
	High	37	18.0
Fortnightly income level	Low	182	88.8
	High	23	11.2

Results in table 4 reveal that 45.9% of all caregivers had reported that their children (<5 years) had suffered with at least one episode of diarrhoea within the last 2 weeks prior to the study. This prevalence rate (45.9%) was exactly five times higher than the national under-five diarrhoea prevalence rate (9.4%) reported by the Solomon Islands National Statistics Office in 2007.

Table 4: Under-five diarrhoea occurrence within 2 weeks prior to the survey

4.2.1.3 Knowledge and practice characteristics of caregivers

Variable	Response	Frequency (N=205)	%
Diarrhoea occurrence	Yes	94	45.9
within 2 weeks	No	111	54.1

Table 5 summarizes the knowledge and practice characteristics of caregivers. It demonstrates that the caregiver's knowledge was extremely high in regard to the causes (99.0%) and prevention (98.0%) of under-five diarrhoea, as well as knowledge concerning the harmfulness of children's faeces (95.1%). Nevertheless, less than half had regularly practiced essential hygiene habits like hand washing (31.7%), boiling drinking water (33.2%), cleaning their toilets (43.4%) and disposing of children's faecal waste (40.0%) and other household waste (14.1%), appropriately. Above half (51.7%) had practiced open defecation.

Further disposal of household waste (29.2%) was one of the domestic uses of the river, apart from bathing (21.2%), laundry (20.2%), fishing (7.0%) and kid's leisure (22.4%). Moreover, 71.3% of caregivers whom their children (<5 years) had diarrhoea had initially sought appropriate care.

Table 5: Knowledge and practice characteristics of caregivers

** Multiple response questions *Applied only to certain category of caregivers

Variables	Response category	Frequency (N=205)	%
Knowledge about causes of u5_ diarrhoea	Did not have knowledge	2	1.0
	Had knowledge	203	99.0
Knowledge about critical times to wash hands.	Did not have knowledge	4	2.0
	Had knowledge	201	98.0
Knowledge about harmfulness of child faeces	Did not have knowledge	10	4.9
	Had knowledge	195	95.1
Practiced hand-washing	Yes	65	31.7
	No	140	68.3
Practiced boiling water	Yes	68	33.2
	No	137	66.8
Practiced cleaning the toilet regularly* (N=99)	Yes	43	43.4
	No	56	56.6
Practiced open defecation	Yes	106	51.7
	No	99	48.3
Methods of disposing children faeces	Inappropriate	123	60.0
	Appropriate	82	40.0
Methods of disposing hld solid waste	Inappropriate	176	85.9
	Appropriate	29	14.1
Uses of the river ** (N=330)	Bathing	85	21.2
	Laundry	81	20.2
	Disposal of hld waste	117	29.2
	Fishing	28	7.0
	Kid's leisure	90	22.4
Children play in the river	Yes	101	49.3
	No	104	50.7
Caregivers seeking behavior when children got diarrhoea* (N=94)	Inappropriate	27	28.7
	Appropriate	67	71.3

4.2.1.4 Environmental charateristics of caregivers

The environmental characteristics within and around the homes of caregivers has been illustrated in table 6. Of the 205 caregivers, only 43.4% had access to safe water sources, while a majority (73.2%) did not own any toilet facility and more than half (51.7%) did not have access

to any toilet. For 48.3% who had access to any toilet facility, some of them were accessed through sharing. Within this rate (48.3%), only 22.2% had accessed to good toilet facility (flush toilet). The number of people using any toilet facility was extremely high per day, indicated by 5 or more people as daily users (99.0%).

Table 6: Environmental characteristics of caregivers

Variable Name	Category	Frequency (N=205)	%
Sources of water	Unsafe	116	56.6
	Safe	89	43.4
Owned toilet facility	Yes	55	26.8
	No	150	73.2
Assess to any toilet facility	Yes	99	48.3
	No	106	51.7
Quality of toilet facility* (N=99)	Poor toilet facility	77	77.8
	Good toilet facility	22	22.2
Toilet facility daily use* (N=99)	Low	1	1.0
	High	98	99.0
Observed stagnant waste water	Yes	15	7.3
	No	190	92.7
Observed flies near	Yes	96	48.3
	No	109	51.7
Observed scattered solid waste	Yes	146	71.2
	No	59	28.8
Observed water filled containers	Yes	70	34.1
	No	135	65.9
Altitudes (m) of u5_hlds* (N=136)	Low	83	61.0
	High	53	39.0
Distance (m) of u5_hlds to the river* (N=136)	Near	96	70.6
	Far	40	29.4

U5_hlds=Under-five households *Applied only to certain category of caregivers

Furthermore, there was presence of stagnant waste water (7.3%), flies (48.3%) and scattered solid waste (71.2%) near some under-five households. Of all under-five households, many (61.0%) were built on low altitude areas (≤19 meters above sea-level); and above half (70.6%) were built near or within a distance of 125 meters to the river.

4.2.2 Bivariate Analysis

4.2.2.1 Association between socio-demographic charateristics and under-five diarrhoea

Age of under-five children (in years), number of under-five children per caregiver, and fortnightly income level below $1500 (SBD) were significantly associated with under-five diarrhoea ($p<0.05$). Unfavorably, under-five diarrhoea was not significantly associated with age of caregivers (in years), household size, and education level. These are summarized in table 7.

Results further indicated that the odds of having diarrhoea were 2.1 times higher in younger children (≤2 years) compared to older children (3-5 years) (OR=2.1, 95% CI: 1.18, 3.71). Similarly, caregivers with 2 or more under-five children were 2.0 times more likely to report under-five diarrhoea infection than caregivers with only one child below five years (OR=2.00, 95% CI:1.14, 3.52). Based on childcare experience, the chance of reporting under-five diarrhoea cases increased by 60.0% among younger caregivers (≤29 years) than older caregivers (≥30 years) (OR=1.6, 95% CI: 0.90, 2.72). Moreover, table 7 showed that children (<5 years) of caregivers living in big household size were 93% more likely to have diarrhoea (OR=1.93, 95% CI: 0.95, 3.93). Like in other studies, results also demonstrated that children of caregivers from low income households were about 2.7 times more likely to have diarrhoea than children of caregivers from high income households (OR=2.65, 95% CI: 1.00, 7.03).

Table 7: Socio-demographic characteristics and under-five diarrhoea

Variables	Category	Diarrhoeal Disease		Bivariate OR (95% CI)	p-value
		Yes (%)	No (%)		
Age of children	≤2 years	64(53.3)	56(46.7)	2.10(1.18, 3.71)	0.011
	3-5 years+	30(35.3)	55(64.7)	1.0	
Age of caregivers	≤29 years	52(51.5)	49(48.5)	1.57(0.90, 2.72)	0.112
	≥30 years+	42(40.4)	62(59.6)	1.0	
No. of children per caregiver	1 child+	47(38.8)	74(61.2)	1.0	
	2 children or more	47(56.0)	37(44.0)	2.00(1.14, 3.52)	0.016
Household size	Low+	14(33.3)	28(66.7)	1.0	
	High	80(49.1)	83(50.9)	1.93(0.95, 3.93)	0.071
Education level	No-education	12(37.5)	20(62.5)	0.71(0.27, 1.85)	0.479
	Low	65(47.8)	71(52.2)	1.08(0.52, 2.23)	
	High+	17(45.9)	20(54.1)	1.0	
Income level	Low income	88(48.4)	94(51.6)	2.65(1.00,7.03)	0.050
	High income+	6(26.1)	17(73.9)	1.0	

OR=Odd Ratio CI=Confident Interval Statistically significant at p<0.05 + Reference group
Source: Researcher

4.2.2.2 Association between knowledge and practice charateristics and under-five diarrhoea

Table 8 shows that irregular hand washing, inappropriate methods of disposing of children's faecal waste and using the river for bathing and laundry appeared to be associated with under-five diarrhoea, respectively denoted by a p-value below 5% (p<0.05). The odds of having diarrhoea were about 2.1, 1.9, 1.8 and 2.2 times, respectively, for children whose caregivers did not regularly practice each of the above associated risk factors. Results further demonstrated that children whose caregivers often boiled drinking water and often cleaned the toilets were 11.0% and 40.0% respectively, less likely to have diarrhoea. In regard to the domestic use of the river, children whose caregivers often used the river were 45% more likely to have diarrhoea than children whose caregivers never used the river for any domestic use.

Table 8.0: Knowledge and practice characteristics and under-five diarrhoea

Variables/Category	Diarrhoeal Disease		Bivariate OR (95% CI)	p-value
	Yes (%)	No (%)		
Knowledge on causes of U5_diarrhoea				
Did not have knowledge	0(0.0)	2(100.0)	-	0.999
Had knowledge+	94(46.3)	109(53.7)		
Knowledge on critical times to wash-hands				
Did not have knowledge	0(0.0)	4(100.0)	-	0.999
Had knowledge+	94(46.8)	107(53.2)		
Practiced hand-washing				
Yes+	22(33.8)	43(66.2)	1.0	
No	72(51.4)	68(48.6)	2.07(1.12, 3.81)	0.020
Practiced boiling drinking water				
Yes+	30(44.1)	38(55.9)	1.0	
No	64(46.7)	73(53.3)	1.11(0.62, 1.99)	0.725
Practiced regular cleaning the toilet				
Yes+	15(34.9)	28(65.1)	1.0	
No	24(42.9)	32(57.1)	1.40(0.62, 3.18)	0.422
Methods of disposing children feces				
Inappropriate	64(52.0)	59(48.0)	1.88(1.06, 3.33)	0.030
Appropriate+	30(36.6)	52(63.4)	1.0	
Methods of disposing hld waste.				
Inappropriate	82(46.6)	94(53.4)	1.24(0.56, 2.74)	0.602
Appropriate+	12(41.4)	17(58.6)	1.0	
Domestically use the river				
Use	81(47.4)	90(52.6)	1.45(0.68, 3.09)	0.331
Never use+	13(38.2)	21(61.8)	1.0	
Use the river for bathing				
Yes	44 (55.0)	36 (45.0)	1.83(1.04, 3.23)	0.036
No+	50 (40.0)	75 (60.0)	1.0	
Use the river for laundry				
Yes	47(57.3)	35(42.7)	2.17(1.23, 3.84)	0.008
No+	47(38.2)	76(61.8)	1.0	
Children play in the river				
Yes	43(43.0)	57(57.0)	0.80(0.46, 1.39)	0.424
No+	51(48.6)	54(51.4)	1.0	
Health seeking behavior				
Inappropriate	27(100.0)	0(0.0)	-	-
Appropriate+	67(100.0)	0(0.0)		

OR=Odd Ratio CI=Confident Interval Statistically significant at p<0.05 + Reference group

Source: Researcher

4.2.2.3 Association between environmental charateristics and under-five diarrhoea

The presence of stagnant waste water, flies, solid waste and water-filled containers near households, plus the distance of under-five households to the river, were found to be directly associated with under-five diarrhoea in Mataniko informal settlements ($p<0.05$). These results are summarized in table 9.

It also revealed that the chance of having diarrhoea was increased by 3.6 times (OR=3.55, 95% CI: 1.09, 11.53) among children from households with observed stagnant waste water, 1.9 times (OR=1.89, 95% CI: 1.08, 3.29) among children from households with observed flies and 2.0 times (OR=2.00, 95% CI: 1.07, 3.76) among children from households with observed solid waste, compared to their respective counterparts. In addition, children from households situated far (above 125 m) from the river were 2.6 times less likely to have diarrhoea than children from households situated near (125 m or less) the river.

Though access to water and sanitation facilities were not associated with under-five diarrhoea, results revealed that the likelihood of having diarrhoea increased by 47% and 66% respectively, among children whose caregivers did not have access to safe water sources and toilet facilities. The odds of having diarrhoea was about 2.7 times higher among children whose caregivers had access to a poor toilet facility (OR=2.7, 95% CI: 1.09, 8.03).

Table 9: Environmental characteristics and under-five diarrhoea

Variables/Category	Diarrhoeal Disease		Bivariate	
	Yes (%)	No (%)	OR (95% CI)	p-value
Water source quality				
Unsafe	58(50.0)	58(50.0)	1.47(0.84, 2.57)	0.174
Safe+	36(59.6)	53(40.4)	1.0	
Assess to any toilet facility				
Yes+	39(39.4)	60(60.6)	1.0	0.074
No	55(51.9)	51(48.1)	1.66(0.95, 2.89)	
Quality of toilet facility				
Poor facility	34(44.2)	43(55.8)	2.69(0.90, 8.03)	0.076
Good facility+	5(22.7)	17(77.3)	1.0	
Presence of stagnant (waste) water				
Yes	11(73.3)	4(26.7)	3.55(1.09, 11.53)	0.036
No+	83(43.7)	107(56.3)	1.0	
Presence of flies				
Yes	52(54.2)	44(45.8)	1.89(1.08, 3.29)	0.026
No+	42(38.5)	67(61.5)	1.0	
Presence of solid waste				
Yes	74(50.7)	72(49.3)	2.00(1.07, 3.76)	0.030
No+	20(33.9)	39(66.1)	1.0	
Presence of water-filled container				
Yes	23(32.9)	47(67.1)	0.44(0.24, 0.81)	0.008
No+	71(52.6)	64(47.4)	1.0	
Altitude (m) of u5_hlds				
Low	39 (47.0)	44 (53.0)	0.63(0.31, 1.26)	0.192
High+	31 (58.5)	22 (41.5)	1.0	
Distance (m) of u5_hlds to river				
Near	56 (58.3)	40 (41.7)	2.60(1.21, 5.60)	0.014
Far+	14 (35.0)	26 (65.0)	1.0	

OR=Odd Ratio; CI=Confident Interval Statistically significant at p<0.05 + Reference group
Source: Researcher

4.3 DISCUSSION

This study identified the prevalence of diarrhoea among children (<5 years) in Mataniko informal settlements and its associated risk factors as answers to the research questions and study objectives. This is the first ever documented prevalence study about under-five diarrhoea in Honiara informal settlements, with no previous published study being cited elsewhere. This study has narrowed an information gap. Nonetheless, the results were alarming and indicated an urgent need for local government and public health sectors to invest in projects and programmes which are capable of reducing the burden of this preventable disease among children (<5 years).

4.3.1 The under-five prevalence of diarrhoea

The 2 weeks' under-five diarrhoea prevalence rate was 45.9%. This was higher than the national prevalence rate (9.4%) cited in the Solomon Islands DHS Report (SINSO 2009) and other previous studies in developing regions. In Korogocho urban informal settlement, in Nairobi, Africa, the 2 weeks' prevalence rate was 35.6% (Ikua 2014); in rural Burundi it was 32.6% (Diouf et al. 2014, p.5); whereas in Walitta Soddo Town, Southern Ethiopia, the prevalence rate was 11.0% (Alambo 2015, p.19). The high prevalence rate (45.9%) in the context of Mataniko informal settlements, in Honiara was mainly due to the initial time frame of data collection set out in the study proposal, which almost coincided with the national diarrhoea outbreak in Solomon Islands. Thus, some cases were recalled by caregivers. Secondly, it was due to the high concentration of younger children (≤2 years) in the study who are often at high risk to diarrhoea infection. The scope of study had also influenced the result as it only covered urban informal settlements with its existing low economic status rather than the entire country, as in the case of DHS.

In regard to under-five diarrhoea cases by locality, the distribution was almost evenly distributed, in which 36.2% of all cases were accounted for Koa Hill, 33.0% for Lord Howe and 30.9% for Mamana Wata informal settlement. This showed that under-five children within these localities were almost equally at risk to diarrhoeal disease.

The result further demonstrated that the prevalence of under-five diarrhoea was associated with other *socio-demographic factors* (age group of children, number of children per caregivers, income level), *practice factors* (hand-washing, methods of disposing children faecal waste and bathing and laundry in the river), and *environmental factors* (presence of stagnant waste water, flies, solid waste and water-filled containers near households, and distance of under-five households to the river).

4.3.2 Socio-demographic charaeristics and under-five diarrhoea

In this study, the age group of children (<5 years) was positively associated with under-five diarrhoea morbidity. Not only that, but the odds of having diarrhoea was 2.1 times higher among younger children (≤2 years) than older children (3-5 years). This is in agreement with a result of DHS in Solomon Islands (SINSO 2007); and studies conducted separately in Ethiopia by Mohammed & Tamiru (2014, p.4) and Alambo (2015, p.19), which revealed that diarrhoea was associated with under-five children in the age group 6-23 months and 12-23 months, respectively. This indicated that younger children (≤2 years) should be given optimal parental care as one of the interventions to address this disease at the household level. Furthermore, within the younger age group (≤2 years), or at least after six months, children started to receive a bit of solid food instead of milk and then often started moving around the house. In addition, crawling and other physical body changes like walking started within this age group (12-23 months) and the risk of picking up contaminated materials and putting them into their mouth is often high.

In comparison to age group of caregivers, this study failed to discover a direct association with under-five diarrhoea, though fewer cases (44.7%) were identified among older caregivers (≥30 years); also the chance for their children to be infected with diarrhoea was decreased by 57% compared to younger caregivers (≤29 years). This contradicts a finding by Diouf et al. (2014, p.5) in rural Burundi, in which they found that under-five diarrhoea was associated with mothers' age below 25 years. Nevertheless, both studies appreciated the fact that disease rates normally decreased among older caregivers because of increased childcare experience following older ages.

Concerning the number of children (<5 years) per caregiver, it was found to have been significantly associated with under-five diarrhoea ($p<0.05$). In addition, caregivers with 2 children or more were 2.0 times more likely to have reported under-five diarrhoea compared to caregivers with only one child. This coincides with a study by Alambo (2015, p.20); and also previous studies in Ethiopia (Alemayehu et al. cited in Alambo, p.20) and Indonesia (Rohmawati (cited in Alambo 2015, p.20). This indicated that having many children (<5 years) in a family had increased the chance of under-five diarrhoea and parental support in terms of food, water and time. It also demonstrated the urgent need for child birth spacing practice and education among childbearing couples in the study settlements.

Results further revealed that high cases (85.1%) were reported by caregivers living in big household size, though such differences were not statistically significant ($p>0.05$). The average household size was 7.9 (± 2.5SD) almost equal to an average household size of 8.4 found by Dutton & Pigolo (2014) in PNG informal settlements; but nearly doubled the national average household size of 5 people reported by the Solomon Islands National Statistics Office (SINSO 2009). This association is not in agreement with a community-based cross-sectional study conducted by Ikua (2014) in Nairobi and APHRC (cited in Ikua 2014) in Kenya. Nonetheless, since the chance of having diarrhoea were about twice as high (OR=1.93, 95% CI:0.95, 3.93)

among children living in big household size compared to those living in small household size, this indicated that overcrowded households can exert pressure on the available social amenities like water and toilet facilities, and as a result can contribute to childhood illnesses like diarrhoea. This also demonstrated that reduction of household size to 6 people or less is a best approach to reduce the occurrence of under-five diarrhoea. Another option would be creating more living rooms and effective family planning, a plan which is made in relation to parent's ability and affordability to basic household resources. As shown in SIG (2014), most living dwellings in Mataniko informal settlements were semi-permanent and non-permanent building structures, built without municipal approval and therefore, at high risk to medical related hazards.

Though education increases knowledge and caregiver care seeking behavior (Mukiira 2012; Douf et al. 2014, p.5), this study was not able to determine a positive association between formal education level and under-five diarrhoea ($p>0.05$), regardless of the fact that most (69.1%) of the cases were reported by caregivers with low education level. This relationship is in agreement with a finding by Mukiira (2012), but is in contradiction with a finding by Ikua (2014); and also Mohammed & Tamiru (2014, p.4) in Arba Minch District, Southern Ethiopia, which revealed that maternal education was significantly associated with under-five diarrhoea. Mohammed & Tamiru (2014, p.4) expounded that children whose mothers did not attend formal education were 89% more likely to develop diarrhoea, as compared to children whose mothers had attended formal education. Despite such benefit, in the context of Mataniko informal settlements, education level cannot significantly reduce the prevalence of under-five diarrhoea, though hygiene practices of caregivers would be influenced by their level of education. This also means that there are other compounding factors that directly influence the spread of diarrhoeal-causing agents to children. For instance, most caregivers (98.1%) have knowledge on diarrhoea transmission and prevention, but due to the fact that the majority (94.7%) of them have very low fortnightly income (≤$1500 SBD), they were unable to purchase safe drinking water from shops

for their children in a daily basis, and to pay water bills to maintain regular access to water services at home. This explanation agrees with Matovu's (cited in Ikua 2014) finding in his study in Zimbabwe. Further, there is a considerable difference between formal education attendees (84.4%) and non-formal education attendees (15.6%) in the study population, which may influence the analyzed result. Nevertheless, consistent health education for caregivers at the community level is a matter of concern, especially for those who did not attend formal education (15.6%). As shown in Diouf et al. (2014, p.5) in rural Burundi informal settlements, lower prevalence of diarrhoea was discovered among children (<5 years) whose primary caregivers had received hygiene education compared to their counterparts.

As in many studies, this study's household income level was found to be one of the necessary causes of under-five diarrhoea; and the odds of having diarrhoea were about 2.7 times higher among children whose caregivers had low fortnightly income (OR=2.64, 95% CI, 1.00,7.03). Furthermore, above ninety percent (94.7%) of cases were reported by caregivers residing in low income households. This relationship is in line with Ikua (2014) and Alambo's (2015) respective findings; and also Ahmed and Millard (cited in Ikua 2014), which stated that household income level was associated with child's survival because it determines the financial capability of households to access basic life necessities like food and WASH services. Opisa et al. (2012, p.2) and Uwizeye et al. (2014, p.1), had illustrated that the better the household income level, the less likely the child is to get a diarrhoeal disease. As depicted in tables 7 and 8 results, though the knowledge about the causes (99.0%) and prevention (98.0%) of diarrhoea is outstanding among caregivers, due to their status of low income, most households (94.7%) were not in a position to buy optimum amounts of water to maintain proper hygiene practices and other essential household resources. In addition, in the context of Solomon Islands, the growth of urban informal settlements was not supported by the government in terms of urban social services provision (UN-HABITAT 2010). This was also discovered by Uwizeye et al. (2014,

p.1) within East African countries. Thus, this situation has required the intervention of the government and other responsible authorities. In particular, to engage informal dwellers with small income generating projects as to help them to improve their financial status suitable for urban life.

4.3.3 Knowledge and practice charateristics and under-five diarrhoea

This study further demonstrated the vital role of health promotion programmes in community-based education, indicated by an outstanding knowledge acquired by case-caregivers (N=94) regarding the causes (100.0%) and prevention (100.0%) of under-five diarrhoea. However, such outstanding knowledge was not directly associated with under-five diarrhoea. It can be interpreted that in such scenarios, knowledge was just a sufficient cause of under-five diarrhoea and not a necessary cause, represented by a higher p-value ($p>0.05$). One possible contributing factor could be the high concentration of formal education attendees (84.4%) in the dataset, which had resulted in no difference between diarrhoea morbidity and knowledge level.

Comparatively, this status of association is the opposite of what Zahid et al. (2014, p.5) had found; and also by Diouf et al. (2014, p.5) in their study in rural Burundi informal settlements. They concluded that lower diarrhoea prevalence was associated with caregivers who had received community hygiene education. Not only that, in Arba Minch District, in Southern Ethiopia, Mohammed & Tamiru (2014, p.4) found that maternal community education had significantly influenced the occurrence of under-five diarrhoea. Hence, in Mataniko informal settlements, in Honiara, knowledge alone cannot be effective in addressing the burden of this disease. Subsequently, it needs support of other protective mechanisms like availability of WASH facility services to practice known knowledge. This same gap had been verified by Freeman et al. (2014, p. 6) in their systematic reviewed studies; and by Dutton & Pigolo (2014) in their study in PNG informal settlements. They further re-emphasized that there is always a gap

between hygiene knowledge and actual practice. Thus creating a supportive environment should become one among the priority agendas of responsible health sectors to address the incidence of under-five diarrhoea. This also implies that community health education among caregivers should be ongoing and not to be undermined since it was very effective in improving mother's knowledge on diarrhoea (Zahid et al. (2014, p.5). Undoubtedly, by understanding the mode of transmission and early recognition of signs and symptoms, will guide caregivers to timely seek appropriate care (Mukiira 2012). As alluded to by Bonita et al. (2006), understanding the difference between the sufficient and necessary cause of any disease is vital in disease prevention.

This study verified the positive impacts of regular hand washing in regard to diarrhoea prevention. This was illustrated by a significant decline of case-children (23.4%) among caregivers who often practiced hand washing; and was further supported by a double diarrhoeal risk reduction among children whose caregivers regularly washed their hands at critical times (OR=2.07, 95% CI: 1.12, 3.81). Moreover, it was also evidenced that such a difference was statistically significant ($p<0.05$). This result is in agreement with many previous studies conducted in similar settings in developing African regions, such as in Korogocho informal settlements, in Nairobi (Ikua 2014); in the Arba Minch District, in Southern Ethiopia (Mohammed & Tamiru 2014,p.4); and also in Malawi and Zambia (Kandak and Mandise cited in Ikua 2014). Mohammed & Tamiru (2014, p.4), elaborated that the risk of developing diarrhoea was approximately 2 times higher among children whose mothers had practiced poor hand washing compared with children whose mothers had good hand washing practices. This implies that regular hand hygiene by caregivers, before attending to their children, is a very effective approach to prevent this disease. Further, this significant result has also emphasized an urgent public health issue for immediate intervention by policy makers and community-based

organizations in their community-based works intended to reduce the gap between hygiene knowledge (98.0%) and actual practice (31.7%).

This study also indicated that many health benefits of regular hand hygiene were not proficient in these settlements because of such a wide gap. This was also evidenced in PNG informal settlements (Dutton & Pigolo 2014). At the global level, regular hand hygiene habits were also poorly practiced, which accounted for only about 19% of the world's population (Freeman et al. 2014, p. 6). Thus, narrowing this gap through nation-wide community education and WASH facility coverage is important. As previously reported, the risk ratio for the reduction in diarrhoeal disease from hand washing with soap is 0.60 (Freeman et al. 2014, p.6).

Regular treatment of drinking water, either through chlorinating or boiling, is effective in killing germs or preventing children from diarrhoeal infection. Nevertheless, in this study, results illustrated that regular boiling of drinking water was not directly associated with under-five diarrhoea ($p>0.05$), though a majority (68.1%) of cases were reported by caregivers who did not regularly treat or boil drinking water for their children. Such an insignificant relationship might be due to the inclusion of children of age six months and below in the denominator who were not used to drinking water, but were only fed on breast milk. Thus, this could be another issue for further study, to exclude such potential confounders in the analysis. Results also indicated that under-five diarrhoea cannot be effectively reduced by means of drinking clean and safe water alone, since there are other factors compounding its transmission. Although the above significant difference may be due to chance ($p>0.05$), it is contradictory to a finding from a similar study setting which confirmed that regular boiling of drinking water was significantly associated with under-five diarrhoea (Ikua 2014). This finding is further supported by Diouf et al. (2014, p.5). Thus, ongoing emphasis on this hygiene practice is vital for diarrhoeal prevention. Related programmes should be designed to convince the majority (66.8%) of caregivers who failed to

treat drinking water for their children. As revealed in this study, caregivers who regularly boiled drinking water were 11% less likely to have children with diarrhoea.

The regular cleanliness of any toilet facility is also an important hygiene practice. A study found that even though it was important, it was not a delegated responsibility of any particular gender in any informal household (Dutton & Pigolo 2014). In this study, results failed to show a significant relationship between the regular cleanliness of a toilet facility and under-five diarrhoea, though many (61.5%) of the cases were reported by caregivers who never cleaned their toilets on a regular basis. Thus, regular cleanliness of toilets did not significantly decrease the chance of under-five diarrhoea in the study settlements ($p>0.05$). Similarly, such a relationship is also in agreement with a finding by Ikua (2014). Logically, in this study, this is true when knowing that more than half (58.5%) of under-five children were in a younger age group (≤2 years), who were incapable of using or having contact with any toilet facility by themselves. Along with that, a majority (77.8%) of toilets were water-sealed and pit-latrines that were unsafe for under-five children, compared to flush toilets (22.2%). This means that the unhygienic practice of caregivers, such as failing to wash hands after using the toilet plus the surrounding household environment, could be the more direct factors in the study area. Nevertheless, regular cleanliness of toilets as a prevention measure should not be undermined because unhygienic toilet facilities and overflowing latrines were previously found to bring bad smells and faecal waste to the nearest households (Uwizeye et al. 2014, p.6; Dutton & Pigolo 2014).

In regards to the inappropriate methods of disposing of children's faeces, it was independently associated with under-five diarrhoea ($p<0.05$) and the odds of having diarrhoea was about 1.9 times higher among children whose caregivers had disposed of faecal waste inappropriately, than for children whose caregivers had disposed of faecal waste appropriately (OR=1.88, 95%CI:1.06, 3.33). Furthermore, the prevalence of diarrhoea within 2 weeks was

double (68.1%) among children (<5 years) whose caregivers had disposed children faecal waste inappropriately. This indicates that inappropriate faecal waste disposal practice is an important cause of under-five diarrhoea in the study settlements and should become one of the targeted priority issues which require deliberate action of responsible public health sectors. Related studies have also supported this finding and recommendation (Water-Aid 2008; Lopez & Murray cited in Ikua 2014). As further evidenced in this study, open defecation practice was high (51.7%) among families. Undoubtedly, reducing the rate of open defecation families through improved WASH facilities, will allow footpaths, river, sea and nearby lands to be environmental disease friendly. As explained in the Water-Aid Report (2008), this approach will prevent children from being directly contacted with contaminated objects in the surrounding households' premises; and also prevent flies from landing on faeces and then food.

On the other hand, unlike faecal waste, this study found that inappropriate methods of disposing other household solid waste didn't necessarily influence under-five diarrhoea at a 5% significance level ($p>0.05$). Nonetheless, almost ninety percent (87.2%) of cases were reported by caregivers who did not regularly dispose of their household solid waste appropriately. Although such differences may be likely due to chance ($p>0.05$), it revealed that disposing household solid waste in places like river, sea and nearby land may have imposed high unhealthy risk to children and others who are exposed to these environments. In addition, as shown in this study, caregivers who had disposed of household solid waste appropriately were found to be 24% less likely for their children to have diarrhoea. This indicated that under-five diarrhoeal disease can be reduced by means of keeping the households and communal environment as child friendly as possible. As verified in Water-Aid (2008) and Lopez & Murray (cited in Ikua 2014), such practice is crucial to disrupt the pathway of transmission of this disease as environment is an important component of the epidemiologic triage.

This study further revealed that there were extremely high cases (87.2%) reported by caregivers who had used the river for one or more domestic uses, compared to those who never used the river (12.8%), though such difference was not statistically significant ($p>0.05$). Besides that, the odds of having diarrhoea was 1.45 times higher for children whose caregivers often used the river compared to those whose caregivers never used the river for any domestic use.

Nonetheless, in terms of other specific river uses like bathing and laundry, results show that they were respectively associated with under-five diarrhoea. This indicated that if caregivers were not using the river for bathing and laundry, the prevalence rate of under-five diarrhoea within 2 weeks could have been reduced. Such significant association is not likely due to chance ($p<0.05$). Reasonably, the river has been regularly contaminated with solid and liquid waste from nearby households (87.2%) and business houses along the river corridor. It was also verified, through micro-bacterial analysis, that the concentration of Escherichia coli rapidly increased from upper stream (low contamination) to lower stream (high contamination); and mostly concentrated in areas of slow water flow, where children and mothers usually bathed and did laundry (Source: Researcher). As a result, the odds of having diarrhoea were extremely high among children whose caregivers had used the river for bathing (OR=1.83) and laundry (OR=2.17). It can also be interpreted that younger children (≤2 years) (58.5%) who were incapable of playing in the river by themselves were indirectly exposed to diarrhoeal-pathogens through their mothers or older children. Hence, as a public health approach to address the health of children, caregivers should be re-educated not to use the river for either bathing or laundry, along with other domestic uses. This advocacy campaign can be effective with support from donors and sectors responsible to improve essential water and sanitation services in the area.

Furthermore, this study also assessed the impact of diarrhoea among children (<5 years) who often played in the river. The result, however, illustrated a non-significant relationship at 5% significant level. Adversely, an odds ratio of 0.80 (OR<1) indicated that those children who

often played in the river were 20% less likely to have diarrhoea than children who never play in the river as reference group ($^{+}$). Hence, this showed that such an insignificant result ($p>0.05$) could have been influenced by the fact that younger children (≤2 years) (58.5%) had dominated the denominator, whose utmost need parental support and were not directly exposed to the river, neither can they go by themselves to the river. Logically, it further affected the outcome result, not to be fully representative of under-five children who were directly exposed to the river. This illustrated another important issue for future researchers to exclude the indirectly exposed age group in the analysis. Nevertheless, based on the severe contamination state of the river, health education should be continuously undertaken in these informal communities to re-educate caregivers on the danger of using the river as a kids' area for leisure. Besides that, a related project for a child friendly environment should also be put in place by responsible community-based organizations.

Another vital practice depicted in this study is the initial care seeking behavior of caregivers when their child below five years had experienced diarrhoea within 2 weeks prior to the survey. Based on the analyzed result, it was discovered that caregivers initial care seeking behavior was not directly associated with under-five diarrhoea ($p>0.05$). Nonetheless, a majority (71.3%) of them had sought appropriate care, whereas very few (28.7%) never sought appropriate care. Perhaps such a relationship was affected by the small population size in the denominator, as above fifty percent (54.1%) of caregivers were excluded because they were categorized as non-case parents and thus unqualified for this particular analysis. The study also discovered that 4.3% of all case-caregivers (N=94) did not do anything to manage this disease. This same practice was discovered by Mohammed and Tamiru (2014, p.3), which showed that about 31% of mothers whose children (<5 years) got diarrhoea did not give anything to manage the diarrhoea. Thus, continuous health education among caregivers should be undertaken in Mataniko informal communities to educate and encourage about the importance of seeking initial

care from health care professionals whenever their children experience any related childhood illnesses. By doing this, it will help them to get first line of treatment and information about diarrhoea home management.

4.3.4 Environmental variable and under-five diarrhoea

The result showed low cases (38.3%) reported by caregivers from households with access to a safe water source. Caregivers without access to safe water sources were 47% more likely to report under-five diarrhoea compared to those with access to safe water sources. Nevertheless, this difference is essential but was not directly associated with under-five diarrhoea within the study settlements ($p>0.05$). This relationship is in agreement with a finding by Ikua (2014) in Korogocho informal settlements. In this study, the insignificant relationship could be influenced by the fact that some households without access to a safe water source have engaged in boiling their drinking water. Diouf et al. (2014, p.5) and Ikua (2014), also agreed that boiling of drinking water was vital in terms of diarrhoea prevention. Furthermore, the above result was believed to also be influenced by a portion of younger infants (≤6 months) in the analysis who were exclusively breast fed at the time of study and thus, entirely rely on drinking milk instead of water.

However, since the majority (56.6%) of caregivers came from households without access to safe water sources, improved access to this service is of utmost importance. Teklemariam (cited in Ikua 2014), had also verified in his study that children coming from households that obtained water from protected sources were less likely to have diarrhoea compared to those from households who got their water from unprotected sources like open wells. Other related studies also revealed that poor access to clean water and a sanitary environment contributed to diarrhoeal infection (WHO/UNICEF 2009; Kakulu 2012). Thus, without improved access to clean water sources, caregivers will find it impossible to practice regular hand hygiene before caring for their

children. Opisa et al. (2012) argued that about one-third of deaths in developing countries were due to consumption of contaminated water.

Comparatively, this study demonstrated high (58.5%) reported cases among caregivers without access to any toilet facility; and the odds of having diarrhoea was increased by 66% among children whose caregivers were without access to any toilet facility. Without undermining the importance of toilet facility accessibility, the depicted result, however, failed to have a significant relationship ($p>0.05$). This is consistent with a similar study conducted in Nairobi, which stated that access and sharing of toilet facilities were not significantly related to under-five diarrhoea (Ikua 2014). In this study, the insignificant difference ($p>0.05$) can be influenced by many factors. These include the existence of a large gap in regard to the accessibility of a toilet facility among three settlements. For instance, lack of accessibility to any toilet facility was apparent in Mamana Wata (94.0%) and Lord Howe (75.3%) families as compared to Koa Hill (2.6%) families. Another important notable factor was, a majority of toilet facilities were not regularly cleaned (57.6%) and most (81.8%) were classified as a poor toilet facility (water sealed and pit latrine), which were characterized by poor running water systems, overflowed sewage during heavy rain and often a bad smelling toilet facility. Reasonably, and the fact that only few families (22.2%) had access to a good toilet facility (flush toilets), this indicated that children from households with access to a poor toilet facility were also at risk for diarrhoea because of the poor status of their toilets. As alluded to earlier, the majority of under-five children in this study were aged 2 years and below (58.5%). This specific age group could be another confounder because children within this age group ($\leq$2 years) need parental support and therefore, were incapable of using the latrine toilets by themselves. Thus, they entirely relied on their caregivers to dispose their faecal waste in the toilets or in the river. This also revealed that they were more likely to be infected with diarrhoeal-pathogens from within and around the household environment, and also through poor hand hygiene by their caregivers after using the toilets or

changing diapers. This, however, signifies that access to cheap and good quality toilet facilities should be a matter of public health concern in the study communities. As revealed in Gyimah (cited in Ikua 2014), access to a toilet facility ensures appropriate disposal of human waste.

The result also demonstrated a kind of chorological ordering of reported cases among caregivers with access to a good toilet facility (5.3%), poor toilet facility (35.1%) and those without access to any toilet facility (59.6%). In addition, the likelihood of having diarrhoea was about 2.7 times higher (OR=2.69, 95% CI: 0.90, 8.03) among children whose caregivers did not have access to good toilet facilities, than children whose caregivers had access to good toilet facilities. Despite that, results also showed that such significant differences were not significantly associated with under-five diarrhoea ($p>0.05$). This is in agreement with a related cross-sectional study conducted in Nairobi informal settlements (Ikua 2014); however, it contradicts a study conducted in Huye town, mountainous informal settlements, in Rwanda (Uwizeye et al. 2014, p.6). This same study further concluded that children from households using modern toilet facilities were more than 60% less likely to experience diarrhoea (Uwizeye et al. 2014, p.6). This indicates that using improved or good toilet facilities is essential to address under-five diarrhoea. To achieve this, responsible sectors and partners should invest more resources on a total sanitation initiative approach.

As in other studies, this study observed that stagnant waste water, flies, solid waste and presence of water-filled containers near under-five households was associated with under-five diarrhoea ($p<0.05$). Regarding the presence of stagnant waste water, it is in line with a study by Uwizeye et al. (2014, p.7), which revealed that stagnant waste water near households, due to poor drainage systems, was associated with diarrhoeal prevalence. Results showed that the likelihood of having diarrhoea was increased by 3.6 times among children (<5 years) from households with observed stagnant waste water. Undoubtedly, diarrhoeal-pathogen concentration

is high in areas of slow water flow (stagnant water), where less disturbance and adequate availability of oxygen for their survival is present.

Furthermore, many of the cases were reported by caregivers with presence of flies (55.3%) and scattered solid waste (78.7%) near their households. These significant differences ($p<0.05$) were also evidenced in Water-Aid (2008) and Dutton & Pigolo (2014). They added that observed flies in close proximity to households due to uncollected garbage and inappropriate human waste disposal was associated with under-five diarrhoea. Not only that, but scattered faecal waste on footpaths and near households were associated with under-five diarrhoea prevalence (Water-Aid 2008; Lopez & Murray cited in Ikua 2014). This indicated that children (<5 years) were also infected with diarrhoeal-pathogens from their surrounding household environment or within a reachable distance of about 20 meters to their houses, where they often played. Thus, improving drainage, proper garbage disposal and other environmental conditions near households is necessary. In turn, this approach will also allow waste water and solid waste to be washed away into the main drainage system, and possibly destroy all possible breeding sites of vectors and diarrhoea causing agents. This shows that government bins should not be placed on the main road near households, as they would have potential contact with children, including their bad smell.

Results further revealed higher reported cases from under-five households located in low altitude areas (55.7%) compared to those located in high altitude areas (44.3%). Nevertheless, such differences were not statistically significant ($p>0.05$). Residing in low altitude areas did not significantly reduce the chance of diarrhoea among children below five years in the study settlements. This insignificant difference can be influenced by many factors. One of these factors is due to the difference in terms of the physical landscape of the settlements. For instance, Mamana Wata and Lord Howe settlements are located on coastal low-lying areas, whereas Koa Hill is located further inland and near a hillside. It is also possible that it was due to limited

population size to perform separate analysis for under-five households located on hilltop and valley areas in Koa Hill informal settlement.

Despite that, this relationship is not in agreement with other studies, which found that altitudes of households were significantly associated with disease occurrence (Lau et al. 2012, p.5; Uwizeye et al. 2014, p.7). As shown in Uwizeye et al. (2014, p.7), diarrhoea prevalence among dwellers depended on household location. This same study concluded that households built in high altitude areas were less likely to experience diarrhea, as compared to households built in valley areas during either rainy or dry seasons. In a similar study to estimate the leptospirosis seroprevalence in American Samoa, Lau et al. (2012, p.5), also found that altitude and location of backyard piggeries were significantly associated to leptospirosis seroprevalence. However, since households built in low altitudes areas near the river, hillside and on coastal areas were at risk to flooding, storm surge and water-borne disease outbreaks, it is advisable not to reside in such hazardous prone areas. This has emphasized another important issue of urgency for local government to work on a long-term relocation plan for these study settlements.

Lastly, the results clearly demonstrated that the distance of under-five households to the river was statistically associated with under-five diarrhoea in Mataniko informal settlements ($p<0.05$). In addition, a majority (80.0%) of under-five households with reported cases within 2 weeks were built near the river ($\leq$ 125 m), in comparison to those far (above 125 m) from the river (20.0%). This significant difference was not likely due to chance ($p<0.05$). The results (OR=2.60, 95% CI: 1.21, 5.60) further illustrated that children from households located near the river were 2.6 times more likely to experience diarrhoea than children from households that were further from the river. Moreover, children from households near the river were highly exposed to river pollutants. Other related studies also supported this finding and argued that household location, such as distance to exposed areas like garbage dump sites and poor drainage areas, were influential factors to diarrhoea prevalence (Dutton & Pigolo 2014; Uwizeye et al. 2014, p.6). As

a matter of prevention, housing and public health authorities should create policy to avoid the establishment of human dwellings within 125 meters to the river in Honiara city.

4.3.5 Possible interventions to reduce the incidence of under-five diarrhoea

The prevalence of under-five diarrhoea and its associated factors stipulated in this thesis are alarming and cannot possibly be reduced without the deliberate intervention of local government, public health sectors and partners responsible for addressing child-health determinants.

The impacts of socio-demographic characteristics, like crowded households with low income level in many households, in relation to the burden of under-five diarrhoea requires awareness and advocacy at the community level. Related programmes should be designed with the aim to influence positive behavioral change among mothers and their respective partners. As revealed in this study, having more than one child below five years in a family and low income level contributed to the increased prevalence of under-five diarrhoea. Undoubtedly, an adoption of appropriate family planning through child birth spacing, plus improved access to employment among families, can ease this burden in the study settlements. As alluded to by WHO (2014) and SINSO (2009), having a number of children that is easy to sustain in terms of food, shelter and other social services, including education and medication, is a wise decision which will result in a healthy family.

With recorded high knowledge and low practice levels on diarrhoea prevention, continuous health education and awareness are of utmost importance to narrow this gap. Ongoing hygiene education has been proven to lower the occurrence of under-five diarrhoea by applying effective means of prevention (Diouf et al.2014, p.5). Additionally, it also enabled caregivers to recognize the related signs and symptoms in order to seek first line of appropriate care (Mukiira 2012). As part of a prevention effort, the WHO had developed a hand hygiene

guideline which stipulated the steps of hand washing practice as a guide for health educators worldwide (WHO 2009).

As evidenced in Cairncross (cited in Curtis et al. 2000), diarrhoeal pathogen transmission often occurs at household level. Thus, improving access to a WASH facility within this domain is necessary to give equal chance to caregivers to practice their existing knowledge. Seeing the importance of a supportive environment, Solomon Islands, as a developing country, needs to strengthen its commitment to the World Health treaties and integrated action plans alongside its public health act and health sector strategic plan. This also requires the strengthening of health setting approaches in communities and other settings like schools where children usually spend most parts of the daylight. For so long very little was done in terms of a healthy setting approach in these domains, though the creation of child friendly environment and the inclusion of hygiene education in the school curriculum have been globally recognized by WHO. Logically, hygiene knowledge among under-five children can cause positive impacts in their life when they know it and practice it by themselves, rather than relying on their caregivers. At the household level, mothers need to be trained about initial home-management of diarrhoea, including the administration of ORS to children (<5 years).

The issue of low coverage of safe water sources and toilet facilities can be addressed by a total WASH initiative. In addition, the responsible sectors like HCC, MHMS, Central Honiara constituency and SWA, should display their commitment in this priority. Undoubtedly, improved WASH facility coverage is important to reduce the gap between WASH facility availability and hygiene practice. As alluded to within this study, and also supported by Uwizeye et al. (2014, p.6), using improved toilet facilities will reduce the risk of diarrhoeal infection. In addition, a significant improvement of sanitation coverage will further reduce the rate of open defecators and the presence of faecal waste on footpaths near households. As a required health standard, the

sanitary facility should be one toilet facility per family, not exceeding 6 people (WHO 2013). This is to prevent excessive use and to provide the ease in maintaining the toilet facility.

To overcome the potential health risk associated with direct exposed to the river, the housing sector, in partnership with the national health sector and HCC as local government, should work on a long-term plan to relocate families located within 125 meters distance to the river and those in low lying coastal areas. Likewise, bylaws should be created to protect the river as a garbage dumpsite and preserve it as an important city ecosystem with minimal pollution.

Apparently, due to the uneven distribution of social services delivery among urban and rural rich and poor children, the country NHSP 2016-2020 has prioritized the survival of children as its number 1 mission statement, especially in disadvantaged communities, remote and hard to reach areas (MHMS 2016). Nevertheless, this said priority needs active involvement and commitment of the health sector and partners to make this initiative become a reality in the coming years.

CHAPTER 5.0: MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary of the key findings discovered in chapter four, which primarily answered the research questions and study objectives set out in chapter three. Based on the findings, it then concludes by outlining some recommendations intended for deliberate actions to address the burden of the said health problem in Mataniko informal settlements, in Honiara.

5.2 SUMMARY OF MAJOR FINDINGS

The 2 weeks prevalence rate of under-five diarrhoea in Mataniko informal settlements was 45.9%. This is exactly five times higher than the nationwide under-five diarrhoea prevalence rate (9.4%), reported in the Solomon Islands DHS Report (SINSO 2007). The DHS data was the only means of comparison, though it was not appropriate in terms of difference in methodology and scope of study. The case distribution by age group revealed high cases among children 2 years and below (58.5%). Case distribution by locality showed an almost equal distribution among the three study settlements, indicated by 36.2%, 33.0% and 30.9%, respectively. This verified that children (<5 years) within these settlements were almost equally at risk to diarrhoeal infection.

In bivariate analysis, a number of socio-demographic risk factors including, age group of children (<5 years) from 2 years and below, having at least 2 children (<5 years) per caregiver and fortnightly income of $1,500 (SBD) and below, were significantly associated with under-five diarrhoeal disease ($p<0.05$). Practice factors which were associated with under-five diarrhoea illustrated in this study were: irregular hand washing, inappropriate methods of disposing of faecal waste and using the river for bathing and laundry. In terms of environmental risk factors,

the presence of stagnant waste water, flies, solid waste and water filled containers near households, along with distance of under-five households less than 125 meters to the river, were independently associated with under-five diarrhoea ($p<0.05$).

The level of childcare needed was different for the age range as under-five children required optimal parental care while children above five years required less. Another difference was in the change of diet from milk to solid food and physical body changes like crawling, walking and the eagerness to explore the surrounding environment occurring within this age group (<5 years). Rationally, in this study the prevalence of this disease is high because the surrounding environment itself is not child friendly, whereby children (<5 years) can easily be exposed to contaminated materials. With low fortnightly income in many families, the opportunity to access essential social services and to improve conditions surrounding their households is even harder. This is a fundament contributor to a wider gap between hygiene knowledge (98.0%) and practice level (31.7%). In this scenario, income is crucial in determining child-health and due to inadequate access to it has potentially denied caregivers the ability to practice critical hygiene behavior, which could have prevented some incidence cases.

On other hand, though regular hand washing is necessary to prevent this disease, as depicted in this study and other studies elsewhere, it was just a generalized concept in the context of Honiara informal settings and normally refers to without soap and clean water or just a basin of rain water outside. In this scenario, regular hand washing cannot always contribute to 60% diarrhoeal risk reduction, as stipulated in Freeman et al. (2014, p.6).

Furthermore, access to safe water sources and toilet facilities did not significantly reduce the prevalence of under-five diarrhoea. The small population size having access to toilets has influenced this result, though access to a toilet facility often ensures proper disposal of faecal waste. Besides that, water sources can be defined safe as in the context of this study, however, there is no microbiological testing to verify it. Apparently, the drinking water could also be

contaminated by means of poor handling and storage using dirty containers. Though SIWA metered pipe water is a chlorinated source, due to its low coverage, added to being unsafe during prolonged heavy rainy seasons, it is not frequently protective against diarrhoea, as compared to shop water sources.

The river is also a potential contributor to this disease, as verified by caregiver's domestic activities like bathing and laundry ($p<0.05$); this is further supported by Escherichia coli bacterial analysis result. It further revealed that even though younger children (≤2 years) are the most unlikely to use the river, they were exposed through their caregivers who were directly exposed to the river. Also, the chance of being infected with diarrhoea being 2.6 times higher among children (<5 years) living in households near (≤125 meters) the river.

Due to uneven distribution of government social services like water and sanitation among the urban rich and poor populace, some families continue to use the river for bathing, laundry and other domestic uses, despite its poor health status.

5.3 STUDY LIMITATIONS

The study was conducted in three (3) informal settlements along the Mataniko River corridor, in Honiara, and therefore did not represent the entire population of children (<5 years) in Honiara's informal settlements. There is also a limitation in the targeted age group since all age groups are at risk to diarrhoea. In addition, courtesy bias is most likely to happen due to the scope and methodology of study and also bias incurred from personal knowledge questions.

The study only generalized diarrhoea occurrence, but failed to considered types of diarrhoea such as acute, watery or bloody diarrhoea in the analysis.

The chance of over reporting diarrhoea cases is high, because some symptoms of other childhood illnesses, like anaemia, can be overlap. Furthermore, this study failed to verify the episodes of diarrhoea due to the investigated factors and those due to other childhood illnesses. It also predicted that high reported cases could be due to the period of the household interview process, which coincided with the post-diarrhoea outbreak period in Honiara. For this reason, it has been assumed that if the study was conducted a few months after the outbreak, it would have given a true prevalence rate. However, this was not possible because of the strict study timeline in the plan.

The study directly involved primary caregivers instead of under-five children who were at a speaking age. This means that some practices of children, including playing in the river and the number of times of passing watery stool per day, can be over reported by caregivers. In this situation there were no children around to verify the responses concerning them.

Some categorical variables are possible confounders since they are only applicable to a certain age group. For instance, younger children (≤2 years) were not directly exposed to the river and pit-latrine toilets. Also, children below 6 months were not highly exposed to unsafe water, since they entirely fed on milk. Nevertheless, they were part of the denominator, which had limited the representativeness of the results.

Although other WASH facilities, like water source, were classified as safe sources, due to limited funds, there was no microbiological and chemical analysis being done to determine the true quality of drinking water sources.

Insecurity is another challenge to effectively conduct the study, as some informal dwellers were involved in illegal drug production and distribution, locally termed as Kwaso. The presence of researchers can be mistakenly defined as law enforcement officers coming to arrest them.

Finally, this study was restricted to only two field research assistants based on the approved research budget. Such restriction affected the timely completion of field data collection in the three settlements. The true 2 weeks recall period was inconsistent, as it was impossible for only 2 assistants and a principal investigator to conduct study in the three settlements in the same week and finish on the same week. In this scenario, only the first settlement was accounted for the true 2 weeks' recall.

5.4 CONCLUSION

Diarrhoea was a major public health problem among children below five years in Mataniko informal settlements, indicated by a high prevalence rate of 45.9%, as compared with documented findings from other developing regions of Africa and Asia-Pacific. This is the first ever prevalence study in Honiara informal settlements and there was no previous data for comparison.

Results showed that under-five diarrhoea was associated with other socio-demographics (age group of under-five children, number of under-five children per caregivers and income level); practice (hand-washing, methods of disposing children faecal waste, used the river for bathing & laundry); and environmental factors (presence of stagnant waste water, flies, solid waste & distance of under-five households to the river), as evidenced in the study.

To address these exposures, relevant programmes and projects should be designed, especially in areas like family planning, household economic empowerment and political commitment to a total WASH coverage initiative. Awareness and advocacy programmes on birth spacing, food hygiene and potential health risks about the river should be ongoing at the community level.

Though not all investigated factors were directly associated with under-five diarrhoea, they were vital factors for public health advocacy, since they were found influential in other studies. Nonetheless, these were important issues which can be considered in another study.

5.5 RECOMMENDATIONS

The following recommendations need to be institutionalized, which require the deliberate actions of policy makers, health educators and others who are directly and indirectly responsible to address public health determinants.

1. First and foremost, the need to implement an ongoing awareness and training targeting caregivers to improve their hygiene habit, home-management of diarrhoea and birth spacing methods.
2. Drainage systems and WASH facility coverage need to be improved in urban informal settlements to ensure proper disposal of faecal and other household solid waste.
3. There is also a high need for capacity building and equal allocation of income generating projects among urban households by the local responsible government and constituency.
4. The MHMS needs to work in collaboration with HCC, MLHS and the in-country UN-HABITAT consultant, to work on a long-term relocation plan, policies and actions which protect the river from human contamination; and prohibit the establishment of buildings within 125 meters distance to the river. This implies that the combined efforts and vision on relocation should be more formalized allotments with services; though it may take years to happen.

5.6 ISSUES FOR FUTURE RESEARCH

This study had spotted other uprising issues for further research. This includes a study to explore the establishment of cheaper and safe sanitation facilities such as the "eco-toilet", since complete coverage of a modern toilet will be very expensive for the sectors responsible. A study is also needed in areas like availability of water and soap for hand washing in relation to under-five diarrhoea prevalence.

There is also a need to investigate the number of mothers who received birth control education from health workers. Additionally, the root causes of the growth of urban informal settlements need to be known to guide rural-urban migration policy makers.

Further, it is vitally important to do an in depth microbiological analysis to explore the presence of all diarrhoeal-pathogens in the river, not limited to Escherichia coli, as revealed in this study. This will provide a broad understanding of health risk of being exposed to the river.

Lastly, but of utmost importance, is for the national government and partners to provide research opportunities to explore the economic benefits of either preserving the Mataniko River for recreational purpose, or utilizing it into a productive water resource, with shared benefits between the government and informal dwellers along the river corridor. Undoubtedly, turning Mataniko River into a productive resource, by means of water recycling and treatment, will provide an adequate safe water source at low cost for city dwellers. Excessive safe water supply can also be used for small scale businesses, like plant and crop irrigation.

To assess for possible behavioral change, it is necessary to reconduct the same study in the near future, but after the recommendations are implemented.

6.0: REFERENCES

Alambo, KA 2015, 'The Prevalence of Diarrhoeal Disease in under five children and associated risk factors in Wolitta Soddo Town, Southern, Ethiopia', *ABC Research House*, vol.3, no.2.

Bonita, R, Beaglehole, R & Kjellstrom, T 2006, *Basic Epidemiology*, 2nd edn, WHO Press, Geneva, Switzerland.

CDC 2015, *Diarrhea: Common Illness, Global Killer*, New York, Washington DC.

CDC 2015, 'Diarrhea: Common Illness, Global Killer Fact Sheets', *Global Water, Sanitation and Hygiene*, 7th December, viewed 19th November 2016, <http://www.cdc.gov /healthywater/pdf/global/programs/globaldiarrhea508c.pdf.

CDC 2015, 'Global WASH Fast Facts', *Global Water, Sanitation and Hygiene*, 11th April, viewed 18th November 2016, <http://www.cdc.gov/healthywater/global/wash_statistics.html.

Chiller, T, Yan, H, Tu'uau-Potoi, N, O'Leary, M, Garin, B, Singh, N et al. 2005, 'Foodborne disease surveillance in the Pacific: perspectives for the future', Pacific *Health Surveillance and Response*, vol.12, no.2.

Chung, M & Hill, D 2002, *Urban informal settlements in Vanuatu: Challenge for equitable development,* Pacific Islands Forum Secretariat, Suva.

Curtis, V, Cairncross, S & Yonli, R 2000, 'Domestic hygiene and diarrhoea-pinpointing the problem', *Tropical Medicine and International Health Journal*, vol.5, no.1, pp. 22-32.

Diouf, K, Tabatabai, P, Rudolph, J & Max, M 2014, 'Diarrhoea Prevalence in children under five years of age in rural Burudi: an assessment of social and behavioral factors at the household level', *Global Health Action*, 7:24895.

Dutton, P & Pigolo, G 2014, *Papua New Guinea: Sanitation, Water Supply and Hygiene in Urban Informal Settlements*, World Bank Group.

ESCAP 2015, *Overview of Natural Disasters and their Impacts in Asia and the Pacific: 1970-2014*, UN, Geneva.

Freeman, M, Stocks, M, Cumming, O, Jeandron, A, Higgins, J, Wolf, J, et al. 2014, 'Hygiene and health: systematic review of hand-washing practices worldwide and update of health effects', *Tropical Medicine and Internal Health Journal*, vol.00, no.00, doi: 10.1111.

Girma, R, Wondwossen, B, Bishaw, D & Tefera, B 2008, 'Environmental Determinants of Diarrhoea Among Under-Five Children in Nekemte Town, Western Ethiopia', *Ethiopia Journal of Health Science*, vol.18, no.2.

Ikua, MD 2014, *Risk Factors Influencing Diarrhoeal Occurrence Among Children Under Five Years Old in Informal Urban Settlements: A Case Study of Korogocho, in Nairobi County, Kenya*, thesis, University of Nairobi, Department of Geography and Environmental Studies, Kenya.

John, J, Sarkar, R, Muliyil, J, Bhandari, N, Bhan, MK & Kang, G 2014, 'Rotavirus gastroenteritis in India, 2011-2013: Revised estimates of disease burden and potential impact of vaccines', *32 Supplement*, 1: A5-9.

Johns Hopkins University 2013, *Diarrhoea: A threat to child health and survival*, International Vaccine Access Center, Baltimore, Maryland, USA.

Jones, P 2012, 'The Challenges of Implementing Millennium Development Goal Target 7D in Pacific Island Towns and Cities', *Asia-Pacific Development Journal*, vol.19, no.1.pp.1-8.

Kakulu, RK 2012, *Diarrhoea among under five Children and Household Water Treatment and Safe Storage Factors in Mkuranga District, Tanzania*, Thesis, Muhimbili University of Health and Allied Sciences, Tanzania, Africa.

Kavan, SP 2013, *Informal Sector in Port Moresby and Lae, Papua New Guinea: Activities and Government Response*, thesis, University of Canberra, viewed 2nd March 2016, UC Digital Thesis database.

Kiddle, G.L 2011, *Informal Settlers, Perceived Security of Tenure and Housing Consolidation: Case Studies from urban Fiji*, thesis, Victoria University of Wellington, viewed 2nd March 2016.

Koto, N 2011, *Exploring informal urban settlements in Suva - its growth and environmental implication, Earthcaching Project*, The University of the South Pacific, Suva.

Lau, C.L, Dobson, A.J, Smythe, L.D, Fearnley, E.J, Skelly, C, Clements, A.C, et al. 2012, 'Leptospirosis in American Samoa 2010: Epidemiology, Environmental Drivers, and the Management of Emergence', *American Society of Tropical Medicine and Hygiene Journal*, vol.86, no.2, p.5.

McMurray, C 2005, *A Situation Analysis of Children, Women & Youth Report*, UNICEF.

McKay, J 2009, *Poverty Housing in the Developing Nations of the Pacific Islands*, Habitat for Humanity International, Asia-Pacific Office, Bangkok, Thailand.

MHMS 2009, *Solomon Islands Ministry of Health Annual Report*, Solomon Islands Government, Honiara.
MHMS 2010, *Solomon Islands Ministry of Health Annual Report*, Solomon Islands Government, Honiara.
MHMS 2011, *Solomon Islands Ministry of Health Annual Report*, Solomon Islands Government, Honiara.
MHMS 2011, *Solomon Islands National Health Strategic Plan (SINHSP) 2011-2015*, Solomon Islands Government, Honiara.

MHMS 2012, *Solomon Islands Health Services Delivery Profile (SIHSDP)*, Solomon Islands Government, Honiara.

MHMS 2014, *The Solomon Islands Rural Water Supply, Sanitation and Hygiene Policy*, Solomon Islands Government, Honiara.

MHMS 2016, *Solomon Islands National Health Strategic Plan (SINHSP) 2016-2020,* Solomon Islands Government, Honiara.

Mohammed, S & Tamiru, D 2014, 'The Burden of Diarrheal Diseases among Children under five years of age in Arba Minch District, South Ethiopia and Associated Risk Factors: A Cross-Sectional Study, Hindawi Publishing Corporation', *International Scholarly Research Notices*, vol. 2014.

Mohanty, M 2007, *Squatters, Vulnerability and Adaptability of Urban Poor in a Small Island Developing State: The Context of Fiji Islands,* The University of the South Pacific (USP), Suva.

Mukiira, C 2012, *Healthcare-seeking practices of caregivers of under-five children with diarrheal diseases in two informal settlement in Nairobi, Kenya,* thesis, University of Witwatersrand, Johannesburg, Faculty of Humanities, School of Social Sciences.

Opisa, S, Odiere, M, Jura,W, Karanja, D & Mwinzi, P 2012, 'Faecal contamination of public water sources in informal settlements of Kisumu City, western Kenya', *Water Science & Technology Journal,* vol.66, no.12, pp.1-3.

Palihawadana, P 2011, 'Diarrhoeal disease - The child killer', *Weekly Epidemiological Report Sri Lanka*, vol.38, no.29.

PPHSN 2015, *Pacific Outbreak Manual,* WHO/SPC Western Pacific Regional Office, Suva, Fiji Islands.

Rosewell, A, Addy, B, Komnapi, L, Makanda, F, Ropa, B, Rosanai, E, et al. 2012, 'Cholera risk factors in Papua New Guinea', *BMC Infectious Diseases Journal,* vol.12.

Safran, P 2013, *Fragility Assessment of an Informal Urban Settlement in Papua New Guinea*, Asian Development Bank (ADB).

SIG 2014, *Rapid Assessment of the Macro and Sectoral Impacts of Flash Floods in the Solomon Islands: April 2014*, The Work Bank Press, Washington, D.C.

Singh, M 2011, 'Fiji Islands Housing Policy', *The Fiji Times*, 31st March, p.1, viewed 10th November 2015, The Fiji Times Online database.

SINSO 2007, *Solomon Islands Demographic & Health Survey Report*, Solomon Islands Government, Honiara.

SINSO 2009, *Solomon Islands Population & Housing Census Report*, Solomon Islands Government, Honiara.

Smith, LC & Subandoro, A 2007, *Measuring Food Security Using Household Expenditure Survey*, International Food Institute, Washington, D.C, USA.

Tabua, J, Kabuabola, I & Rafai, E 2013, 'Retrospective study on the effect of climate variability on the incidence of dengue in Fiji from 2003 to 2007', *Fiji Journal of Public Health*, vol.2, no.2.

Tate, JE, Sarkar R, Ajjampur SSR, Kattula D, John J, Ward, HD et al. 2014, 'Burden of Diarrhea, Hospitalization and Mortality Due to Cryptosporidial Infections in Indian Children', *PLOS Neglected Tropical Diseases Journal*, vol. 8, no.7, p.2.

UNESCO 2005, *Natural Disaster Preparedness and Education for Sustainable Development*, The Asia-Pacific Programme of Educational Innovation for Development Education for Sustainable Development, Bankok, Thailand.

UNDP 2014, *Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience*, New York, USA.

UNDP undated, *Sustainable Development Goals-Booklet*, viewed 7th June 2017, <http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web.

UN-HABITAT 2010, *UN Housing Rights Assessment Mission to Papua New Guinea July 2010 Report*, Regional office, Suva, Fiji.

UN-HABITAT 2012, *SOLOMON ISLANDS: HONIARA URBAN PROFILE Report*, Nairobi, Kenya.
UNICEF 2011, *Children in Vanuatu: An Atlas of Social Indicators*, UNICEF Pacific, Suva, Fiji Islands.
UNICEF 2012, *THE STATE OF THE WORLD'S CHILDREN Report*, Brodock Press Inc, New York, USA.

UN World Water Development Report 2009, *Water in a Changing World*, UN Human Settlement Program, UNESCO.

Uwizeye, D, Sokoni, C & Kabiru, C 2014, 'Prevalence and correlates for diarrhoea in the mountainous informal settlements of Huye town, Rwanda', *A Springer Open Journal, vol.3:* 745.

Water-Aid 2008, *Sharing Experiences: Sustainable Sanitation in South East Asia and the Pacific Report*, Brisbane, Australia.

WHO 2008, *Weekly Epidemiological Report*, no.47.

WHO 2009, *Country profile of Environmental Burden of Disease: Public Health & Environment Report*, Geneva, Switzerland.

WHO/SPC 2015, *Eleventh Pacific Health Ministers Meeting: Yanuca Island Declaration on health in Pacific Islands Countries and Territories, 15-17th April 2015,* WHO/SPC Western Pacific Regional Office, Suva, Fiji Islands.

WHO/UNICEF 2009, *Diarrhoea: Why Children Are Still Dying And What Can Be Done Report*, WHO Press, Geneva, Switzerland.

WHO 2009, *WHO Guidelines on Hand Hygiene in Health Care*, WHO Press, Geneva, Switzerland.

WHO/UNICEF 2010, *Joint Statement: Clinical Management of Acute Diarrhea*, WHO Press, Geneva, Switzerland.

WHO 2009, *Hand Hygiene: Why, How & When?', A World Alliance for Safer Health care*, viewed 21st November 2016, <http://www.who.int/gpsc/5may/Hand_Hygiene_Brochure.pdf.

WHO 2014, *The Solomon Islands Diarrhoea Outbreak: Health Situation Report No 1*, WHO office, Honiara.

WHO 2015, *Solomon Islands Health System Review: Health Systems in Transition, Vol. 5, No. 1*, WHO Press, Geneva, Switzerland.

Wilson, C 2013, 'Water Shortage Hits Pacific Women', *Inter Press Service (IPS) News Agency*, 8th April, p.2, viewed 23rd February 2015, IPS News database.

Zahid, S, Zehra, N, Ullah, S, Khan, N, Hamza, M & Khan, M 2014, 'Mother's Awareness and Practices Regarding Home Management of Childhood Diarrhea in a Squatter Settlement of Karachi', *Pakistan Journal of Medicine and Dentistry*, vol. 3, no.2, p.5.

7.0: APPENDICES

7.1 Appendix 1: Introduction Script

I'm Ambrose Gali, working in the Ministry of Health and also a current student from Fiji National University (FNU), pursing a degree in the Master of Applied Epidemiology. The purpose of this study is to assess factors contributing to under-five diarrhoeal prevalence in Mataniko informal settlements, in Honiara. I therefore would be very happy to discuss the following questions with you about diarrhea, if you're not busy.

CONFIDNTIALITY AND VOLUNTARY OF PARTICIPATION

Effort will be made to keep your information confidential. Your participation in this exercise is voluntary.

BENEFITS

You will be given information regarding prevention of future reoccurrence of diarrhoea. The results obtained from this study will be used to effectively manage the disease.

PROBLEM OR QUESTIONS

If you have any problem or question about the research study, you may contact this number: (677) 7775643

7.2 Appendix 2: Consent form

Theme: **Causes of under-five diarrhoea in Mataniko informal settlements.**

My name is: _____from____province, and I am conducting interviews to assist Ambrose Gali, a student from Fiji National University (FNU) for his Thesis Project. He is studying the factors that contribute to under-five diarrhoea prevalence. During this field study, you will be asked to

answer some questions relating to the theme. This interview was designed to take about 25 minutes of your time. However, please feel free to expand on the theme or talk about related ideas. If there are any questions you would rather not answer or that you do not feel comfortable answering, please say so and we will stop the interview or move on to the next question, whichever you prefer. All the information will be kept confidential. Only the research team and project supervisors will have accessed to this information. Upon completion of this project, all raw data will be destroyed or stored in a secure location.

Participant's Agreement:

I am aware that my participation in this interview is voluntary. I understand the intent and purpose of this research. If, for any reason, at any time, I wish to stop the interview, I may do so without having to give an explanation.

The research assistant has reviewed the individual and social benefits and any potential risks of this project with me. I am aware the data will be used in a thesis project that will be presented to the university faculty and SI-MHMS for public health and academic purposes only. I have the right to review, comment on, and/or withdraw information prior to the thesis project's submission. The data gathered in this study are confidential with respect to my personal identity unless I specify otherwise.

If I have any questions about this study, I am free to contact the student researcher (Ambrose Gali, email: s111039@student.fsm.ac.fj or agali00479@gmail.com) or the FSM/USP faculty supervisors (Keshwa Nand Krishna, email: keshwa.krishna@fnu.ac.fj, telephone: (679) 3113231; Sabiha Khan, email: sabiha.khan@fnu.ac.fj; Dr. John Lowry, e-mail: lowry_j@usp.ac.fj, telephone (679)3232549)).

If I have any questions about my rights as a research participant, I am free to contact the Chair of Fiji School of Medicine (FSM) Research and Ethics Committee. Also the CHREC (College of Health Research & Ethics Committee) Secretariat: Mr. Mohseen Khan, Email: Mohseen.Khan@fnu.ac.fj, Telephone: (679) 3311700.

I have been offered a copy of this consent form that I may keep for my own reference. I have read the above form and, with the understanding that I can withdraw at any time and for whatever reason, I consent to participate in today's interview.

Participant's Signature: …… Date: …….

Interviewer's Signature: …… Date: …….

7.3 Appendix 3: Questionnaire form

Confidentiality: Every effort will be made to ensure that the confidentiality of all information is maintained. **No names** will be found written in this form and it will be only used for computer data entry which will be kept confidential.

Participation & withdrawal: Since this survey is voluntarily, you may withdraw or discontinue at any time you wish without expecting any harm or any form of penalty. All your views or responses are good, there are no wrong answers. I will protect and keep your answers in a safe place and treat them equally.

Instructions: Either circle, tick (√) or specify where appropriate.

Name of settlement: _____ Household No: _____ Date: _____

1.0 Demographics Information		**Responses**
1.1 Are you the mother or primary give-taker of the child? (If **No**, end of interview)	A. Yes……1 B. No ……..2	☐
1.1a If Yes, your relationship to the child	A. Mother ……...1 C. House-girl ……3 B. Father ……2 D. Others: _____	☐
1.2 Sex	A. Male ..... 1 Female 2	
1.3 How old are you?	Age in years:_____	☐
1.4 Usual Place of residence	A. Honiara..... 1 B. Rural..... 2	☐
1.5 If Honiara, how long have you lived here?	A. <12 months ……1 C. 3-5 years ……3 B. 1-3 years ……2 D. >5 years …….4	☐
1.6 Number of occupants in the house.	A. 3 people or less ..... 1 B. 4-5 people ..... 2 C. 6-7 people..... 3 D. 8-9 people ..... 4 E. 10 people or more ...5	☐
2.0 Households socio-economic factors.		
2.1 Highest level of formal education attended by primary care-taker.	A. Primary ..... 1 B. Lower secondary ……..... 2 C. Upper secondary..... 3 D. Tertiary (college/vocational/university) …….. 4	☐

	E. No formal education ……..5	
2.2 Household source (s) of income	A. No income ……..……...…1 B. Wages/salary……...….2 C. Own business ……...3 D. Sale of fish/crop/handicraft …….4 E. Market vendors (sale of cooked food, betel nut etc)....5 F. Land lease ……6 G. House rent ……..……7 H. Remittances ……8 I. Others (specify): ……9 I1: _____ I2: _____	☐ ☐ ☐
2.3 Household fortnightly income level	A. $499 or less …….1 C. $1000-$1500 ……. 3 B. $500-$999 …..….2 D. >$1500 ……...…..…. 4	☐
3.0 Hygiene knowledge and practices		
3.1 What do you think could be the possible causes of under-five diarrhoea?	Please check (√) those being correctly identified: 1. Dirty water…….. ☐ 2. Dirty hands …… ☐ 3. Spoiled food …… ☐ 4. Spoiled fruits …. ☐ 5. Food vendor …… ☐ 6. Others (specify)…….. ☐ 7. Did not know ……. ☐ _____	☐ ☐
3.2 What are critical times to wash hands before attaining a child (<5 years)?	Please check (√) those being correctly identified: 1. After using the toilet... ☐ 3. Before feeding a child… ☐ 2. After changing diaper.. ☐ 4. After feeding a child….. ☐	☐
3.3 Do you always wash your hands at critical times (e.g. after using the toilet etc)?	A. Yes ……1 B. No ……2	☐
3.4 Do you treat or boil drinking water for your children (<5 years)?	A. Yes ……1 B. No ……2	☐
3.5 Is toilet you're using regularly cleaned?	A. Yes ……1, B. No……2.	☐
3.6 Where do you dispose your children (<5 years) faecal waste?	A. Flash toilet ……1 B. Latrine ……...2 C. Open yard ……..3 D. Open drain ……4 E. River ……..5 F. Sea ……..…6 G. HCC Bin ……..……..7	☐ ☐
3.7 Do you think that children faeces are harmful?	A. Yes ……1, B. No……2.	☐
3.8 How do you dispose the household solid waste?	1. Government waste collection … ☐ 5. Sea …… ☐ 2. Bury ……..... ☐ 6. Backyard…. ☐ 3. Burn …… ☐ 7. Others …. ☐ 4. River/ Stream … ☐	☐ ☐

3.9 What do you normally use the river for?	Please check (√) those being correctly identified: 1. Bathing …….☐ 4. Fishing …. ☐ 2. Laundry (washing clothes).. ☐ 5. Cooking … ☐ 3. Disposal of human & animal waste..☐ 6. Kids leisure..☐	☐ ☐
3.9a Do your children (<5 years) often play in the river?	A. Yes ……1, B. No……2.	☐
4.0 Environmental factors (WASH facilities in and around homes)		
4.1 Where do you get water used in the home? (Note: Assess water sources)	A. Metered-SIWA ……..1 B. Communal standpipe...2 C. HH tank ……..3 D. Communal tank ……..4 E. Well-protected ……5 F. Well-unprotected …..6 G. River/Stream …….7 H. Bottled water from shops ……..8 I. Others (specify) …….9	☐ ☐
4.2 Do you own a latrine/toilet facility?	A. Yes ……..1 B. No ……2	☐
4.3 Type of toilet facility used?	A. Flash private …….. 1 B. Flash shared ……2 C. Water sealed private ...3 D. Water sealed shared …4 E. Pit latrine private … 5 F. Pit latrine shared…...6 G. Other ……..…7 H. None ……..…8	☐ ☐
4.4 Do you have accessed to any toilet facility?	A. Yes ……..1 B. No ……2	☐
4.5 If yes, how many people use the toilet facility?	# of people: _____	☐
4.6 Interviewers will assess the presence or absence of stagnant (waste) water, flies and scattered solid waste around the homes. Also potential breeding sites for mosquitos and flies.	Please check (√) those being correctly identified: A. Stagnant (waste) water …… ☐ B. Flies …… ☐ C. Scatted soild waste …….. ☐ D. Scattered water-filled containers…☐	☐ ☐
4.7 Altitude of under-five households	-	☐
4.8 Distance of under-five households to the river	-	☐
5.0 Age of child and under-five diarrhoea occurrences		
5.1 How many children in this household are below five years old?	A. 1 child ……☐ B. 2 children ….☐ C. 3 children …☐ D. 4 children ….☐	☐
5.2 to 5.5: If more than one child, what is the age of each child?	5.2 Child 1: Age in months: _____ Age (years): _____ 5.3 Child 2: Age in months: _____ Age (years): _____ 5.4 Child 3: Age in months: _____ Age (years): _____ 5.5 Child 3: Age in months: _____ Age (years): _____	☐ ☐
5.6 to 5.9:	**Please circle the number of time (s)**	

How many times has each child had diarrhea in the last 2 weeks?	5.6: Child 1: 0, 1, 2, 3, 4 5.7: Child 2: 0, 1, 2, 3, 4 5.8: Child 3: 0, 1, 2, 3, 4 5.9: Child 4: 0, 1, 2, 3, 4	☐
6.0 What initial action have you been taken when your child (<5 years) experienced diarrhoeal disease?	Please check (√) those being correctly identified: 1. Go to nearest gov't clinic … ☐ 2. Go to private doctor…….. ☐ 3. Give herbs ….. ☐ 4. Give rice water …… ☐ 5. Give juice/fruits …….. ☐ 6. Give cleaned water ……. ☐ 7. Others (specify) …... _____	☐ ☐ ☐

Note: The altitude (m) and distance (m) of under-five households to the river will be captured using GPS technology, and will be categorized using the readings generated in the field.

7.4 Appendix 4: SI-NHREC certificate of study approval

No: 15/36

National Health Research & Ethics Committee
Solomon Islands Ministry of Health & Medical Services

Research Certificate

To Ambrose Roots Gali
Fiji National University
College of Medicine, Nursing & Health Science

The National Health Research & Ethics Committee (NHREC) of the Ministry of Health & Medical Services, Solomon Islands has deliberated in 25th August 2015 and has approved your application to do research titled "Exploring factors that correlate to diarrheal prevalence among children [<5 years] in mataniko informal settlements, Honiara, Solomon Islands".

You are hereby granted permission to conduct your research in Solomon Islands for your proposed duration in 2015 and 2016 only. This approval is for the one-time conduction of your research and any amendments, repetition and/or extension of this research will need further NHREC approval. A report is to be submitted to the committee upon completion of this approved term of research. Failure to abide to the above terms will result in suspension or discontinuation of approval.

Dr Titus Nasi
Vice Chairman, NHREC

Date 01/09/2015

7.5 Appendix 5: FNU-CMNHS certificate of study approval

College Health Research and Ethics Committee (CHREC)
College of Medicine, Nursing and Health Sciences
Research Unit Hoodless House
PH: 3311700 EXT: 3018

Date: 27/11/15

Student ID: s111039

Dear Ambrose Gali,

Thank you for your application for review to the College Health Research & Ethics Committee.

Title of Research: Exploring factors that correlate to diarrheal prevalence among children (<5 years) in Mataniko informal settlements, Honiara, Solomon Islands.

I am pleased to advise you that the CHREC has granted FULL approval for your above-mentioned study. Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

i. **Duration of Approval** – approval is granted till the duration of project as outlined in the research proposal. However, if the study cannot be completed in the time frame given, researcher has to seek an extension by submitting a progress report.
ii. **Variation to Project**: Any subsequent variations or modifications you might wish to make to your project must be notified formally to the Chair, College Research Committee for further considerations and approval.
iii. **Incidence or adverse effects**: Researchers must report immediately to the Chair of the College Health Research & Ethics Committee.
iv. **Monitoring:** Projects are subject to monitoring at any time by the Committee.
v. **Final Report**: You must submit a final report at the conclusion of the project by completing the Final Report form.

Please note that all health related research conducted in Solomon Islands using Solomon Islands Ministry of health data, patients, personnel or facilities will have to be reviewed and approved by the Solomon Islands National Research Ethics Review Committee. An approval letter has already been received and sighted.

If you have any further queries on these matters or require information, please do not hesitate to contact the secretariat on telephone: (679) 323 3406 or email: CMNHS-RCO@fnu.ac.fj

Yours sincerely,

.....

Prof. Rajanishwar Gyaneshwar
Chair: College Health Research & Ethics Committee
Acting Dean: College of Medicine, Nursing & Health Sciences